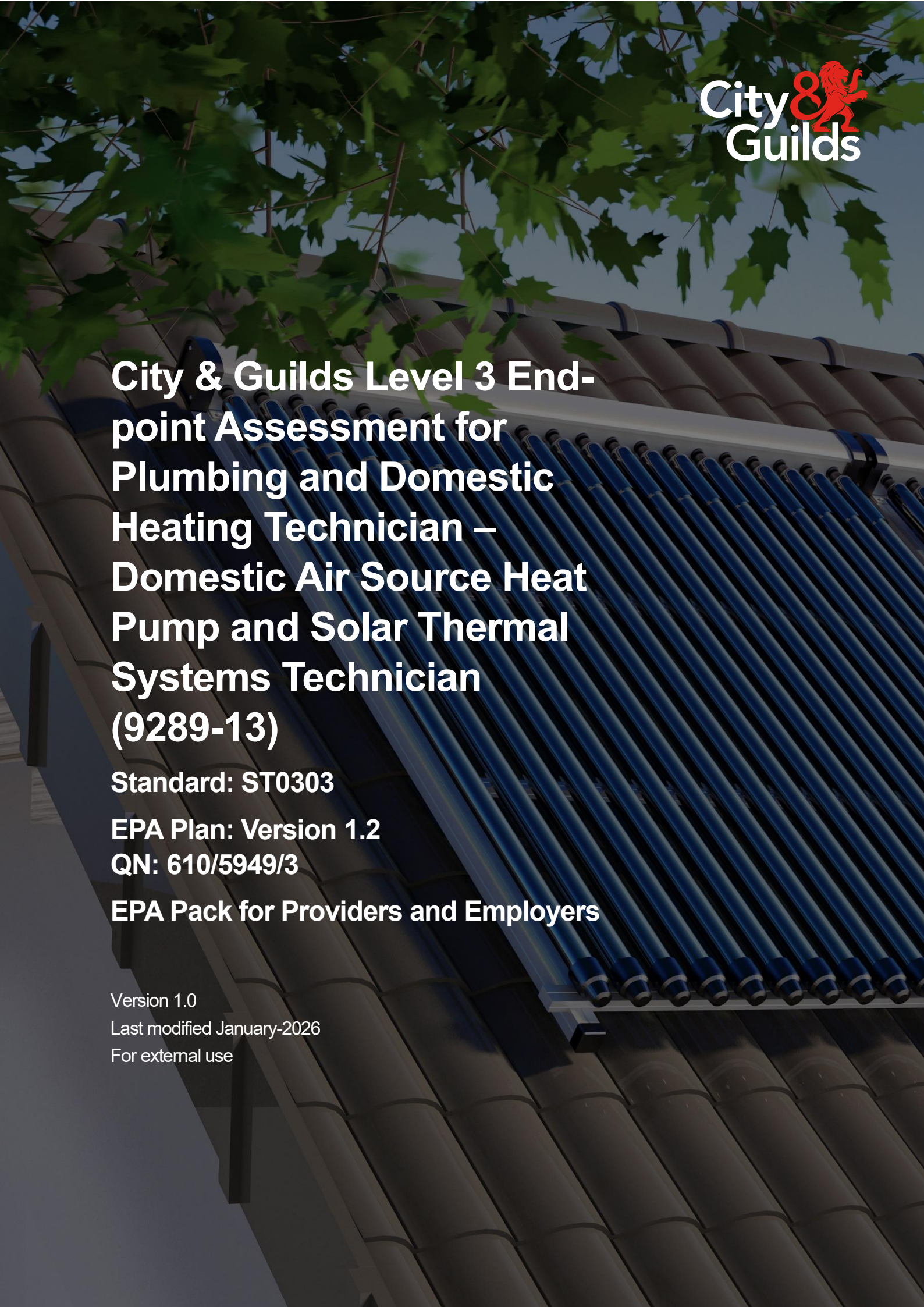


City & Guilds Level 3 End-point Assessment for Plumbing and Domestic Heating Technician – Domestic Air Source Heat Pump and Solar Thermal Systems Technician (9289-13)

Standard: ST0303

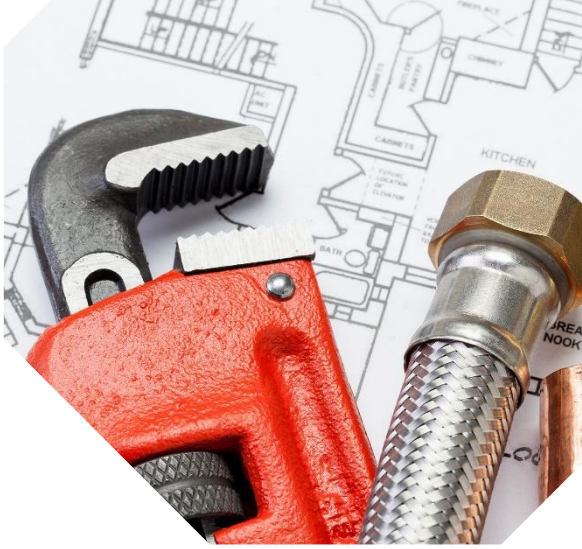
EPA Plan: Version 1.2
QN: 610/5949/3

EPA Pack for Providers and Employers

Version 1.0
Last modified January-2026
For external use

Version	Summary of changes	Section
1.0 January 2026	Document created	N/A

Contents



1. Apprenticeships

This pack will help providers and employers prepare apprentices for their End-point Assessment (EPA) for the City & Guilds Level 3 End-point Assessment for Plumbing and Domestic Heating Technician Domestic Air Source Heat Pump and Solar Thermal Systems Technician (9289-13). It explains how apprentices will demonstrate the knowledge, skills and behaviours (KSBs) which they developed during their apprenticeship.

This pack must be used alongside the:

- Recording Forms for Providers and Employers
- EPA Knowledge test Guidance
- Resource Pack for Providers and Employers
- EPA Documents Library, which includes the Manual for the End-point Assessment Service, information about the EPA Service, policies about malpractice and appeals, FAQS, and a video about EPA which can be shared with apprentices.

The City & Guilds Manual for the End-point Assessment Service includes information on:

- application, registration and booking
- assessment
- results and post results (including resits)
- fees
- quality assurance.

Full-time apprentices will typically spend 48 months on-programme working towards meeting the Standard, with required off-the-job training as specified by the apprenticeship funding rules. The employer should ensure that the apprentice has access to development opportunities to gain the KSBs, as outlined in the Standard, and must hold regular progress reviews with the provider and apprentice.

Once the apprentice has completed their training, they should be ready to go through 'Gateway' to EPA. See the Gateway and Assessment Instructions sections within this pack to understand what happens.

The EPA for this apprenticeship includes the following assessments which can be taken in any order, as requested by the apprentice:

- Assessment 1 – Knowledge test Paper 1 (9289-300) **and** Paper 2a (9289-301) **and** Paper 2b (9289-302)
- Assessment 2 – Practical planning Test (9289-700)
- Assessment 3 – Practical competence test (Core Tasks 1–3 and Tasks 4a–4d) (9289-703)
- Assessment 4 – Interview underpinned by an apprenticeship portfolio of evidence (9289-704).

Preparing for EPA

In preparation for EPA, providers and employers should:

- read the Assessment instructions sections before reaching Gateway – the EPA Partnership Managers can help with any queries
- review which completed **Recording Forms and evidence** must be submitted, and when
- use the Recording Forms provided in the format laid out, unless indicated otherwise
- plan the venue and resources required for EPA – make sure the assessment environment is secure and comfortable, without interruptions
- use the epaPro portal to help manage the apprentice's progress through EPA
- for on-site assessment, arrange for a designated contact to be available on the day to ensure the correct resources are available.

To help apprentices prepare for EPA, providers and employers should:

- explain the assessments and **Recording Forms** to the apprentice – refer to details in the Assessment Instructions sections of this pack
- agree a realistic timeframe for submission of evidence that meets the EPA deadlines – any delays in submission of evidence will delay the assessments
- make sure the apprentice has the resources and time to prepare for, and undertake, EPA
- take the apprentice through some mock assessments
- share the EPA Preparation Guide with the apprentice, which includes information about system requirements for virtual meetings

- let City & Guilds know if access arrangements are required to support an apprentice through EPA. Information about City & Guilds access arrangements, including reasonable adjustments is on the City & Guilds website, under EPA Documents Library.

Authenticating the apprentice's work

The Independent End-point Assessor (IEPA) must ensure all decisions satisfy Validity, Authenticity, Currency and Sufficiency (VACS). For evidence produced outside controlled conditions, the apprentice will be required to:

- sign a declaration that the work is their own
- reference all sources.

The employer/provider should also aid authentication by:

- supplementary (oral) questioning to gauge familiarity with the topic
- looking out for any changes to the apprentice's usual writing style, unusual sources/examples or the use of US spellings or phrases that might indicate cutting and pasting from the internet
- requiring access to evidence of steps in the process, for example drafts, notes, planning etc.

City & Guilds have produced forms for use when reviewing evidence produced outside of controlled conditions. These forms include a Declaration of Authenticity Form which must be completed when submitting evidence. The forms are incorporated in the Recording Forms document.

City & Guilds Position Statement on artificial intelligence

The following guidance on artificial intelligence (AI) is designed to help candidates/apprentices, teachers and assessors to complete NEAs, coursework and other internal assessments successfully. Please ensure familiarity with it.

Position Statement on AI | City & Guilds

Health & Safety and Codes of Practice

The importance of safe working practices, the demands of the Health and Safety at Work Act and any Codes of Practice associated with the industry **must** always be adhered to.

Following safe working practices is an integral part of all City & Guilds assessments, and it is the responsibility of the provider and employer to ensure that all the health and safety requirements are in place when apprentices are working on any projects or before apprentices begin any EPA.

Should an apprentice fail to follow correct health and safety practices and procedures during an EPA, the IEPA may advise the apprentice to stop and explain why.

Results submission and feedback

The knowledge test component will be delivered using the E-volve on screen test platform. Test results will be available on Walled Garden within 24 hours following the test.

The IEPA will not provide feedback to the apprentice during or immediately following the assessment process. The provider will be informed by the City & Guilds EPA Team of the assessment results.

The IEPA will communicate the grade allocated for each assessment to the Lead Independent End-point Assessor (LIEPA) for quality assurance and sampling. The LIEPA will submit the results to the City & Guilds EPA Team.

Summary feedback will be provided to all apprentices after any grade determination has been carried out. The feedback will cover the areas against which insufficient evidence has been provided, leading to a ‘Fail’. Our ‘End-point Assessment Feedback’ will also cover the areas against which the apprentice’s evidence has resulted in the award of a Pass or Distinction.

If the apprentice has passed EPA, the City & Guilds EPA Team will issue the EPA Statement of Achievement to the provider confirming the grade achieved and will notify Skills England who will issue the apprenticeship certificate.

Professional recognition

This apprenticeship aligns with Engineering Council (EngTech) for Level 3.

Statement of Achievement

A printed EPA Statement of Achievement will be issued to each successful apprentice.

Providers and employers with access can view and download PDF copies of the Statement 24 hours after the results are published. A PDF supports more efficient processing of funding claims by providing evidence of apprentice certification before the apprentice's paper certificate arrives.

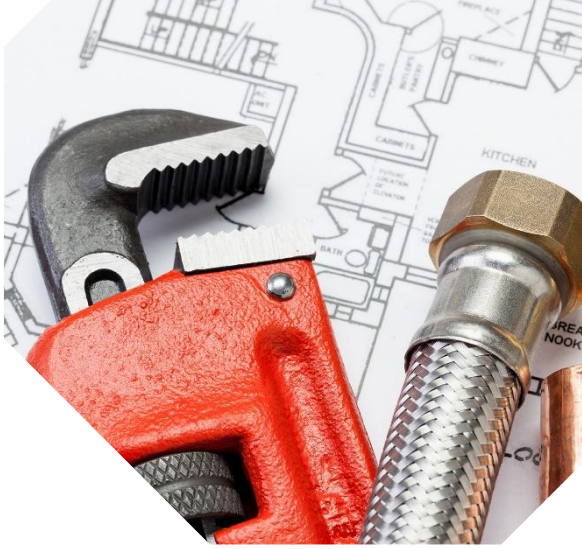
The overall apprenticeship certificate will be issued by Skills England.

Digital credentials

A digital credential is a verified, visual representation of knowledge and skills earned in various learning environments. Please see an example below:

Digital credentials are issued and verified online, making it easy for individuals to demonstrate their competencies to employers, clients and peers online. Each digital credential has a unique URL that can be shared electronically via social media, in an email signature and on a CV. This is a complimentary service in addition to the paper certificate.

For further information, please visit the City & Guilds EPA Digital Credentials webpage and the general terms in respect of our privacy policy or contact digitalsupport@cityandguilds.com.



2. The Apprenticeship Standard

Occupation summary

This occupation is found in the building services sector of the construction industry.

Plumbing & domestic heating technicians size and select, plan and install, service, maintain and commission plumbing and domestic heating systems.

All technicians will be required to work on typical plumbing elements such as hot and cold water systems and storage, supplies to dwellings and associated pipework, above-ground pipework, connection to below-ground, sanitary pipework, fittings and furniture. Appliances and equipment can include central heating boilers, bathroom furniture, sanitary appliances, drainage and rainwater systems. Further to that, technicians can specialise in one of three areas:

Domestic gas fired hot water heating appliances technician: installation and maintenance of domestic natural gas systems and central heating and hot water appliances.

Domestic air source heat pumps and solar thermal systems technician: installation and maintenance of air source heat pumps and solar thermal hot water systems in domestic premises.

Non-domestic plumbing technician: installation and maintenance of plumbing systems in premises such as hospitals and healthcare premises, schools, high rise buildings, public buildings, industrial and commercial premises, etc.

This EPA pack covers the domestic air source heat pumps and solar thermal systems technician area.

In their daily work an employee in this occupation interacts with customers and end users, and as such require a high level of customer service. Technicians can find themselves working inside or outside a customers' property as well as on building sites.

An employee in this occupation will be responsible for working both independently with a minimum of supervision and also as a member of a team involving close liaison and cooperation with site and line management, colleagues and other trades.

Occupational duties

This apprenticeship Standard has a number of duties which someone working in the role would typically be able to undertake. These duties are underpinned by a range of KSBs which a successful apprentice will be able to demonstrate

Core

Duty	KSBs
Duty 1 Plan core plumbing and domestic heating systems to meet customers' needs and in accordance with manufacturers guidance, regulatory requirements and industry recognised standards and procedures.	K1 – K18 S1 – S13 B1 – B4
Duty 2 Select and size core plumbing and domestic heating systems to meet customers' needs and in accordance with manufacturers guidance, regulatory requirements and industry recognised standards and procedures.	
Duty 3 Carry out preparatory work for the Installation of core plumbing and domestic heating systems.	
Duty 4 Install core plumbing and domestic heating systems in accordance with design criteria, manufacturers guidance, regulatory requirements and industry recognised standards and procedures.	
Duty 5 Test and commission core plumbing and domestic heating system installations in accordance with manufacturers guidance, regulatory requirements and industry recognised standards and procedures.	
Duty 6 Carry out appropriate handover procedures for core plumbing and domestic heating systems to customers and or end users including the provision of written information, diagrammatic information, verbal information and demonstration regarding system operation and use.	
Duty 7 Carry out routine service and maintenance procedures on core plumbing and domestic heating systems.	
Duty 8 Perform fault finding, diagnosis and rectification procedures on core plumbing and domestic heating systems.	
Duty 9 Decommission core plumbing and domestic heating systems.	

Duty	KSBs
Duty 10 Conform to all health, safety and welfare in the workplace requirements.	

Domestic air source heat pumps and solar thermal systems technician duties

Duty	KSBs
Duty 20 Plan environmental technology systems (air source heat pump appliances and solar thermal systems) to meet customers' needs and in accordance with manufacturers guidance, regulatory requirements and industry recognised standards and procedures.	K27 – K42 S19 – S28 B1 – B4
Duty 21 Select and size environmental technology systems (air source heat pump appliances and solar thermal systems) to meet customers' needs and in accordance with manufacturers guidance, regulatory requirements and industry recognised standards and procedures.	
Duty 22 Carry out preparatory work for the Installation of environmental technology systems (air source heat pump appliances and solar thermal systems).	
Duty 23 Install environmental technology systems (air source heat pump appliances and solar thermal systems) in accordance with design criteria, manufacturers guidance, regulatory requirements and industry recognised standards and procedures.	
Duty 24 Test and commission environmental technology systems (air source heat pump appliances and solar thermal systems) in accordance with manufacturers guidance, regulatory requirements and industry recognised standards and procedures.	
Duty 25 Carry out appropriate handover procedures for environmental technology systems (air source heat pump appliances and solar thermal systems) to customers and or end users including the provision of written information, diagrammatic information, verbal information and demonstration regarding system operation and use.	
Duty 26 Carry out routine service and maintenance procedures on environmental technology systems (air source heat pump appliances and solar thermal systems).	

Duty	KSBs
Duty 27 Perform fault finding, diagnosis and rectification procedures on environmental technology systems (air source heat pump appliances and solar thermal systems).	
Duty 28 Decommission environmental technology systems (air source heat pump appliances and solar thermal systems).	

Knowledge, skills and behaviours

Key

KT – Knowledge Test

PPT – Practical Planning Test

PCT – Practical Competence Test

IPE – Interview Underpinned by an Apprenticeship Portfolio of Evidence

Knowledge

Ref.	Knowledge Core	Assessment method
K1	The health and safety legislation, approved Codes of Practice and guidance and safe working practices applicable to work in the building services and wider construction industry.	KT Paper 1 and IPE
K2	The common processes and techniques used in the installation and test of plumbing and domestic heating systems (cold water systems, hot water systems, domestic wet central heating systems, sanitation systems).	KT Paper 1 and PCT
K3	The common processes and techniques used in the installation and test of rainwater systems.	KT Paper 1 and IPE
K4	Scientific and mechanical principles applicable to plumbing and domestic heating systems work.	KT Paper 1
K5	The roles and responsibilities of persons within the plumbing and domestic heating systems and wider construction industry.	KT Paper 1
K6	The legislative requirements and sources of information applicable to plumbing and domestic heating systems system installation, service and repair.	KT Paper 1, PPT and IPE
K7	How to communicate with customers, suppliers, co-workers and members of the public who may come into contact with the work area.	KT Paper 1 and IPE
K8	The layout features, working principles and legislative requirements of plumbing and domestic heating systems.	KT Paper 1, PPT and IPE

Ref.	Knowledge Core	Assessment method
K9	The basic factors which influence system choice for particular applications with regard to the installation of plumbing and domestic heating systems.	KT Paper 1, PPT and IPE
K10	The installation and testing requirements applicable to plumbing and domestic heating systems and components (cold water, hot water, central heating, sanitary appliances and pipework).	KT Paper 1 and PCT
K11	The installation and testing requirements applicable to rainwater systems and components.	KT Paper 1 and IPE
K12	The commissioning requirements applicable to plumbing and domestic heating systems and components.	KT Paper 1 and IPE
K13	The testing and commissioning requirements applicable to electrical control systems and components.	KT Paper 1 and PCT
K14	The decommissioning procedures applicable to plumbing and domestic heating systems.	IPE
K15	The routine service and maintenance procedures applicable to plumbing and domestic heating systems.	KT Paper 1 and IPE
K16	The fault finding, diagnosis and rectification procedures applicable to plumbing and domestic heating systems.	KT Paper 1 and IPE
K17	The procedures for sizing and selecting plumbing and domestic heating systems and components to meet customer's needs.	KT Paper 1, PPT and IPE
K18	The legislative requirements, processes and procedures of electrical supply and control systems applicable to plumbing and domestic heating systems and work including limits to operative competence.	KT Paper 1 and PCT

Ref.	Knowledge Domestic air source heat pumps and solar thermal systems technician	Assessment method
K27	The common processes and techniques used in the installation and maintenance of air source heat pump (non-refrigerant circuits) systems.	KT Paper 2a and PCT
K28	The common processes and techniques used in the installation and maintenance of solar thermal systems.	KT Paper 2b and PCT
K29	The legislative requirements, approved codes of practice and guidance and sources of information applicable to the installation, service and repair of air source heat pump (non-refrigerant circuits) systems.	KT Paper 2a and IPE
K30	The legislative requirements, approved codes of practice and guidance and sources of information applicable to the installation, service and repair of solar thermal systems.	KT Paper 2b and IPE
K31	The installation requirements (including retrofit) applicable to air source heat pump (non-refrigerant circuits) systems and components.	KT Paper 2a and PCT
K32	The installation requirements (including retrofit) applicable to solar thermal systems and components.	KT Paper 2b and PCT
K33	The testing and commissioning requirements applicable to air source heat pump (non-refrigerant circuits) systems.	KT Paper 2a and PCT
K34	The testing and commissioning requirements applicable to solar thermal systems.	KT Paper 2b and PCT
K35	The decommissioning procedures applicable to air source heat pump (non-refrigerant circuits) systems.	IPE
K36	The decommissioning procedures applicable to solar thermal systems.	IPE
K37	The routine service and maintenance procedures applicable to air source heat pump (non-refrigerant circuits) systems.	PCT

Ref.	Knowledge Domestic air source heat pumps and solar thermal systems technician	Assessment method
K38	The routine service and maintenance procedures applicable to solar thermal systems.	PCT
K39	The fault finding, diagnosis and rectification procedures applicable to air source heat pump (non-refrigerant circuits) systems.	PCT
K40	The fault finding, diagnosis and rectification procedures applicable to solar thermal systems.	PCT
K41	The procedures for sizing and selecting air source heat pump (non-refrigerant circuits) systems.	KT Paper 2a and IPE
K42	The procedures for sizing and selecting solar thermal systems.	KT Paper 2b and IPE

Skills

Ref.	Skills Core	Assessment method
S1	Operate in a safe working manner by adhering to health and safety legislation, approved codes of practice and guidance and applying safe working practices.	IPE
S2	Carry out and apply the common processes and techniques used in the installation and test of plumbing and domestic heating systems (cold water, hot water, central heating and sanitary appliances and pipework).	PCT
S3	Carry out and apply the common processes and techniques used in the installation and test of rainwater systems.	IPE
S4	Plan tasks within plumbing and domestic heating systems industry.	PPT
S5	Identify and document hazards for the plumbing and domestic heating systems work. Apply control measures.	PPT

Ref.	Skills Core	Assessment method
S6	Carry out commission and handover procedures and techniques on plumbing and domestic heating systems (cold water, hot water, central heating, sanitary appliances, and rainwater).	IPE
S7	Install, test, and commission, electrical and electrical control systems applicable to plumbing and domestic heating systems.	PCT
S8	Perform routine service, maintenance, fault diagnosis and rectification procedures and techniques on the non-electrical components of plumbing and domestic heating systems.	IPE
S9	Perform routine service, maintenance, fault diagnosis and rectification procedures and techniques on electrical and electrical control systems applicable to plumbing and domestic heating systems including industry safe isolation procedures.	PCT
S10	Decommission plumbing and domestic heating systems.	IPE
S11	Decommission electrical and electrical control systems applicable to plumbing and domestic heating systems.	IPE
S12	Plan, size and select cold and hot systems to meet customer's needs in accordance with manufacturers guidance, regulatory requirements and industry recognised standards and procedures.	PPT
S13	Plan, size and select domestic heating and rainwater systems to meet customers' needs in accordance with manufacturers' guidance, regulatory requirements and industry recognised standards and procedures.	IPE

Ref.	Skills Domestic air source heat pumps and solar thermal systems technician	Assessment method
S19	Carry out and apply the common processes and techniques used in the installation of air source heat pump (non-refrigerant circuits) systems.	PCT

Ref.	Skills Domestic air source heat pumps and solar thermal systems technician	Assessment method
S20	Carry out and apply the common processes and techniques used in the installation of solar thermal systems.	
S21	Test, commission and handover air source heat pump (non-refrigerant circuits) systems.	
S22	Test, commission and handover solar thermal systems.	
S23	Perform routine service, maintenance, fault diagnosis and rectification procedures and techniques on air source heat pump (non-refrigerant circuits) systems.	
S24	Perform routine service, maintenance, fault diagnosis and rectification procedures and techniques on solar thermal systems.	
S25	Decommission (including disconnection and dismantling) air source heat pump (non-refrigerant circuits) systems.	IPE
S26	Decommission (including disconnection and dismantling) solar thermal systems.	
S27	Plan, size and select air source heat pump (non-refrigerant circuits) systems.	
S28	Plan, size and select solar thermal systems.	

Behaviours

Ref.	Behaviours Core	Assessment method
B1	Acts professionally and ethically to collaborate with colleagues and customers.	IPE
B2	Takes ownership of work within limits of own competence, knowing when to seek advice or assistance.	PCT
B3	Committed to continuous professional development.	IPE

Ref.	Behaviours Core	Assessment method
B4	Committed to keeping up to date with industry best practice.	IPE

Overall grade

This End-point Assessment is graded Fail, Pass or Distinction. The EPA will be assessed and graded by the IEPA.

Information about how each assessment is graded can be found in the Assessment Instructions sections of this pack. The apprentice will fail an assessment method if they do not meet the grading descriptors.

Apprentices who fail one or more assessment method will be awarded an overall EPA 'Fail'.

In order to achieve an overall EPA 'Pass', apprentices must achieve at least a 'Pass' in all the assessment methods.

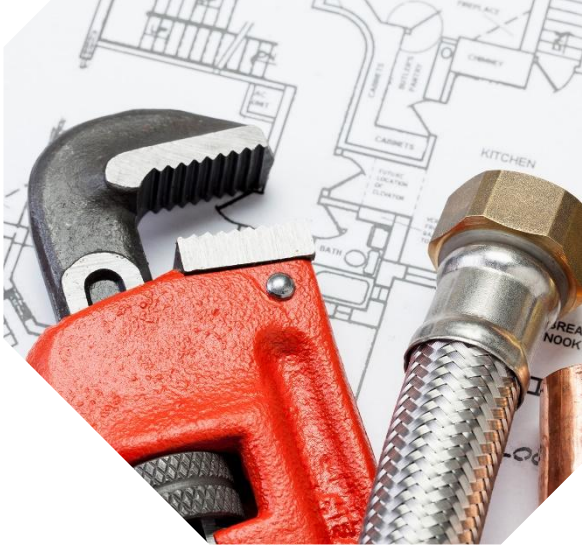
In order to achieve an overall EPA 'Distinction', apprentices must achieve:

- a Distinction in the knowledge test (9289-300)
- a Pass in the knowledge test (9289-301)
- a Pass in the knowledge test (9289-302)
- a Pass in the practical planning test (9289-700)
- a Pass in the practical competence test (9289-703)
- a Distinction in the interview underpinned by an apprenticeship portfolio of evidence (9289-704).

Grades from individual assessment methods should be combined in the following way to determine the grade of the EPA as a whole:

Assessment 1: Knowledge test	Assessment 2: Practical planning test	Assessment 3: Practical competence test	Assessment 4: Interview underpinned by portfolio	Overall grade
Fail	Any grade	Any grade	Any grade	Fail
Any grade	Fail	Any grade	Any grade	Fail
Any grade	Any grade	Fail	Any grade	Fail
Any grade	Any grade	Any grade	Fail	Fail
Pass	Pass	Pass	Pass	Pass
Distinction	Pass	Pass	Pass	Pass
Pass	Pass	Pass	Distinction	Pass
Distinction	Pass	Pass	Distinction	Distinction

The overall EPA grade will be capped at a Pass if the apprentice has had to resit or retake any assessment method, however the grade the apprentice has achieved for each component is not capped and will be identified on the Statement of Achievement.



3. Gateway

The EPA period will only start when the **employer** is satisfied that the apprentice is consistently working at, or above, the level of the Standard. The apprentice must be able to evidence that they fully demonstrate the Occupational Standard and required level of professional competence in an authentic workplace context. In making this decision, the employer could take advice from the provider, but the ultimate decision is made solely by the employer.

If there is a **provider** working alongside the employer, they should support the apprentice's preparation for Gateway.

The following must be provided at Gateway:

- evidence they have fulfilled the English and mathematics requirements in line with the apprenticeship funding rules
- evidence they have passed one of the following on-programme qualifications or equivalent in the same pathway as the EPA:
    - City & Guilds Level 3 Diploma in Plumbing and Domestic Heating (610/4672/3)
    - BPEC Level 3 Diploma in Plumbing and Domestic Heating (610/4782/X).
- provider/employer's risk assessment regarding safe use and storage of hand and power tools
- apprenticeship portfolio of evidence with signed and dated Evidence Matrix and Declaration of Authenticity.

The following should be completed on the epaPro platform:

- Gateway Declaration Form signed by the apprentice
- Gateway Declaration by the provider, on behalf of the employer and tutor, confirming that the apprentice has completed the minimum time required on-programme, in line with the apprenticeship funding rules.

City & Guilds will confirm when all the Gateway requirements have been met.

4. Timetable for End-point Assessment

The EPA period is typically completed within 6 months of the EPA Gateway, starting when City & Guilds has confirmed that all Gateway requirements have been met.

Further information about the booking process and timelines can be found in the ILM/City & Guilds Manual for the End-point Assessment Service.

Ongoing during on-programme	Evidence and forms
Provider and employer • Reviews progress as part of their regular performance management process and ensures apprentice's performance is on track. • Identifies any gaps and creates a plan with the apprentice. • Enrols apprentice on epaPro and provides 'Expected Date Ready for EPA.'	N/A
Apprentice • Apprentice fulfils the English and mathematics requirements in line with the apprenticeship funding rules. • Achieve the Level 3 Diploma in Plumbing and Domestic Heating on-programme qualification in advance of Gateway. • Compile an apprenticeship portfolio of evidence.	Compile: • Portfolio of evidence • English and mathematics certifications.

Gateway process	Evidence and forms
Employer • Reviews progress and ensure the apprentice is ready for EPA. • Reviews portfolio of evidence to confirm that it is appropriate and sufficient to meet the Standard.	Signs: • Portfolio of evidence Declaration of Authenticity.
Apprentice • Must have been on-programme for the minimum time required, in line with the apprenticeship funding rules. • Completes and submits evidence and forms.	Submits to provider: • Apprentice Gateway Declaration • Portfolio of evidence with signed and dated Evidence Matrix and Declaration of Authenticity • English and mathematics certifications.
Provider – on epaPro • Books EPA on the epaPro portal, in line with City & Guilds booking timelines in the EPA Manual. • Makes City & Guilds aware of any additional needs of the apprentice so that they can review reasonable adjustments – see the current policy on the City & Guilds website, under EPA Documents Library. • Completes Provider Gateway Declaration on behalf of the employer and tutor. • Uploads portfolio of evidence and forms onto epaPro.	Completes on epaPro: • Provider Gateway Declaration. Signs: • Portfolio of evidence Declaration of Authenticity. Uploads onto epaPro: • Apprentice Gateway Declaration • Portfolio of evidence with signed and dated Evidence Matrix and Declaration of Authenticity • Provider/employer risk assessment.
City & Guilds EPA Gateway Team • Formally confirms when all the Gateway requirements have been met.	N/A
City & Guilds EPA Team • Agrees on a mutually convenient date for the EPA events with the provider/employer and IEPA.	N/A

End-point Assessment	Evidence and forms
Apprentice • Completes End-point Assessments.	Completes: • Practical planning test Declaration of Authenticity.
Provider and employer • Ensures the apprentice has access to the resources required for the assessments (see the Resources section).	N/A
Provider • Invigilates practical planning test. • Submits practical planning test evidence for marking and Declaration of Authenticity forms to epaPro.	Completes: • Practical planning test invigilator record. Uploads onto epaPro: • Completed practical planning test produced by the apprentice • Practical planning test Declaration of Authenticity.
IEPA • Reviews the portfolio of evidence prior to EPA events. • Carries out End-point Assessments (excluding PPT). • Grades each assessment, communicates the results to the LIEPA. • Provides feedback for assessments in epaPro. • Confirms ACS evidence submitted on epaPro.	Completes: • Overall Grade and Feedback Recording form.
LIEPA • Samples and quality assure assessments • Confirms overall grade to EPA Team.	Reviews: • Overall Grade and Feedback Recording form.
City & Guilds EPA Team • Communicates the results to the provider via epaPro. • Processes the overall result if the apprentice has passed all the assessments and advises Skills England, who issue the certificate. The data will be provided to Skills England.	N/A

Summary timescales

Providers and employers should check the previous Timetable and the Assessment Instruction sections of this document for the detailed requirements for each stage.

Further information on EPA Service Timelines can be found on www.cityandguilds.com.

On programme	Enrol apprentice on epaPro, including 'expected date ready for EPA' The apprentice passes the on-programme qualification. The apprentice compiles their portfolio of evidence for their EPA.
Gateway process	Provider submits evidence and forms on epaPro.
Gateway	Assessment components can only be booked after Gateway has been approved.
Assessment method 1	Knowledge test (KT) – Papers 1, 2a and 2b.
Assessment method 2	Practical planning test (PPT).
Assessment method 3	Practical competence test (PCT).
Assessment method 4	Interview underpinned by an apprenticeship portfolio of evidence (IPE).

End-point assessment completed

5. End-point Assessment resources

Assessment method	Resources required
Knowledge test	• A quiet room, free from distractions and interruptions. • Access to a computer for taking the knowledge tests on the E-volve platform. • Tests must be invigilated by the provider/employer.

Practical planning test	• A quiet room, free from distractions and interruptions.
	• The test must be invigilated by the provider/employer.
	• The test can be completed on paper or computer; suitable resources must be provided to each apprentice.
	• Each apprentice must have the following normative documents available for use during the test:
	  ○ Water regulations guide
	  ○ Building regulations Approved Document G
	  ○ BS 8558
	  ○ BS 806 Parts 1–5
	  ○ Domestic building services compliance guide
	  ○ manufacturer's technical documents (supplied in the Practical Planning Test Resource Pack).

Practical competence test	• Each apprentice must have a separate work area/bay, materials, tools, equipment, appliances and components to complete skills assessments:
	  ○ Fabricate, install, test and commission domestic cold water, hot water and heating plumbing systems
	  ○ Test, commission and service/maintain a domestic hot water and heating plumbing system
	  ○ Install, test, commission and service/maintain an air source heat pump system, including a heat distribution system.
	  ○ Install, test, commission and service/maintain a thermal solar system (active fully filled and drain back systems, including solar collector, expansion/drain back vessel, solar circulating pump or pumping station, and connection to a hot water storage and distribution system).
	• Full details can be found in the Practical Competence Test Resource Pack.

Interview underpinned by an apprenticeship portfolio of evidence	• A quiet room, free from distractions and interruptions. • Access to a computer with video-conferencing software which is tested prior to the assessment starting. The video-conferencing software will be advised at the point of booking.

6. Assessment information: Assessment 1 – Knowledge test (9289-300/301/302)

Overview

This assessment has three papers:

- Paper 1 (9289-300) – Core
- Paper 2a (9289-301) – Air Source Heat Pumps
- Paper 2b (9289-302) – Solar Thermal Hot Water Systems.

The tests give the apprentice the opportunity to demonstrate the knowledge mapped to this assessment method.

Rationale

This EPA assessment method is being used because:

- it allows for the efficient testing of knowledge where there is a right or wrong answer
- it can be conducted remotely and administered to multiple apprentices at the same time, potentially reducing cost
- it allows for flexibility in terms of when, where and how it is taken.

Assessment instruction for Paper 1

Number of questions	60
Marks available	60
Grading	P/D/X To achieve a **Pass**, the apprentice must achieve a minimum of 36 marks (60%). To achieve a **Distinction**, the apprentice must achieve a minimum of 50 marks (83.3%).
Type of questions	Multiple-choice
Duration	2 hours

Marking	The test will be carried out online and marked electronically on the E-volve platform.
Permitted materials	The test is closed book which means that the apprentice cannot refer to reference books or materials while taking the test. The apprentice will have access to a calculator within the E-volve platform if there are any calculate questions in the test.
Location	The apprentice must take the test in a suitably controlled and invigilated environment that is a quiet room, free from distractions and influence.

Assessment specification for Paper 1

Paper 1 is assessed against the following Learning Outcomes (LOs) and Assessment Criteria (ACs) as prescribed in the Assessment Plan. The numbering of these LOs and ACs may not be sequential, as some LOs and ACs will be assessed in a different assessment method.

Learning outcome	Assessment criteria	Number of question(s)
1. Know and apply health and safety legislation that applies to the building services industry.	1.1 Identify health & safety legislation in protecting the workforce and members of the public.	1
	1.2 Identify responsibilities of members of the construction team.	
	1.3 Identify the legal status of health and safety guidance materials.	
	1.4 Identify the role of enforcing authorities.	
	1.5 Identify the control measures of inspectors.	
2. Understand hazardous situations working in the building services industry.	2.1 Identify types of site hazards that may be encountered while at work or by members of the public.	2
	2.2 Identify strategies used to prevent accidents during work activities.	
	2.3 Identify how the hazards of some substances and mixtures can be identified from the labels and packaging.	
	2.4 Identify how to deal with commonly encountered substances including disposal where applicable.	

Learning outcome	Assessment criteria	Number of question(s)
	2.5 Identify common building materials and services components that may contain asbestos	
	2.6 Identify types of asbestos that may be encountered in the workplace.	
	2.7 Identify procedures that must be used to safely work with asbestos cement based materials.	
4. Understand how to respond to accidents.	4.1 Identify requirements for first aid provision in the workplace.	1
	4.2 Identify actions that should be taken when an accident or emergency is discovered.	
	4.3 Identify procedures for dealing with minor injuries.	
	4.4 Identify procedures for dealing with major injuries.	
	4.5 Identify recording procedures for accidents and near misses at work.	
6. Understand how to work safely with heat producing equipment.	6.1 Identify various types of gases used in pipe jointing processes.	1
	6.2 Identify how bottled gases and equipment should be safely transported and stored.	
	6.3 Identify various types of heat producing equipment and how to check them for safety.	
	6.4 Identify how gas heating equipment is safely assembled and used.	
	6.5 Identify the three elements of the fire triangle and how combustion takes place.	
	6.6 Identify the dangers of working with heat producing equipment and how to prevent fires occurring.	
	6.7 Identify the method for fighting small, localised fires that can occur in the workplace in order to aid escape.	
7. Understand and safely use access equipment.	7.1 Identify situations where it may be necessary to work at height.	1
	7.2 Identify how to select appropriate access equipment to permit work at heights.	

Learning outcome	Assessment criteria	Number of question(s)
8. Understand working safely in excavations and confined spaces.	8.1 Identify situations where it may be necessary to work in excavations and confined spaces.	1
	8.2 Identify safe working in excavations and confined spaces.	
	8.3 Identify dangers associated with excavations and confined spaces.	
	8.4 Identify safety measures when working in excavations and confined spaces	
10. Know types of plumbing and domestic heating system pipework and their jointing principles.	10.1 Identify pipework materials and sizes used in dwellings.	1
	10.2 Identify fitting types used in dwellings.	
	10.3 Identify methods of jointing pipework.	
	10.4 Identify methods of bending pipework.	
12. Understand and use clips and brackets to support plumbing and domestic heating pipework and components.	12.2 Identify types of fixing devices.	1
	12.3 Identify clip and bracket types.	
14. Understand units of measurement used in the plumbing and domestic heating systems industry.	14.1 Identify internationally recognised (SI) units of measurement.	1
	14.2 Identify the application and use of SI derived units.	
	14.3 Identify the use of conversion tables for non-SI units.	
15. Understand properties of materials.	15.1 Identify relative densities of common materials.	1
	15.2 Identify properties and applications of solid materials.	
	15.3 Identify why solid materials breakdown.	
	15.4 Identify methods of preventing corrosion.	

Learning outcome	Assessment criteria	Number of question(s)
	15.5 Identify applications of liquids and gases.	
	15.6 Identify basic properties of liquids.	
	15.7 Identify basic properties of gases.	
16. Understand the relationship between energy, heat and power.	16.1 Identify the relationship between the Celsius and Kelvin temperature scales.	2
	16.2 Identify the principles associated with a change of state.	
	16.3 Identify the terms latent and sensible heat as they apply to liquids and gases.	
	16.4 Identify methods of heat transfer.	
	16.5 Identify how units of energy and heat are related and derived.	
	16.6 Carry out heat, energy and power calculations.	
17. Understand principles of force and pressure and their application in the plumbing and domestic heating systems industry.	17.1 Identify the units of force and pressure derived from SI units.	2
	17.2 Identify pressure and flow rate units of measurements.	
	17.3 Identify the application of pressure and flow rate measurements.	
	17.4 Carry out simple force and pressure calculations.	
	17.5 Identify the relationship between velocity, pressure and flow rate in systems.	
	17.6 Identify how restrictions in the pipework effects the flow of liquids and gases.	
	17.7 Identify the principles of a siphon.	
18. Understand mechanical principles in the plumbing and domestic heating systems industry.	18.1 Identify principles of simple machines.	1
	18.2 Identify principles of basic mechanics.	

Learning outcome	Assessment criteria	Number of question(s)
19. Understand principles of electricity in the plumbing and domestic heating systems industry.	19.1 Identify basic principles of electron flow theory.	1
	19.2 Identify the purpose and application of simple units of electrical measurement.	
	19.3 Carry out simple electrical calculations.	
	19.4 Identify the requirements for earthing of electrical circuits.	
	19.5 The testing and commissioning requirements applicable to electrical control systems and components.	
20. Know the sources of renewable and non-renewable energy.	20.1 Identify the different types of non-renewable energy.	1
	20.2 Identify the different types of renewable energy.	
	20.3 Identify the effects of using renewable and non-renewable energy sources.	
21. Know current energy efficiency advice and guidance.	21.1 Identify the benefits of energy efficient products, services and equipment.	1
	21.2 Identify the key factors of the Building Regulations and Guidance that apply to energy efficiency.	
22. Know the role of the construction team within the plumbing and domestic heating systems industry.	22.1 Identify key roles of the site management team.	1
	22.2 Identify key roles of the site operatives.	
	22.3 Identify common site visitors.	
24. Know how to communicate with others.	24.1 Identify methods for effective communication with individual's needs.	1
	24.2 Identify suitable communication methods.	
	24.3 Identify appropriate actions to deal with conflicting parties.	
	24.4 Identify the effects of poor communication with individuals.	
	25.1 Identify different types of client.	1

Learning outcome	Assessment criteria	Number of question(s)
25. Understand responsibilities of relevant people in the building services industry.	25.2 Identify what may be communicated to the client through the progress of a job.	
	25.3 Identify duties and methods for supervising staff.	
26. Understand and produce work programme for tasks in the plumbing and domestic heating systems industry.	26.1 Identify types of projects.	1
	26.3 Identify the impact when materials are not delivered on time against the work programme.	
	26.4 Identify factors which affect working time allocation to work activities.	
28. Understand cold water supply to dwellings.	28.1 Identify the key stages in the rainwater cycle.	2
	28.2 Identify the various sources of water and the typical properties of water from those sources.	
	28.3 Identify the types of water supply to dwellings and how these are regulated.	
	28.4 Identify the different types of water and uses of water in dwellings.	
	28.5 Identify the mains water treatment processes and typical mains water distribution system from treatment works to property.	
	28.6 Identify the private supply water treatment processes.	
	28.7 Identify water treatment processes and typical supply pipework and storage systems utilising harvested rainwater and recycled greywater.	
	28.8 Identify water service to the property and isolation points.	
	28.9 Identify the requirements to provide water whilst preventing waste, undue consumption, misuse or contamination.	
29. Understand and recognise	29.1 Identify types and layout features of cold water systems in dwellings.	5

Learning outcome	Assessment criteria	Number of question(s)
the layouts of plumbing and domestic heating systems.	29.2 Identify the types and layout features of hot water systems in dwellings.	
	29.3 Identify the types and layout features of domestic central heating systems.	
	29.4 Identify the types and layout features of sanitary pipework systems.	
	29.5 Identify the types and layout features of rainwater systems: pipe (RWP) and gutter.	
30. Understand and install cold water systems.	30.1 Identify fluid categories of water and uses of water supplied to dwellings.	3
	30.2 Identify the advantages and disadvantages of cold water systems.	
	30.4 Identify working principles of cold water systems, positioning fixing, connection and operation of components.	
	30.5 Identify layout and installation requirements for protected plastic storage cisterns.	
	30.6 Identify insulation requirements, system frost protection and prevention of undue warming of cold water systems.	
	30.9 Identify backflow risk and required methods of prevention.	
31. Understand and install hot water systems.	31.1 Identify advantages and disadvantages of hot water systems.	2
	31.2 Identify types and typical pipe sizes used in hot water systems within dwellings.	
	31.3 Identify working principles of hot water systems, positioning fixing, connection and operation of components.	
	31.4 Identify insulation requirements and system frost protection.	
	31.6 Identify expansion and contraction in hot water systems and negative effects.	

Learning outcome	Assessment criteria	Number of question(s)
	31.8 Identify secondary circulation and how trace heating can be used.	
	31.10 Identify backflow risk and required methods of prevention.	
32. Understand and install domestic central heating systems.	32.1 Identify advantages and disadvantages of types and layout features of heating systems.	3
	32.3 Identify working principles of types of central heating systems, positioning fixing, connection and operation of components.	
	32.4 Identify the importance of pump positioning.	
	32.5 Identify operating principles for system control.	
	32.6 Identify zoning and control requirements of central heating systems in accordance with statutory legislation.	
	32.7 Identify insulation requirements and system frost protection.	
	32.9 Identify expansion and contraction in central heating systems and negative effects.	
	32.11 Identify procedures for filling and venting system types.	
	32.12 Identify the operating principles of heat-producing appliances.	
33. Install sanitary appliances and pipework systems.	33.1 Identify advantages and disadvantages of sanitary appliances pipework systems.	2
	33.3 Identify working principles of sanitary appliances pipework systems and layouts and the positioning, fixing, connection and operation of components.	
	33.5 Identify expansion and contraction in sanitary appliances pipework systems and negative effects.	
	33.7 Identify different types of sanitary appliances and components used in dwellings.	
	33.8 Identify factors that lead to trap seal loss in sanitary pipework systems.	

Learning outcome	Assessment criteria	Number of question(s)
	33.9 Identify the suitability of below ground drainage systems to receive waste water.	
	33.10 Identify the installation features of sanitary facilities and equipment in dwellings for the disabled including wet rooms.	
	33.12 Identify working principles of greywater recycling systems.	
34. Understand and install rainwater systems.	34.1 Identify advantages and disadvantages of rainwater systems: pipe (RWP) and gutter.	2
	34.2 Identify typical sizes and materials used in rainwater systems: pipe (RWP) and gutter.	
	34.4 Identify expansion and contraction in rainwater systems and negative effects.	
	34.5 Identify factors affecting gutter bracket selection and fixing for buildings.	
36. Understand and perform a soundness test and commission cold water systems and components.	36.1 Identify information sources required to complete testing and commissioning.	1
	36.2 Identify how to fill and vent cold water systems.	
	36.5 Identify the flushing requirements including the use of system additives for new and existing cold water systems.	
37. Understand and perform a soundness test and commission hot water systems and components.	37.1 Identify information sources required to complete testing and commissioning.	1
	37.2 Identify how to fill and vent hot water systems.	
	37.5 Identify the flushing requirements including the use of system additives for new and existing hot water systems.	
38. Understand and perform a soundness test and commission central heating systems and components.	38.1 Identify information sources required to complete testing and commissioning.	1
	38.2 Identify how to fill and vent central heating systems.	
	38.5 Identify the flushing requirements including the use of system additives for new and existing central heating systems.	

Learning outcome	Assessment criteria	Number of question(s)
40. Understand and perform a soundness test and commission rainwater systems and components.	40.1 Identify information sources required to complete testing and commissioning.	1
46. Understand and carry out service and maintenance on cold water systems.	46.1 Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of system components.	1
	46.3 Identify types of information to be provided on a maintenance record for cold water systems.	
	46.4 Identify requirements for legionella and bacterial growth control measures.	
47. Understand and carry out service and maintenance of hot water systems.	47.1 Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of system components.	1
	47.3 Identify types of information to be provided on a maintenance record for hot water systems.	
	47.4 Identify requirements for legionella and bacterial growth control measures.	
48. Understand and carry out service and maintenance on central heating systems.	48.1 Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of system components.	1
	48.3 Identify types of information to be provided on a maintenance record for central heating systems.	
49. Understand and carry out service and maintenance on sanitary appliances and pipework systems.	49.1 Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of system components.	1
	49.3 Identify types of information to be provided on a maintenance record for sanitary appliances and pipework systems.	
56. Know the basic operating	56.1 Identify the basic operating principles of heat producing micro-renewable energy technologies.	1

Learning outcome	Assessment criteria	Number of question(s)
principles of micro-renewable energy technologies.	56.2 Identify the basic operating principles of heat-led microcombined heat and power.	
57. Understand requirements to install micro-renewable energy systems to existing systems.	57.1 Identify the suitability of building location and features when installing micro-renewable energy systems.	1
	57.2 Identify statutory regulations affecting installation of microrenewable energy systems.	
	57.3 Identify what would be typically classified as 'permitted development' under town and country planning regulations in relation to the deployment of technologies.	
	57.4 Identify which parts of the regulations apply in relation to the installation of environmental technologies.	
	57.5 Identify typical advantages and disadvantages associated with environmental technologies.	
58. Understand factors affecting fuel selection.	58.1 Identify the types of fuels used in appliances.	2
	58.2 Identify the factors which affect the selection of fuels.	
	58.3 Identify sources of information for fuel supply installation.	
	58.4 Identify the regulatory type bodies which govern the installation of various fuel types.	
	58.5 Identify the storage requirements for fuels.	
	58.6 Identify factors which could affect storage requirements for fuels.	
59. Know combustion processes of fuel supplied systems.	59.1 Identify the combustion process.	2
	59.2 Identify the main constituents of complete and incomplete combustion.	
	59.3 Identify causes of incomplete combustion.	
	59.4 Identify signs of incomplete combustion.	
	59.5 Identify the symptoms of CO poisoning.	

Learning outcome	Assessment criteria	Number of question(s)
	59.6 Identify the purpose of CO detectors.	
	59.7 Identify the requirements for ventilation.	
	59.8 Identify the different types of ventilation.	
	59.9 Identify installation practices for ventilation.	
60. Know principles of chimney/flue systems.	60.1 Identify the operating principles of chimney/flue systems.	2
	60.2 Identify types of chimney/flue systems.	
	60.3 Identify the components within chimney/flue systems.	
	60.4 Identify the effects of layout on chimney/flue systems.	
	60.5 Identify the layout and features of chimney and flue construction.	
	60.6 Identify termination requirements for chimney/flue systems from relevant documents.	
	60.7 Identify basic inspection and testing procedures for chimney/flue systems.	
61. Understand and perform preinstallation activity prior to undertaking electrical work on plumbing and domestic heating systems.	61.1 Identify the limitations of your responsibility when carrying out work on electrical supplies and/or circuits for the control of plumbing and domestic heating systems.	1
	61.2 Identify the applications, advantages and limitations of electrical supplies.	
	61.3 Identify the applications, advantages and limitations of different electrical equipment, cables/wiring and components in relation to the working environment.	
	61.4 Identify the appropriate industry standards and regulations relevant to carrying out work on electrical supplies and/or circuits for the control of plumbing and domestic heating systems.	
	61.5 Identify how to verify that job information and documentation is current and relevant and that the plant, instruments, access equipment and tools are fit for purpose.	

Learning outcome	Assessment criteria	Number of question(s)
62. Apply industry standard safe isolation procedures.	62.1 Identify the correct means of electrical isolation prior to commencing work.	1
	Total	**60**

Assessment criteria and amplification for Paper 1

In order to support teaching and learning, assessment criteria assessed through the multiple-choice test have been amplified. The full amplification can be found in Appendix 1.

It is important that the amplified content for the EPA is covered though the teaching and learning.

The amplified content for each Assessment Criteria (AC) in the End-point Assessment will either:

- align to the City & Guilds Level 3 Diploma in Plumbing and Domestic Heating (9289-01/02/03/91/92/93) on-programme qualification **or**
- have additional or altered amplification to the assessment criteria in the on-programme qualification.

Providers and employers must ensure that the apprentice is familiar with the amplification content for the EPA as part of their preparation for the knowledge test.

Sample knowledge test for Paper 1

A sample knowledge test is available to prepare apprentices for their assessment. This is available on epaPro and the City & Guilds website.

Apprentices should sit the sample knowledge test under invigilated exam conditions. This will help them to familiarise themselves with the style of questions and develop techniques for answering multiple-choice questions.

Grading for Paper 1

The multiple-choice test for Paper 1 will be graded Fail, Pass or Distinction.

Grade	Marks	%
Fail	0 – 35	N/A
Pass	36 – 49	60%
Distinction	50 – 60	83.3%

Assessment instruction for Paper 2a and Paper 2b

The following applies to **each** paper.

Number of questions	30
Marks available	30
Grading	P/X To achieve a **Pass**, the apprentice must achieve a minimum of 18 marks (60%).
Type of questions	Multiple-choice
Duration	1 hour
Marking	The test will be carried out online and marked electronically on the E-volve platform.
Permitted materials	The test is closed book which means that the apprentice cannot refer to reference books or materials while taking the test. The apprentice will have access to a calculator within the E-volve platform if there are any calculate questions in the test.
Location	The apprentice must take the test in a suitably controlled and invigilated environment that is a quiet room, free from distractions and influence.

Assessment specification for Paper 2a – Air Source Heat Pumps

Paper 2a is assessed against the following Learning Outcomes (LOs) and Assessment Criteria (ACs) as prescribed in the Assessment Plan. The numbering of these LOs and ACs may not be sequential, as some LOs and ACs will be assessed in a different assessment method.

Learning outcome	Assessment criteria	Number of question(s)
1. Know what an air source heat pump is, the principle of the vapour compression system and	1.1 Identify key components of the vapour compression refrigeration cycle: • compressor • condenser • expansion valve • evaporator	2

Learning outcome	Assessment criteria	Number of question(s)
system components.	• refrigerant.	
	1.2 Identify how the vapour compression refrigerant circuit within a heat pump unit operates.	
2. Know the different operational characteristics of each type of heat pump unit and system arrangement.	2.1 Identify the different types of Air Source heat pump: • monoblock, fixed speed, inverter driven • split • air to air.	1
	2.2 Identify the requirements of the current fluorinated greenhouse gases regulations in relation to: • the competence of personnel installing heat pumps where the refrigerant circuit has been assembled and tested by the product manufacturer • the competence of personnel installing and charging split air source heat pumps where the refrigerant circuit is to be assembled and tested in the location where the heat pump is to be installed and operated • the competence of personnel undertaking leakage checking on heat pump refrigerant circuits • the competence of personnel undertaking servicing of a split air source heat pumps • the competence of personnel undertaking recovery of fluorinated greenhouse gases from heat pump refrigerant circuits • flammability of certain refrigerants.	
3. Know the fundamental principles of heat pump efficiency and design selection that are common for heat pumps.	3.1 Identify the meaning of the term ‘Coefficient of Performance’.	10
	3.2 Identify the relationship between Coefficient of Performance and the: • heat pump input temperature • heat pump emitter temperature.	
	3.3 Identify the effect that ambient temperature can have on: • coefficient of performance • heat pump output.	
	3.4 Identify the meaning of the term ‘Seasonal Coefficient of Performance’.	

Learning outcome	Assessment criteria	Number of question(s)
	3.5 Identify the factors that can affect the Seasonal Coefficient of Performance.	
	3.6 Identify the purpose and content of a products ErP label and product Fiche.	
	3.7 Identify the meaning of the term ‘System Efficiency’.	
	3.8 Identify the factors that can affect the ‘System Efficiency’.	
	3.9 Identify why achieving minimum heat loss from the building is particularly important when designing a heat pump system.	
	3.10 Identify the effect that oversizing of a heat pump has on: • system performance/efficiency • heat pump operation.	
	3.11 Identify the effect that under-sizing of a heat pump has on: • system performance/efficiency • heat pump operation.	
	3.12 Identify the meaning of the terms: • monovalent system • bivalent system • hybrid system.	
	3.14 Identify the meaning of the term ‘bivalent points’ in relation to heat pump output charts.	
	3.15 Identify how ‘bivalent points’ are used to determine auxiliary heat requirements.	
	3.16 Identify how heat pump output capacity is affected by: • heat pump input temperature • heat pump output temperature.	
	3.17 Identify the typical mean water temperature recommended when designing a hydraulic emitter circuit that incorporates: • standard panel radiators. • underfloor heating • fan assisted convector heaters	

Learning outcome	Assessment criteria	Number of question(s)
	• fan coils.	
	3.18 Identify the typical annual operating hours for a heat pump that is being used for: • heating only • heating and domestic hot water.	
	3.19 Identify how heat pump annual operating hours may vary in relation to the: • type of building • geographical location of the installation.	
5. Know the fundamental principles of domestic hot water cylinder selection and system design that are common for heat pumps.	5.1 Identify the different type of heat pump hot water cylinders: • heat pump, hot water packaged unit • coiled indirect cylinder • tank in tank cylinder • thermal store • solar cylinder.	3
	5.2 Identify volume of hot water cylinder required for the building.	
	5.3 Identify output required from heat pump to heat the hot water cylinder.	
	5.4 Identify correct selection of hot water cylinder for the heat pump.	
	5.5 Identify correct zone valve selection for heat pump and hot water cylinder.	
	5.6 Identify requirements for secondary hot water circulation.	
	5.7 Identify safe system design in relation to regulations for: • legionella protection • hot water temperature protection and prevention of scalding.	
6. Know the fundamental principles of hydraulic system design	6.1 Identify the installation requirements where flow and return pipework passes through the external building fabric in relation to: • provision for movement • prevention of water ingress.	5

Learning outcome	Assessment criteria	Number of question(s)
that are common for heat pumps.	6.2 Identify the suitability of the following types of hydraulic heating system emitter for heat pump systems: • standard panel radiators • underfloor heating • fan assisted convector heaters • fan coils • combined systems (radiators, underfloor heating) • multiple zones.	
	6.3 Identify the installation requirements for the connection to the following types of hydraulic heating system emitter: • standard panel radiators • underfloor heating • fan assisted convector heaters • fan coils • combined systems (radiators, underfloor heating) • multiple zones.	
	6.4 Identify heat pump hydraulic flow rate requirements and circulation pump selection.	
	6.5 Identify heat pump pipe size requirements in relation to designed flow temperature.	
	6.6 Identify the correct pipe size requirements in relation to designed flow temperature.	
	6.7 Identify why a buffer vessel maybe required in the system design.	
	6.8 Identify if a buffer vessel is required in the system design and is correctly sized.	
	6.9 Identify correct piping alternatives for buffer vessels in the system design.	
	6.10 Identify the installation requirements for suitable insulation of external pipework in relation to: • thermal loss • protection against freezing • UV protection • animal protection.	

Learning outcome	Assessment criteria	Number of question(s)
7. Know the fundamental principles of heat pump controls.	7.1 Identify the common control systems for heat pump units in relation to: • weather compensation • indoor and outdoor sensors • heat curves • scheduling • optimisation • accessories • internet connections and Apps.	1
8. Know the preparatory work required for heat pump installation work.	8.1 Identify the common requirements of pre-installation checks for heat pump unit installations connected to hydraulic emitters circuits in relation to: • authorisation for the work to proceed • the availability and collation of all relevant information • verification of the suitability of the hydraulic emitter circuit for connection to the heat pump unit • verification that the heat output capacity of the heat pump unit is matched to the required proportional contribution of the total building heat load • verification that the buffer tank sizing is correct • the availability of appropriate access to all required work areas • the availability and condition of a suitable electrical input service • verify the correct fuse rating for heat pump • adequate provision for the siting of key internal system components • the suitability of the building structure in relation to the proposed installation • DNO notification • building regulation and assignment of rights.	2
9. Know the preparatory work required for the installation of an air source heat pump.	9.4 Identify the requirements for moving and handling air source heat pumps units to avoid damage and personal injury.	2
	9.5 Identify the options to deal with the condensate produced from normal and defrost cycle operation of an air source heat pump.	
	9.6 Identify suitable electrical supply in relation to: • District Network Operator (DNO) connection • isolation switches	

Learning outcome	Assessment criteria	Number of question(s)
	• fuse rating.	
10. Know the requirements to install and test air source heat pump systems (non-refrigerant circuits).	10.1 Identify the requirements for moving and handling heat pump units to avoid damage to the unit.	3
	10.2 Identify the requirements to avoid undue noise and/or vibration transmission from the heat pump unit to the building structure during the operation of the heat pump.	
	10.3 Identify the requirements where brine circuit pipework passes through the external building fabric in relation to: • provision for movement • protection against freezing • prevention of water ingress.	
	10.4 Identify the charging and flushing requirements for hydraulic system in relation to: • correct filling and venting • purging of air and installation debris • addition of antifreeze protection and suitable cleansers and or inhibitors • checking for leaks • check filters for debris.	
	10.5 Identify what equipment is needed for system charging and flushing.	
	10.6 Identify the hydraulic test requirements.	
11. Understand the requirements to commission air source heat pump system installations (non-refrigerant circuits).	11.1 Identify the conditions that are required to implement commissioning activities for heat pump systems.	1
	Total	**30**

Assessment specification for Paper 2b – Solar Thermal Hot Water Systems

Paper 2b is assessed against the following Learning Outcomes (LOs) and Assessment Criteria (ACs) as prescribed in the Assessment Plan. The numbering of these LOs and ACs may not be sequential, as some LOs and ACs will be assessed in a different assessment method.

Learning outcome	Assessment criteria	Number of question(s)
1. Know the health and safety risks and safe systems of work associated with solar thermal system installation work.	1.1 Identify which aspects of solar thermal system installation work pose risk of: • electrocution/electric shock • burns • toxic poisoning • injury through flash to steam of system heat transfer fluid • a fall from height • personal injury though component/equipment handling.	3
	1.2 Identify safe systems of work for solar thermal system installation work in relation to prevention of: • electrocution/electric shock • burns • toxic poisoning • injury through flash to steam of system heat transfer fluid • a fall from height • personal injury though component/equipment handling.	
2. Know the requirements of relevant regulations/standards relating to practical installation, testing, and commissioning activities for solar thermal system installation work.	2.1 Interpret building regulation/building standards guidance documentation as relevant to solar thermal system installation work to identify the requirements in relation to: • maintaining the structural integrity of the building • maintaining the fire-resistant integrity of the building • the prevention of moisture ingress (building water tightness) • notification of work requirements • control of temperature in primary and secondary circuits including primary circuits connected to unvented hot water storage systems • energy conservation • testing and commissioning requirements • compliance certification.	2

Learning outcome	Assessment criteria	Number of question(s)
	2.2 Interpret industry recognised water regulation/byelaw guidance documentation as relevant to solar thermal system installation work to identify the requirements in relation to: • prevention of contamination of the wholesome water supply • energy conservation • safe operation • testing and commissioning requirements.	
3. Know the types and layouts of solar thermal system.	3.1 Identify the following solar thermal system types: • fully filled (active) • drain back (active) • passive (thermos-siphon).	2
	3.2 Identify the following solar thermal system storage vessel types and collector circuit arrangements: • direct (fully filled) DHW storage cylinder only • indirect, sealed collector circuit, DHW storage cylinder only (solar primary coil only) • indirect, sealed collector circuit, DHW storage cylinder only (dual coil) • indirect, sealed collector circuit, pre-heat cylinder and DHW storage cylinder • indirect, sealed collector circuit, thermal store.	
5. Know the types and key operating principles of solar collectors.	5.1 Identify the following types of solar collector: • unglazed collector • flat plate glazed collector • roof integrated glazed collector • evacuated tube collector – direct flow • evacuated tube collector – heat pipe.	2
	5.2 Identify the key operating principles for: • flat plate collectors • evacuated tube collector – direct flow • evacuated tube collector – heat pipe.	
	5.3 Identify the effect that the temperature difference between the solar primary circuit/collector temperature and the ambient temperature has on the relative efficiency of the following types of solar collector: • unglazed collector • flat plate glazed collector • evacuated tube collector.	

Learning outcome	Assessment criteria	Number of question(s)
6. Know the information requirements to enable system component selection and sizing.	6.3 Identify the information requirements in relation to: • building occupancy • required hot water usage pattern.	1
7. Know the fundamental techniques used to select, size and position components for solar thermal systems.	7.2 Identify how to determine typical domestic hot water system collector area requirements in relation to: • building occupancy • proposed angle of collector installation • proposed orientation of collector installation • shading that may affect collector performance.	6
	7.3 Identify the annual irradiation yield as a % of optimum in relation to: • collector orientation • collector angle • proposed orientation of collector installation • shading that may affect collector performance.	
	7.4 State typical recommended solar primary circuit circulation rates.	
	7.5 Identify solar primary circuit pipe size requirements in relation to: • primary circuit circulation rates • collector area • primary circuit pipework length.	
	7.6 Identify total solar primary circuit water content volume.	
	7.7 Identify total solar primary circuit expansion vessel size requirements in relation to: • primary circuit water content volume • collector height above cylinder.	
	7.8 Identify typical sizing requirements for drain back vessels in relation to: • net collector area • total volume of the system.	
	7.9 Identify solar primary circuit dynamic pressure drop and circulating pump size requirements for: • fully filled systems	

Learning outcome	Assessment criteria	Number of question(s)
	• drain back systems.	
8. Know how the performance of solar hot water systems is measured.	8.1 Identify the meaning of the term 'solar fraction'.	1
	8.2 Identify factors that affect the solar fraction.	
9. Know the preparatory work required for solar thermal system installation work.	9.1 Identify the requirements in relation to: • authorisation for the work to proceed • the availability of appropriate access to all required work areas.	3
	9.2 Identify the requirements of pre-installation checks in relation to: • the suitability of the proposed location and position of the solar collector(s) for optimum collection capacity • the suitability of the building structure and the building fabric in relation to the installation of system components • verification that the generation capacity of the proposed solar hot water system installation is appropriate to the hot water system energy load and usage • the inspection of existing hot water/heating system installations • water quality • the availability of a suitable electrical input service • the proposed siting of key internal system components.	
10. Know the requirements for connecting solar thermal system collector circuits to combination boiler domestic hot water circuits.	10.1 Identify the suitability of combination boilers to receive preheated water.	1
	10.2 Identify the pipework layout and components required for connecting a solar thermal system to a combination boiler to include the: • arrangements for prevention of backflow • arrangements for ensuring that the combination boiler cold inlet supply water is provided at an appropriate temperature • arrangements for allowing stored hot water to be used directly from the store when the temperature of the stored water is appropriate.	

Learning outcome	Assessment criteria	Number of question(s)
11. Know the requirements for installing solar collector arrays.	11.1 Identify the positioning and fixing requirements and where appropriate the weathering requirements for the following solar collector types: • flat plate, surface mounted, inclined roof with single lap roof covering • flat plate, surface mounted, inclined roof with double lap roof covering • flat plate, integrated, inclined single lap roof covering • flat plate, integrated, inclined double lap roof covering • evacuated tube, inclined single lap roof covering • evacuated tube, inclined double lap roof covering • frame mounted, inclined (roof, wall or ground) • frame mounted, horizontal (roof or ground).	3
	11.2 Identify the pipework layout, component requirements and component positioning requirements for the following system types and collector array connection arrangements: • fully filled system, collector array connected in series • fully filled system, collector array connected in parallel • fully filled system, collector array connected with east/west split • drain back system, single collector array.	
	11.3 Identify the requirements to achieve durable weather-tightness of buildings where collector array connection pipework passes through the building fabric.	
	11.4 Identify when specialist equipment is required in relation to preventing irradiation reaching collector absorbers during installation.	
12. Know the requirements for installing for solar thermal system pipework.	12.2 Identify the requirements for pipework supports in relation to: • suitable materials • spacing of pipework supports.	2
	12.3 Identify suitable pipework jointing methods in relation to: • system operating temperatures • system operating pressures • system chemicals.	

Learning outcome	Assessment criteria	Number of question(s)
	12.4 Identify the requirements for pipework insulation for solar thermal system installation work in relation to: • system operating temperatures • system efficiency and performance • potential exposure of the insulation to ultra-violet rays/light • potential exposure of the insulation to adverse weather • the sections of installations that must be insulated • the sections of installations that must not be insulated • resistance to vermin attack.	
	12.5 Identify the requirements for installing pressure relief valve discharge pipework in relation to: • routing of pipework • termination of pipework.	
13. Know the requirements to test and commission solar thermal system installations.	13.1 Identify the requirements to prepare for testing and commissioning in relation to: • compliance with the system design and specification • compliance with system/component manufacturer requirements • suitability of electrical supply circuit arrangements • flushing the system of installation debris • selection of suitable heat transfer fluid • filling and venting the hydraulic circuits • checking system water quality • protection against freezing • provision of system labelling.	4
	13.2 Identify what specialist equipment is required in relation to: • the introduction and checking of system freeze protection fluids • setting system pressure • checking the corrosion protection of the system.	
	13.3 Identify the testing requirements for hydraulic circuits within solar thermal system installations in relation to: • hydraulic test pressure • hydraulic test duration.	

Learning outcome	Assessment criteria	Number of question(s)
	Total	**30**

Assessment criteria and amplification for Paper 2a and Paper 2b

In order to support teaching and learning, assessment criteria assessed through the multiple-choice tests have been amplified. The full amplification can be found in Appendix 2 and Appendix 3.

It is important that the amplified content for the EPA is covered though the teaching and learning.

The amplified content for each Assessment Criteria (AC) in the End-point Assessment will either:

- align to the City & Guilds Level 3 Diploma in Plumbing and Domestic Heating (9289-01/02/03/91/92/93) on-programme qualification **or**
- have additional or altered amplification to the assessment criteria in the on-programme qualification.

Providers and employers must ensure that the apprentice is familiar with the amplification content for the EPA as part of their preparation for the knowledge tests.

Sample knowledge test for Paper 2a and Paper 2b

A sample knowledge test is available to prepare apprentices for their assessment. This is available on epaPro and the City & Guilds website.

Apprentices should sit the sample knowledge tests under invigilated exam conditions. This will help them to familiarise themselves with the style of questions and develop techniques for answering multiple-choice questions.

Grading for Paper 2a and Paper 2b

The multiple-choice tests for Paper 2a and Paper 2b will each be graded Fail or Pass.

Grade	Marks	%
Fail	0 – 17	N/A
Pass	18 – 30	60%

Overall Grade for Assessment 1: Knowledge test

To achieve a Pass in the knowledge test, the apprentice must Pass Paper 1, Paper 2a and Paper 2b.

To achieve a Distinction in the knowledge test, the apprentice must achieve a Distinction in Paper 1 and achieve a Pass in Paper 2a and Paper 2b.

Resits and retakes

An apprentice who fails any of the papers will be offered the opportunity to resit or retake the paper(s) they have failed.

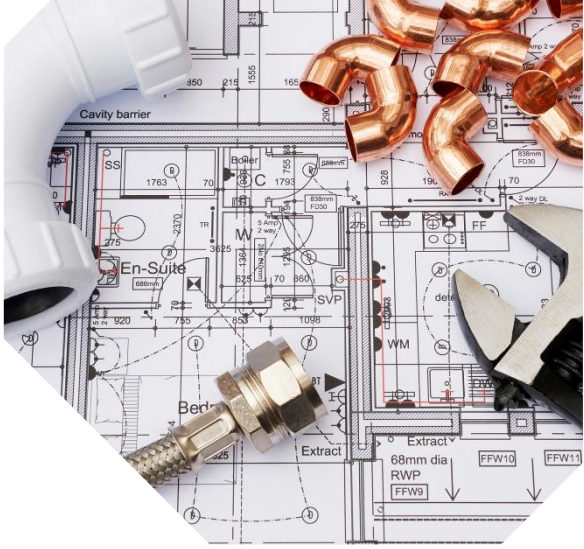
- A resit is where the apprentice takes the assessment again without the need for new learning.
- A retake is where the employer determines new learning is needed first.

Only the paper(s) failed will need to be resat or retaken.

The apprentice will be given different paper(s).

The maximum grade the apprentice can achieve for Paper 1 is Distinction and for Paper 2a and Paper 2b is Pass.

Please see the *Resits and retakes* section for further information.



7. Assessment information: Assessment 2 – Practical planning test (9289-700)

Overview

In the Practical Planning Test (PPT), the apprentice produces a design plan in a controlled and invigilated environment. It gives the apprentice the opportunity to demonstrate the knowledge and skills mapped to this assessment method.

Rationale

This EPA method is being used because:

- it allows the apprentice to demonstrate knowledge that does not lend itself to a knowledge test
- it allows for the efficient testing of knowledge and skills, using realistic scenarios
- it allows for flexibility in terms of when, where and how it is taken
- it is a holistic assessment method.

Assessment

Grading	P/X To achieve a **Pass** the apprentice must achieve a Pass in all grading descriptors.
Type of assessment	Practical
Duration	5 hours This can be completed over two working days.
Permitted materials	Open book which means that the apprentice can refer to reference books or materials while taking the test. The following normative documents must be available for use: • Water regulations guide • Building regulations Approved Document G • BS 8558 • BS 806 Parts 1–5 • Domestic building services compliance guide • manufacturers' technical documents.

Location	The apprentice must take the practical planning test in a suitably controlled and invigilated environment that is a quiet room, free from distractions and influence. The provider/employer must provide the invigilator and follow the invigilation instructions which can be found later in this section.
Resources	Equipment and resources must be provided and set up by the provider/employer. Each apprentice must have a calculator/calculation software (no internet access) available for use. See the Practical Planning Test Resource Pack for details.

Assessment specification and grading descriptors

Note: The Grading Descriptor (GD) reference is from the Assessment Plan.

Some learning outcomes have the same grading descriptors.

Task planning and risk

KSB: S4 and S5

Learning outcome	Assessment criteria	Pass grading descriptor
Understand information sources in the building services industry.	Interpret workplace information. (underpins GD)	GD63 Complies with company policies and procedures.
	Comply with company policies and procedures.	
Understand and produce work programme for tasks in the plumbing and domestic heating systems industry.	Identify factors to consider when planning activities to job specifications. (underpins GD)	GD61 Produces a simple work programme including: a. planning work with other trades b. material deliveries c. simple work programmes d. simple bar (progress) charts in line with the task requirements.
	Produce a simple work programme including: a. Planning work with other trades b. Material deliveries. c. Simple work programmes.	

Learning outcome	Assessment criteria	Pass grading descriptor
	d. Simple bar (progress) charts.	
Produce risk assessments and method statements for the plumbing and domestic heating systems industry.	Identify different hazards. (underpins GD)	GD62 Produce a risk assessment and method statement for the work to be carried out, in accordance with: a. the plumbing and domestic heating system's design b. the conditions of the working environment c. organisational procedures.
	Identify levels of risk. (underpins GD)	
	Produce a risk assessment for a task.	
	Produce a method statement for a task.	

Technical Planning

KSBs: S12 underpinned by K6, K8, K9 and K17

Learning outcome	Assessment criteria	Pass grading descriptor
Understand and install cold water systems.	Identify types and typical pipe sizes used in cold water systems within dwellings. (underpins GD)	GD64 Plans a cold water system in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.
	Identify sources of information required when undertaking work on cold water systems. (underpins GD)	
	Plan cold water systems.	
Understand and install hot water systems.	Identify location and function of unvented system components. (underpins GD)	GD65 Plans a hot water system in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.
	Identify sources of information required when undertaking work on hot water systems.	

Learning outcome	Assessment criteria	Pass grading descriptor
	(underpins GD)	
	Plan hot water systems.	
Size and select cold water systems and components for dwellings.	Apply factors that affect the selection of cold water systems for dwellings. (underpins GD)	GD64 Plans a cold water system in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.
	Use information sources required to size and select cold water systems and components. (underpins GD)	
	Consider recommended design temperatures within cold water systems. (underpins GD)	
	Calculate cold water system requirements used in dwellings. (underpins GD)	
	Select cold water components in accordance with calculations from predetermined data. (underpins GD)	
	Present calculations and information in a suitable format for quotation and tender. (underpins GD)	
	Interpret information to complete a detailed materials list. (underpins GD)	GD61 Produces a simple work programme including: a. planning work with other trades b. material deliveries c. simple work programmes

Learning outcome	Assessment criteria	Pass grading descriptor
		d. simple bar (progress) charts in line with the task requirements.
Size and select hot water systems and components for dwellings.	Consider factors that affect the selection of hot water systems for dwellings. (underpins GD)	GD65 Plans a hot water system in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.
	Use information sources required to size and select hot water systems and components. (underpins GD)	
	Consider recommended design temperatures within hot water systems. (underpins GD)	
	Calculate hot water system requirements used in dwellings. (underpins GD)	
	Select hot water components in accordance with calculations from predetermined data. (underpins GD)	
	Present calculations and information in a suitable format for quotation and tender. (underpins GD)	
	Interpret information to complete a detailed materials list. (underpins GD)	GD61 Produces a simple work programme including: a. planning work with other trades b. material deliveries c. simple work programmes

Learning outcome	Assessment criteria	Pass grading descriptor
		d. simple bar (progress) charts in line with the task requirements.
Understand and perform pre-installation activity prior to undertaking electrical work on plumbing and domestic heating systems.	Produce a risk assessment and method statement for the work to be carried out, in accordance with: a. the plumbing and domestic heating system's design b. the conditions of the working environment c. organisational procedures.	GD62 Produce a risk assessment and method statement for the work to be carried out, in accordance with: a. the plumbing and domestic heating system's design b. the conditions of the working environment c. organisational procedures.

Assessment instructions

Duration

The duration of the practical planning test is 5 hours and it may be completed over two working days.

Delivery

The practical planning test is structured to give the apprentice the opportunity to demonstrate the knowledge and skills mapped to this assessment method as outlined in the grading descriptors.

The provider/employer must book the practical planning test on epaPro, giving the apprentice at least 14 days' notice of the date and time of the test. The provider/employer must confirm that the assessment environment is suitable.

City & Guilds will give the provider/employer contact access to the Practical Planning Test Assessment Pack on epaPro up to five days before the booked EPA event.

On the day of the practical planning test the assessment materials must be provided to the apprentice with the resources required (see the Practical Planning Test Resource Pack). The practical planning test can be computer or paper-based.

The provider/employer must maintain the security of the assessment materials. If the assessment materials are printed there must be one copy per apprentice.

Task overview

The apprentice will need to complete a domestic cold and hot water system design capable of meeting a specific job specification.

The apprentice will then produce a design plan incorporating the following aspects:

- hot and cold water pipework sizing
- final layout plans
- materials list
- merchant order
- work programme
- risk assessment and method statement
- present calculations and information in a suitable format for quotation and tender.

Evidence produced

The apprentice can produce their evidence either on computer or paper-based; spell check can be used. The evidence will need to be uploaded to epaPro along with a completed Declaration of Authenticity for **each** apprentice.

Assessment location

The requirements for the controlled environment include a quiet room, away from the normal place of work, with a dedicated workstation, with access to all the required equipment and materials.

Invigilation requirements

The practical planning test must be taken in the presence of an invigilator provided by the provider/employer.

Appointing an invigilator

It is the responsibility of the provider to ensure that invigilators are appropriately trained in their duties.

The role of the invigilator is to ensure that the practical planning test is conducted according to these requirements, in order to:

- confirm the identity of apprentices
- check that apprentices have access to the necessary materials for the practical planning test
- ensure apprentices have an equal opportunity to demonstrate their abilities
- ensure the security of the practical planning test before, during and after the test
- ensure the submitted evidence is an apprentice's own work
- prevent possible malpractice
- prevent possible administrative failures
- deal with hardware, software and communication failures (which may affect individual workstations or the whole network). The invigilator should normally allow the apprentice(s) to continue the assessment session at a different workstation or at a later time, if necessary, without loss of working time. In extreme cases, please contact City & Guilds EPA Team EPA@cityandguilds.com.

The invigilator must **not**:

- make any comment where an apprentice believes that there is an error or omission on the practical panning test. The invigilator must, however, refer the matter immediately to EPA@cityandguilds.com
- give any information about possible mistakes in the practical planning test, unless there is an erratum notice or permission has been given by the City & Guilds EPA Team
- comment on the content of the practical planning test
- re-phrase questions or instructions
- explain any subject-specific or technical terms
- offer any advice or comment on apprentices' work
- carry out any other non-examination related tasks in the room.

Before the assessment

On the day of the assessment, before any assessment can take place, the invigilator must:

- establish the identity of apprentices sitting the assessment. Any apprentice who is not known to the invigilator must show photographic ID to prove that they are the same person who is entered for the assessment, e.g. a passport or driving licence
- check that the location where the assessment is to be carried out is safe
- check that application of any access arrangements have been approved by City & Guilds.

Attendance of anyone other than the invigilator and apprentices must be agreed with the City & Guilds EPA Team prior to the event.

The invigilator must make signed records of:

- the seating plan
- names of invigilators
- list of apprentice names, enrolment numbers (ENR) and type of identity evidence provided where the invigilator does not know the apprentice.

These records and the practical planning test assessment materials must be maintained by the provider for three months after the assessment date.

Before the assessment starts, the invigilator must remind apprentices:

- of the controlled conditions as set out in the practical planning test assessment materials
- to include their name, enrolment number (ENR) and the date on all the pages that they that will submit for grading
- to complete and sign a Declaration of Authenticity.

During the assessment

Throughout the assessment, invigilators must ensure that:

- the assessment is completed under controlled conditions
- only apprentices sitting the assessment are present in the room while the assessment is taking place
- all apprentices are within direct sight of the invigilator throughout the duration of the assessment
- display materials which might aid apprentices have been removed or covered
- apprentices only use resources that are listed within the Practical Planning Test Resource Pack
- apprentices do **not** have access to e-mail or internet, including phones and tablets
- the practical planning test is limited to 5 hours; this may be split over two days
- apprentices complete their work independently and complete a Declaration of Authenticity. There is no interaction with other apprentices
- apprentices are **not** allowed to add to notes and resources between sessions. If the assessment is run over two days **all** materials must be collected and stored securely at the end of each session (and not made accessible to the apprentice), including the work to be assessed and the practical planning test assessment materials
- additional precautions are taken if apprentices use computers to store work. This may involve collecting memory sticks for secure storage between sessions or restricting apprentices' access to a specific area of the provider/employer's IT network.

Ending the assessment early

The apprentice may choose to end the assessment early. The apprentice must be confident they have demonstrated competence against the assessment requirements for the assessment method. The invigilator must ensure the apprentice is fully aware of all assessment requirements. The invigilator cannot suggest or choose to end the assessment early, unless in an emergency. The invigilator may suggest the assessment continues.

The invigilator must document the apprentice's request to end the assessment early in the attendance register.

After the assessment

At the end of the assessment invigilators must:

- tell apprentices to stop working and remind them that they are still under controlled conditions
- remind apprentices to include their name, enrolment number (ENR) and the date on all the pages that they that will submit for marking
- collect all the practical planning tests assessment materials and work completed by apprentices before they are allowed to leave the room
- check that there is practical planning test assessment evidence and a completed Declaration of Authenticity for every apprentice marked as present on the attendance register
- check that the names on the practical planning test assessment materials match the details on the attendance register
- sign the Declaration of Authenticity for each apprentice
- give the practical planning test assessment evidence and Declaration of Authority to the person responsible for uploading them to epaPro.

Storing assessment materials

All live assessment materials remain live at all times and provider/employer staff, including invigilators, must ensure assessment materials are handled securely at all times.

Assessment materials can be stored either:

- on paper, in a strong safe or security cabinet or metal cabinet with locking bar, or
- electronically,

In all cases, access must be restricted to those responsible for administrating the assessment. City & Guilds **must** be informed immediately if the security of any live assessment materials is put at risk.

Submitting the work

Providers/employers must upload the apprentice's practical planning test evidence and completed Declaration of Authenticity to epaPro.

Grading

The practical planning test is graded Fail or Pass. The practical planning test will be graded against all the grading descriptors mapped to this assessment method. The IEPA is fully responsible for making the grading decision. The results will not be shared with the apprentice on the day of the assessment.

Resits and retakes

An apprentice who fails the practical planning test will be offered the opportunity to resit or retake.

- A resit is where the apprentice takes the assessment again without the need for new learning.
- A retake is where the employer determines new learning is needed first.

The apprentice will be given a different test.

The maximum grade the apprentice can achieve is Pass.

Please see the *Resits and retakes* section for further information.

8. Assessment information: Assessment 3 – Practical competence test (9289-703)

Overview

The IEPA observes the apprentice completing the Practical Competence Test (PCT). The practical competence tasks are set by City & Guilds. This assessment gives the apprentice the opportunity to demonstrate the KSBs mapped to this assessment method.

This assessment has the following tasks:

- Tasks 1, 2 and 3 (core)
- Tasks 4a and 4b (domestic air source heat pump system)
- Task 4c and 4d (solar thermal system).

Rationale

This EPA method is being used because:

- it allows for a varied range of tasks to be observed, that could not be guaranteed to be achieved through a single observation in the workplace
- this is a practical role, best demonstrated through completing tasks in a realistic work setting
- it allows for consistency of activities to be completed and efficiency in scheduling
- it allows for the testing of related underpinning knowledge, skills and behaviours where an opportunity to observe them has not occurred
- it is a holistic assessment method.

Assessment

Grading	P/X To achieve a **Pass** the apprentice must achieve a Pass in all grading descriptors.
Type of assessment	Practical
Duration	Tasks 1, 2 and 3: 7 hours, must be completed in one day. Tasks 4a, 4b, 4c and 4d: 14.5 hours, must be completed over two days. The independent assessor can increase the time of the practical competence test by up to 10%.

Permitted materials	See the Practical Competence Test Resource Pack.
Location	The simulated environment must relate to the apprentice's natural work environment.
Resources	Equipment and resources must be provided and set up by the provider/employer. The equipment and resources must be in good and safe working condition. See the Practical Competence Test Resource Pack for details.

Assessment specification and grading descriptors

Note: The Grading Descriptor (GD) references are from the Assessment Plan.

Some learning outcomes have the same grading descriptor.

Core: Installation and test (mechanical)

KSB: S2, K2, K10

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
Use hand and power tools in plumbing and domestic heating systems work.	Identify the purpose of hand tools and power tools. (underpins GDs)	GD1 Uses and maintains hand and power tools in line with manufacturers' instructions. GD2 Applies the methods of safe storing of tools and equipment in line with organisational procedures.	1, 2, 3
	Use and maintain hand and power tools.	GD1 Uses and maintains hand and power tools in line with manufacturers' instructions.	

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
Apply site preparation techniques for plumbing and domestic heating systems work.	Apply work methods for preparing and protecting the building for installation work.	GD3 Applies work methods for preparing and protecting the building for installation work in line with industry guidance.	1
	Identify the pre-existing damage checks to the building fabric or customer property before the work commences. (underpins GD)		
	Use sources of information for carrying out preparatory work. (underpins GD)		
	Apply the methods of safe storing of tools and equipment.	GD2 Applies the methods of safe storing of tools and equipment in line with organisational procedures.	1, 2
Understand and Use clips and brackets to support plumbing and domestic heating pipework and components.	Measure and mark out fixings for pipework and plumbing and heating components. (underpins GD)	GD4 Uses clips and brackets appropriate to the system pipework and the industry recommended spacing.	1
	Use clips and brackets appropriate to the system pipework and the industry recommended spacing.		
Install plumbing and domestic	Identify pipework installation requirements. (underpins GD)	GD5 Joins pipework to specification.	1

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
heating system pipework.	Select pipework materials and fittings from instructions. (underpins GD)		
	Measure, mark and cut pipework materials for installation. (underpins GD)		
	Fabricate pipework bends to clear obstacles. (underpins GD)		
	Select, position and fix pipework materials to specifications. (underpins GD)		
	Join pipework to specifications.		
Understand and install cold water systems.	Identify the positioning and fixing of pipework within the building fabric. (underpins GD)	GD6 Applies the installation processes and techniques used in the installation of: a. a cold water system b. a hot water system c. a central heating system d. a sanitary appliances and pipework system in line with task requirements.	1
	Apply the processes and techniques used in the installation of a cold water system.		
Understand and install hot water systems.	Identify the positioning and fixing of pipework within the building fabric. (underpins GD)		
	Apply the processes and techniques used in the		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	installation of a hot water system.		
Understand and install domestic central heating systems.	Identify the positioning and fixing of pipework within the building fabric. (underpins GD)		
	Apply the processes and techniques used in the installation of a central heating systems.		
Install sanitary appliances and pipework systems.	Identify the positioning and fixing of pipework within the building fabric. (underpins GD)		
	Apply the processes and techniques used in the installation of a sanitary appliances and pipework system.		
Understand and perform a soundness test and commission cold water systems and components.	Carry out a visual inspection of a cold water system to confirm that it is ready to be soundness tested. (underpins GD)	GD7 Applies the processes and techniques used in the soundness testing of: a. a cold water system b. a hot water system c. a central heating system d. a sanitary appliances and pipework system in line with company procedures.	1
	Apply soundness test industry requirements on cold water systems and components. (underpins GD)		
	Apply the processes and techniques used in the soundness testing of a cold water system.		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
Understand and perform a soundness test and commission hot water systems and components.	Carry out a visual inspection of a hot water system to confirm that it is ready to be soundness tested. (underpins GD)		
	Apply soundness test industry requirements on a hot water system and components. (underpins GD)		
	Apply the processes and techniques used in the soundness testing of a hot water system.		
Understand and perform a soundness test and commission central heating systems and components.	Carry out a visual inspection of a central heating system to confirm that it is ready to be soundness tested. (underpins GD)		
	Apply soundness test industry requirements on a central heating system and components. (underpins GD)		
	Apply the processes and techniques used in the soundness testing of a central heating system.		
Understand and perform a soundness test and commission	Carry out a visual inspection of a sanitary appliances and pipework system to confirm that it is		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
sanitary appliances, pipework systems and components.	ready to be soundness tested. (underpins GD)		
	Apply soundness test industry requirements on a sanitary appliances and pipework system and components. (underpins GD)		
	Apply the processes and techniques used in the soundness testing of a sanitary appliances and pipework system.		

Core: Installation, fault finding, repair, test and commissioning (electrical)

KSB: S7, S9, K13, K18

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
Apply procedures for electrical safety.	Identify common electrical dangers encountered on construction sites and in private dwellings. (underpins GD)	GD8 Prioritises electrical safety of tools and equipment in line with company procedures and industry practice.	2, 3
	Demonstrate methods of safe supply for electrical tools and equipment on site. (underpins GD)		
	Demonstrate the procedure that should be applied for tools and		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	equipment that fail safety checks. (underpins GD)		
	Identify safe isolation procedure when replacing attachments to power tools. (underpins GD)		
	Conduct a visual inspection of a power tool for safe condition before use. (underpins GD)		
	Use temporary continuity bonding when working on pipework components. (underpins GD)		
	Prioritise the electrical safety of tools and equipment.		
Understand and perform pre-installation activity prior to undertaking electrical work on plumbing and domestic heating systems.	Confirm the status of the electrical supply. (underpins GD)	GD9 Carries out the safe isolation of electrical equipment and components associated with the electrical supply of the plumbing and domestic heating system in line with company procedures and industry practice.	2, 3
	Confirm, as necessary, that the electrical supply is suitable for the plumbing and domestic heating systems. (underpins GD)		
	Select, as required, electrical equipment, cables, wiring and	GD10 Selects, as required, electrical equipment, cables, wiring and	2, 3

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	components and confirm that they are: a. of the right type and size b. fit for purpose in accordance with the plumbing and domestic heating system's design.	components and confirm that they are: a. of the right type and size b. fit for purpose in accordance with the plumbing and domestic heating system's design.	
Apply industry standard safe isolation procedures.	Carry out the safe isolation of electrical equipment and components associated with the electrical supply of the plumbing and domestic heating system.	GD9 Carries out the safe isolation of electrical equipment and components associated with the electrical supply of the plumbing and domestic heating system in line with company procedures and industry practice.	2, 3
Carry out the safe installation, testing, commissioning and decommissioning of electrical systems.	Carry out work on electrical equipment, cables, wiring and components associated with the electrical supply and control of the plumbing and domestic heating system in accordance with the requirements of: a. industry recognised methods and procedures b. manufacturers' instructions.	GD11 Carries out work on electrical equipment, cables, wiring and components associated with the electrical supply and control of the plumbing and domestic heating system in accordance with the requirements of: a. industry recognised methods and procedures b. manufacturers' instructions.	2, 3
	Check that the electrical equipment, cables, wiring	GD12	2, 3

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	and components are in accordance with the requirements of the plumbing and domestic heating system.	Checks that the electrical equipment, cables, wiring and components are in accordance with the requirements of the plumbing and domestic heating system.	
	Check that the electrical equipment, cables, wiring and components are of proper construction in accordance with the requirements of the plumbing and domestic heating system.	GD13 Checks that the electrical equipment, cables, wiring and components are of proper construction in accordance with the requirements of the plumbing and domestic heating system.	2, 3
	Undertake functional testing of the electrical equipment and components associated with the electrical supply and control of the plumbing and domestic heating system in accordance with: a. industry recognised methods and procedures b. manufacturers' instructions.	GD14 Undertakes functional testing of the electrical equipment and components associated with the electrical supply and control of the plumbing and domestic heating system in accordance with: a. industry recognised methods and procedures b. manufacturers' instructions.	2, 3
	Commission electrical control systems in accordance with:	GD15 Commissions electrical control systems	2, 3

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	a. industry recognised methods and procedures b. manufacturers' instructions c. legislative requirements.	components in accordance with: a. industry recognised methods and procedures b. manufacturers' instructions c. legislative requirements.	
Carry out the identification of faults and safe repair of electrical work.	Identify and rectify electrical faults and deficiencies on plumbing and domestic heating systems in accordance with: a. industry recognised methods and procedures b. manufacturers' instructions.	GD16 Identifies and rectifies electrical faults and deficiencies on plumbing and domestic heating systems in accordance with: a. industry recognised methods and procedures b. manufacturers' instructions.	3

Core: Ownership

KSB: B2

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
Use hand and power tools in plumbing and domestic heating systems work.	N/A	Takes ownership by completing the tasks and outlines the limits of the role and how they escalate, seek advice and assistance, in line with company policy.	1, 2, 3

Air source heat pump system: Installation, fault finding, repair, test and commissioning (mechanical and electrical)

KSB: S19, S21, S23, underpinned by K27, K31, K33, K37, K39

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
Understand the requirements to commission air source heat pump system installations (non-refrigerant circuits).	Know the commissioning requirements for heat pump systems in relation to: • setting of mechanical controls • setting of electrical controls and temperature sensor-09 • functional tests • hydraulic balancing • checking flow rates • checking the designed Δt • checking start and stop temperatures. (underpins GD)	GD22 Commissions the installation of an air source heat pump system in accordance with: a. manufacturers' guidance b. design requirements c. client's requirements d. statutory requirements and e. industry recognised procedures.	4a
Understand the requirements to handover heat pump system installations.	Know the pre-handover checks that need to be carried out for a heat pump system installation. (underpins GD) Know the industry handover procedures for a heat pump system installation in relation to the: • Provision of completed commissioning sheet • Provision of diagrammatic information	GD23 Explains and demonstrates to the end user the operation and use of the air source heat pump system using manufacturers' guidance and industry agreed handover procedures.	4a

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	• Provision of verbal information or demonstration relating to system operation and use. (underpins GD)		
Plan and prepare for the installation of an air source heat pumps (non-refrigerant circuits).	Undertake pre-installation checks for an air source heat pump installation to include checks relating to: • authorisation for the work to proceed • client/end user requirements • statutory regulations and industry recognised procedures • manufacturer's requirements • the availability of appropriate access to all required work areas • the availability and collation of all relevant information • verification that the heat pump rating is suitable for the emitter circuit load (heating and/or heating and hot water) • verification of the suitability of the proposed location of the heat pump unit • verification that the emitter circuit design or existing installation is compatible with the	GD19 Prepares an air source heat pump system in line with task requirements.	4a

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	proposed heat pump installation • verification that the buffer tank size (where relevant) is appropriate • verification of the suitability of the availability of a suitable electrical input service • the proposed siting of key internal system components • the suitability of the building structure in relation to the proposed installation. (underpins GD)		
	Confirm that the tools, materials, and equipment required for the installation work are available and are in a safe, usable condition. (underpins GD)		
	Prepare an air source heat pump system.		
Install an air source heat pump unit (non-refrigerant circuits).	Apply the processes and techniques used in the installation of an air source heat pump in accordance with manufacturers' guidance, regulatory requirements and industry recognised procedures.	GD20 Applies the processes and techniques used in the installation of an air source heat pump in accordance with: a. manufacturers' guidance	4a

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
		b. regulatory requirements c. industry recognised procedures.	
Install system pipework.	Identify pipework installation requirements. (underpins GD)	GD18 Joins pipework to specification.	4a
	Select pipework materials and fittings from instructions. (underpins GD)		
	Measure, mark and cut pipework materials for installation. (underpins GD)		
	Fabricate pipework bends to clear obstacles. (underpins GD)		
	Select, position and fix pipework materials to specifications. (underpins GD)		
	Join pipework to specifications.		
Carry out electrical work safely.	Carry out work on electrical equipment, cables, wiring and components associated with the electrical supply and controls in accordance with the requirements of:	GD17 Carries out work on electrical equipment, cables, wiring and components associated with the electrical supply and control in accordance	4a

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	a. industry recognised methods and procedures b. manufacturers' instructions.	with the requirements of: a. industry recognised methods and procedures b. manufacturers' instructions.	
Test and commission an air source heat pump system (non-refrigerant circuits).	Prepare an air source heat pump system for testing and commissioning to include checks/actions to confirm: • compliance with the system design and specification • compliance with system/component manufacturer requirements • the suitability of electrical supply circuit arrangements • correct flushing the system of installation debris • correct filling and venting the hydraulic circuits • protection of the system against freezing. (underpins GD)	GD21 Tests the system for hydraulic soundness of the air source heat pump using appropriate test equipment in accordance with: a. manufacturers' guidance b. regulatory requirements c. industry recognised procedures.	4a
	Test the system for hydraulic soundness of the air source heat pump using appropriate test equipment in accordance with manufacturers' guidance, regulatory requirements, and		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	industry recognised procedures.		
	Identify the commissioning requirements for the installation in relation to: • the system and component manufacturer(s) requirements • system design/specification requirements • the client or end user requirements • statutory regulations and industry recognised procedures. (underpins GD)	GD22 Commissions the installation of an air source heat pump system in accordance with: a. manufacturers' guidance b. design requirements c. client's requirements d. statutory requirements and e. industry recognised procedures.	4a
	Commission the installation of an air source heat pump system in accordance with manufacturers' guidance, design requirements, client's requirements, and statutory requirements and industry recognised procedures.		
	Complete relevant documentation to record the commissioning activities. (underpins GD)		
Handover an air source heat pump installation (non-	Undertake relevant checks to ensure that the system is ready for handover and compliant	GD23 Explains and demonstrates to the	4a

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
refrigerant circuits).	with manufacturers' guidance, the system design/specification, client's requirements, regulatory requirements and industry recognised requirements. (underpins GD)	end user the operation and use of the air source heat pump system using manufacturers' guidance and industry agreed handover procedures.	
	Explain and demonstrate to the end user the operation and use of the air source heat pump system using manufacturers' guidance and industry agreed handover procedures.		
	Identify and explain to the end user any aspects of the system that varies from the agreed specifications and requirements. (underpins GD)		
	Obtain acceptance by the end user of the system according to the industry agreed handover procedures. (underpins GD)		
	Ensure that all relevant handover documentation is correctly completed and recorded in the appropriate information systems and passed to the end user in accordance with manufacturers' guidance		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	and industry recognised procedures. (underpins GD)		
Know the requirements for non-refrigerant circuit routine service and maintenance of an air source heat pump system installation (non-refrigerant circuits).	Know which documentation needs to be available to enable routine service and maintenance work on air source heat pump system installations. (underpins GD)	GD25 Applies routine service or maintenance techniques including functional tests on an air source heat pump system to confirm: a. safe operation b. sufficient operation c. the function of system components and controls d. noise and vibration levels in accordance with: a. manufacturer's instructions b. regulatory requirements and c. industry recognised procedures.	4b
	Know typical routine service and maintenance requirements for an air source heat pump installation in relation to: • visual inspection requirements • cleaning of components • checking of system water content • functional tests. (underpins GD)		
	Know the industry requirements for the recording and reporting of routine service and maintenance work on heat pump system installations. (underpins GD)		
	Know the action(s) to take in the event of a failure or suspected failure of the refrigerant circuit and/or a		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	suspected refrigerant circuit defect. (underpins GD)		
Undertake routine service and maintenance of an air source heat pump system (non-refrigerant circuits).	Obtain relevant documentation required to be enable a routine service and maintenance work on air source heat pump system installations. (underpins GD)		
	Demonstrate knowledge of the routine servicing of relevant components of an air source heat pump installation, including checks in relation to: • external isolation is used • evaporator fins for any blockage • evaporator fins are cleaned • fan is not obstructed and moving freely • outer casing • condensate drain functioning and not blocked • condition of flexible hoses • condition and grade of pipe insulation • signs of system water leakage • oil leaks or deposits • condition and security of fixing system		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	• anti-vibration mounts • fuse rating. (underpins GD)		
	Demonstrate knowledge of the routine servicing of an air source heat pump connected to hydraulic emitter circuits and controls, including checks in relation to: • signs of system water leakage • heating system water pressure • heating system water content and makeup • expansion vessel size and pressure • pressure relief valve (prv) operation • system filters • system bypass • buffer vessel if installed • circulation pumps • mechanical valves • condition and grade of pipe insulation • control unit and alarm logs • heating settings • hot water settings • indoor and outdoor sensors or thermostats. (underpins GD)		
	Apply routine service or maintenance techniques including functional tests		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	on an air source heat pump system to confirm: • safe operation • sufficient operation • the function of system components and controls • noise and vibration levels in accordance with: a. manufacturers' guidance b. regulatory requirements c. industry recognised procedures.		
	Complete service and maintenance records. (underpins GD)		
Undertake non-refrigerant circuit fault diagnosis work on an air source heat pump system installation.	Apply identification and rectification techniques on **four** separate faults including functional tests on an air source heat pump system to confirm: • safe operation • efficient operation • the correct functioning of system components and controls in accordance with: • manufacturers' guidance • regulatory requirements • industry recognised procedures.	GD24 Applies identification and rectification techniques on four separate faults including functional tests on an air source heat pump system to confirm: a. safe operation b. efficient operation c. the correct functioning of system components and controls in accordance with:	4b

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	Agree with the relevant person(s) fault rectification procedures for the faults identified. (underpins GD)	a. manufacturers' guidance b. regulatory requirements c. industry recognised procedures.	
	Know the information that needs to be available to enable fault diagnosis. (underpins GD)		
	Know the work action and sequences required to diagnose and rectify the faults. (underpins GD)		
	Obtain the relevant information required to enable the fault diagnosis and fault rectification work. (underpins GD)		
	Take relevant precautionary actions to prevent unauthorised use of the system prior to or during the fault rectification work. (underpins GD)		

Solar thermal system: Installation, fault finding, repair, test and commissioning (mechanical and electrical)

KSB: S20, S22, S24, underpinned by K28, K32, K34, K38, K40

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
Know the requirements to test and commission solar thermal system installations.	Know the commissioning requirements for a fully filled indirect sealed collector circuit installation in relation to: • setting of the expansion vessel charge pressure • setting of the system fluid level • setting of mechanical controls • setting of electrical controls and temperature sensors • system functional tests (underpins GD)	GD29 Commissions a fully filled or drain back system in accordance with: a. manufacturers' guidance b. design requirements c. client's requirements d. statutory requirements and e. industry recognised procedures.	4c
	Know the commissioning requirements for a fully filled drain back installation in relation to: • setting of the system fluid level • setting of mechanical controls • setting of electrical controls and temperature sensors • system functional tests (underpins GD)		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	Know the commissioning requirements for multiple collector arrays connected in series. (underpins GD)		
	Know the recording requirements for the commissioning of solar thermal system installations. (underpins GD)		
Know the requirements to handover solar thermal systems.	Know the pre- handover checks that need to be carried out. (underpins GD)	GD30 Explains and demonstrates to the end user the operation and use of the solar thermal system using manufacturers' guidance and industry agreed handover procedures.	4c
	Know industry handover procedures in relation to the: • provision of written information • provision of diagrammatic information • provision of verbal information or demonstration relating to system operation and use (underpins GD)		
Know the requirements for the routine service and maintenance of 'active' solar thermal systems.	Know which documentation needs to be available to enable routine service and maintenance work on 'active' solar thermal systems. (underpins GD)	GD32 Applies routine service or maintenance techniques including functional tests on a fully-filled or drain back solar	4d

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	Know the typical routine service and maintenance requirements for fully filled systems in relation to: • visual inspection requirements • cleaning of components • checking of system water content • functional tests. (underpins GD)	thermal system to confirm: a. safe operation b. efficient operation c. the correct functioning of system components and controls in accordance with: a. manufacturers' guidance b. regulatory requirements c. industry recognised procedures.	
	Know the typical routine service and maintenance requirements for drain back systems in relation to: • visual inspection requirements • cleaning of components • checking of system water content • functional tests. (underpins GD)		
	Know the industry requirements for the recording and reporting of routine service and maintenance work on solar thermal systems. (underpins GD)		
Know how to diagnose faults in 'active' solar	Know the information that needs to be available to enable fault diagnosis. (underpins GD)	GD31 Apply identification and rectification techniques on a	4d

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
thermal system installations.	Know the work action and sequences required to diagnose the following faults: • loss of system pressure without evidence of discharge • discharge from pressure relief valve on the solar primary circuit • insulation melting on solar collector circuit pipework • overheating of solar collector circuit • lack of circulation within the solar collector circuit • poor or no system performance • system noise and/or vibration. (underpins GD)	minimum of two separate faults on a solar thermal systems to confirm: a. safe operation b. efficient operation c. the correct functioning of system components and controls in accordance with: a. manufacturers' guidance b. regulatory requirements c. industry recognised procedures.	
Know how to rectify faults in 'active' solar thermal systems.	Know the work action and sequences required to rectify the following faults: • loss of system pressure without evidence of discharge • evidence of discharge valve on the solar primary circuit • insulation melting on solar collector circuit pipework • overheating of solar collector circuit		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	• lack of circulation within the solar collector circuit • poor or no system performance • system noise and/or vibration. (underpins GD)		
Plan and prepare for the installation of 'active' solar thermal system.	Undertake pre-installation checks for a solar hot water system installation to include checks relating to: • authorisation for the work to proceed • verification that the generation capacity of the proposed solar hot water system installation is appropriate to the hot water system load • the availability of appropriate access to all required work areas • the inspection of existing domestic hot water/heating system installations • the availability of a suitable electrical input service • the proposed siting of key internal system components • the suitability of the building structure in relation to the proposed installation • the suitability of the proposed location	GD26 Prepares a solar thermal system in-line with task requirements.	4c

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	and position of the solar collector panel(s). (underpins GD)		
	Confirm that the tools, materials, and equipment required for the installation work are available and are in a safe, usable condition. (underpins GD)		
	Prepare a solar thermal system.		
Install solar thermal system components.	Apply the processes and techniques used in the installation of a solar thermal system in accordance with manufacturers' guidance, regulatory requirements and industry recognised procedures.	GD27 Applies the processes and techniques used in the installation of a solar thermal system in accordance with: a. manufacturers' guidance b. regulatory requirements c. industry recognised procedures.	4c
Install system pipework.	Identify pipework installation requirements. (underpins GD)	GD18 Joins pipework to specification.	4c
	Select pipework materials and fittings from instructions. (underpins GD)		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	Measure, mark and cut pipework materials for installation. (underpins GD)		
	Fabricate pipework bends to clear obstacles. (underpins GD)		
	Select, position and fix pipework materials to specifications. (underpins GD)		
	Join pipework to specifications.		
Carry out electrical work safely.	Carry out work on electrical equipment, cables, /wiring and components associated with the electrical supply and controls in accordance with the requirements of: a. industry recognised methods and procedures b. manufacturers' instructions.	GD17 Carries out work on electrical equipment, cables, wiring and components associated with the electrical supply and control in accordance with the requirements of: a. industry recognised methods and procedures b. manufacturers' instructions.	4c
Test and commission an	Prepare a fully filled or drain back solar thermal system for testing and	GD28	4c

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
'active' solar thermal system.	commissioning to include checks/actions to confirm: • compliance with the system design and specification • compliance with system/component manufacturer requirements • the suitability of electrical supply circuit arrangements • correct flushing the system of installation debris • correct filling and venting the hydraulic circuits • protection of the system against freezing • adequate provision of system labelling. (underpins GD)	Tests the solar thermal system for hydraulic soundness using appropriate test equipment in accordance with: a. manufacturers' guidance b. regulatory requirements c. industry recognised procedures.	
	Test the solar thermal system for hydraulic soundness using appropriate test equipment in accordance with manufacturers' guidance, regulatory requirements, and industry recognised procedures.		
	Identify the commissioning requirements for the installation in relation to: • the system and component manufacturer(s) requirements	GD29 Commissions a fully filled or drain back system in accordance with:	4c

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	• system design/specification requirements • the client or end user requirements • statutory regulations and industry recognised procedures. (underpins GD)	a. manufacturers' guidance b. design requirements c. client's requirements d. statutory requirements and e. industry recognised procedures.	
	Commission a fully filled or drain back system in accordance with manufacturers' guidance, design requirements, client's requirements, statutory requirements, industry recognised procedures.		
	Complete relevant documentation to record the commissioning activities. (underpins GD)		
Handover an 'active' solar thermal system.	Undertake relevant checks to ensure that the system is ready for handover and compliant with manufacturers' guidance, the system design and specification, client's requirements, regulatory requirements and industry recognised requirements. (underpins GD)	GD30 Explains and demonstrates to the end user the operation and use of the solar thermal system using manufacturers' guidance and industry agreed handover procedures.	4c
	Explain and demonstrate to the end user the operation and use of the		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	solar thermal system using manufacturers' guidance and industry agreed handover procedures.		
	Identify and explain to the end user any aspects of the system that varies from the agreed specifications and requirements. (underpins GD)		
	Obtain acceptance by the end user of the system according to the industry agreed handover procedures. (underpins GD)		
	Ensure that all relevant handover documentation is correctly completed and recorded in the appropriate information systems and passed to the end user in accordance with manufacturers' guidance and industry recognised procedures. (underpins GD)		
Undertake the routine service and maintenance of an 'active' solar thermal system.	Obtain the relevant information required to enable the work to commence. (underpins GD)	GD32 Applies routine service or maintenance techniques including functional tests on a fully-filled	4d
	Undertake a visual service and maintenance		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	inspection of a fully-filled or drain back, 'active' solar thermal system installation to include checks in relation to: • compliance with manufacturer's installation instructions • compliance with statutory regulations • condition of system components including cleanliness • correct positioning of system components • security of fixing of system components. (underpins GD)	or drain back solar thermal system to confirm: a. safe operation b. efficient operation c. the correct functioning of system components and controls in accordance with: a. manufacturers' guidance b. regulatory requirements c. industry recognised procedures.	
	Undertake routine service and maintenance of relevant components on a fully-filled or drain back, 'active' solar thermal system to include: • checking the system water levels • checking provision for the expansion of system water • checking for protection of the system water against freezing • cleaning of system components adjustment of system controls.		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	Apply routine service or maintenance techniques including functional tests on a fully-filled or drain back solar thermal system to confirm: • safe operation o efficient operation • the correct functioning of system components and controls in accordance with: • manufacturers' guidance • regulatory requirements • industry recognised procedures.		
	Complete the relevant service and maintenance records in accordance with industry recognised procedures. (underpins GD)		
Undertake fault diagnosis work on 'active' solar thermal system installations.	Obtain the relevant information required to enable the fault diagnosis work. (underpins GD)	GD31 Apply identification and rectification techniques on a minimum of two separate faults on a solar thermal systems to confirm: a. safe operation b. efficient operation	4d
	Identify the cause of a minimum of **two** separate faults from the following list: • loss of system pressure without evidence of discharge		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	• discharge from pressure relief valve on the solar primary circuit • insulation melting on solar collector circuit pipework • overheating of solar collector circuit • lack of circulation within the solar collector circuit • poor or no system performance • system noise and/or vibration. (underpins GD)	c. the correct functioning of system components and controls in accordance with: a. manufacturers' guidance b. regulatory requirements c. industry recognised procedures.	
	Agree with the relevant person(s) fault rectification procedures for the faults identified. (underpins GD)		
Undertake fault rectification work on 'active' solar thermal system installations.	Obtain the relevant information required to enable the fault rectification work. (underpins GD)		
	Take relevant precautionary actions to prevent unauthorised use of the system prior to or during the fault rectification work. (underpins GD)		
	Take relevant precautionary actions to minimise the risk of injury		

Learning outcome	Assessment criteria	Pass grading descriptor	Task reference
	to self or others during the fault rectification work. (underpins GD)		
	Apply identification and rectification techniques on a minimum of **two** separate faults on a solar thermal systems to confirm: • safe operation • efficient operation • the correct functioning of system components and controls in accordance with • manufacturers' guidance • regulatory requirements • industry recognised procedures.		

Assessment instructions

Duration

Tasks 1, 2 and 3 must be completed over one working day with a total assessment time of 7 hours. The Assessment Plan does not stipulate how long apprentices must be given to complete each individual task. Apprentices should plan their work to complete all of the tasks within 7 hours. They can use the following durations as a guide:

- Task 1 – 4.5 hours
- Task 2 – 1.5 hours
- Task 3 – 1 hour.

Tasks 4a, 4b, 4c and 4d must be completed over two consecutive working days with a total assessment time of 14.5 hours:

- Tasks 4a and 4b – 6 hours
- Tasks 4c and 4d – 8.5 hours.

The IEPA can increase the time of the practical competence test by up to 10%. This time is to allow the apprentice to complete a task or respond to a question if necessary.

A working day is typically considered to be 8.5 hours long, including breaks.

Ending the assessment early

The apprentice may choose to end the assessment method early. The apprentice must be confident they have demonstrated competence against the assessment requirements for the assessment method. The IEPA must ensure the apprentice is fully aware of all assessment requirements. The IEPA cannot suggest or choose to end the assessment methods early, unless in an emergency. The IEPA is responsible for ensuring the apprentice understands the implications of ending an assessment early if they choose to do so.

The IEPA may suggest the assessment continues. The IEPA must document the apprentice's request to end the assessment early.

Delivery

The practical competence test is structured to give the apprentice the opportunity to demonstrate the KSBs mapped to this assessment method, as outlined in the grading descriptors.

The IEPA:

- will conduct and assess the practical competence test
- can observe up to four apprentices
- will introduce themselves and their role and give the apprentice the opportunity to ask questions. The IEPA cannot answer any questions that will aid interpretation
- will explain to the apprentice the format and timescales of the practical competence test before it starts. This does **not** count towards the assessment time
- will ensure that no assistance is provided to the apprentice during the assessment. This includes breaks and moving between locations
- will provide the apprentice with the EPA assessment pack on the assessment days
- will ask the apprentice a minimum of one question as part of each task:
    - the time for questioning is included in the overall assessment time. To remain as unobtrusive as possible, the IEPA will ask questions during natural breaks rather than disrupting the apprentice's flow
    - the purpose of the questions is:
        - to seek clarification where required
        - to assess the level of competence against the grading descriptors.

The apprentice **must** inform the IEPA when they reach specified stages of tasks to undertake safe isolation and reactivation of electrical systems; these are specified in the relevant tasks in the assessment packs.

Task overview

The following tasks must be completed by the apprentice, as prescribed in the Assessment Plan.

Task 1

The apprentice will be required to complete the part installation and testing of a domestic plumbing system, incorporating:

- fabricating a domestic pipework layout
- a branch connection from a water closet (WC) and a waste pipe branch from a wash basin to a soil stack
- a hot and cold water tap connections to a wash basin
- the installation of a double panel radiator, this is also intended to demonstrate manual handling techniques
- utilising different pipework materials, including copper, plastic pressure and plastic soil and waste pipe
- utilising simple jointing techniques, e.g. push fit, solvent welded
- utilising complex jointing techniques including soldered, compression and press fit
- pipe bending (offset and passover) techniques
- utilising brackets and fixings
- dimensional tolerances of ±2 mm on the lengths and ±2° on the angles
- soundness testing
- testing the system, pressure pipework to withstand a pressure test of 3 bar for 5 minutes, soil and waste pipework must maintain an air test of 38 mm water gauge for 3 minutes. Soundness testing of the soil and waste pipework to require the use of a stepladder or hop up work platform.

The apprentice will be asked a minimum of one question by the IEPA.

Task 2

The apprentice will be required to complete the installation, testing and commissioning of electrical components and electrical controls of a domestic heating and hot water system, incorporating:

- installing and wiring either a room thermostat or cylinder thermostat (one of which may be pre-installed)
- safe isolation
- testing the system
- commissioning the system.

The apprentice will be asked a minimum of one question by the IEPA.

Task 3

The apprentice will be required to complete servicing and maintenance including fault finding, diagnosis, repair and testing procedures, of the electrical components of a domestic hot water system, incorporating:

- finding 2 electrical faults in the system
- diagnosing the 2 faults
- repairing the 2 faults
- testing the system.

The apprentice will be asked a minimum of one question by the IEPA.

Task 4a

The apprentice will be required to complete the part installation, testing, commissioning and handover of an air source heat pump system, incorporating:

- connecting an air source heat pump to a pre-installed heat distribution system either radiators, underfloor heating or both
- completing the electrical connections, as a minimum, the connection of the heat pump unit to the hydraulic emitter circuit
- testing, commissioning and handing over the system.

The apprentice will be asked a minimum of one question by the IEPA.

Task 4b

The apprentice will be required to complete fault finding, diagnosis, repairing and testing procedures, and then either servicing or maintenance of an air source heat pump system, incorporating:

- finding four faults, including mechanical and electrical, for example:

    - heat pump low pressure trip or alarm activated by a collector circuit malfunction
    - heat pump high pressure trip or alarm activated by an emitter circuit malfunction
    - poor or no collector circuit performance
    - insufficient heat output to emitter circuit
    - domestic hot water heat up is satisfactory, but space heating is not operating
    - system noise
    - system vibration.
- diagnosing the faults
- rectifying the faults
- testing the system
- servicing or maintaining the system.

The apprentice will be asked a minimum of one question by the IEPA.

Task 4c

The apprentice will be required to confirm the suitability of a building for solar thermal system installation from a given scenario and complete the part installation, testing, commissioning and handover of a solar thermal system, incorporating:

- the use of the Microgeneration Certification Scheme (MCS) Solar thermal domestic hot water energy calculator and appendix H of the Standard Assessment Procedure SAP) to calculate the estimated annual fuel saving
- installing key system components on either a fully filled or drain back, ‘active’ solar thermal system to include as a minimum the positioning, fixing and connection of the following components:
    - for a fully filled system:
        - solar collector
        - expansion vessel
        - solar circulating pump and/or pumping station.

    or

    - for a drain back system:
        - solar collector
        - drain back vessel
        - solar circulating pump and/or pumping station .

- connecting the solar thermal collector circuit to the hot water storage and distribution system
- testing, commissioning and handing over the system.

The apprentice will be asked a minimum of one question by the IEPA.

Task 4d

The apprentice will be required to complete fault finding, diagnosis, repairing and testing procedures, then either servicing or maintenance of a solar thermal system, incorporating:

- finding a minimum of two faults, including mechanical and electrical faults, for example:
    - loss of system pressure without evidence of discharge
    - discharge from pressure relief valve on the solar primary circuit
    - insulation melting on solar collector circuit pipework
    - overheating of solar collector circuit
    - lack of circulation within the solar collector circuit
    - poor or no system performance
    - system noise and/or vibration.
- diagnosing the faults
- rectifying the faults
- testing the system
- servicing or maintaining the system.

The apprentice will be asked a minimum of one question by the IEPA.

Assessment location

The practical competence test will take place in a simulated environment at the training provider/employer's premise.

The simulated environment must relate to the apprentice's natural work environment. Equipment and resources must be provided and set up by the provider/employer. The equipment and resources must be in good and safe working condition.

Information about the equipment and resources required and the set up of the test is provided in the Practical Competence Test Resource Pack. The Practical Competence Test Resource Pack must be treated as part of the assessment materials and **must not** be shared with apprentices.

If an apprentice is new to a venue they must be inducted to the assessment area in terms of orientation, evacuation procedures and all health and safety policies and procedures. This does **not** count towards the assessment time.

Administration

The provider/employer must book the practical competence test at least two weeks' in advance.

The IEPA will provide the apprentice with the assessment materials on the day(s) of the assessment.

The provider/employer must provide a dedicated contact for the IEPA. Before the assessment begins the IEPA will confirm that the assessment area has been set up as required. If the IEPA has any concerns they will report to the City & Guilds EPA Team who will make the final decision.

At the end of each task within the practical competence test the IEPA will confirm to the provider/employer that the task is complete; the provider/employer **must** remove/cover any resources to ensure that the assessment is not visible to other apprentices.

Where the assessment task runs over more than one day, at the end of each day the provider/employer **must** cover any resources to ensure that the assessment is not visible to other apprentices and secure the assessment area, eg lock the door.

Grading

The practical competence test is graded Fail or Pass. The practical competence test will be graded against all the grading descriptors mapped to this assessment method. The IEPA is fully responsible for making the grading decision. The results will not be shared with the apprentice on the day of their assessment.

Resits and retakes

An apprentice who fails the practical competence test will be offered the opportunity to resit or retake.

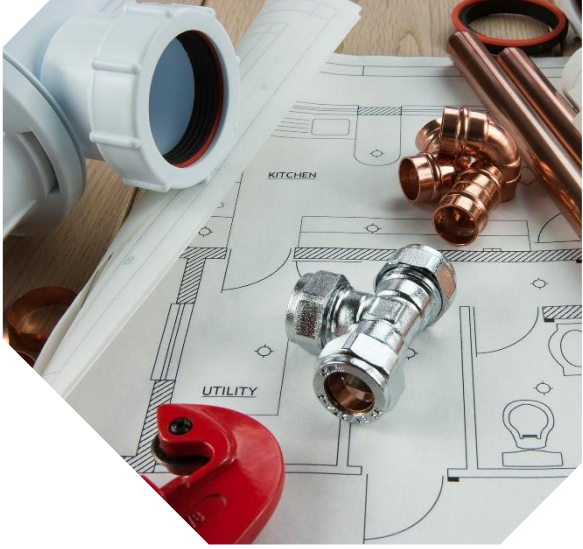
- A resit is where the apprentice takes the assessment again without the need for new learning.
- A retake is where the employer determines new learning is needed first.

The IEPA will observe the apprentice under the same circumstances.

Only those task(s) failed will need to be resat or retaken. The apprentice will be given a different task/set of tasks.

The maximum grade the apprentice can achieve is Pass.

Please see the *Resits and retakes* section for further information.



9. Assessment information: Assessment 4 – Interview underpinned by an apprenticeship portfolio of evidence (9289-704)

Overview

In The Interview Underpinned by an Apprenticeship Portfolio of Evidence (IPE), an IEPA will ask the apprentice questions to give the apprentice the opportunity to demonstrate the KSBs mapped to this assessment method. The apprentice can refer to and illustrate their answers with evidence from their apprenticeship portfolio of evidence.

Rationale

This EPA method is being used because:

- it allows the apprentice to be assessed against KSBs which may not naturally occur during the practical competence test
- it is underpinned by an apprenticeship portfolio of evidence, enabling the apprentice to demonstrate the application of skills and behaviours as well as knowledge
- it allows for testing of responses where there are a number of potential answers that could not be tested through a knowledge test.

Assessment

Grading	P/D/X To achieve a **Pass** the apprentice must achieve a Pass in all grading descriptors. To achieve a **Distinction** the apprentice must achieve Distinctions in all grading descriptors.
Type of assessment	Minimum of 10 questions on the core and minimum of five questions on air source heat pump and solar thermal systems.
Duration	1 hour and 30 minutes The IEPA can increase the time of the assessment by up to 10%. This time is to allow the apprentice to respond to a question if necessary.
Permitted materials	The apprentice's apprenticeship portfolio of evidence and the Evidence Matrix.

Location	The interview will be conducted by video conference.
Resources	A quiet room, free from distractions and interruptions. Access to a computer with video-conferencing software which is tested prior to the assessment starting. The video-conferencing software will be advised at the point of booking.

Assessment specification and grading descriptors

Note: The Grading Descriptor (GD) reference is from the Assessment Plan.

Some learning outcomes have the same grading descriptors.

Core:

Health and safety

KSB: S1 underpinned by K1

Installation and test of domestic rainwater systems

KSB: S3 underpinned by K3, K11

Commissioning and handover

KSB: S6 underpinned by K12

Servicing, maintenance, fault diagnosis and rectification (mechanical parts)

KSB: S8 underpinned by K15, K16

Decommissioning

KSB: S10, S11 underpinned by K14

Technical planning

KSB: S13 underpinned by K6, K8, K9, K17

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
Know and apply health and safety legislation that applies to the building services industry.	Explain how to operate in a safe working manner by adhering to health and safety legislation, approved codes of practice and	GD69 Explains how to operate in a safe working manner by adhering to health and safety	GD69 Explains the importance to individuals and the business of operating safely

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	guidance and applying safe working practices.	legislation, approved codes of practice and guidance and applying safe working practices.	and adhering to health and safety legislation, approved codes of practice and guidance.
Apply personal protection measures.	Understand the purpose of personal protective equipment (PPE). (underpins GD)	GD47 Explain how they apply and use personal protective equipment (PPE) in line with regulatory requirements and company procedures.	GD47 Explain the importance of using PPE correctly and the consequences of not doing so.
	Explain how to apply and use personal protective equipment (PPE).		
	Understand procedures for manual handling. (underpins GD)	GD48 Explain how they carry out correct manual handling in line with industry standards.	GD48, GD49, GD50 Explain the importance of safe manual handling techniques to the individual and the business. Explain the importance of using manufacturers' instructions when using mechanical lifting aids or access equipment.
	Explain how to carry out correct manual handling.		
	Explain how to use mechanical lifting aids.	GD49 Explains how they use mechanical lifting aids in line with manufacturers' instructions.	
Understand and safely use access equipment.	Identify safety checks to be carried out on access equipment. (underpins GD)	GD50 Explain how they use access equipment in line	

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	Explain how to use access equipment.	with manufacturers' instructions.	
Understand and install domestic central heating systems.	Identify typical pipe sizes used in central heating systems types and layouts within dwellings. (underpins GD)	GD66 Explains how to plan central heating systems in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.	N/A
	Identify sources of information required when undertaking work on central heating systems. (underpins GD)		
	Explain how to plan central heating systems.		
Install sanitary appliances and pipework systems.	Identify typical pipe sizes and maximum and minimum distances permitted in sanitary appliances pipework systems within dwellings. (underpins GD)	GD67 Explains how to plan sanitary appliances and pipework system in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.	N/A
	Identify sources of information required when undertaking work on sanitary appliances and pipework systems. (underpins GD)		
	Identify jointing methods used in sanitary		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	appliances pipework systems. (underpins GD)		
	Plan sanitary appliances and pipework systems.		
Understand and install rainwater systems.	Identify working principles of rainwater systems (positioning fixing, connection and operation of components). (underpins GD)	GD51 Explains how to install rainwater systems in-line with manufacturer's guidance and customer requirements.	GD51 Explains how they accommodate changes to customer requirements during installation.
	Identify sources of information required when undertaking work on rainwater systems. (underpins GD)		
	Identify working principles of rainwater recycling systems. (underpins GD)		
	Explain how to install rainwater systems.		
	Explain how to plan rainwater harvesting or greywater reuse systems.	GD68 Explains how to plan rainwater harvesting or greywater reuse systems in line with task requirements, manufacturers' guidance, regulatory	N/A

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
		requirements and industry recognised standards.	
Decommission plumbing and central heating systems.	Explain how to carry out decommissioning of cold water systems in accordance with company procedures.	GD57 Explains how they carry out decommissioning of: a. cold water systems b. hot water systems c. central heating systems d. sanitary appliances and pipework systems e. rainwater systems f. electrical systems in accordance with company procedures.	GD57 Explains the impact of not decommissioning correctly, on the customer and on the business.
	Explain how to carry out decommissioning of hot water systems in accordance with company procedures.		
	Explain how to carry out decommissioning of central heating systems in accordance with company procedures.		
	Explain how to carry out decommissioning of sanitary appliances and pipework systems in accordance with company procedures.		
	Explain how to carry out decommissioning of rainwater systems in accordance with company procedures.		
Understand and perform a soundness test and commission	Identify operational checks required during commissioning. (underpins GD)	GD53 Describes how they carry out	GD53 Justifies their decisions when their

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
cold water systems and components.	Identify the range of information that would be detailed on commissioning documentation. (underpins GD)	commissioning procedures for: a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components e. rainwater systems and components in line with company procedures.	commissioning has found defects.
	Identify actions that must be taken when commissioning reveals defects. (underpins GD)		
	Describe how to carry out commissioning procedures for cold water systems and components.		
	Describe the procedure for handing over to the end user.	GD54 Describes the procedure for handing over to the end user: a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances,	N/A

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
		pipework systems and components e. rainwater systems and components f. electrical control systems and components in line with company procedures.	
Understand and perform a soundness test and commission hot water systems and components.	Identify operational checks required during commissioning. (underpins GD) Identify the range of information that would be detailed on commissioning documentation. (underpins GD) Identify actions that must be taken when commissioning reveals defects. (underpins GD) Describe how to carry out commissioning procedures for hot water systems and components.	GD53 Describes how they carry out commissioning procedures for: a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components e. rainwater systems and components in line with company procedures.	GD53 Justifies their decisions when their commissioning has found defects.

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	Describe the procedure for handing over to the end user.	GD54 Describes the procedure for handing over to the end user: a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components e. rainwater systems and components f. electrical control systems and components in line with company procedures.	N/A
Understand and perform a soundness test and commission central heating systems and components.	Identify operational checks required during commissioning. (underpins GD)	GD53 Describes how they carry out commissioning procedures for:	GD53 Justifies their decisions when their commissioning has found defects.
	Identify the range of information that would be detailed on		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	commissioning documentation. (underpins GD)	a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components e. rainwater systems and components in line with company procedures.	
	Identify actions that must be taken when commissioning reveals defects. (underpins GD)		
	Describe how to carry out commissioning procedures for central heating systems and components.		
	Describe the procedure for handing over to the end user.	GD54 Describes the procedure for handing over to the end user: a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components	N/A

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
		e. rainwater systems and components f. electrical control systems and components in line with company procedures.	
Understand and perform a soundness test and commission sanitary appliances, pipework systems and components.	Identify information sources required to complete testing and commissioning. (underpins GD)	GD53 Describes how they carry out commissioning procedures for: a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components e. rainwater systems and components in line with company procedures.	GD53 Justifies their decisions when their commissioning has found defects.
	Identify operational checks required during commissioning. (underpins GD)		
	Identify the range of information that would be detailed on commissioning documentation. (underpins GD)		
	Identify actions that must be taken when commissioning reveals defects. (underpins GD)		
	Describe how to carry out commissioning procedures for sanitary appliances, pipework		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	systems and components.		
	Describe the procedure for handing over to the end user.	GD54 Describes the procedure for handing over to the end user: a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components e. rainwater systems and components f. electrical control systems and components in line with company procedures.	N/A
Understand and perform a soundness test and commission rainwater systems and components.	Carry out a visual inspection of a rainwater system to confirm that it is ready to be soundness tested. (underpins GD)	GD52 Explains how to carry out a soundness test in-line with	N/A

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	Apply soundness test industry requirements on rainwater systems and components. (underpins GD)	company procedures.	
	Explain how to carry out a soundness test.		
	Identify operational checks required during commissioning. (underpins GD)	GD53 Describes how they carry out commissioning procedures for: a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components e. rainwater systems and components in line with company procedures.	GD53 Justifies their decisions when their commissioning has found defects.
	Identify the range of information that would be detailed on commissioning documentation. (underpins GD)		
	Identify actions that must be taken when commissioning reveals defects. (underpins GD)		
	Describe how to carry out commissioning procedures for rainwater systems and components.		
	Describe the procedure for handing over to the end user.	GD54 Describes the procedure for handing over to the end user:	N/A

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
		a. cold water systems and components b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components e. rainwater systems and components f. electrical control systems and components in line with company procedures.	
Perform fault diagnosis and rectification procedures on cold water systems and components.	Apply methods of obtaining information on system faults. (underpins GD)	GD55 Explain how to carry out identification and rectification procedures and techniques to deal with a range of faults on: a. cold water systems and components	GD55 Justifies their fault-finding approach.
	Carry out diagnostic checks for a range of faults. (underpins GD)		
	Explain how to carry out identification and rectification procedures and techniques to deal with a range of faults.		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
Perform fault diagnosis and rectification procedures on hot water systems and components.	Apply methods of obtaining information on system faults. (underpins GD)	b. hot water systems and components c. central heating systems and components d. sanitary appliances, pipework systems and components e. rainwater systems and components in line with company procedures.	
	Carry out diagnostic checks for a range of faults. (underpins GD)		
	Explain how to carry out identification and rectification procedures and techniques to deal with a range of faults.		
Perform fault diagnosis and rectification procedures on central heating systems and components.	Apply methods of obtaining information on system faults. (underpins GD)		
	Carry out diagnostic checks for a range of faults. (underpins GD)		
	Explain how to carry out identification and rectification procedures and techniques to deal with a range of faults.		
Perform fault diagnosis and rectification procedures on	Apply methods of obtaining information on system faults. (underpins GD)		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
sanitary appliances, pipework systems and components.	Carry out diagnostic checks for a range of faults. (underpins GD)		
	Explain how to carry out identification and rectification procedures and techniques to deal with a range of faults. (underpins GD)		
Perform fault diagnosis and rectification procedures on rainwater systems and components.	Apply methods of obtaining information on system faults. (underpins GD)		
	Carry out diagnostic checks for a range of faults. (underpins GD)		
	Explain how to carry out repair and rectification procedures to deal with a range of faults.		
Understand and carry out service and maintenance on cold water systems.	Understand routine checks required on cold water system components and pipework as part of a periodic maintenance programme. (underpins GD)	GD56 Explain how to carry out: a. service or maintenance of cold water systems b. service or maintenance of hot water systems	N/A
	Explain how to carry out service or maintenance of cold water systems.		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
Understand and carry out service and maintenance of hot water systems.	Understand routine checks required on hot water system components and pipework as part of a periodic maintenance programme. (underpins GD)	c. service or maintenance of central heating systems d. routine checks of sanitary appliances and pipework systems in line with company procedures.	
	Explain how to carry out service or maintenance of hot water systems.		
Understand and carry out service and maintenance on central heating systems.	Understand routine checks required on central heating system components and pipework as part of a periodic maintenance programme. (underpins GD)		
	Explain how to carry out service or maintenance of central heating systems.		
Understand and carry out service and maintenance on sanitary appliances and pipework systems.	Understand routine checks required on sanitary appliances and pipework systems as part of a periodic maintenance programme. (underpins GD)		
	Explain how to carry out routine checks of sanitary appliances and pipework systems.		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
Size and select rainwater harvesting and greywater reuse systems and components for dwellings.	Consider the design requirements for types and layouts of rainwater harvesting systems. (underpins GD)	GD68 Explains how to plan rainwater harvesting or greywater reuse systems in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.	N/A
	Consider the design requirements for types and layouts of greywater reuse systems. (underpins GD)		
	Consider the information requirements used to select, size and position components. (underpins GD)		
	Confirm the pre-installation design requirements. (underpins GD)		
	Calculate rainwater harvesting or greywater reuse system requirements used in dwellings. (underpins GD)		
Size and select central heating systems and components for dwellings.	Consider factors that affect the selection of central heating systems for dwellings. (underpins GD)	GD66 Explains how to plan central heating systems in line with task requirements, manufacturers' guidance,	N/A
	Use information sources required to size and select central heating		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	systems and components. (underpins GD)	regulatory requirements and industry recognised standards.	
	Consider the principles of heat loss and heat gain and how this affects heating requirements. (underpins GD)		
	Calculate central heating system requirements used in dwellings. (underpins GD)		
	Select central heating system components in accordance with calculations from predetermined data. (underpins GD)		
	Interpret information to complete a detailed materials list. (underpins GD)		
	Present calculations and information in a suitable format for quotation and tender. (underpins GD)		
Size and select sanitary appliances	Consider factors that affect the selection of sanitary appliances	GD67	N/A

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
pipework systems and components for dwellings.	pipework systems for dwellings. (underpins GD)	Explains how to plan sanitary appliances and pipework system in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.	
	Use information sources required to size and select sanitary appliances pipework systems. (underpins GD)		
	Calculate sanitary appliance pipework system requirements used in dwellings. (underpins GD)		
	Select sanitary system components in accordance with calculations from predetermined data. (underpins GD)		
	Interpret information to complete a detailed materials. (underpins GD)		
	Present calculations and information in a suitable format for quotation and tender. (underpins GD)		
Size and select rainwater systems components for dwellings.	Consider factors that affect the selection of rainwater systems for dwellings.	GD68 Explains how to plan rainwater harvesting or	N/A

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	(underpins GD)	greywater reuse systems in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.	
	Use information sources required to size and select rainwater systems components. (underpins GD)		
	Calculate rainwater systems requirements used in dwellings. (underpins GD)		
	Select rainwater system components in accordance with calculations from predetermined data. (underpins GD)		
	Interpret information to complete a detailed materials. (underpins GD)		
	Present calculations and information in a suitable format for quotation and tender. (underpins GD)		
Understand and perform pre-installation activity prior to undertaking electrical work on plumbing and domestic heating systems.	Explain how to apply and use personal protective equipment (PPE).	GD47 Explain how they apply and use personal protective equipment (PPE) in line with regulatory requirements and	GD47 Explain the importance of using PPE correctly and the consequences of not doing so.

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
		company procedures.	
Carry out the safe installation, testing, commissioning and decommissioning of electrical systems.	Explain how to carry out decommissioning of electrical systems in accordance with company procedures.	GD57 Explains how they carry out decommissioning of: a. cold water systems b. hot water systems c. central heating systems d. sanitary appliances and pipework systems e. rainwater systems f. electrical systems in accordance with company procedures.	GD57 Explains the impact of not decommissioning correctly, on the customer and on the business.

Core: Professionalism

KSBs: B1, B3, B4, underpinned by K7

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
Professionalism	N/A	Explains how their collaboration and communication with customers	N/A

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
		and colleagues is achieved by acting professionally and upholding ethical principles. Outlines the planned and unplanned learning and development activities they have carried out and shows a commitment to future continued professional development to maintain and enhance competence. Describes how they keep up to date with industry best practice.	

Planning skills

KSB: S27, S28, underpinned by K29, K30, K41, K42

Decommissioning

KSB: S25, S26, underpinned by K35, K36

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
Know what an air source heat pump is, the principle of	Know the purpose and operational	GD71	N/A

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
the vapour compression system and system components. S27 underpinned by K29, K41	characteristics of the following components: • evaporator fan coil • compressor • high pressure switch • condenser • fan • expansion valve • refrigerant four-way valve • de-frost cycle. (associated with GD)	Explains how they plan, size and select heat pump systems in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.	
Know the fundamental principles of heat pump efficiency and design selection that are common for heat pumps. S27 underpinned by K29, K41	Use manufacturers' data to select heat pump units: • output charts • other data. (associated with GD)		
Know the fundamental design considerations that are specific to air source heat pumps. S27 underpinned by K29, K41	Identify the factors that need to be considered when selecting an air source heat pump in relation to: • heat load based on a heat loss calculation based on worst case outside temperature • flow temperature • emitter type • hot water requirements		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	• monovalent, bivalent or hybrid systems. (associated with GD)		
Know the preparatory work required for the installation of an air source heat pump. S27 underpinned by K29, K41	Explain how to plan air source heat pump systems. (associated with GD)		
	Identify the factors that need to be considered when positioning an air source heat pump in relation to: • operating noise and proximity to habitable rooms and neighbouring properties • planning considerations and permitted development • ensuring adequate airflow and clearances. (associated with GD)		
	Identify the factors that need to be considered when wall or floor mounting an air source heat pump. (associated with GD)		
Decommission air source heat pump systems.	Explain how to carry out decommissioning of an air source heat pump system in accordance	GD58 Explain how to carry out decommissioning of:	Explains the impact of not decommissioning correctly on the

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
S25, S26 underpinned by K35, K36	with company procedures.	a. an air source heat pump system b. a solar thermal system in accordance with company procedures.	customer and the business.
Know the purpose of components used within solar thermal system installations. S28 underpinned by K30, K42	Know the purpose of the following solar thermal system components: • differential temperature controller • cylinder sensor(s) • solar collector sensor • drain back vessel • flow meter • flow regulator (mechanical) • expansion vessel. (associated with GD)	GD70 Explains how they plan, size and select solar thermal systems in line with task requirements, manufacturers' guidance, regulatory requirements and industry recognised standards.	N/A
Know the information requirements to enable system component selection and sizing. S28 underpinned by K30, K42	Plan solar thermal systems.		
	Determine the information requirements in relation to: • building design • building dimensions/angles • building location and orientation • building fabric/material details • existing input services		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
	• existing hot water/heating systems.		
Know the fundamental techniques used to select, size and position components for solar thermal systems. S28 underpinned by K30, K42	Determine or use typical domestic hot water system storage vessel requirements in relation to: • daily demand (Vd) (litres/day per person or litres/day per m^2 of floor area) • boiler volume (Vb) • dedicated solar volume (Vs) (litres per m^2 of collector area or as a % or Vd) • total cylinder volume (Vt) • solar heat exchange coli surface area (m^2 of surface area in relation to collector flow rate and collector surface area).		
Know the requirements for installing for solar thermal system pipework. S28 underpinned by K30, K42	Propose suitable pipework materials in relation to: • system operating temperatures • system operating pressures • system chemicals.		
Plan and prepare for the installation of 'active' solar thermal system.	Plan for optimum collection capacity: • the suitability of the building fabric		

Learning outcome	Assessment criteria	Pass grading descriptor	Distinction grading descriptor
S28 underpinned by K30, K42	in relation to the installation of the solar collector panel(s).		
Decommission solar thermal systems. S25, S26 underpinned by K35, K36	Explain how to carry out decommissioning of a solar thermal system in accordance with company procedures.	GD58 Explain how to carry out decommissioning of: a. an air source heat pump system b. a solar thermal system in accordance with company procedures.	Explains the impact of not decommissioning correctly on the customer and the business.

Apprenticeship portfolio of evidence requirements

The apprentice must submit an apprenticeship portfolio of evidence at Gateway.

The apprentice must compile an apprenticeship portfolio of evidence during the on-programme period of the apprenticeship. It should only contain evidence related to the KSBs and grading descriptors that will be assessed by the interview.

The portfolio of evidence will typically contain 10 discrete pieces of evidence. Evidence must be mapped against the KSBs and grading descriptors in the Evidence Matrix provided in the Recording Forms for Providers/employers. Evidence may be used to demonstrate more than one grading descriptor; a qualitative as opposed to quantitative approach is suggested. If the apprentice is using evidence from their on-programme work log, they should review what evidence is submitted for the EPA to ensure it is their best evidence.

Evidence sources may include workplace documentation and records, for example:

- workplace policies and procedures
- witness statements
- annotated photographs

- video clips with a maximum total duration of 10 minutes; the apprentice must be in view and identifiable.

This is not a definitive list; other evidence sources can be included.

The apprenticeship portfolio of evidence must **not** include reflective accounts or any methods of self-assessment.

Any employer contributions should focus on direct observation of performance, for example, witness statements, rather than opinions. The evidence provided should be valid and attributable to the apprentice; the apprenticeship portfolio of evidence must contain a Declaration of Authenticity signed by the employer and apprentice confirming this.

The IEPA will **not** assess the apprenticeship portfolio of evidence directly as it underpins the interview. The IEPA will review the apprenticeship portfolio of evidence to prepare questions for the interview. The IEPA will **not** provide feedback on the apprenticeship portfolio of evidence.

The completed portfolio, including the Declaration of Authenticity and Evidence Matrix must be submitted at Gateway. The submission of a fully completed Evidence Matrix is mandatory.

Apprentice preparation for the interview

Apprentices must prepare for the interview by reviewing their apprenticeship portfolio and how it meets the grading descriptors. The Evidence Matrix shows the grading descriptors grouped into themes. The IEPA's interview questions will be structured around these themes.

Apprentices may not have work-based evidence for every grading descriptor, for example installing rainwater systems; however they must be prepared to answers questions about every grading descriptor.

The IEPA will make the grading decision against all grading descriptors for this assessment method. There are a number of grading descriptors to cover in the interview, so the apprentice must be ready to make the most of the time available.

Assessment instructions

Duration

The assessment duration is 1 hour and 30 minutes.

The IEPA can increase the time by up to 10%. This time is to allow the apprentice to respond to a question if necessary.

Ending the assessment early

The apprentice may choose to end the assessment method early. The apprentice must be confident they have demonstrated competence against the assessment requirements for the assessment method. The IEPA must ensure the apprentice is fully aware of all assessment requirements. The IEPA cannot suggest or choose to end the assessment methods early, unless in an emergency. The IEPA is responsible for ensuring the apprentice understands the implications of ending an assessment early if they choose to do so. The IEPA may suggest the assessment continues. The IEPA must document the apprentice's request to end the assessment early.

Delivery

The interview underpinned by an apprenticeship portfolio of evidence is structured to give the apprentice the opportunity to demonstrate the KSBs and grading descriptors mapped to this assessment method to the highest available grade.

The IEPA:

- will conduct and assess the interview underpinned by an apprenticeship portfolio of evidence individually with each apprentice
- will introduce themselves and their role, explain the format of the interview and give the apprentice the opportunity to ask questions to clarify the requirements
- will ask the apprentice a minimum of 15 questions.

The apprentice must have access to their apprenticeship portfolio of evidence during the interview. The apprentice can refer to and illustrate their answers with evidence from their apprenticeship portfolio of evidence. Apprentices can give examples that have not been included in their portfolio of evidence.

Assessment location

The assessment will be conducted by video conferencing. The apprentice must be in a quiet room, free from distractions and influence.

City & Guilds has processes in place to verify the identity of the apprentice and ensure that the apprentice is not being aided.

Face-to-face assessments can be arranged via the City & Guilds EPA Partnership Manager.

Administration

The provider/employer must book the interview underpinned by an apprenticeship portfolio of evidence at least two weeks' in advance. The IEPA must have at least two weeks to review the portfolio of evidence.

Before the assessment begins the IEPA will confirm that the assessment has been set up as required. If the IEPA has any concerns they will report to the City & Guilds EPA Team who will make the final decision.

Grading

The interview underpinned by an apprenticeship portfolio of evidence is graded Fail, Pass or Distinction. The interview will be graded against all the grading descriptors mapped to this assessment method. The IEPA is fully responsible for making the grading decision. The results will not be shared with the apprentice on the day of the assessment.

Resits and retakes

An apprentice who fails the interview underpinned by an apprenticeship portfolio of evidence will be offered the opportunity to resit or retake.

- A resit is where the apprentice takes the assessment again without the need for new learning.
- A retake is where the employer determines new learning is needed first.

The apprentice may choose to submit an amended portfolio of evidence. This could be a mixture of new evidence and evidence previously submitted. The same requirements apply, including typically providing 10 pieces of evidence and submitting an Evidence Matrix and Declaration of Authenticity. However, the portfolio does **not** need to be resubmitted if no amendments are made to it.

The interview will be carried out in the same way as the original assessment.

The maximum grade the apprentice can achieve is Distinction.

Please see the *Resits and retakes* section for further information.

10. Resits and retakes

Apprentices who fail one or more assessments will be offered the opportunity to take a resit or retake. The apprentice's employer needs to agree that a resit or retake is appropriate.

- A resit is where the apprentice takes the assessment again without the need for new learning.
- A retake is where the employer determines new learning is needed first.

The employer and the EPAO should agree the timescale for a resit or retake.

A resit is typically taken within three months of the EPA outcome notification. The timescale for a retake is dependent on how much re-training is required and is typically taken within six months of the EPA outcome notification.

Failed assessment methods must be resat or retaken within a six-month period from the EPA outcome notification, otherwise the entire EPA will need to be resat or retaken in full.

Resits and retakes are not offered to an apprentice wishing to move from Pass to a higher grade.

The apprentice will get a maximum overall EPA grade of Pass if they need to resit or retake one or more assessment methods, unless the EPAO determines there are exceptional circumstances.

Please see the resits and retakes section for each individual assessment method for further information.

11. Security, confidentiality and copyright of End-point Assessment materials

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- ensure that:

- any EPA Assessment Materials are made accessible to Apprentices only during formal EPA assessment as governed by the assessment conditions specified for the individual Apprenticeship Standard;
- whilst the portfolio of an Apprentice may contain EPA assessment results referenced to the EPA assessment taken from time to time, they do not at any time contain the EPA Assessment Materials, unless otherwise stated in the individual Apprenticeship Standard; and the content of any EPA Assessment Materials is not made public in any format, whether in part or in full, at any time;

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Appendix 1 – Assessment criteria amplification for Knowledge test Paper 1 (9289-300)

Learning outcome 1 – Know and apply health and safety legislation that applies to the building services industry.

Assessment criteria	Content – What needs to be covered
1.1 Identify health & safety legislation in protecting the workforce and members of the public.	The purpose of: • The Health & Safety at Work etc. Act • Construction (Design and Management) Regulations • Confined Spaces Regulations • Control of Asbestos Regulations • Control of Noise at Work Regulations • Control of Substances Hazardous to Health (COSHH) Regulations • Electricity at Work Regulations • Gas Safety (Installation and Use) Regulations • Health & Safety (First Aid) Regulations • Health & Safety (Signs and Signals) Regulations • Lifting Operations and Lifting Equipment Regulations • Manual Handling Operations Regulations • Personal Protective Equipment at Work Regulations • Provision and Use of Work Equipment Regulations (PUWER) • Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) • Work at Height Regulations

1.2 Identify responsibilities of members of the construction team.	• Employers (including employer representatives)
	  ○ compliance with health and safety
	  ○ communication
	  ○ employee welfare
	  ○ training and development
	  ○ employee workplace safety
	  ○ issue and replace personal protective equipment (PPE)
	• Designers
	  ○ design safety considerations
	  ○ compliance with legislation
	  ○ communication of risks
	  ○ site visits and inspections
	• Main contractors
	  ○ health and safety management
	  ○ compliance with legislation
	  ○ risk assessments
	  ○ communication and training
	  ○ site supervision and monitoring
	  ○ coordinating with subcontractors
	  ○ incident reporting and investigation
	  ○ emergency procedures

Assessment criteria	Content – What needs to be covered
	○ welfare facilities • Sub-contractors ○ compliance with legislation ○ risk assessments ○ safe systems of work ○ training and compliance ○ use and supply personal protective equipment (PPE) ○ incident reporting and investigation ○ follow emergency procedures • Employees ○ personal safety ○ safety using equipment ○ risk awareness ○ use of personal protective equipment (PPE) ○ reporting hazards ○ follow emergency procedures • Clients (customers) ○ personal safety ○ appoint designers and contractors ○ provide project information ○ risk awareness ○ compliance with legislation ○ emergency procedures
1.3 Identify the legal status of health and safety guidance materials.	• Non-statutory
1.4 Identify the role of enforcing authorities.	• Inspection • Compliance monitoring and enforcement • Advising • Investigation • Training • Issuing notices • Withdrawing approval • Issuing cautions
1.5 Identify the control measures of inspectors.	• Issuing improvement notices • Issuing prohibition notices • Powers of prosecution • Providing advice and guidance

Learning outcome 2 – Understand hazardous situations working in the building services industry.

Assessment criteria	Content – What needs to be covered
2.1 Identify types of site hazards that may be encountered while at work or by members of the public.	• Trips • Slips • Falls • Burns • Cuts • Falling objects (tools)
2.2 Identify strategies used to prevent accidents during work activities.	• Training • Near miss of accidents reported • Risk assessments • Method statements • Permit to work systems • Safety notices • Construction Skills Certification Scheme (CSCS) card

2.3 Identify how the hazards of some substances and mixtures can be identified from the labels and packaging.	• Pictograms and/or written warnings
	  ○ physical hazards
	  ▪ explosive
	  ▪ flammable gases
	  ▪ oxidising liquids
	  ▪ corrosive
	  ○ health hazards
	  ▪ acute toxicity
	  ▪ skin corrosion/irritation
	  ▪ eye damage/irritation
	  ▪ respiratory/skin sensitisation
	  ○ environmental hazards
	  ▪ hazardous to the aquatic environment

2.4 Identify how to deal with commonly encountered substances including disposal where applicable.	• Lead – solid and fumes
	  ○ dealing with
	  ▪ extractors and ventilation
	  ▪ skin protection
	  ▪ PPE
	  ○ disposal
	  ▪ recycling
	• Substances covered by COSHH
	  ○ dealing with
	  ▪ assess the risk
	  ▪ read the labelling
	  ▪ use PPE
	  ▪ ventilation
	  ▪ training

Assessment criteria	Content – What needs to be covered
	○ disposal ▪ licenced ▪ unlicenced ▪ disposal guidelines ▪ training ▪ personal protective equipment ▪ transportation
2.5 Identify common building materials and services components that may contain asbestos.	• Flue • Soil pipework • Rainwater pipes • Gutters • Tanks and cisterns • Artex • Small gaskets and seals • Bath panels/panelling • Floor tiles
2.6 Identify types of asbestos that may be encountered in the workplace.	• Chrysotile ○ white • Amosite ○ brown or grey • Crocidolite ○ blue
2.7 Identify procedures that must be used to safely work with asbestos cement based materials.	• Complete an asbestos awareness training • Conduct a risk assessment before carrying out the following: ○ wear appropriate PPE ○ set up a controlled work area ○ use warning signs to restrict access ○ handle materials to avoid breakage ○ avoid sanding, drilling or cutting where possible ○ follow emergency procedures for accidental disturbance

Learning outcome 4 – Understand how to respond to accidents.

Assessment criteria	Content – What needs to be covered
4.1 Identify requirements for first aid provision in the workplace.	• First aiders • First aid kit • First aid information • First aid training • Record keeping • Emergency procedures

Assessment criteria	Content – What needs to be covered

4.2 Identify actions that should be taken when an accident or emergency is discovered.	• Actions for accidents in the following order:
	  ○ ensure personal safety
	  ○ raise the alarm
	  ○ evaluate the situation
	  ○ call first aiders
	  ○ contact emergency services
	  ○ record accident
	• Actions for emergencies in the following order:
	  ○ ensure personal safety
	  ○ raise the alarm to evacuate
	  ○ call emergency services
	  ○ assist with evacuation
	  ○ administer first aid
	  ○ go to the assembly point

4.3 Identify procedures for dealing with minor injuries.	• Dealing with cuts in the following order:
	  ○ wash the wound area
	  ○ clean the cut
	  ○ apply first aid
	  ○ seek medical advice
	• Dealing with minor burns and scalds in the following order:
	  ○ cool with water
	  ○ cover the burn
	  ○ avoid creams
	  ○ treat for shock
	  ○ seek medical advice
	• Dealing with objects in the eye in the following order:
	  ○ do not rub
	  ○ wash hands
	  ○ inspect
	  ○ clean with a sterile solution
	  ○ cover the eye
	  ○ seek medical advice
	• Dealing with exposure to fumes in the following order:
	  ○ personal safety
	  ○ evacuate or ventilate area
	  ○ check for breathing
	  ○ loosen clothing
	  ○ seek medical advice

4.4 Identify procedures for dealing with major injuries.	• Procedures in the following order:
	  ○ ensure personal safety
	  ○ assess the situation, assisting if it is safe to do so
	  ○ call for help – first aider
	  ○ contact the emergency services
	  ○ record the incident

Assessment criteria	Content – What needs to be covered

4.5 Identify recording procedures for accidents and near misses at work.	• Statutory requirements for the reporting of accidents/serious occurrences
	• Recording details in the company accident book for minor and major accidents
	• Consider the requirements of RIDDOR
	  ○ death in the workplace
	  ○ fractures
	  ○ amputation
	  ○ serious burns

Learning outcome 6 – Understand how to work safely with heat producing equipment.

Assessment criteria	Content – What needs to be covered

6.1 Identify various types of gases used in pipe jointing processes.	• Propane
	  ○ stored in red bottle
	• Methyl acetylene-propadiene-propane (MAPP) gas
	  ○ stored in yellow bottle
	• Butane
	  ○ stored in blue bottle
	• Oxygen
	  ○ stored in black bottle with a white shoulder
	• Acetylene
	  ○ stored in maroon bottle

6.2 Identify how bottled gases and equipment should be safely transported and stored.	• Transported
	  ○ secured in open top vehicles, containers or trailers
	  ○ vehicles, containers and trailers must be labelled with warning signage
	• Storage
	  ○ bottles and equipment kept upright
	  ○ stored open to the atmosphere
	  ○ positioned away from drains, excavation or trenches
	  ○ kept in a secured location

6.3 Identify various types of heat producing equipment and how to check them for safety.	• Types
	  ○ propane torches
	  ○ oxy-acetylene welding equipment
	• Safety checks
	  ○ inspect gas cylinders
	  ○ inspect hoses and valves
	  ○ check regulators
	  ○ check gauges

Assessment criteria	Content – What needs to be covered
	○ correct storage ○ correctly secured ○ flashback arrestors ○ control valves
6.4 Identify how gas heating equipment is safely assembled and used.	• Assembled ○ inspect components ○ secure cylinders ○ attach regulators ○ check hoses ○ assembly torch ○ test for leaks ○ set pressure • Used ○ ensure adequate ventilation of work area ○ ensure access to fire extinguisher ○ ignite torch safely ○ adjust flame to required heat ○ maintain safe distance from flammable material ○ monitor safe operation of work ○ shut down torch appropriately ○ store equipment safely
6.5 Identify the three elements of the fire triangle and how combustion takes place.	• Elements ○ oxygen ○ heat ○ fuel • Combustion ○ heat raises fuel to its ignition point ○ fuel reacts with oxygen and starts burning ○ combustion continues while heat, fuel and oxygen are all present
6.6 Identify the dangers of working with heat producing equipment and how to prevent fires occurring.	• Dangers ○ fire hazard ○ burns ○ explosions ○ electrical hazards ○ heat stress • Prevention ○ remove combustible materials ○ flame protection ○ maintenance ○ inspection ○ fire extinguishers ○ dampening areas ○ risk assess/hot works permit ○ use of appropriate PPE

Assessment criteria	Content – What needs to be covered

6.7 Identify the method for fighting small, localised fires that can occur in the workplace in order to aid escape.	• Selection of extinguisher by fire type
	  ○ water extinguisher (red label) suitable for class A fires
	  ▪ wood
	  ▪ paper
	  ▪ textiles
	  ○ foam extinguisher (cream label) suitable for class A and B fires
	  ▪ flammable liquids
	  ▪ flammable solids
	  ○ dry powder extinguisher (blue label) suitable for class A, B and C fires
	  ▪ solids
	  ▪ flammable liquids
	  ▪ flammable gases
	  ○ carbon dioxide (CO_2) extinguisher (black label) suitable for Class B and electrical fires
	  ▪ electrical equipment
	  ▪ flammable liquids
	  ○ wet chemical extinguisher (yellow label) suitable for Class F fires
	  ▪ cooking oils and fats
	• Correct use of fire extinguisher
	• Follow evacuation procedures

Learning outcome 7 – Understand and safely use access equipment.

Assessment criteria	Content – What needs to be covered
7.1 Identify situations where it may be necessary to work at height.	• External roof work • Installing and maintaining external soil stack and waste systems • Maintaining rainwater systems • Accessing internal roofs voids and spaces for installation and maintenance

7.2 Identify how to select appropriate access equipment to permit work at heights.	• Types of access equipment
	  ○ step ladders
	  ○ ladders
	  ○ harnesses
	  ○ roof ladders
	  ○ crawling boards
	  ○ mobile tower scaffolds
	  ○ fixed scaffolds
	  ○ mobile elevated work platforms (MEWP)
	• Factors to be considered
	  ○ duration of work

Assessment criteria	Content – What needs to be covered
	○ type of activity ○ the height ○ weather conditions ○ location ○ ground condition ○ weight of tools and equipment to be used ○ number of workers required

Learning outcome 8 – Understand working safely in excavations and confined spaces.

Assessment criteria	Content – What needs to be covered
8.1 Identify situations where it may be necessary to work in excavations and confined spaces.	• Drainage systems • Rainwater harvesting systems • Cold water mains • Work in attic space • Work under timber suspended floor void
8.2 Identify safe working in excavations and confined spaces.	• Safety plan in place • No lone working • Equipping with appropriate PPE • Secure the area • Barrier and vehicle stops • Measurement of the atmosphere inside • Ventilation of the confined area • Authorisation to enter
8.3 Identify dangers associated with excavations and confined spaces.	• Inadequate ventilation • Inadequate lighting • Flooding • Obstruction of an escape route • Explosion • Collapse • Gases • Asphyxiation
8.4 Identify safety measures when working in excavations and confined spaces.	• Warning signs • Barrier stop • Vehicle stops • Permit to work • Use qualified and competent employees

Learning outcome 10 – Know types of plumbing and domestic heating system pipework and their jointing principles.

Assessment criteria	Content – What needs to be covered

10.1 Identify pipework materials and sizes used in dwellings.	• Pipework up to and no greater than 28 mm
	• Copper (BS EN 1057)
	  ○ R220 soft coils
	  ○ R250 half hard lengths
	  ○ R290 hard lengths
	  ▪ carbon steel
	  ▪ stainless steel
	  ▪ corrugated stainless steel
	  ○ medium grade
	• Plastic pipework (hot, cold, heating)
	  ○ polyethylene (MDPE and HDPE)
	  ○ cross linked polyethylene (PEX)
	  ○ polybutylene (PB)
	• Plastic pipework (underfloor heating)
	  ○ PE-RT (underfloor heating)
	  ○ plastic – metal composite or multilayer pipe for underfloor heating
	• Plastic pipework (sanitary pipework up to and no greater than 110 mm)
	  ○ PVC-u
	  ○ polypropylene
	  ○ PVC-mu
	  ○ ABS
	• Lead

10.2 Identify fitting types used in dwellings.	• Couplers • Elbows and bends • Equal tees • Reducing tees • Reducers • Tap connectors • Flexible connectors • Manifolds • Tank connectors • Stop ends • Union

10.3 Identify methods of jointing pipework.	• Copper pipe
	  ○ solder integral ring and end feed
	  ○ compression
	  ▪ type A
	  ▪ type B
	  ○ push-fit
	  ○ press-fit

Assessment criteria	Content – What needs to be covered

	• Carbon steel, stainless steel
	  ○ press-fit
	  ○ compression
	• Corrugated stainless steel
	  ○ compression
	• Low carbon steel (LCS) pipe
	  ○ threaded
	  ○ compression
	• Plastic/composite pressure pipe
	  ○ push fit
	  ○ compression
	  ○ proprietary – copper and MDPE
	• Plastic jointing for sanitary pipework
	  ○ ring seal
	  ○ compression
	  ○ solvent weld
	• Lead
	  ○ proprietary fitting

10.4 Identify methods of bending pipework.	• Copper/carbon steel/stainless steel machine bending
	  ○ 90º bends
	  ○ sets and offset bends
	  ○ passover bends
	• Copper spring bend
	  ○ 90º bends
	  ○ sets and offset bends
	• LCS hydraulic bending machine
	  ○ 90º bends
	  ○ sets and offset bends
	  ○ passover bends
	• Plastic/composite pressure pipe
	  ○ spring bend
	  ○ cabling technique
	  ○ cold forming bend
	  ○ minimum bend radius

Learning outcome 12 – Understand and use clips and brackets to support plumbing and domestic heating pipework and components.

Assessment criteria	Content – What needs to be covered

12.2 Identify types of fixing devices.	• Nails
	  ○ for timber
	  ○ for masonry
	• Screws
	  ○ slotted head
	  ○ Phillips head
	  ○ Pozidrive
	  ○ torx
	  ○ hex
	• Plastic plugs
	• Heavy duty fixings
	  ○ coach bolts
	  ○ rawlbolts
	• Cavity fixings
	• Drive in fixings
	• Chemical fixing
	• Channel fixings
	• Concrete screws

12.3 Identify clip and bracket types.	• Clips
	  ○ saddle clips
	  ○ stand-off plastic clips
	  ○ school board clips
	• Brackets
	• Munsen rings

Learning outcome 14 – Understand units of measurement used in the plumbing and domestic heating systems industry.

Assessment criteria	Content – What needs to be covered
14.1 Identify internationally recognised (SI) units of measurement.	• Pressure – pascal (Pa) • Length – metre (m) • Mass – kilogram (kg) • Time – second (s) • Temperature – kelvin (K) • Electric current – ampere (A)

14.2 Identify the application and use of SI derived units.	• Pascal (Pa)
	  ○ pressure
	  ▪ pressure vessel
	  ▪ sealed systems

Assessment criteria	Content – What needs to be covered

	• Velocity (m/s)
	  ○ speed
	  ▪ flow of water in pipeworks
	• Area (m^2)
	  ○ size
	  ▪ heat loss
	  ▪ rainwater intensity
	  ▪ underfloor heating design
	• Volume (m^3)
	  ○ capacity
	  ▪ storage
	  ▪ expansion
	  ○ consumption
	  ▪ water storage
	  ▪ gas
	  ▪ flush
	• Length (mm and cm)
	  ○ area of floor

14.3 Identify the use of conversion tables for non-SI units.	• Converting non-SI units to SI units • Ensuring accuracy to minimise the chance of calculation errors • Technical measurements • Comparison • Consistency

Learning outcome 15 – Understand properties of materials.

Assessment criteria	Content – What needs to be covered

15.1 Identify relative densities of common materials.	• Aluminium
	  ○ 2.7
	• Copper
	  ○ 8.9
	• Lead
	  ○ 11.3
	• PVCu
	  ○ 1.35

15.2 Identify properties and applications of solid materials.	• Pure metals
	  ○ properties
	  ▪ high electrical conductivity
	  ▪ high malleability
	  ▪ ductility

Assessment criteria	Content – What needs to be covered
	○ application ▪ copper ☐ electrical wiring ☐ water pipes ☐ earthing – copper rods ▪ connectors and terminals • Ferrous metals ○ properties ▪ high strength ▪ magnetic ▪ corrosion-prone ▪ hardness ○ application ▪ baths ▪ radiators • Alloys including solders ○ properties ▪ enhanced strength ▪ corrosion resistance ▪ hardness ▪ low melting point ○ application ▪ fittings ▪ solder ▪ valves ▪ taps • Thermoplastics ○ properties ▪ lightweight ▪ malleable when heated ▪ good insulators ▪ hardness ▪ resistant to chemicals ○ application ▪ pipework ▪ insulation • Thermo-setting plastics ○ properties ▪ rigid ▪ strong ▪ heat resistant ▪ durable ○ application ▪ worktops ▪ countertops

Assessment criteria	Content – What needs to be covered
	▪ electrical sockets • Fireclays/ceramics o properties ▪ heat resistance ▪ hard ▪ brittle ▪ corrosion resistant o application ▪ sanitaryware
15.3 Identify why solid materials breakdown.	• Atmospheric corrosion • Oxidisation of metals • Ultraviolet (UV) damage to plastics • Heat damage to plastics • Electrolytic corrosion • Electromotive series • Dissimilar metals in the presence of an electrolyte (water) • Erosion corrosion
15.4 Identify methods of preventing corrosion.	• Internal o inhibitor • External o paint o tape o coating
15.5 Identify applications of liquids and gases.	• Liquids o water ▪ plumbing systems ▪ hydraulic systems o anti-freeze/glycol mixes ▪ HVAC systems ▪ solar water heating systems ▪ industrial cooling systems ▪ geothermal systems ▪ refrigeration systems o fuel oils ▪ heating appliances ▪ power generation ▪ diesel engines o lubricants/greases ▪ construction equipment ▪ HVAC systems o biocides ▪ water treatment ▪ cooling systems

Assessment criteria	Content – What needs to be covered

	• Gases
	  ○ air and steam
	  ▪ cooling
	  ▪ pneumatic systems
	  ○ Liquefied Petroleum Gas (LPG)
	  ▪ cooking
	  ▪ heating
	  ○ natural gas
	  ▪ cooking
	  ▪ heating
	  ○ carbon dioxide
	  ▪ fire extinguishers
	  ▪ freezing
	  ○ refrigerants gases
	  ▪ heat pumps

15.6 Identify basic properties of liquids.	• Liquid has a fixed volume • No fixed shape • Cannot be compressed • Low density compared to solids • Different boiling points • Different freezing points
15.7 Identify basic properties of gases.	• Easy to compress • Expands to fill their container • Lower density than liquids and solids • Exerts pressure equally in all directions • Gas behaviour changes with high temperature

Learning outcome 16 – Understand the relationship between energy, heat and power.

Assessment criteria	Content – What needs to be covered
16.1 Identify the relationship between the Celsius and Kelvin temperature scales.	• One unit increase in the Kelvin scale is the same as a one-degree increase in the Celsius scale • Converting from Kelvin to Celsius involves subtracting 273.15 from the given temperature in Kelvin
16.2 Identify the principles associated with a change of state.	• Melting • Freezing • Boiling • Evaporating • Condensing

Assessment criteria	Content – What needs to be covered

16.3 Identify the terms latent and sensible heat as they apply to liquids and gases.	• Latent heat
	  ○ the heat that is needed to change the state of a substance without changing its temperature or pressure
	• Sensible heat
	  ○ the amount of heat or energy needed to change the temperature of the substance without changing the phase of the substance

16.4 Identify methods of heat transfer.	• Conduction • Convection • Radiation

16.5 Identify how units of energy and heat are related and derived.	• Energy and heat are related
	  ○ the units of energy is joule (J). Since heat is a form of energy, its SI unit is also joule
	• Energy and heat are derived
	  ○ energy derived from heat refers to the extraction to energy from a source of heat, through applying temperature

16.6 Carry out heat, energy and power calculations.	• Heat
	  ○ specific heat capacity x mass x temperature rise = heat kJ
	• Energy
	  ○ specific heat capacity x mass x temperature rise = energy kJ
	• Power
	  ○ specific heat capacity x mass x temperature rise
	  ---------- = power kW
	  Seconds in an hour

Learning outcome 17 – Understand principles of force and pressure and their application in the plumbing and domestic heating systems industry.

Assessment criteria	Content – What needs to be covered
17.1 Identify the units of force and pressure derived from SI units.	• Acceleration (m/s^2) • Force – Newton (N) • Pressure (N/m^2) • Atmospheric pressure – Pascal (Pa)

17.2 Identify pressure and flow rate units of measurements.	• Pressure
	  ○ Bar/millibar
	  ○ kPa
	  ○ Psi
	  ○ metre head

Assessment criteria	Content – What needs to be covered

	• Flow rate
	  ○ m^3/s
	  ○ l/s
	  ○ kg/s

17.3 Identify the application of pressure and flow rate measurements.	• Pressure
	  ○ pressure gauge
	• Flow rate measurements
	  ○ weir cup

17.4 Carry out simple force and pressure calculations.	• Force
	  ○ Mass (kg) x 9.81 m/s^2 = Newtons (force)
	• Pressure
	  ○ 1 m = 10 kpa/ 0.1 bar
	  ○ Head (m) x Kilopascals (kpa) = pressure

17.5 Identify the relationship between velocity, pressure and flow rate in systems.	• Pressure and flow rate
	  ○ when pressure increases, so does flow rate, as long as other variables remain constant
	• Velocity and pressure
	  ○ when velocity increases, pressure decreases, and when velocity decreases, pressure increases
	• Flow rate and velocity
	  ○ flow rate is the product of velocity and the cross-sectional area through which fluid flows

17.6 Identify how restrictions in the pipework effects the flow of liquids and gases.	• Reduced flow capacity • Increase pressure loss • Increase noise • Reduced waterfall • Increased void friction
17.7 Identify the principles of a siphon.	• Gravity pulls down on the taller column of liquid in a siphon, creating a lower pressure at the top • The pressure difference between the ends of the siphon causes the liquid to flow • Cohesive forces prevent the liquid column from separating under its own weight

Learning outcome 18 – Understand mechanical principles in the plumbing and domestic heating systems industry.

Assessment criteria	Content – What needs to be covered

18.1 Identify principles of simple machines.	• Levers
	  ○ pivots on a fulcrum and moves a load on the other end
	• Pulleys
	  ○ a simple machine which is made up of wheels and ropes to lift or move loads
	• Archimedes screws
	  ○ a helical screw inside a hollow pipe, which, when rotated, lifts water from a lower level to a higher level
	• Inclined planes
	  ○ an inclined plane is a ramp that allows a load to move to a higher level with less force than lifting it vertically

18.2 Identify principles of basic mechanics.	• Theory of moments • Action and reaction • Centre of gravity • Equilibrium • Velocity and ratio

Learning outcome 19 – Understand principles of electricity in the plumbing and domestic heating systems industry.

Assessment criteria	Content – What needs to be covered
19.1 Identify basic principles of electron flow theory.	• Alternating current (AC) and direct current (DC) • The flow of electrons is from negative to positive • Electric current creates its own magnetic field around the wire • Magnetic lines have direction and change direction when the current flow changes in the wire from one direction to another • As current increases the field strengthens

19.2 Identify the purpose and application of simple units of electrical measurement.	• Current (Amps)
	  ○ purpose
	  ▪ helps determine the appropriate wire sizes
	  ▪ ensures that circuits do not exceed safe current levels
	  ▪ indicates the power consumption
	  ○ application
	  ▪ unit of electrical measurement
	  ▪ measuring and managing electric current

Assessment criteria	Content – What needs to be covered

	• Voltage (Volts)
	  ○ purpose
	  ▪ energy transfer delivered to an electrical device or load.
	  ▪ driving current through a circuit
	  ▪ power distribution delivering to devices
	  ○ application
	  ▪ household voltage supply
	  ▪ measurement used for test equipment
	  ▪ high-voltage transmission along distances
	  ▪ determining battery compacity
	• Resistance (Ohms)
	  ○ purpose
	  ▪ used to control the flow of current in electrical circuits
	  ▪ prevent excessive current from flowing, protecting devices from overheating or short circuits
	  ○ application
	  ▪ resistors in electrical circuits
	  ▪ resistance is used in temperature sensors (thermistors)
	• Power (Watts)
	  ○ purpose
	  ▪ measuring the rate of energy consumed
	  ▪ measuring the rate of energy produced
	  ○ application
	  ▪ rating of electrical appliances and devices
	  ▪ to evaluate the power ratings of portable devices and batteries

19.3 Carry out simple electrical calculations.	• Current
	  ○ I = V x R
	• Resistance
	  ○ R = V ÷ I
	• Power
	  ○ P = V x I
	• Voltage
	  ○ V = R ÷ I
	• Amps
	  ○ A = W ÷ V

19.4 Identify the requirements for earthing of electrical circuits.	• Diverts current to the ground • Overcurrent protection • Equipment protection

Assessment criteria	Content – What needs to be covered

19.5 The testing and commissioning requirements applicable to electrical control systems and components.	• Wiring integrity check
	  ○ inspect all electrical connections against wiring diagrams to verify correct installation and secure terminations
	  ○ ensure appropriate cable types and ratings are used, adhering to safety standards
	• Electrical safety checks
	  ○ polarity check
	  ▪ verify correct polarity at all outlets, controls and motorized valves to ensure safe operation
	  ▪ check that Live (L), Neutral (N) and Earth (E) are correctly wired in all components
	  ○ earth continuity test
	  ▪ test continuity between exposed metal parts and the main earth terminal
	  ▪ confirm earth bonding complies with current wiring regulations
	  ○ earth loop impedance test
	  ▪ measure the earth fault loop impedance to ensure a low-resistance path for fault currents, allowing protective devices to trip effectively
	  ○ insulation resistance test (IR Test)
	  ▪ apply 500 volt DC between Live/Neutral conductors and Earth to check for insulation breakdown
	  ▪ minimum acceptable reading: 1 MΩ (per current wiring regulations)
	• Control system functionality
	  ○ thermostats and timers
	  ▪ verify correct operation of room and cylinder thermostats by adjusting setpoints and observing system response
	  ▪ ensure timers/programmers switch circuits on/off as scheduled
	  ○ motorized valve operation
	  ▪ check the correct movement of 2-port (S plan) or 3-port (Y plan) valves
	  ▪ confirm valves respond to control signals and isolate zones correctly
	  ○ boiler interlocks
	  ▪ ensure controls like thermostats and valves provide a proper interlock to prevent boiler dry-firing or unnecessary operation
	• Performance and final electrical checks
	  ○ voltage supply verification
	  ▪ measure supply voltage at key points (boiler, controls) to ensure it falls within manufacturer tolerances

Assessment criteria	Content – What needs to be covered
	○ load testing ▪ simulate operational load conditions to confirm stability under normal running currents ▪ monitor for abnormal voltage drops or overcurrent ○ functional safety testing ▪ simulate fault conditions • Documentation and compliance ○ test results log ▪ record all test results for compliance and future maintenance ○ labelling and identification ▪ ensure all key circuits and control elements are correctly labelled ○ handover pack ▪ provide the end-user with system schematics, test certificates and operation manuals

Learning outcome 20 – Know the sources of renewable and non-renewable energy.

Assessment criteria	Content – What needs to be covered
20.1 Identify the different types of non-renewable energy.	• Gas • Oil • Solid fuel (mineral)
20.2 Identify the different types of renewable energy.	• Electricity generated by renewable energy sources ○ solar ○ wind ○ hydro ○ geothermal • Solid fuel (biomass) • Hydrogen
20.3 Identify the effects of using renewable and non-renewable energy sources.	• Renewable ○ reduced greenhouse emissions ○ lower pollution ○ sustainable resources ○ reduced energy cost • Non-renewable ○ global warming ○ increase air pollution ○ increased greenhouse emissions ○ not sustainable ○ high energy cost

Learning outcome 21 – Know current energy efficiency advice and guidance.

Assessment criteria	Content – What needs to be covered
21.1 Identify the benefits of energy efficient products, services and equipment.	• Reduction in greenhouse gas • Reduction in pollution • Waste reduction • Lower energy demand • Improved carbon footprint • Economic benefits

21.2 Identify the key factors of the Building Regulations and Guidance that apply to energy efficiency.	• Document L Volume 1 Dwellings
	  ○ conservation of fuel and power
	• Document L Volume 2 Buildings other than Dwellings
	  ○ conservation of fuel and power
	• Domestic Building Services Compliance Guide
	  ○ installation of energy efficient systems
	• Non-domestic Building Services Compliance Guide
	  ○ installation of energy efficient systems
	• PAS 2035
	  ○ covers retro fit

Learning outcome 22 – Know the role of the construction team within the plumbing and domestic heating systems industry.

Assessment criteria	Content – What needs to be covered
22.1 Identify key roles of the site management team.	• Architect • Project manager • Clerk of works • Structural engineer • Surveyor • Building services engineer • Quantity surveyor • Buyer • Estimator • Contracts manager • Site manager • Health and safety manager • Client; as part of the construction design and management (CDM)

Assessment criteria	Content – What needs to be covered
22.2 Identify key roles of the site operatives.	• Supervisor • Manager • Building services engineer • Heating engineer • Plumber • Gas engineer

22.3 Identify common site visitors.	• Inspectors
	  ○ building control
	  ○ water
	  ○ HSE
	  ○ electrical services
	• Members of the public
	• Delivery drivers
	• Clients

Learning outcome 24 – Know how to communicate with others.

Assessment criteria	Content – What needs to be covered
24.1 Identify methods for effective communication with individual's needs.	• Listening • Feedback • Verbal communication • Written communication • Visual aids • Adaptive and inclusive communication
24.2 Identify suitable communication methods.	• In person • Online • Telephone • E-mail • Letter • Text messaging • Social media
24.3 Identify appropriate actions to deal with conflicting parties.	• Mediation • Negotiating • Compromising • Escalation
24.4 Identify the effects of poor communication with individuals.	• Misunderstandings • Errors • Frustration • Reduced productivity • Low morale • Delays

Assessment criteria	Content – What needs to be covered
	• Dissatisfaction • Potential safety issues • Loss of reputation

Learning outcome 25 – Understand responsibilities of relevant people in the building services industry.

Assessment criteria	Content – What needs to be covered
25.1 Identify different types of client.	• Private customer • Contracting customer • Internal customer within same company • Public sector customer
25.2 Identify what may be communicated to the client through the progress of a job.	• Updates • Issues • Changes • Costs to date vs budget • Quality control • Safety compliance • Client decisions • Date adjustments • Recommendations

25.3 Identify duties and methods for supervising staff.	• Duties
	  ○ guiding and directing staff
	  ○ monitoring performance
	  ○ maintaining workplace discipline
	  ○ motivating and supporting staff
	  ○ managing workflow and deadlines
	  ○ handling conflicts and resolving issues
	  ○ reporting to senior management
	• Methods
	  ○ direct supervision
	  ▪ overseeing work, with immediate feedback and guidance
	  ○ delegation and trust-based supervision
	  ○ regular performance reviews and feedback
	  ○ staff training and development
	  ○ use of technology for supervision
	  ○ encouraging open communication
	  ○ lead by example

Learning outcome 26 – Understand and produce work programme for tasks in the plumbing and domestic heating systems industry.

Assessment criteria	Content – What needs to be covered

26.1 Identify types of projects.	• Private installation work
	• Private service/maintenance work
	• New-build installation contract work
	• Service/maintenance contract work
	  ○ planned
	  ○ reactive

26.3 Identify the impact when materials are not delivered on time against the work programme.	• Alteration of work schedule • Late delivery of materials • Possible extra work • Additional cost
26.4 Identify factors which affect working time allocation to work activities.	• Labour resources • Planning work with other trades • Material deliveries

Learning outcome 28 – Understand cold water supply to dwellings.

Assessment criteria	Content – What needs to be covered
28.1 Identify the key stages in the rainwater cycle.	• Evaporation • Condensation • Precipitation

28.2 Identify the various sources of water and the typical properties of water from those sources.	• Surface sources
	  ○ lakes and reservoirs
	  ▪ contains low to moderate mineral content
	  ▪ has organic matter, sediments and biological organisms
	  ○ rivers and streams
	  ▪ more oxygenated compared to lakes
	  ▪ lower mineral content compared to groundwater
	• Underground sources
	  ○ deep and shallow wells
	  ▪ free from biological contaminants but may contain dissolved gases like hydrogen sulphide
	  ○ artesian wells
	  ▪ high in mineral content due to long underground flow

Assessment criteria	Content – What needs to be covered
	○ boreholes ▪ water is usually mineral-rich and free from biological contamination ○ springs ▪ clean and free from pathogens ▪ mineral content varies based on rock composition • Harvested rainwater ○ low in minerals • Recycled greywater ○ contains organic matter, soap residues, and minor contaminants
28.3 Identify the types of water supply to dwellings and how these are regulated.	• Mains ○ The Water Supply (Water Fittings) Regulations 1999 • Private ○ The Private Water Supplies (England) Regulations 2016
28.4 Identify the different types of water and uses of water in dwellings.	• Wholesome water ○ drinking water ○ general use ○ food preparation • Unwholesome water (stored) ○ flushing toilets ○ washing clothes ○ washing cars ○ watering plants and gardens ○ hot water storage
28.5 Identify the mains water treatment processes and typical mains water distribution system from treatment works to property.	• Treatment ○ screening ○ coagulation and flocculation ○ sedimentation ○ filtration ○ disinfection ○ reverse osmosis • Distribution system ○ treatment works ○ storage reservoirs ○ pumping stations ○ trunk mains ○ distribution mains ○ service reservoirs ○ water mains
28.6 Identify the private supply	• Pre-treatment (screening and sedimentation) • Filtration • Disinfection • pH adjustment

Assessment criteria	Content – What needs to be covered

water treatment processes.	• Water softening
	  ○ ion exchange
	  ○ reverse osmosis

28.7 Identify water treatment processes and typical supply pipework and storage systems utilising harvested rainwater and recycled greywater.	• Treatment
	  ○ pre-treatment
	  ▪ screening
	  ▪ sedimentation
	  ○ biological treatment
	  ○ filtration
	  ○ disinfection
	• Supply pipework and storage systems
	  ○ storage tanks
	  ○ treatment units
	  ○ pipework
	  ○ pumps

28.8 Identify water service to the property and isolation points.	• Connection methods to the main
	• Communication pipe detail
	• Service pipe detail
	  ○ main external stop valve location
	  ○ installed at a depth of 750 mm – 1350 mm
	• Meter housings
	• Pump installations
	• Installation requirements
	• Methods of entry of the service pipework to a property
	  ○ insulated
	  ○ ducted
	  ○ sealed at both ends

28.9 Identify the requirements to provide water whilst preventing waste, undue consumption, misuse or contamination.	• Preventing waste
	  ○ leak prevention
	  ○ efficient appliances
	  ○ water meter
	• Undue consumption
	  ○ regulated supply pressure
	  ○ timers and controllers
	• Misuse or contamination
	  ○ mechanical backflow protection
	  ○ no-mechanical backflow protection

Learning outcome 29 – Understand and recognise the layouts of plumbing and domestic heating systems.

Assessment criteria	Content – What needs to be covered

29.1 Identify types and layout features of cold water systems in dwellings.	• Wholesome water supply
	  ○ direct cold water system
	  ▪ all outlets fed from a rising main
	  ○ indirect cold water system
	  ▪ outlets fed from the same cistern
	  ○ direct booster
	  ▪ pumps connected to the mains with no cistern at ground level
	  ○ indirect boosted
	  ▪ Incorporate a break cistern and pumps
	• Unwholesome water supply
	  ○ harvested rainwater system
	  ▪ water collected in a storage tank and fed by gravity to the point(s) of use
	  ▪ water collected in a storage tank and pumped directly to the point(s) of use
	  ▪ water collected in a storage tank and pumped to an intermediate cistern and fed by gravity to the point(s) of use
	  ○ greywater reuse system
	  ▪ takes water from domestic appliances to flush WC

29.2 Identify the types and layout features of hot water systems in dwellings.	• Direct vented cylinder
	  ○ centrally located and supplies to all outlets in the property
	  ○ heated with an immersion heater directly via a boiler
	  ○ does not have a coil
	  ○ water is stored in a large cylinder
	• Indirect vented cylinder
	  ○ centrally located and supplies water to all outlets in the property
	  ○ passes hot water through a coil
	  ○ water is heated by an external boiler or heat source
	  ○ water is stored in a large cylinder
	• Thermal store
	  ○ high pressure
	  ○ no storage cistern
	  ○ passes cold water through a coil
	  ○ supplies water to one outlet or appliance
	• Combination boiler
	  ○ is connected to radiators
	  ○ instantaneous hot water
	  ○ does not store water
	  ○ does not have a coil

Assessment criteria	Content – What needs to be covered
	○ supplies water to all outlets in the property • Multi-point heater ○ small unit that supplies water to multiple appliances ○ does not have a coil ○ instantaneous hot water • Single-point (point of use) water heater ○ small unit that supplies hot water to a tap/single appliance which is located near by ○ instantaneous hot water
29.3 Identify the types and layout features of domestic central heating systems.	• Types ○ wet central heating ▪ open vented heating systems for heat only boiler ○ sealed heating systems ▪ system boiler ▪ combination boiler ○ warm air ○ storage heaters ○ heat networks (district heating) ▪ heat interface unit • Layout ○ one pipe ▪ one pipe forming a loop connected to each side of a radiator ○ two pipe ▪ consists of a separate flow and return pipe to each radiator ○ three pipe ▪ all radiators are connected together ○ manifold (micro and minibore) ▪ each radiator is supplied from a central manifold with individual pipes connected to each radiator ○ underfloor heating ▪ closed-loop pipework system that circulates warm water beneath the floor surface to heat a room evenly ○ configuration ▪ pumped heating gravity hot water ▪ fully pumped, 2 × two port valves (S plan) ▪ fully pumped, 3 × two port valves (S plan+) ▪ fully pumped, 3-port valve (mid position/diverting) (Y/W plans) ▪ fully pumped with a low loss header

Assessment criteria	Content – What needs to be covered

29.4 Identify the types and layout features of sanitary pipework systems.	• primary ventilated stack system
	  ○ contains one vertical pipe which vent/terminates to the atmosphere
	• secondary ventilated stack system
	  ○ two vertical pipes which both vent/terminate to the atmosphere (all vents are outside)
	• ventilated branch stack system
	  ○ contains two vertical pipes connected to the branch pipework which vent/terminates to the atmosphere
	• stub stack system
	  ○ one vertical pipe which vent/terminates above the appliance in the same room

29.5 Identify the types and layout features of rainwater systems: pipe (RWP) and gutter.	• Pipe (RWP)
	  ○ round section
	  ○ square section
	• Gutter
	  ○ half round
	  ○ square
	  ○ ogee
	  ○ high capacity

Learning outcome 30 – Understand and install cold water systems.

Assessment criteria	Content – What needs to be covered

30.1 Identify fluid categories of water and uses of water supplied to dwellings.	• Fluid Category 1 – wholesome water – no health risk
	  ○ drinking and culinary purpose water
	  ○ general use
	• Fluid Category 2 – slight impairment
	  ○ hot water
	  ○ stored cold water
	• Fluid Category 3 –slight health hazard
	  ○ domestic washing machine
	  ○ dishwasher
	  ○ central heating water
	  ○ hose pipes
	  ○ garden use
	• Fluid Category 4 – significant health hazard
	  ○ irrigation
	  ○ industrial cleaning
	• Fluid Category 5 – serious health hazard
	  ○ drainage water
	  ○ sewage systems

Assessment criteria	Content – What needs to be covered

30.2 Identify the advantages and disadvantages of cold water systems.	• Direct cold water systems (mains and private supplies)
	  ○ advantages
	  ▪ water quality
	  ▪ easier to install
	  ▪ lower installation cost
	  ▪ no stagnant water
	  ▪ high pressure system
	  ○ disadvantages
	  ▪ not easy to install
	  ▪ no backup supply
	  ▪ potential noise
	  ▪ not suitable for low pressure components
	  ▪ demand can reduce pressure
	• Indirect cold water systems (mains and private supplies)
	  ○ advantages
	  ▪ back supply
	  ▪ less noisy
	  ▪ low operating pressure
	  ▪ consistent pressure
	  ○ disadvantages
	  ▪ contamination
	  ▪ space
	  ▪ cost to install
	  ▪ low pressure system
	  ▪ high maintenance
	• Rainwater harvesting and greywater reuse
	  ○ advantages
	  ▪ reduces reliance on mains water
	  ▪ reduces water bills over time
	  ▪ eco-friendly
	  ▪ can be used in multiple applications
	  ▪ reduces soil erosion and flooding
	  ○ disadvantages
	  ▪ high initial cost of setup
	  ▪ poor water quality
	  ▪ limited supply
	  ▪ storage space needed
	  ▪ potential contamination

30.4 Identify working principles of cold water systems, positioning fixing, connection and operation of components.	• Cold water systems
	  ○ delivering potable water to taps, toilets and appliances
	  ○ direct system (mains-fed system)
	  ▪ water is supplied directly from the mains to all fixtures
	  ○ indirect system (storage cistern system)
	  ▪ water is first stored in a cold water storage cistern (usually in the loft)
	  ▪ gravity supplies water to outlets water to outlets

Assessment criteria	Content – What needs to be covered
	▪ one outlet remains directly from mains supply • Positioning fixing, connection and operation of components o mains water inlet entry point for water from service pipe supply ▪ located at ground level, typically near the main stopcock ▪ connects to the main water meter and stop valve o stop valve (main shut-off valve) ▪ controls water supply to the house ▪ installed at the main entry point inside the building ▪ operated manually to turn water on/off for maintenance o cold water storage cistern (for indirect systems) ▪ stores water for gravity-fed distribution ▪ positioned in lofts or high spaces for gravity pressure ▪ connected to the mains via a float-operated inlet valve to maintain water level o float valve (ball valve) ▪ regulates water entry into the storage tank ▪ inside the cold water cistern ▪ opens/closes based on water level o overflow pipe ▪ prevents overflow in case of float valve failure ▪ connected from storage cistern to an external point ▪ water flows out if the cistern overfills o distribution pipework ▪ delivers water to fixtures (taps, toilets, appliances) ▪ runs from the cistern or mains to fixtures ▪ concealed under floors/walls ▪ uses copper, PVC or PEX pipes with compression or push-fit joints o gate/service valves controls ▪ supply to individual appliances ▪ near each major water outlet (bath, sink, toilet) ▪ allows maintenance without shutting off the entire supply o taps and fixtures ▪ dispense cold water at the point of use ▪ installed at sinks, baths and outdoor locations ▪ connected to pipework with standard threaded or compression fittings o pressure reducing valve (PRV) ▪ regulates water pressure to prevent damage ▪ installed on the main supply line or before appliances ▪ automatically adjusts pressure based on flow

Assessment criteria	Content – What needs to be covered
	○ check valve (non-return valve) ▪ prevents backflow contamination ▪ fitted in appliances like washing machines, dishwashers ▪ ensures one-way water flow to avoid contamination risks • Non-potable cold water supplies (unwholesome) ○ rainwater harvesting ▪ rainwater is collected from surfaces ▪ it passes through gutters and downpipes into a storage system ▪ filtration removes debris, leaves and sediments before storage ▪ water is stored in an above-ground or underground tank ▪ a pump system (or gravity) distributes water to outlets for reuse ▪ additional filtration or disinfection may be required for potable use ○ greywater reuse ▪ greywater is collected ▪ water is filtered to remove solids, soap residues and contaminants ▪ biological or chemical treatment used to improve quality ▪ treated greywater is stored in a tank before reuse ▪ a pump system or gravity distributes water to flushing toilets, irrigation or cleaning • Positioning fixing, connection and operation of components ○ catchment surface ▪ collects rainwater (rooftop, paved surfaces) ▪ roofs must be clean, non-toxic (no lead/asbestos) ▪ water flows into gutters and down pipes ○ gutters and downpipes ▪ directs rainwater into the system ▪ fixed along roof edges and walls ▪ sloped towards a collection point ○ first flush diverter ▪ prevents initial dirty runoff from entering storage ▪ installed between downpipe and tank inlet ▪ discards first flow, allowing cleaner water into the tank ○ pre-filtration system ▪ removes debris, leaves and sediments ▪ before the storage tank (mesh filters, sand filters) ▪ requires periodic cleaning ○ storage tank ▪ holds collected rainwater

Assessment criteria	Content – What needs to be covered
	▪ placed above or underground with a stable base ▪ connects to the pump and outlet pipes o pump (if required) ▪ pressurises stored water for use ▪ near the tank or inside the building ▪ delivers water to fixtures when needed o overflow pipe ▪ directs excess water to drainage ▪ connected to storm drains or soakaways ▪ prevents flooding o filtration and UV treatment (if potable use required) ▪ removes bacteria and pathogens ▪ near the distribution point ▪ essential for drinking water applications o distribution pipes ▪ delivers water to toilets, washing machines, irrigation ▪ separate from mains supply to prevent cross-contamination ▪ pipes must be labelled as non-potable
30.5 Identify layout and installation requirements for protected plastic storage cisterns.	• Typical cistern sizes for dwellings o the minimum size cold water storage cistern for an indirect cold water system is 230 litres o the minimum size cold water storage cistern for a direct cold water system supplying hot water only is 110 litres • Warning pipe (overflow) arrangements o 25 mm from warning pipe to the float operated valve (FOV) • Inlet/outlet position o opposite ends • Position of float operated valve o installed on the side of a cistern • Position of cistern vent o located on the top of the cistern • Position of open vent pipe connection o located on the top of the cistern, connected using a grommet • Requirement for a rigid close-fitting lid o to allow access for maintenance and prevent anything from entering the cistern • Service valve requirements o requires a service valve on the inlet and outlet pipe • Insect screens • Insulation • Support • Drilling requirement • Maintenance and access requirements

Assessment criteria	Content – What needs to be covered
	• Prevention of stagnation • Linking multiple cisterns

30.6 Identify insulation requirements, system frost protection and prevention of undue warming of cold water systems.	• Insulation requirements
	  ○ insulation types
	  ▪ nitrile rubber
	  ▪ mineral wool
	  ▪ foam
	  ○ insulation locations
	  ▪ in a loft
	  ▪ under a suspended floor
	  ▪ where subject to frost
	  ▪ outbuildings
	  ▪ non-heated areas
	• System frost protection and prevention
	  ○ trace heating
	  ○ insulation
	  ○ frost and pipe thermostat
	• Prevention of undue warming
	  ○ pipe separation
	  ○ UV protection

30.9 Identify backflow risk and required methods of prevention.	• Backflow risk
	  ○ back pressure
	  ○ back siphonage
	• Methods of prevention
	  ○ air gaps
	  ▪ AA
	  ▪ AB
	  ▪ AD
	  ▪ AG
	  ▪ AUK1
	  ▪ AUK2
	  ▪ AUK3
	  ▪ DC
	  ○ mechanical
	  ▪ BA
	  ▪ CA
	  ▪ DB
	  ▪ EA/EB
	  ▪ EC/ED
	  ▪ HA
	  ▪ HUK1
	  ▪ HC

Learning outcome 31 – Understand and install hot water systems.

Assessment criteria	Content – What needs to be covered

31.1 Identify advantages and disadvantages of hot water systems.	• Vented storage
	  ○ advantages
	  ▪ meets high demand
	  ▪ backup of hot water
	  ▪ works with low pressure
	  ○ disadvantages
	  ▪ high running costs
	  ▪ high installation cost
	• Unvented storage
	  ○ advantages
	  ▪ meets high demand
	  ▪ has high pressure
	  ○ disadvantages
	  ▪ high running costs
	  ▪ high installation cost
	• Instantaneous
	  ○ advantages
	  ▪ low installation cost
	  ▪ space saving
	  ▪ energy efficient
	  ○ disadvantages
	  ▪ no backup
	  ▪ requires high pressure
	• Solar thermal
	  ○ advantages
	  ▪ reduces running costs
	  ▪ environmentally friendly
	  ○ disadvantages
	  ▪ high installation cost
	  ▪ limited efficiency

31.2 Identify types and typical pipe sizes used in hot water systems within dwellings.	• Gravity hot water pumped heating systems
	  ○ 22 mm hot water distribution
	  ○ 28 mm primary flow and return
	  ○ 22 mm cold feed
	• Fully pumped hot water system
	  ○ 22 mm hot water distribution
	  ○ 22 mm primary flow and return
	  ○ 22 mm cold feed
	• Instantaneous hot water system
	  ○ 15 mm hot water distribution
	  ○ 15 mm cold feed

Assessment criteria	Content – What needs to be covered

31.3 Identify working principles of hot water systems, positioning fixing, connection and operation of components.	• Working principles
	  ○ water heated using a boiler, immersion heater or renewable energy (solar, heat pumps)
	  ○ hot water stored in a cylinder (vented or unvented) or heating it on demand (combi boiler)
	  ○ hot water distributed to fixtures and appliances through insulated pipework
	  ○ controlling temperature and pressure using thermostats, expansion vessels and pressure relief valves
	• Positioning fixing, connection and operation of components
	  ○ bath
	  ▪ provides hot water for bathing
	  ▪ positioned against walls with secure support
	  ▪ hot and cold water feeds connect to mixer taps
	  ○ WCs (toilets)
	  ▪ uses cold water for flushing, not hot
	  ▪ fixed against walls, floor-mounted or wall-hung
	  ▪ cold water supply from mains or storage cistern
	  ○ bidets
	  ▪ provides warm water for personal hygiene
	  ▪ wall-mounted or floor-standing
	  ▪ requires a thermostatic mixing valve to prevent scalding
	  ○ wash hand basins
	  ▪ supplies hot and cold water for washing hands and face
	  ▪ wall-mounted or vanity-fitted
	  ▪ mixer taps or separate hot/cold taps
	  ○ sinks (kitchen and utility)
	  ▪ supplies hot and cold water for washing dishes
	  ▪ secured into worktops with plumbing underneath
	  ▪ connects to hot water system and drainage
	  ○ washing machines
	  ▪ uses hot and cold water for washing clothes
	  ▪ free standing or under counter integrated, near drainage
	  ▪ direct connection to hot and cold supply pipes (or cold feed only with internal heater)

31.4 Identify insulation requirements and system frost protection.	• Building Regulations Approved Document L
	• Water Supply (Water Fittings) Regulations 1999
	• Insulation requirements
	  ○ Insulation types
	  ▪ nitrile rubber
	  ▪ mineral wool
	  ▪ foam

Assessment criteria	Content – What needs to be covered
	○ Insulation locations ▪ in a loft ▪ under a suspended floor ▪ where subject to frost ▪ outbuildings ▪ non-heated areas ▪ pipework connected to a cylinder ▪ secondary circulation
31.6 Identify expansion and contraction in hot water systems and negative effects.	• Expansion and contraction ○ physical change in length of the pipes due to temperature changes ○ pipes lengthen when heated (expands) ○ pipes shorten when cooled (contract) ○ joint and support failure • Negative effects ○ pipework damage ○ damage to fittings ○ noise ○ damage to fixings ○ joint and support failure
31.8 Identify secondary circulation and how trace heating can be used.	• Secondary circulation ○ bronze circulating pump ○ pipework ○ cylinder ○ timer ○ insulation • How trace heating can be used ○ preventing fluid from freezing ○ preventing bacteria growth in dead legs sections
31.10 Identify backflow risk and required methods of prevention.	• Backflow risk ○ back pressure ○ back siphonage • Methods of prevention ○ air gaps ▪ AA ▪ AB ▪ AD ▪ AUK2 ▪ AUK3 ▪ DC ○ mechanical ▪ BA ▪ CA ▪ DB ▪ EA/EB ▪ EC/ED

Assessment criteria	Content – What needs to be covered
	▪ HA ▪ HC

Learning outcome 32 – Understand and install domestic central heating systems.

Assessment criteria	Content – What needs to be covered
32.1 Identify advantages and disadvantages of types and layout features of heating systems.	• Pumped heating gravity hot water o advantages ▪ even heat distribution throughout the property ▪ reliable hot water supply ▪ simple design o disadvantages ▪ limited hot water pressure ▪ lack of controls ▪ inefficient when distributing the heat to the hot water cylinder • Fully pumped, 2 × two port valves (S plan) o advantages ▪ independent control ▪ energy efficient ▪ fast heat distribution ▪ compliant Part L o disadvantages ▪ higher installation costs ▪ complex wiring ▪ space requirements • Fully pumped, 3 × two port valves (S plan+) o advantages ▪ independent zone control ▪ energy efficient ▪ flexibility to add another zone ▪ compliant Part L o disadvantages ▪ higher installation costs ▪ complex wiring ▪ space requirements • Fully pumped, 3-port valve (mid position/diverting) (Y/W plans) o advantages ▪ simplified design ▪ lower installation cost ▪ compact system ▪ easy setup

Assessment criteria	Content – What needs to be covered
	○ disadvantages ▪ less energy efficient ▪ no zoning capability ▪ slower response times • Fully pumped with a low loss header ○ advantages ▪ hydraulic separation ▪ improved efficiency ▪ balanced flow rates ▪ flexible design ○ disadvantages ▪ higher installation costs ▪ space requirements ▪ complex installation ▪ increased maintenance • Low temperature hot water central heating systems ○ advantages ▪ high energy efficiency ▪ low running costs ▪ even heat distribution ▪ compatible with renewable energy ▪ long system lifespan ▪ reduced carbon emissions ○ disadvantages ▪ high installation costs ▪ slow heat response ▪ requires good insulation ▪ not always compatible with older homes ▪ large heating surfaces needed • Layout – one pipe ○ advantages ▪ simple design ▪ cost-effective ▪ reduced material use ○ disadvantages ▪ uneven heating ▪ lower efficiency ▪ limited flow control ▪ slow response time • Layout – two pipes ○ advantages ▪ even heat distribution ▪ efficient operation ▪ faster heating ▪ easier balancing

Assessment criteria	Content – What needs to be covered
	○ disadvantages ▪ higher installation costs ▪ complex installation ▪ maintenance challenges • Manifold (micro and minibore) ○ advantages ▪ reduced material use ▪ easier installation ▪ lower installation costs ▪ compact design ▪ aesthetic benefits ○ disadvantages ▪ blockages ▪ reduced flow rates ▪ not ideal for large properties ▪ high maintenance requirements • Underfloor heating – series ○ advantages ▪ simple design ▪ cost-effective ▪ reliable flow path ▪ ideal for small areas ○ disadvantages ▪ uneven heat distribution ▪ limited pipe length ▪ not suitable for large areas ▪ harder to balance • Underfloor heating – spiral ○ advantages ▪ even heat distribution ▪ efficient heating ▪ ideal for large areas ▪ personal comfort as provides a natural, even, and consistent warmth maintaining a consistent room temperature ○ disadvantages ▪ complex installation ▪ higher installation costs ▪ skilled labour required ▪ overlapping zones risk
32.3 Identify working principles of types of central heating systems, positioning fixing, connection and	• Wet central heating ○ sealed systems ▪ system boiler □ heats hot water in a storage cylinder and provides space heating

Assessment criteria	Content – What needs to be covered
operation of components.	▪ combination boiler ▫ heats hot water on demand and provides space heating from one unit ▪ heat only boiler (with external expansion vessel) ○ open vented systems ▪ heat only boiler • Warm air • Storage heaters • Heat networks (district heating) ○ heat interface unit • Sealed systems ○ expansion vessel ○ pressure gauge ○ filling loop ○ pressure relief valve • Open vented systems ○ feed and expansion cisterns ○ air separators ○ open vent and feed pipe ○ automatic air vents • Generic ○ radiator valves – thermostatic and manual/lock shield valves ○ circulating pumps – uses an impeller to distribute water around the system ○ pump valves ○ thermo-mechanical cylinder control valves ○ anti-gravity valve ○ drain valves ○ additives ▪ inhibitor ▪ de-scaler ▪ de-sludger ○ primary and secondary heating circuits: ▪ low loss headers for multiple boiler installations ▪ buffer tanks ○ corrosion filters ○ controls ▪ zone valves (2-port, 3-port, mid position and diverter) ▪ programmer ▪ timer ▪ thermostats ▫ programmable room stat ▫ cylinder stat ▫ frost stat ▪ optimizer

Assessment criteria	Content – What needs to be covered
	▪ weather compensator ▪ wiring centre o automatic by-pass o heat emitters ▪ bespoke heat emitters ▪ panel radiators ▪ column radiators ▪ low surface temperature radiators ▪ fan convectors ▪ plinth heaters o underfloor heating components ▪ manifolds ▪ pump control unit ▪ insulation ▪ pipework ▪ manifold isolation ball valves ▪ supports o underfloor heating pipework ▪ clip rails and staple clips ▪ screed system plates ▪ pocketed polystyrene products ▪ heat emission/transfer plates ▪ floating floor panels ▪ reflective foil insulation ▪ bend supports
32.4 Identify the importance of pump positioning.	• Optimal performance • Prevents airlocks • Minimises wear and tear • Energy efficiency • Maintains system balance • Improves lifespan • Noise reduction
32.5 Identify operating principles for system control.	• Time • Temperature • Weather compensation o delayed start o optimum start/stop • Smart control systems and associated equipment correct connection to home Wi-Fi networks • Multiple boiler controls • Zoning requirements • 'Boiler Plus' requirements • Pump overrun requirements

Assessment criteria	Content – What needs to be covered

32.6 Identify zoning and control requirements of central heating systems in accordance with statutory legislation.	• Compliance with statutory legislation
	  ○ central heating systems must meet zoning and control requirements for efficiency, comfort and energy conservation
	• Zoning requirements
	  ○ separate zones for different areas (over 150 m²)
	  ○ independent thermostats for each zone
	  ○ hot water and heating separation
	  ○ smart controls and multi-zone systems
	• Control requirements
	  ○ programmable room thermostats
	  ○ thermostatic radiator valve (TRV) installed
	  ○ boiler interlock
	  ○ time and temperature control
	  ○ weather and load compensation (for modern systems)

32.7 Identify insulation requirements and system frost protection.	• Building Regulations Approved Document L
	• Water Supply (Water Fittings) Regulations 1999
	• Insulation requirements
	  ○ Insulation types
	  ▪ nitrile rubber
	  ▪ mineral wool
	  ▪ foam
	  ○ Insulation locations
	  ▪ in a loft
	  ▪ under a suspended floor
	  ▪ where subject to frost
	  ▪ outbuildings
	  ▪ non-heated areas
	  ▪ pipework connected to a cylinder
	  ○ boiler frost protection
	  ○ frost thermostat

32.9 Identify expansion and contraction in central heating systems and negative effects.	• Expansion and contraction
	  ○ physical change in volume of water within the system as it heats up (expands) and cools down (contacts)
	• Negative effects
	  ○ pipework damage
	  ○ damage to fittings
	  ○ damage to fixings
	  ○ noise

32.11 Identify procedures for filling and venting system types.	• Sealed system in the following order
	  ○ locate filling loop
	  ○ open filling loop
	  ○ monitor pressure
	  ○ close filling loop
	  ○ vent the lowest radiator first

Assessment criteria	Content – What needs to be covered
	○ release air ○ finish venting the highest radiator ○ re-check pressure ○ top up via filling loop if needed • Open system in the following order ○ locate feed and expansion cistern ○ fill and check fall leaks ○ wait for cistern to stop filling ○ open automatic air vents ○ vent the lowest radiator first ○ release air ○ finish venting the highest radiator ○ bleed air from pump
32.12 Identify the operating principles of heat-producing appliances.	• Gas boiler ○ fuel combustion ▪ burns natural gas or LPG to generate heat ○ heat exchanger ▪ transfers heat from combustion gases to water in the system ○ flue system ▪ expels waste gases safely outside the property ○ control system ▪ thermostats, timers and modulating burners regulate heat output ○ types ▪ combi boilers ▪ system boilers ▪ conventional boilers • Oil boiler ○ fuel atomization and combustion ▪ atomizes and burns heating oil to generate heat ○ heat transfer ▪ a heat exchanger transfers heat from combustion gases to water ○ flue and ventilation ▪ exhaust gases are expelled via a flue or chimney ○ efficiency features ▪ modern condensing oil boilers recover heat from exhaust gases to improve efficiency • Heat pumps (air-source and ground-source) ○ refrigerant cycle ▪ extracts heat from the air, ground or water using a refrigerant

Assessment criteria	Content – What needs to be covered
	○ compression and heat exchange ▪ the refrigerant is compressed to increase its temperature, then transfers heat to water or air ○ energy efficiency ▪ high coefficient of performance (COP); typically, 1 kW of electricity can produce 3–5 kW of heat • Biomass boiler ○ fuel combustion ▪ burns organic material (wood pellets, logs or chips) to produce heat ○ heat exchange ▪ transfers heat from burning fuel to water for heating or hot water supply ○ automated fuel feeding (in some models) ▪ pellet-fed systems automatically supply fuel for continuous operation ○ low carbon footprint ▪ considered a renewable energy source when sourced sustainably • Electric boiler ○ resistive heating elements ▪ uses electricity to heat water directly via immersion heaters ○ no combustion required ▪ no fuel burning, making it safer and more suitable for homes without a gas supply ○ efficiency ▪ nearly 100% efficient as all electrical energy is converted into heat ○ types ▪ direct electric boilers ▪ thermal storage boilers

Learning outcome 33 – Install sanitary appliances and pipework systems.

Assessment criteria	Content – What needs to be covered

33.1 Identify advantages and disadvantages of sanitary appliances pipework systems.	• Primary ventilated stack system
	  ○ advantages
	  ▪ simplified installation
	  ▪ cost-effective
	  ▪ reduces airlocks
	  ○ disadvantages
	  ▪ limited to certain buildings
	  ▪ design restrictions
	  ▪ increased potential noise
	• Secondary ventilated stack system
	  ○ advantages
	  ▪ additional venting
	  ▪ good airflow
	  ▪ improves efficiency
	  ○ disadvantage
	  ▪ more expensive
	  ▪ installation complexity
	  ▪ requires more space
	  ▪ increased maintenance
	• Ventilated branch discharge system
	  ○ advantages
	  ▪ prevents trap seal
	  ▪ reduces siphonage and pressure
	  ▪ ideal for complex layouts
	  ○ disadvantage
	  ▪ more expensive
	  ▪ increased complexity
	  ▪ uses more space
	  ▪ higher maintenance
	• Stub stack system
	  ○ advantages
	  ▪ simplifies installation
	  ▪ saves space
	  ▪ cost-effective
	  ▪ no vent needed to outside
	  ○ disadvantages
	  ▪ limited to low-rise buildings
	  ▪ requires being close to appliances
	  ▪ over-reliance on air admittance valves

33.3 Identify working principles of sanitary appliances pipework systems	• Sanitary appliances pipework systems
	  ○ primary ventilated stack system
	  ▪ appliances connected to the stack via sloped branch pipes
	  ▪ centralised location for close grouping of appliances

Assessment criteria	Content – What needs to be covered
and layouts and the positioning, fixing, connection and operation of components.	▪ appliances use water traps to prevent smells ▪ allowance for expansion ▪ ventilated stack to atmosphere ○ secondary ventilated stack system ▪ appliances connected to the stack via sloped branch pipes ▪ the secondary stack provides additional air circulation ▪ the secondary stack may connect to the primary stack or a separate vent system ▪ allowance for expansion ▪ ventilated stack to atmosphere ○ ventilated branch discharge system ▪ appliances connected to the stack via sloped branch pipes ▪ branch discharge pipes are vented to ensure pressure equalisation ▪ ventilation allows air to enter the system, ensuring that wastewater can flow freely ▪ allowance for expansion ▪ ventilated stack to atmosphere ○ stub stack system ▪ limited vertical connection ▪ compact design ▪ vented using an air admittance valve • Layouts ○ discharge stacks ▪ soil stack sizes based on WC outlet size ▪ waste stack sizes serving waste appliances only ▫ basin 32 mm ▫ bath 40 mm ▫ shower 40 mm ▫ sink 40 mm ▪ use and types of bends ▪ proximity of low-level connections ○ branch discharge ▪ layout of unventilated and ventilated branch discharge pipework ▪ maximum pipework lengths and gradients ▪ sizes of branch discharge pipework for soil and waste appliances ▪ use of traps and self-sealing valves ▪ methods of ventilating branch discharge pipework ▪ methods of connecting multiple waste appliances to branch discharge pipework ▪ methods of connecting branch discharge pipework into the main stack

Assessment criteria	Content – What needs to be covered
	○ stack ventilation ▪ proximity of vent outlet to openable windows is 900 mm above an openable window when within 3 metres ▪ use of air admittance valves ○ systems and appliances ▪ waste appliance connections to gullies ▪ waste appliance connections direct to drain ▪ WC connection direct to drain • Components ○ bend ▪ male and female ▪ 92½º ▪ 135º ▪ access bend ▪ offset bend ○ branch tee ○ socket ○ strap boss ○ socket boss ○ vent terminal ○ waste manifold ○ pan connectors ○ traps ○ waterless trap ○ air admittance valve ○ clips/brackets ○ socket plug ○ socket rodding access ○ floor gullies
33.5 Identify expansion and contraction in sanitary appliances pipework systems and negative effects.	• Expansion and contraction ○ physical change in length of the pipes due to temperature changes ○ pipes lengthen when heated (expands) ○ pipes shorten when cooled (contracts) • Negative effects ○ pipework damage ○ damage to fittings leading to leaks ○ damage to fixings ○ noise
33.7 Identify different types of sanitary appliances and components used in dwellings.	• Appliances ○ conventional WC ○ flushing cisterns (automatic and manual) ○ waste disposal units ○ baths ○ bidets ○ wash hand basins ○ shower tray

Assessment criteria	Content – What needs to be covered
	○ bath/shower screens and cubicles ○ sinks ○ WC macerators ○ waste water lifters/pumps used in domestic dwellings • Components ○ waste traps – P trap, S trap, bottle trap ○ overflow pipes ○ soil and vent pipes ○ waste pipes ○ stop valves ○ isolation valves ○ ball valves (in toilet cisterns) ○ flush mechanisms – syphon, push-button, dual-flush ○ shower pumps ○ tundish (for safety discharge) ○ gully traps ○ air admittance valves (AAVs) ○ pipe insulation ○ sealants and gaskets ○ flexible hoses ○ water filters ○ anti-scald valves ○ backflow prevention devices
33.8 Identify factors that lead to trap seal loss in sanitary pipework systems.	• Self-siphonage • Induced siphonage • Compression • Wavering out • Evaporation • Capillary • Gradient • Pipe size
33.9 Identify the suitability of below ground drainage systems to receive waste water.	• Combined drainage system ○ allows waste and rainwater to discharge into a common sewer • Separate drainage system ○ waste and rainwater are discharge through separate pipes • Partially separate drainage system ○ a hybrid system where some surface water is discharged separately but wastewater may still be combined with other flows • Soakaway ○ manages surface water runoff • Cesspit ○ sealed tanks that collect wastewater

Assessment criteria	Content – What needs to be covered
	• Septic tanks ○ properties not connected to public sewer and used where soil is permeable

33.10 Identify the installation features of sanitary facilities and equipment in dwellings for the disabled including wet rooms.	• Features
	  ○ wide doorways
	  ○ wheelchair-accessible layout
	  ○ non-slip floors
	  ○ level-entry shower (wet room)
	• Equipment
	  ○ grab rails
	  ○ lever taps
	  ○ thermostatic controls
	  ○ wall mounted seats

33.12 Identify working principles of greywater recycling systems.	Stages in the following order: • Collection • Filtration • Treatment • Storage • Reuse

Learning outcome 34 – Understand and install rainwater systems.

Assessment criteria	Content – What needs to be covered

34.1 Identify advantages and disadvantages of rainwater systems: pipe (RWP) and gutter.	• Pipe (RWP)
	  ○ advantages
	  ▪ efficient drainage
	  ▪ prevents water damage
	  ▪ low maintenance
	  ○ disadvantages
	  ▪ blockages
	  ▪ installation costs
	  ▪ visual impact
	• Gutter
	  ○ advantages
	  ▪ prevents roof damage
	  ▪ protects walls and foundations
	  ○ disadvantages
	  ▪ blockages
	  ▪ high maintenance
	  ▪ weather damage

Assessment criteria	Content – What needs to be covered

34.2 Identify typical sizes and materials used in rainwater systems: pipe (RWP) and gutter.	• Pipe (RWP)
	  ○ square size
	  ▪ 65 mm
	  ○ round size
	  ▪ 68 mm
	  ○ materials
	  ▪ PVCu
	  ▪ extruded aluminium
	  ▪ cast iron
	  ▪ copper
	  ▪ lead
	• Gutter
	  ○ size
	  ▪ 112 mm
	  ▪ 150 mm
	  ○ materials
	  ▪ PVCu
	  ▪ cast iron
	  ▪ aluminium
	  ▪ copper

34.4 Identify expansion and contraction in rainwater systems and negative effects.	• Expansion and contraction
	  ○ temperature variation
	  ○ incorrect installation
	  ○ material stress
	• Negative effects
	  ○ fitting failure
	  ○ distortion
	  ○ broken fixings
	  ○ leakage

34.5 Identify factors affecting gutter bracket selection and fixing for buildings.	• Fascia boards
	  ○ fascia brackets
	• Exposed rafters
	  ○ rafter brackets
	• No fascia board
	  ○ rise and fall brackets
	• Gutter and rainwater material selection

Learning outcome 36 – Understand and perform a soundness test and commission cold water systems and components.

Assessment criteria	Content – What needs to be covered
36.1 Identify information sources required to complete testing and commissioning.	• Statutory regulations • Industry standards • Manufacturer's technical instructions

36.2 Identify how to fill and vent cold water systems.	• Fill and vent cold water systems in the following order:
	  ○ isolate taps
	  ○ fill with water
	  ○ monitor for leaks
	  ○ vent taps
	  ○ final flush

36.5 Identify the flushing requirements including the use of system additives for new and existing cold water systems.	• Flushing requirement during commissioning
	  ○ cold flush with wholesome water
	• Use of system additives during commissioning
	  ○ disinfection with chlorine
	  ○ biocidal treatment
	  ○ final flush

Learning outcome 37 – Understand and perform a soundness test and commission hot water systems and components.

Assessment criteria	Content – What needs to be covered
37.1 Identify information sources required to complete testing and commissioning.	• Statutory regulations • Industry standards • Manufacturer's technical instructions

37.2 Identify how to fill and vent hot water systems.	• Fill and vent hot water systems in the following order:
	  ○ isolate taps
	  ○ fill with water
	  ○ monitor for leaks
	  ○ vent taps
	  ○ final flush

Assessment criteria	Content – What needs to be covered

37.5 Identify the flushing requirements including the use of system additives for new and existing hot water systems.	• Flushing requirement during commissioning
	  ○ cold flush with wholesome water
	• Use of system additives during commissioning
	  ○ disinfection with chlorine
	  ○ biocidal treatment
	  ○ final flush

Learning outcome 38 – Understand and perform a soundness test and commission central heating systems and components.

Assessment criteria	Content – What needs to be covered
38.1 Identify information sources required to complete testing and commissioning.	• Statutory regulations • Industry standards • Manufacturer's technical instructions

38.2 Identify how to fill and vent central heating systems.	• Fill and vent sealed systems in the following order:
	  ○ locate filling loop
	  ○ open filling loop
	  ○ monitor pressure
	  ○ close filling loop
	  ○ vent the lowest radiator first
	  ○ release air
	  ○ finish venting the highest radiator
	  ○ re-check pressure
	  ○ top up via filling loop if needed
	• fill and vent open systems in the following order:
	  ○ locate feed and expansion cistern
	  ○ fill and check for leaks
	  ○ wait for cistern to stop filling
	  ○ open automatic air vents
	  ○ vent the lowest radiator first
	  ○ release air
	  ○ finish venting the highest radiator
	  ○ bleed air from pump

38.5 Identify the flushing requirements including the use of system additives	• Flushing requirements
	  ○ cold flush
	  ○ hot flush
	  ○ cleaning

Assessment criteria	Content – What needs to be covered

for new and existing central heating systems.	• Use of systems additives
	  ○ neutralisers for neutralising any acid in the system
	  ○ cleanser for cleaning and maintaining the system
	  ○ descaler for dissolving limescale and calcium carbonate deposits
	  ○ inhibitor for preventing rust and internal corrosion occurring

Learning outcome 40 – Understand and perform a soundness test and commission rainwater systems and components.

Assessment criteria	Content – What needs to be covered
40.1 Identify information sources required to complete testing and commissioning.	• Statutory regulations • Industry standards • Manufacturer's technical instructions • British Standard (BS) 12056 and Approved Document H building regulations

Learning outcome 46 – Understand and carry out service and maintenance on cold water systems.

Assessment criteria	Content – What needs to be covered

46.1 Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of system components.	• Review service requirements
	  ○ visual inspection of pipework for leakage and adequate support
	  ○ effective operation of terminal fittings
	  ○ effective operation of float operated valves
	  ○ effective operation of valves
	  ○ condition of cold water storage cistern
	  ○ strainer/filter inspection and cleaning
	  ○ pump operation
	  ○ float and pressure switch operation
	  ○ pressure relief valves
	• Reasons for checking
	  ○ to check safety requirements
	  ○ to identify replacement components
	  ○ to determine service intervals

46.3 Identify types of information to be provided on a	• Components checked • Status • Actions taken

Assessment criteria	Content – What needs to be covered
maintenance record for cold water systems.	• Repairs carried out

46.4 Identify requirements for legionella and bacterial growth control measures.	• Health and Safety Executive (HSE), Approved Code of Practice (ACoP) L8 and Water Regulations
	  ○ temperature control
	  ○ regular flushing
	  ○ water storage and distribution
	  ○ chemical and filtration treatments
	  ○ risk assessment and monitoring every six months
	  ○ proper system design and maintenance

Learning outcome 47 – Understand and carry out service and maintenance of hot water systems.

Assessment criteria	Content – What needs to be covered

47.1 Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of system components.	• Review service requirements
	  ○ visual inspection of pipework for leakage, adequate support and insulation
	  ○ effective operation of terminal fittings
	  ○ effective operation of float operated valve for open vented systems
	  ○ effective operation of service valves
	  ○ condition of hot water cylinder
	  ○ condition of storage cisterns
	  ○ condition of unvented cylinder and controls
	  ○ effective operation of thermostatic control devices
	  ○ temperature and pressure relief valve
	  ○ expansion vessel
	  ○ composite valve
	  ○ pumps
	• Reasons for checking:
	  ○ to check safety requirements
	  ○ to identify replacement components
	  ○ to establish service intervals

47.3 Identify types of information to be provided on a maintenance record for hot water systems.	• Components checked • Status • Actions taken • Repairs carried out

Assessment criteria	Content – What needs to be covered

47.4 Identify requirements for legionella and bacterial growth control measures.	• Health and Safety Executive (HSE), Approved Code of Practice (ACoP) L8 and Water Regulations
	  ○ temperature control
	  ○ regular flushing
	  ○ water storage and distribution
	  ○ chemical and filtration treatments
	  ○ risk assessment and monitoring
	  ○ proper system design and maintenance

Learning outcome 48 – Understand and carry out service and maintenance on central heating systems.

Assessment criteria	Content – What needs to be covered

48.1 Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of system components.	• Review service requirements
	  ○ visual inspection of pipework for leakage, adequate support and insulation
	  ○ effective operation of float operated valves
	  ○ effective operation of valves
	  ○ condition of cistern for open vented systems
	  ○ effective operation of thermostatic control devices
	  ○ temperature and pressure relief valve
	  ○ expansion vessel
	  ○ pumps
	  ○ condition of heat emitters
	  ○ performance checks
	• Reasons for checking:
	  ○ to check safety requirements
	  ○ to identify replacement components
	  ○ to establish service intervals

48.3 Identify types of information to be provided on a maintenance record for central heating systems.	• Components checked • Status • Actions taken • Repairs carried out

Learning outcome 49 – Understand and carry out service and maintenance on sanitary appliances and pipework systems.

Assessment criteria	Content – What needs to be covered

49.1 Identify how to use manufacturer instructions and job maintenance schedules to establish the periodic servicing requirements of system components.	• Review service requirements
	  ○ visual inspection of pipework for leakage, adequate support
	  ○ effective operation of terminal fittings
	  ○ effective operation of float operated valves
	  ○ effective operation of valves
	  ○ condition of cisterns
	  ○ operation of flushing cisterns/mechanisms
	  ○ fitting of effective waste outlet plugs
	  ○ effective operation of appliance traps/self-sealing valves
	  ○ pumps
	  ○ performance checks
	  ○ appliance support
	• Reasons for checking:
	  ○ to check safety requirements
	  ○ to identify replacement components
	  ○ to establish service intervals

49.3 Identify types of information to be provided on a maintenance record for sanitary appliances and pipework systems.	• Manufacturer's information • Date of activity • Location of activity • Access arrangements • Activity (what has been done) • Operative details • Asset code or reference • Date of next activity

Learning outcome 56 – Know the basic operating principles of micro-renewable energy technologies.

Assessment criteria	Content – What needs to be covered

56.1 Identify the basic operating principles of heat producing micro-renewable energy technologies.	• Solar thermal (hot water)
	  ○ uses solar collectors mounted on a roof to obtain energy from the sun to heat domestic hot water
	• Ground source heat pump
	  ○ uses a loop buried in the ground to extract heat which is converted by a heat pump into useful heat for heating purposes
	• Water source heat pump
	  ○ uses a loop located in a body of water such as a lake to extract heat which is converted by a heat pump into useful heat for heating purposes

Assessment criteria	Content – What needs to be covered

	• Air source heat pump
	  ○ uses an external unit to draw in outside air which is converted by a heat pump into useful heat for heating purposes
	• Biomass
	  ○ uses a sustainable wood source to burn and produce useful heat for heating or hot water

56.2 Identify the basic operating principles of heat-led micro-combined heat and power.	• Combined heat and power (CHP) boilers simultaneously produce both electricity and heat from a single fuel source • The system prioritises heat production, with electricity generated as a by-product

Learning outcome 57 – Understand requirements to install micro-renewable energy systems to existing systems.

Assessment criteria	Content – What needs to be covered
57.1 Identify the suitability of building location and features when installing micro-renewable energy systems.	• Structural • Orientation • Listed buildings • Environmental conditions • Adjacent structures and obstructions • Geographical

57.2 Identify statutory regulations affecting installation of micro-renewable energy systems.	• Building Regulations Approved Document
	  ○ Part A
	  ○ Part E
	  ○ Part G
	  ○ Part H
	  ○ Part F
	• Town and country planning regulations

57.3 Identify what would be typically classified as ‘permitted development’ under town and country planning regulations in relation to the	• Solar thermals
	  ○ installation of collectors/arrays
	• Heat pumps
	  ○ location of the outdoor unit
	• Biomass boilers and flues
	  ○ location of fuel storage
	• Rainwater harvesting
	  ○ installation of tanks

Assessment criteria	Content – What needs to be covered
deployment of technologies.	

57.4 Identify which parts of the regulations apply in relation to the installation of environmental technologies.	• Solar thermal (hot water)
	• Ground source heat pump
	• Water source heat pump
	• Air source heat pump
	• Biomass
	• Micro-combined heat and power (heat-led)
	• Building Regulations
	  ○ Approved Document A
	  ▪ covers structure and securing components to the building
	  ○ Approved Document G
	  ▪ sanitation
	  ○ Approved Document L
	  ▪ energy efficiency
	  ○ Approved Document P
	  ▪ electrical safety

57.5 Identify typical advantages and disadvantages associated with environmental technologies.	• Advantages
	  ○ reduces pollution – lowers carbon emissions and waste
	  ○ sustainable energy – uses renewable sources like solar and wind
	  ○ long-term cost savings – reduces energy bills and reliance on fossil fuels
	  ○ energy efficiency – improves resource use and reduces waste
	  ○ government incentives – grants, tax breaks and subsidies available
	  ○ creates jobs – expands employment in green industries
	  ○ improves public health – reduces air and water pollution, benefiting health
	• Disadvantages
	  ○ high initial costs – expensive to install and set up
	  ○ technology limitations – some solutions depend on weather conditions
	  ○ infrastructure challenges – requires updates to grids and distribution networks
	  ○ resource demand – production of green tech relies on scarce materials
	  ○ land and space requirements – large-scale renewables need significant space
	  ○ intermittency issues – energy storage solutions are needed for reliability

Learning outcome 58 – Understand factors affecting fuel selection.

Assessment criteria	Content – What needs to be covered

58.1 Identify the types of fuels used in appliances.	• Natural gas
	  ○ CH_4
	• Liquefied petroleum gas (LPG)
	  ○ butane (C_4H_{10})
	  ○ propane (C_3H_8)
	• Oil
	  ○ kerosene grade C2
	• Solid fuel
	  ○ coal
	  ○ coke
	  ○ peat
	• Hydrogen (H)
	• Biomass
	  ○ wood chips
	  ○ wood pellets

58.2 Identify the factors which affect the selection of fuels.	• Client preference • Availability • Appliance type • Fuel storage requirements • Environmental considerations • Smoke control legislation • Cost
58.3 Identify sources of information for fuel supply installation.	• Industry standards • Statutory regulations • Manufacturer's instructions • Guidance notes
58.4 Identify the regulatory type bodies which govern the installation of various fuel types.	• Gas Safe • Oil Firing Technical Association (OFTEC) • Heating Equipment Testing and Approval Scheme (HETAS) • Microgeneration Certification Scheme (MCS)

58.5 Identify the storage requirements for fuels.	• Oil
	  ○ stored in a tank
	• Propane
	  ○ stored in a tank or cylinder
	• Natural gas
	  ○ does not require storage as supplied via mains
	• Biomass
	  ○ stored in a fuel store or silo

Assessment criteria	Content – What needs to be covered

58.6 Identify factors which could affect storage requirements for fuels.	• Space
	  ○ biomass and solid fuel
	• Delivery requirements
	  ○ oil, LPG, biomass and solid fuel
	• Weather conditions
	  ○ biomass and solid fuel
	• Distribution
	  ○ natural gas
	• Proximity to dwelling
	  ○ oil and LPG

Learning outcome 59 – Know combustion processes of fuel supplied systems.

Assessment criteria	Content – What needs to be covered
59.1 Identify the combustion process.	• Fuel and oxygen combine to produce heat and combustion products ○ $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

59.2 Identify the main constituents of complete and incomplete combustion.	• Complete
	  ○ carbon dioxide (CO_2)
	  ○ water vapor (H_2O)
	• Incomplete
	  ○ carbon monoxide (CO)
	  ○ soot (carbon particles)
	  ○ water vapor (H_2O)

59.3 Identify causes of incomplete combustion.	• Insufficient air
	  ○ too much fuel
	  ○ vitiated air
	  ○ flame impingement

59.4 Identify signs of incomplete combustion.	• Poor flame picture • Soot deposits • Staining
59.5 Identify the symptoms of CO poisoning.	• Headache • Dizziness • Weakness • Nausea and vomiting • Rapid heartbeat • Shortness of breath • Seizures • Chest pain

Assessment criteria	Content – What needs to be covered
	• Loss of consciousness • Disorientation
59.6 Identify the purpose of CO detectors.	• Alerts people with early warning so can evacuate or fix issue • Detects dangerous levels of carbon monoxide gas in the air
59.7 Identify the requirements for ventilation.	• Combustion air • Cooling air
59.8 Identify the different types of ventilation.	• Natural • Mechanical
59.9 Identify installation practices for ventilation.	• Adequately sized • Continuous free area • Sleeved • Permanently open • Fly screen removed • Correctly positioned

Learning outcome 60 – Know principles of chimney/flue systems.

Assessment criteria	Content – What needs to be covered
60.1 Identify the operating principles of chimney/flue systems.	• Remove combustion products • Draw in combustion air

60.2 Identify types of chimney/flue systems.	• Open flued
	  ○ natural draught
	  ○ forced draught
	• Room sealed
	  ○ natural draught
	  ○ forced draught

60.3 Identify the components within chimney/flue systems.	• Primary flue
	  ○ creates initial flue draught
	• Draught diverter/stabiliser
	  ○ allows products of combustion to be diluted with air
	• Secondary flue
	  ○ transfers products of combustion to atmosphere

Assessment criteria	Content – What needs to be covered
	• Terminal ○ protects debris from falling into the flue
60.4 Identify the effects of layout on chimney/flue systems.	• Equivalent height • Internal temperature • External temperature • Air quality • Humidity • Route • Bends • Termination • Type of material

60.5 Identify the layout and features of chimney and flue construction.	• Rigid chimney types
	  ○ brick/masonry
	  ○ pre-cast flue blocks
	• Metallic (single and double wall flues)
	• Flexible metallic liner installation (types and suitability)

60.6 Identify termination requirements for chimney/flue systems from relevant documents.	• Industry standards • Approved documents • Manufacturer's instructions

60.7 Identify basic inspection and testing procedures for chimney/flue systems.	• Visual inspection
	  ○ carried out prior to any test to check for defects
	• Flue flow
	  ○ used to check the integrity of a chimney
	• Spillage test
	  ○ used to check appliance operation – open flued
	• Combustion analysis
	  ○ used to check appliance operation – room sealed

Learning outcome 61 – Understand and perform pre-installation activity prior to undertaking electrical work on plumbing and domestic heating systems.

Assessment criteria	Content – What needs to be covered
61.1 Identify the limitations of your responsibility when carrying out work on electrical supplies and/or circuits for the control of plumbing and domestic heating systems.	• Can replace like for like • Can connect to a fuse spur • Can replace a damaged cable • Cannot install a new circuit • Cannot replace a consumer unit • Cannot carry out any additions or alterations to an existing circuit in a special location

61.2 Identify the applications, advantages and limitations of electrical supplies.	• Control
	  ○ applications
	  ▪ thermostats
	  ▪ motorised valves
	  ▪ pumps
	  ▪ programmer/time clocks
	  ○ advantages
	  ▪ optimise the operation
	  ▪ desired settings
	  ▪ energy efficient
	  ○ limitations
	  ▪ power dependant
	  ▪ maintenance costs
	• Heating
	  ○ applications
	  ▪ power electric boilers
	  ▪ operate controls
	  ○ advantages
	  ▪ quick response
	  ▪ precise control
	  ○ limitations
	  ▪ installation retrofit
	  ▪ power outages
	• Power
	  ○ applications
	  ▪ heating components
	  ▪ pumps
	  ▪ controls
	  ○ advantages
	  ▪ easier to install and maintain
	  ▪ suitable for lower power loads

Assessment criteria	Content – What needs to be covered
	○ limitations ▪ limited power capacity ▪ voltage drops over long distances
61.3 Identify the applications, advantages and limitations of different electrical equipment, cables/wiring and components in relation to the working environment.	• Isolators ○ applications ▪ electrical isolation ▪ emergency shutoff ○ advantages ▪ safety assurance ▪ simple operation ▪ clear visual indication ▪ reliable isolation ○ limitations ▪ manual operation ▪ no fault protection ▪ limited use • Circuit breakers ○ applications ▪ overcurrent protection ▪ short circuit protection ▪ fault isolation ▪ load management ▪ residual current device (RCD) ▪ residual current breaker with over-current (RCBO) ○ advantages ▪ automatic protection ▪ reusability ▪ improved safety ○ limitations ▪ cost ▪ complex maintenance ▪ limited lifespan ▪ false tripping • Electrical fuses ○ applications ▪ protect household wiring and appliances ▪ used in industrial machines and motor circuits ▪ found in car electrical systems ▪ protect circuit boards in electronics ▪ safeguard power distribution systems ○ advantage ▪ fast protection against overcurrent ▪ low cost and easy to install ▪ no maintenance required ▪ compact size for space-saving ▪ reliable and automatic operation

Assessment criteria	Content – What needs to be covered
	○ limitations ▪ single-use – needs replacement after blowing ▪ not resettable like circuit breakers ▪ may not suit high-power industrial systems ▪ wrong fuse rating can cause issues • Switches, socket-outlets and fused-spurs ○ applications ▪ power ▪ control ▪ isolation ○ advantages ▪ convenient control ▪ safety enhancement ▪ space saving ▪ versatility ▪ durable ○ limitations ▪ manual operation ▪ limited load capacity ▪ fixed location • Earthing protection ○ applications ▪ electrical circuit protection ▪ appliances protection ▪ power distribution systems ○ advantages ▪ safety from electric shock ▪ prevents fire hazards ▪ equipment protection ▪ fault detection ○ limitations ▪ maintenance requirements • PVC flat profile (twin and earth) ○ applications ▪ general domestic wiring ▪ fixed installations ▪ low voltage applications ▪ concealed ○ advantages ▪ ease of installation ▪ cost-effective ▪ durable insulation ○ limitations ▪ temperature limits ▪ limited flexibility ▪ UV degradation

Assessment criteria	Content – What needs to be covered
	▪ not for outdoor use ▪ mechanical damage • Flex including heat resistant (butyl) rubber o applications ▪ portable appliances ▪ heat-generating equipment ▪ flexible connections ▪ lighting fixtures o advantages ▪ high heat resistance ▪ flexibility ▪ durable ▪ moisture resistant ▪ chemical resistance o limitations ▪ higher cost ▪ limited UV resistance ▪ thickness and weight • Central heating controls o applications ▪ timed heating and hot water ▪ control temperatures for heating and hot water ▪ zone control ▪ frost protection o advantages ▪ energy efficient ▪ enhanced comfort ▪ convenience to use ▪ heating zoning – individual/independent control of areas of a property ▪ individual time setting o limitations ▪ initial cost ▪ complex installation ▪ maintenance ▪ compatibility issues with some systems ▪ dependence on power • Immersion heater o applications ▪ water heating ▪ back up in case main heat source failure o advantages ▪ cost effective ▪ compact design ▪ simple operation ▪ independent control

Assessment criteria	Content – What needs to be covered
	○ limitations ▪ slow heating ▪ limited heating capacity ▪ inefficient for large systems ▪ manual control • Shower pump ○ applications ▪ boosting water ▪ power showers ○ advantages ▪ improved water pressure ▪ better performance ▪ compatible with various showers ▪ simple to install ○ limitations ▪ potential noise ▪ increased energy consumption ▪ space requirements • Macerator WC ○ applications ▪ basement toilets ▪ conversion projects ▪ remote locations ▪ renovations ○ advantages ▪ flexible installation ▪ space saving ▪ cost effective ○ limitations ▪ potential noise ▪ blockages ▪ power dependency
61.4 Identify the appropriate industry standards and regulations relevant to carrying out work on electrical supplies and/or circuits for the control of plumbing and domestic heating systems.	• Building Regulations Approved Document P • Electricity at Work Regulations 1989 • BS 7671:2018 (IET Wiring Regulations)

Assessment criteria	Content – What needs to be covered

61.5 Identify how to verify that job information and documentation is current and relevant and that the plant, instruments, access equipment and tools are fit for purpose.	• Verifying job information and documentation
	  ○ review job documentation
	  ○ check revision dates
	  ○ compare with industry standards
	  ○ consult subject matter experts (SMEs)
	  ○ use document control systems
	  ○ confirm compliance with work scope
	• Verifying plant and equipment
	  ○ inspection and pre-use checks
	  ○ maintenance records
	  ○ calibration and certification
	  ○ check safety compliance
	  ○ operator feedback
	• Verifying access equipment (ladders, scaffolds, platforms)
	  ○ pre-use inspections
	  ○ load ratings and certification
	  ○ tagging system
	  ○ compliance with safety regulations
	• Verifying tools and instruments
	  ○ Pre-use functional testing
	  ○ calibration and certification
	  ○ check for damage or wear
	  ○ proper storage and handling
	  ○ pat ensures the safety of electrical appliances, particularly portable tools and equipment
	  ○ identifying appliances for testing
	  ▪ any portable electrical device, including power tools, extension cords and computers
	  ▪ equipment that is frequently moved or used in harsh environments
	  ▪ class I (earthed) and class II (double-insulated) appliances require different testing procedures

Learning outcome 62 – Apply industry standard safe isolation procedures.

Assessment criteria	Content – What needs to be covered
62.1 Identify the correct means of electrical isolation prior to commencing work.	Actions in the following order: • Seek permission from the relevant responsible person • Identify the point of isolation turn off and lock it off to prevent the system from being energised • Place warning labels to warn others that the electrical installation has been isolated • Secure the isolation and keep the key to the lock with you at all times • Prove that your voltage indicator or test lamp are functioning correctly, on a proving unit or a known live source • Prove the system or equipment is dead using an approved voltage indicator or test lamp • Test the outgoing side of the means of isolation to ensure it is dead • Complete the following tests, depending on the type of supply: o single phase installations test to confirm that there is no voltage between: ▪ Earth and line ▪ Earth and Neutral ▪ Neutral and line o re-test the voltage indicator on the proving unit o once the system/equipment is isolated, only then can you begin work

Appendix 2 – Assessment criteria amplification for Knowledge test Paper 2a (9289-301)

Learning outcome 1 – Know what an air source heat pump is, the principle of the vapour compression system and system components.

Assessment criteria	Content – What needs to be covered
1.1 Identify key components of the vapour compression refrigeration cycle: • compressor • condenser • expansion valve • evaporator • refrigerant.	• Compressor • Condenser • Expansion valve • Evaporator • Refrigerant

1.2 Identify how the vapour compression refrigerant circuit within a heat pump unit operates.	• Compressor
	  ○ the low-pressure refrigerant is compressed, raising its pressure and temperature
	  ○ this high-pressure, high-temperature vapour is then sent to the condenser
	• Condenser
	  ○ the high-temperature, high-pressure vapour releases its heat to the surroundings (usually air or water) and condenses back into a high-pressure liquid
	• Expansion valve
	  ○ the high-pressure liquid refrigerant passes through the expansion valve, which reduces its pressure and temperature. The low-pressure, low-temperature liquid is then ready to enter the evaporator, and the cycle repeats
	• Evaporator
	  ○ the low-pressure, low-temperature refrigerant absorbs heat from the surroundings (air, water, or ground) and the refrigerant evaporates, turning from a liquid into a vapour
	• Refrigerant
	  ○ the working fluid for the whole vapour compression cycle

Learning outcome 2 – Know the different operational characteristics of each type of heat pump unit and system arrangement.

Assessment criteria	Content – What needs to be covered

2.1 Identify the different types of Air Source heat pump:
 	
monoblock, fixed speed, inverter driven
• split
• air to air.
	• Monoblock
	  ○ one unit
	  ▪ fixed speed
	  ▪ inverter driven
	• Split
	  ○ split refrigerant air to water heat pump
	  ○ split type – outdoor unit with connecting refrigeration pipework to indoor unit
	• Air to air
	  ○ air to air heat pump
	  ○ hot water heat pump

2.2 Identify the requirements of the current fluorinated greenhouse gases regulations in relation to:
 	
• the competence of personnel installing heat pumps where the refrigerant circuit has been assembled and tested by the product manufacturer
• the competence of personnel installing and charging split air source heat pumps where the refrigerant circuit is to be assembled and tested in the location where the heat pump is to be installed and operated
• the competence of personnel undertaking leakage checking on heat pump refrigerant circuits
• the competence of personnel undertaking servicing of a split air source heat pumps
• the competence of personnel undertaking recovery of fluorinated greenhouse gases from
	• To work on refrigerant systems, operatives must have completed a relevant training course
	• Category of F Gas
	  ○ Category I
	  ▪ installation, leakage checking, refrigerant recovery, maintenance or servicing
	  ○ Category II
	  ▪ install, maintain, service and recover refrigerant from systems containing less than 3 kg of F gas, (or less than 6 kg of F gas if hermetically sealed)
	  ○ Category III
	  ▪ recovery only from systems containing < 3 kg refrigerant (or < 6 kg for hermetically sealed systems)
	  ○ Category IV
	  ▪ leakage checking only
	• Flammability of certain refrigerants
	  ○ Class 1: non-flammable
	  ○ Class 2L: mildly flammable with low burning velocity
	  ○ Class 2: flammable but less than Class 3 (rarely used)
	  ○ Class 3: highly flammable

Assessment criteria	Content – What needs to be covered
• heat pump refrigerant circuits • flammability of certain refrigerants.	

Learning outcome 3 – Know the fundamental principles of heat pump efficiency and design selection that are common for heat pumps.

Assessment criteria	Content – What needs to be covered
3.1 Identify the meaning of the term 'Coefficient of Performance'.	• The Coefficient of Performance (CoP) is a measure of the efficiency of a heat pump operating in heating mode
3.2 Identify the relationship between Coefficient of Performance and the: • heat pump input temperature • heat pump emitter temperature.	• The heating CoP is the ratio of the heat pump output to the power input • Heating CoP = $\frac{\text{Heat output}}{\text{Power input}}$

3.3 Identify the effect that ambient temperature can have on:
• coefficient of performance
• heat pump output.
	• Coefficient of Performance (CoP)
	  ○ the CoP of a heat pump decreases as the ambient temperature drops
	  ○ the CoP of a heat pump increases as the ambient temperature rises
	• Heat pump output
	  ○ the heat pump output decreases with lower ambient temperatures
	• Heat Output = Electrical Input × CoP

3.4 Identify the meaning of the term 'Seasonal Coefficient of Performance'.	• The Seasonal Coefficient of Performance (SCoP) is the measure of a heat pump's energy efficiency over an entire heating season

3.5 Identify the factors that can affect the Seasonal Coefficient of Performance.	• Type of heat pump used
	• System flow temperature
	• System design and installation
	• Refrigerant type
	• External weather conditions
	  ○ outdoor temperatures
	  ○ seasonal variations
	  ○ humidity
	• Heat pump operating characteristics
	• Geographical location
	• System maintenance

Assessment criteria	Content – What needs to be covered

3.6 Identify the purpose and content of a products ErP label and product Fiche.	• The ErP label is a standardised label that provides the following information about the energy efficiency of a product
	  ○ energy efficiency ratings
	  ○ energy consumption
	  ○ noise levels
	  ○ water usage
	  ○ manufacturer's name
	• A product fiche is a document that provides detailed information about the following product's performance and energy consumption
	  ○ manufacturer's name
	  ○ model identifier
	  ○ energy efficiency class
	  ○ annual energy consumption
	  ○ technical specifications

3.7 Identify the meaning of the term 'System Efficiency'.	• Used as a term to evaluate the overall effectiveness of the entire heating system • The total energy output of the whole energy generating system in relation to the electrical energy used to achieve the energy output
3.8 Identify the factors that can affect the 'System Efficiency'.	• Type of heat pump used • Heat emitter circuit flow temperature • Heat emitter sizing/design • Accuracy of the sizing of the heat pump in relation to the heat demand • Heat pump operating characteristics • Heat pump unit component electrical energy consumption • The number of electrical components within the heat emitter circuit • The energy efficiency of the electrical components within the heat emitter circuit • How well maintained the system is • Location of the heat pump

3.9 Identify why achieving minimum heat loss from the building is particularly important when designing a heat pump system.	• System efficiency
	  ○ heat pumps operate most efficiently when the temperature difference between inside and outside is minimised
	  ○ lower heat loss means the system doesn't need to work as hard to maintain indoor comfort
	  ○ this improves the CoP and Seasonal Performance Factor (SPF), leading to better energy use per kWh consumed
	• Optimal sizing
	  ○ the heat pump needs to be designed in relation to the heat loss from the building

Assessment criteria	Content – What needs to be covered

	• Optimal performance of the heat pump
	  ○ a well-insulated building requires less heating capacity, allowing for a smaller, more cost-effective heat pump
	  ○ oversized systems cycle on and off more frequently, reducing lifespan and efficiency
	  ○ undersized systems struggle to meet demand, especially in colder periods
	• Energy costs
	  ○ less heat escaping means lower energy consumption to maintain target temperatures
	• Building regulations compliance
	  ○ UK Building Regulations (Part L) require minimum standards for thermal performance
	• Heat emitter size
	  ○ lower heat loss allows for lower flow temperatures, which are ideal for heat pumps
	  ○ this enables the use of smaller radiators or underfloor heating loops, reducing installation costs and improving aesthetics

3.10 Identify the effect that oversizing of a heat pump has on:
system performance/efficiency
• heat pump operation.
	• System performance/efficiency
	  ○ increased electrical consumption
	• Heat pump operation
	  ○ short cycling
	  ○ reduced efficiency
	  ○ poor temperature control
	  ○ oversized pipework
	  ○ higher maintenance costs
	  ○ increased wear and tear
	  ○ reduced lifespan

3.11 Identify the effect that under-sizing of a heat pump has on:
• system performance/efficiency
• heat pump operation.
	• System performance/efficiency
	  ○ reduced heat output
	  ○ increased electrical consumption
	• Heat pump operation
	  ○ continuous running
	  ○ reduced efficiency
	  ○ poor temperature control
	  ○ higher maintenance costs
	  ○ increased wear and tear
	  ○ reduced lifespan
	  ○ the building heat demand not being met
	  ○ increased cycling of the heat pump
	• Reduced SPF due to the frequency and duration of supplementary electrical heater use

3.12 Identify the meaning of the terms:	• Monovalent ○ the heat pump is the only heat generator and it is sized to meet the full design heat load

Assessment criteria	Content – What needs to be covered

• monovalent system
• bivalent system
• hybrid system.
	• Bivalent system
	  ○ the heat pump is the main heat generator but the system includes a supplementary electrical heater to provide top-up heat when heat demand exceeds the heat pump output capacity at a defined bivalent point
	• Hybrid system
	  ○ these combine an air source heat pump with a traditional boiler. The system can switch between the heat pump and the boiler depending on which is more efficient at the time

3.14 Identify the meaning of the term 'bivalent points' in relation to heat pump output charts.	• The outdoor temperature at which the heat pump's capacity is no longer sufficient to meet the entire heating demand
3.15 Identify how 'bivalent points' are used to determine auxiliary heat requirements.	• Identifying the outdoor temperature at which a heat pump alone can no longer meet the building's total heat demand, thus signifying the point where a secondary heating source needs to be activated
3.16 Identify how heat pump output capacity is affected by: • heat pump input temperature • heat pump output temperature.	• heat pump output capacity decreases as the ambient air inlet temperature decreases • heat pump output capacity increases as the ambient air inlet temperature increases

3.17 Identify the typical mean water temperature recommended when designing a hydraulic emitter circuit that incorporates:
standard panel radiators
• underfloor heating
• fan assisted convector heaters
• fan coils.
	• The mean water design temperatures can vary dependant on the individual design of the building
	• The typical mean water design temperatures are
	  ○ standard panel radiators
	  ▪ 45 – 55 °C
	  ○ underfloor heating
	  ▪ 30 – 40 °C
	  ○ fan-assisted convector heaters
	  ▪ 35 – 50 °C
	  ○ fan coils
	  ▪ 30 – 45 °C

3.18 Identify the typical annual operating hours for a heat pump that is being used for:
• heating only
• heating and domestic hot water.
	• Heating only
	  ○ 2 000 hours or more per year
	• Heating and domestic hot water
	  ○ 2 500 hours or more per year

Assessment criteria	Content – What needs to be covered

3.19 Identify how heat pump annual operating hours may vary in relation to the:
• type of building
• geographical location of the installation.
	• Type of building
	  ○ factors that will vary the heat pump annual operating hours
	  ▪ exposed sides
	  ▪ heating load
	  ▪ size of building
	  ▪ types of rooms
	  ▪ number of floors
	  ▪ construction detail
	  ▪ ventilation
	  ▪ insulation
	• Geographical location of the installation
	  ○ average outdoor temperature
	  ▪ lower outdoor temperature increases the annual operating hours
	  ▪ higher outdoor temperature decreases the annual operating hours
	  ○ design outdoor temperature
	  ▪ geographical location will affect the design outdoor temperature and impact on the annual operating hours
	  ○ orientation
	  ▪ the optimum position for a heat pump fan coil evaporator unit is south facing

Learning outcome 5 – Know the fundamental principles of domestic hot water cylinder selection and system design that are common for heat pumps.

Assessment criteria	Content – What needs to be covered

5.1 Identify the different type of heat pump hot water cylinders:
• heat pump, hot water packaged unit
• coiled indirect cylinder
• tank in tank cylinder
• thermal store
• solar cylinder.
	• Heat pump, hot water packaged unit
	• Coiled indirect cylinder
	• Tank in tank cylinder
	• Thermal store
	  ○ one heat exchanger
	  ○ passes cold water through the heat exchanger
	• Solar cylinder
	  ○ two heat exchangers one connected to the heat pump and one connected to the solar array

5.2 Identify volume of hot water cylinder required for the building.	• Occupancy: 35 – 45 litres per person
	• Hot water sizing rule of thumb
	  ○ 2 – 3 bedroom property with one bathroom: 120 –150 litres
	  ○ 3 – 4 bedroom property with one to two bathrooms: 180 – 210 litres

Assessment criteria	Content – What needs to be covered
	○ 4 – 5 bedroom property with more than two bathrooms: 210 – 300 litres
5.3 Identify output required from heat pump to heat the hot water cylinder.	• Equation ○ Output = $\frac{\text{Volume} \times T \times \text{SHC of water}}{3\,600}$ where T = temperature and SHC = specific heat capacity
5.4 Identify correct selection of hot water cylinder for the heat pump.	• Factors that affect selection ○ cylinder capacity ○ insulation ○ flow rates ○ recovery time ○ space requirements ○ compliance
5.5 Identify correct zone valve selection for heat pump and hot water cylinder.	• 2-port valve • 3-port valve
5.6 Identify requirements for secondary hot water circulation.	• Building size • Pipework lengths ○ 15 mm diameter pipework: maximum permitted length is 12 metres from the hot water source to the outlet • Demand • Temperature control • Time control • Energy efficiency • Pump selection ○ bronze pump/stainless steel for a hot water secondary circulation system • Insulation • Compliance
5.7 Identify safe system design in relation to regulations for: • legionella protection • hot water temperature protection and prevention of scalding.	• Legionella protection ○ storage temperature no less than 60 °C ○ distribution temperatures no less than 50 °C for hot water ○ compliance with HSE ACoP L8 • Hot water temperature protection and prevention of scalding ○ thermostatic mixing valve

Learning outcome 6 – Know the fundamental principles of hydraulic system design that are common for heat pumps.

Assessment criteria	Content – What needs to be covered

6.1 Identify the installation requirements where flow and return pipework passes through the external building fabric in relation to:
• provision for movement
• prevention of water ingress.
	• Provision for movement
	  ○ sleeved through wall with metallic pipe
	  ○ Approved Document A
	• Prevention of water ingress
	  ○ pipe sleeve
	  ▪ sealed to sleeve
	  ○ Approved Document C
	• The prevention of moisture ingress (building water tightness)
	  ○ site preparation and resistance to contaminants and moisture
	  ○ Approved Document C

6.2 Identify the suitability of the following types of hydraulic heating system emitter for heat pump systems:
• standard panel radiators
• underfloor heating
• fan assisted convector heaters
• fan coils
• combined systems (radiators, underfloor heating)
• multiple zones.
	• Standard panel radiators
	  ○ moderate suitability
	  ○ typically designed for high flow temperatures (70 – 80 °C). New limit on design temperature is 55 °C where possible
	  ○ when used with heat pumps (30 – 55 °C), output is reduced
	  ○ may require resizing or replacement with low-temperature models
	• Underfloor heating (UFH)
	  ○ high suitability
	  ○ operates efficiently at low flow temperatures (30 – 45 °C)
	  ○ large surface area and low thermal resistance make UFH ideal for heat pump systems
	  ○ most suited for direct connection to a heat pump
	• Fan-assisted convector heaters
	  ○ suitable
	  ○ fans enhance heat transfer even at lower temperatures
	  ○ useful in retrofit applications where space or response time is a concern
	• Fan coil units (FCUs)
	  ○ suitable
	  ○ designed for low-temperature systems
	  ○ offer rapid response and zonal control
	  ○ ideal for commercial or multi-zone residential setups
	• Combined systems (radiators, underfloor heating (UFH))
	  ○ suitable with careful design

Assessment criteria	Content – What needs to be covered
	○ requires hydraulic separation or mixing valves to manage different flow temperatures ○ zoning and control logic must be well coordinated • Multiple zones ○ suitable ○ enables tailored comfort and energy efficiency ○ requires smart thermostats, actuators and hydraulic balancing to ensure optimal performance ○ properties larger than 150 m^2 will require multiple heating zones
6.3 Identify the installation requirements for the connection to the following types of hydraulic heating system emitter: • standard panel radiators • underfloor heating • fan assisted convector heaters • fan coils • combined systems (radiators, underfloor heating) • multiple zones.	• Standard panel radiators ○ system configuration: typically two-pipe systems with thermostatic radiator valves (TRVs) ○ connection to emitters: flow and return connections at opposite ends or bottom opposite; TRVs and lockshield valves required ○ pipe sizes: usually 15 mm for domestic; larger sizes for commercial or long runs ○ system controls: TRVs, programmable room thermostats and zone valves • Underfloor heating (UFH) ○ system configuration: manifold-based system with multiple loops; often mixed with buffer or blending valves ○ connection to emitters: pipes embedded in screed or dry panels; connected to manifold with flow meters and actuators ○ pipe sizes: typically 16 mm PEX or MLCP; loop lengths limited to ~100 m for pressure balance ○ system controls: individual room thermostats, manifold actuators, blending valves and pump sets • Fan assisted convector heaters ○ system configuration: two-pipe system with electrical supply for fan operation ○ connection to emitters: flow and return via standard pipework; electrical connection for fan and control ○ pipe sizes: 10–15 mm typically; ensure adequate flow rate for heat transfer ○ system controls: room thermostats, fan speed controllers and time switches • Fan coil units (FCUs) ○ system configuration: two-pipe or four-pipe systems depending on heating/cooling requirements

Assessment criteria	Content – What needs to be covered
	○ connection to emitters: flow and return with isolation valves; electrical connection for fan and control ○ pipe sizes: 15 – 22 mm depending on unit capacity and distance ○ system controls: BMS integration, thermostats, fan speed control and zone valves • Combined systems – radiators and underfloor heating ○ system configuration ▪ zoned system with hydraulic separation or blending valves ○ connection to emitters ▪ radiators via TRVs ▪ UFH via manifold ○ pipe sizes ▪ radiators: 10 –15 mm ▪ UFH: 16 mm ▪ primary circuits: 22 – 28 mm ○ system controls ▪ multi-zone thermostats ▪ blending valves ▪ actuators ▪ time controls • Multiple zones ○ floor area over 150 m^2 ○ separate time and temperature for each zone
6.4 Identify heat pump hydraulic flow rate requirements and circulation pump selection.	• Hydraulic flow ○ flow rate ○ heat transfer ○ cycling ○ pipe sizing • Pump selection ○ flow rate ○ pressure head ○ variable speed ○ low energy ○ noise
6.5 Identify heat pump pipe size requirements in relation to designed flow temperature.	• Correct pipe sizing is essential to maintain the flow rates around the system and to deliver adequate heat to the heat emitters • Flow temperature • Pressure drop • Pipe sizing rule of thumb ○ 3 kW ▪ flow rate: 0.14 l/s ▪ suggested pipe size: 15 mm OD

Assessment criteria	Content – What needs to be covered
	○ 6 kW ▪ flow rate: 0.29 l/s ▪ suggested pipe size: 22 mm OD ○ 9 kW ▪ flow rate: 0.43 l/s ▪ suggested pipe size: 28 mm OD ○ 12 kW ▪ flow rate: 0.57 l/s ▪ suggested pipe size: 35 mm OD ○ 15 kW ▪ flow rate: 0.72 l/s ▪ suggested pipe size: 42 mm OD ○ 18 kW ▪ flow rate: 0.86 l/s ▪ suggested pipe size: 54 mm OD • Regulations • Material • Insulation
6.6 Identify the correct pipe size requirements in relation to designed flow temperature.	• Factors that affect pipe sizing ○ heat load (kW) ○ ΔT (temperature difference) ○ flow rate (L/min or kg/s) ○ pipework material ○ maximum velocity ○ pressure drop allowance ▪ ≤ 350 Pa/m (CIBSE guidance) ○ system layout ○ pump capability ○ manufacturers recommendations
6.7 Identify why a buffer vessel maybe required in the system design.	• Buffer vessels should be used when ○ the flow volume through the system can be reduced by controls ○ there are circuits which require different temperatures • The purpose of a buffer vessel is to ○ ensure the minimum flow through the heat pump ○ ensure the minimum run time of the heat pump and reduce cycling of the heat pump ○ provide heat when the heat pump is unavailable ○ maintain the minimum system volume
6.8 Identify if a buffer vessel is required in the system design and is correctly sized.	• The size will depend on the heating system, total water volume and the time for which storage is required • Manufacturer's instructions will detail sizing requirements

Assessment criteria	Content – What needs to be covered
6.9 Identify correct piping alternatives for buffer vessels in the system design.	• Buffer tank connected in series • Buffer tank connected in parallel • Buffer tank connected in parallel with heating circuit return by passing buffer tank • Monovalent circuit, heating with buffer tank (buffer tank connected in series) • Monovalent circuit, heating with buffer tank and indirect stored domestic hot water (buffer tank connected in series) • Monovalent circuit, heating with buffer tank and indirect stored domestic hot water with solar coil (buffer tank connected in parallel with heating return bypassing buffer tank) • Bivalent circuit, heating with buffer tank (buffer tank connected in parallel) • Bivalent circuit, heating with buffer tank and indirect stored domestic hot water (buffer tank connected in parallel) • Bivalent circuit, heating with buffer tank and indirect stored domestic hot water with solar coil (buffer tank connected in parallel) • Bivalent circuit, heating with buffer tank and thermal store (buffer tank connected in parallel)

6.10 Identify the installation requirements for suitable insulation of external pipework in relation to:
• thermal loss
• protection against freezing
• UV protection
• animal protection.
	• External pipework should be insulated to meet minimum thermal performance standards
	• Insulation used must
	  ○ have good thermal loss protection properties
	  ○ provide protection against freezing
	  ○ have little or no UV degradation
	  ○ provide protection against animals and vermin
	• Suitable insulation type
	  ○ EPDM rubber
	  ▪ UV resistant
	  ▪ weatherproof
	  ▪ flexible

Learning outcome 7 – Know the fundamental principles of heat pump controls.

Assessment criteria	Content – What needs to be covered

7.1 Identify the common control systems for heat pump units in relation to:
• weather compensation
• indoor and outdoor sensors
	• Weather compensation
	  ○ a smart feature used in heating systems, including heat pumps, to adjust the heating flow temperature based on the outdoor temperature
	• Indoor and outdoor sensors
	  ○ outdoor sensor

Assessment criteria	Content – What needs to be covered
• heat curves • scheduling • optimisation • accessories • internet connections and Apps.	▪ allow the heat pump to operate with weather compensation ▪ installed on a north facing wall ○ indoor sensor ▪ can be used with the outdoor sensor to adjust weather compensation • Heat curves ○ programmed into the heat pump to ensure weather compensation works within design parameters • Scheduling ○ on and off periods for heating and hot water • Optimisation ○ advanced systems designed to enhance the efficiency and performance of the heat pump • Accessories ○ Thermostats – devices to control the temperature settings of the heat pump ▪ anti-freeze valves – prevent the system from freezing in cold weather ▪ buffer tanks – help to maintain a consistent temperature and reduce cycling ▪ flow setters – ensure the correct flow rate of the refrigerant ▪ pre-insulated pipe packs – reduce heat loss in the piping system ▪ magnetic particle filters – keep the system clean by removing debris and particle ▪ remote control – allows for remote operation and monitoring of the heat pump ▪ expansion vessels – accommodate the expansion of water in the system • Internet connections and apps ○ smart central heating controls

Learning outcome 8 – Know the preparatory work required for heat pump installation work.

Assessment criteria	Content – What needs to be covered
8.1 Identify the common requirements of pre-installation checks for heat pump unit installations connected to	• Authorisation for the work to proceed ○ is town planning or listed building consents needed? ○ has any required permission or consent been given?

Assessment criteria	Content – What needs to be covered

hydraulic emitters circuits in relation to:
• authorisation for the work to proceed
• the availability and collation of all relevant information
• verification of the suitability of the hydraulic emitter circuit for connection to the heat pump unit
• verification that the heat output capacity of the heat pump unit is matched to the required proportional contribution of the total building heat load
• verification that the buffer tank sizing is correct
• the availability of appropriate access to all required work areas
• the availability and condition of a suitable electrical input service
• verify the correct fuse rating for heat pump
• adequate provision for the siting of key internal system components
• the suitability of the building structure in relation to the proposed installation
• DNO notification
• building regulation and assignment of rights.
	• The availability and collation of all relevant information
	  ○ the installation design specification is available
	  ○ manufacturer's installation and commissioning instructions are available for all equipment
	  ○ client specific information is available
	• Verification of the suitability of the hydraulic emitter circuit for connection to the heat pump unit
	  ○ the emitter circuit flow temperature is appropriate for the type and size of emitters
	  ○ the domestic hot water storage vessel storage volume and heat exchanger design is appropriate
	  ○ the buffer tank sizing is correct
	• Verification that the heat output capacity of the heat pump unit is matched to the required proportional contribution of the total building heat load
	  ○ verification that the heat of the heat pump unit output capacity is matched to the design heat load to be met by the heat pump
	• Verification that the buffer tank sizing is correct
	  ○ verification that the buffer tank has been designed in accordance with manufacturer guidance
	• The availability of appropriate access to all required work areas
	  ○ safe access is available to all required areas
	  ○ restricted access to all appropriate personal
	• The availability and condition of a suitable electrical input service
	  ○ is the electrical service suitable for the rating of the heat pump?
	• Verify the correct fuse rating for heat pump
	  ○ does the service have the correct circuit over current protection rating and size?
	  ○ typical fuse ratings by heat pump size
	  ▪ 5 kW 10 – 16 A
	  ▪ 8 kW 16 – 20 A
	  ▪ 12 kW 20 – 25 A
	  ▪ 16 kW 25 – 32 A
	• Adequate provision for the siting of key internal system components
	  ○ does the proposed siting of components meet manufacturer's, regulatory and any possible client's requirements?
	• The suitability of the building structure in relation to the proposed installation

Assessment criteria	Content – What needs to be covered
	○ is the type and condition of the structure suitable for the load that will be imposed by the heat pump unit? • District Network Operator (DNO) notification ○ Has the DNO been notified? • Building regulation and assignment of rights ○ Part A – structure ○ Part B – fire safety ○ Part C – site preparation and resistance to contaminants and moisture ○ Part E – resistance to the passage of sound ○ Part G – sanitation, hot water safety and water efficiency

Learning outcome 9 – Know the preparatory work required for the installation of an air source heat pump.

Assessment criteria	Content – What needs to be covered
9.4 Identify the requirements for moving and handling air source heat pumps units to avoid damage and personal injury.	• Heat pump should always be transported and stored in an upright position • The risk of cosmetic damage to the unit casing panels should be assessed before moving • Assess the risk and the load • Minimise the need to handle the unit by planning delivery/installation sequences • Use a sack truck for mechanical lifting equipment as a first choice; if this is not possible, seek assistance with the lift • A heat pump should be left for 24 hours prior to activating it following tilting a heat pump during moving
9.5 Identify the options to deal with the condensate produced from normal and defrost cycle operation of an air source heat pump.	• Internal gravity discharge (preferred method) ○ connect to ▪ internal soil stack ▪ sink, basin, bath, or shower waste pipe ○ pipe requirements ▪ minimum internal diameter: 19 mm ▪ minimum fall: 45 mm per metre ○ advantages ▪ protected from freezing ▪ complies with BS 6798:2014 and Heating and Hot Water Industry Council (HHIC) guidance • Condensate pump (if gravity discharge is not possible) ○ used when ▪ the discharge point is above the appliance

Assessment criteria	Content – What needs to be covered
	▪ long internal pipe runs are impractical ○ connect to ▪ internal soil stack ▪ internal waste pipe (eg sink or bath) ○ pump must be ▪ WRAS-approved ▪ installed per manufacturer instructions • External termination (only if internal options are impractical) ○ pipe requirements ▪ minimum internal diameter: 30 mm ▪ insulated with UV-resistant, waterproof material ▪ maximum external length: 3 metres ○ terminate ▪ below the grid but above the water line ▪ with a drain/leaf guard ▪ pipe end cut at 45-degree angle to reduce freezing risk
9.6 Identify suitable electrical supply in relation to: • District Network Operator (DNO) connection • isolation switches • fuse rating.	• District Network Operator (DNO) connection ○ checks must be carried out that the electrical supply is installed in accordance with BS7671 • Isolation switches ○ suitable isolation should be provided in accordance with BS7671 – a rotary isolator • Fuse rating ○ power to the heat pump should be provided through a dedicated circuit with a fuse or circuit breaker rated according to the manufacturer's recommendations ▪ 12 kW = 32 A ▪ 5 kW = 16 A

Learning outcome 10 – Know the requirements to install and test air source heat pump systems (non-refrigerant circuits).

Assessment criteria	Content – What needs to be covered
10.1 Identify the requirements for moving and handling heat pump units to avoid damage to the unit.	• Heat pump should always be transported and stored in an upright position • The risk of cosmetic damage to the unit casing panels should be assessed before moving • A heat pump should be left for 24 hours prior to activating it following tilting a heat pump during moving
10.2 Identify the requirements to avoid undue noise and/or vibration transmission from the heat pump unit to the building structure during the operation of the heat pump.	• Mounted on a suitable anti-sound/vibration pad or mat • Anti-sound/vibration feet • Flow and return pipework connections should be made using flexible hoses • Heat pump connections should be made using non-ageing flexible hoses

10.3 Identify the requirements where brine circuit pipework passes through the external building fabric in relation to:
• provision for movement
• protection against freezing
• prevention of water ingress.
	• Provision for movement
	  ○ sleeved through wall with suitable pipework material
	• Protection against freezing
	  ○ protection against freezing, condensation and heat loss, insulation with a wall thickness to suit the collector pipe diameter
	• Prevention of water ingress
	  ○ sealed to sleeve
	• The prevention of moisture ingress (building water tightness)
	  ○ site preparation and resistance to contaminates and moisture
	  ○ Approved Document C

10.4 Identify the charging and flushing requirements for hydraulic system in relation to:
• correct filling and venting
• purging of air and installation debris
• addition of antifreeze protection and suitable cleansers and or inhibitors
• checking for leaks
• check filters for debris.
	• Correct filling and venting
	  ○ System flushing
	  ○ System filled via the filling loop and vented at all heat emitters
	• Purging of air and installation debris
	  ○ air
	  ▪ manually air bleed valves
	  ▪ install air vents, automatic air eliminators
	  ▪ purge pumps
	  ○ debris
	  ▪ inline strainer
	• Addition of antifreeze protection and suitable cleansers and or inhibitors
	  ○ cleanser
	  ▪ used to clean the system and remove sludge, scale and debris

Assessment criteria	Content – What needs to be covered
	○ inhibitor ▪ used to prevent corrosion and improve efficiency • Checking for leaks ○ hydraulic pressure test ▪ a heat pump heating system should be tested for a minimum of 10 minutes at 1.5 times working/operating pressure, unless otherwise specified by the manufacturer • Checking filters for debris ○ all filters/inline strainers should be checked and cleared of any installation debris
10.5 Identify what equipment is needed for system charging and flushing.	• Flushing pump ○ used to circulate cleaning fluid through the system at high velocity ○ removes debris, sludge, and contaminants from pipework, emitters and components • Filling point ○ designated connection for introducing fluid into the system ○ allows for controlled filling during commissioning and maintenance • Pressure gauge ○ essential for monitoring system pressure during charging, flushing and operation ○ helps verify that the system is within safe operating limits and assists in identifying leaks or blockages • Hydraulic pressure tester ○ used to test the system's integrity under pressure ○ verifies that pipework, joints and components can withstand operating pressures without leaks
10.6 Identify the hydraulic test requirements.	• Test pressure ○ the system must be pressure tested at 1.5 times the working/operating pressure, unless otherwise specified by the manufacturer • Test medium ○ use water or an approved non-compressible fluid for hydraulic testing • Duration ○ maintain the test pressure for a minimum of 10 minutes, monitoring for any pressure drop or visible leaks ○ longer durations may be required for larger systems or complex installations

Assessment criteria	Content – What needs to be covered

	• System isolation
	  ○ the heat pump unit itself must be isolated during testing to prevent damage to internal components
	• Visual inspection
	  ○ while under pressure, inspect all joints, fittings, valves and pipework for signs of leakage, deformation or stress. All components must remain stable and leak-free
	• Documentation
	  ○ record the test pressure, duration, medium used and results in the commissioning report
	  ○ any corrective actions taken must also be documented
	• Compliance standards
	  ○ hydraulic testing must comply with the following
	  ▪ MCS MIS 3005 (Microgeneration Certification Scheme)
	  ▪ BS EN 806 (specifications for installations inside buildings)
	  ▪ BS EN 12828 (heating systems in buildings)

Learning outcome 11 – Understand the requirements to commission air source heat pump system installations (non-refrigerant circuits).

Assessment criteria	Content – What needs to be covered

11.1 Identify the conditions that are required to implement commissioning activities for heat pump systems.	• Visual inspection completed prior to implementing commissioning activities
	• Pre-commissioning checks
	  ○ complete installation of all mechanical and electrical components
	  ○ system pipework flushed and cleaned to remove debris and contaminants
	  ○ water quality verified (correct pH, hardness and inhibitor levels)
	  ○ all pipework insulated, especially external runs
	  ○ electrical safety checks completed
	  ▪ MCB/RCBO ratings
	  ▪ isolators
	  ▪ bonding
	  ○ refrigerant circuit sealed and ready for pressure testing
	• Commissioning

Assessment criteria	Content – What needs to be covered
	○ fully charge the system with fluid and refrigerant, then carry out the following ▪ leak testing completed and passed ▪ flow rate and temperature differential (ΔT) verified ▪ control systems operational ▪ emitters balanced and delivering heat evenly ▪ minimum water volume confirmed (buffer tank or volumiser if required) • Testing and documentation ○ hydraulic pressure testing completed ○ functional testing under various load conditions ○ commissioning report completed and signed off ○ customer handover with manuals and user training • Compliance and standards ○ meets Building Regulations Part L – energy efficiency ○ follows MCS MIS 3005 – heat pump installation standard ○ adheres to manufacturer commissioning guideline

Appendix 3 – Assessment criteria amplification for Knowledge test Paper 2b (9289-302)

Learning outcome 1 – Know the health and safety risks and safe systems of work associated with solar thermal system installation work.

Assessment criteria	Content – What needs to be covered

1.1 Identify which aspects of solar thermal system installation work pose risk of:
electrocution/electric shock
• burns
• toxic poisoning
• injury through flash to steam of system heat transfer fluid
• a fall from height
• personal injury though component/equipment handling.
	• Electrocution/electric shock
	  ○ touching live contacts during the installation or maintenance of electrically operated system components and controls
	  ○ conductive system components becoming energised due to contact with electrical supply conductors
	• Burns
	  ○ contact with solar collectors or system components
	  ○ contact with steam
	• Toxic poisoning
	  ○ contact, digestion or consumption of aqueous glycol solar heat transfer fluids
	• Injury through flash to steam of system heat transfer fluid
	  ○ contact with steam produced as a result of the escape or release of heat transfer fluid that is in a gaseous state or release of heat transfer fluid that is at a temperature above the fluid's atmospheric boiling point.
	  ○ during commissioning and when carrying out servicing and maintenance on live systems
	• A fall from height
	  ○ installing solar collectors
	• Personal injury though component/equipment handling
	  ○ during commissioning and when carrying out servicing and maintenance on live systems
	  ○ back and or other injury from incorrect lifting procedure
	  ○ cuts from broken glass in damaged solar collectors

1.2 Identify safe systems of work for solar thermal system installation work in relation to prevention of:
electrocution/electric shock
• burns
• toxic poisoning
	• Electrocution/electric shock
	  ○ risk assessment
	  ○ method statement
	  ○ permit to work
	  ○ ensure that component covers are fitted whenever the system/components are energised unless it is essential that the cover is removed

Assessment criteria	Content – What needs to be covered
• injury through flash to steam of system heat transfer fluid • a fall from height • personal injury though component/equipment handling.	○ follow safe isolation processes before working on installed systems • Burns ○ risk assessment ○ method statement ○ permit to work ○ use appropriate personal protective equipment (PPE) ○ isolate other heat sources if working on installed systems ○ do not break joints on the sealed circuit solar-loop pipework when the system is subject to high levels of solar radiation • Toxic poisoning ○ risk assessment ○ method statement ○ permit to work ○ follow the use and handling guidance given in the manufacturer's safety data sheet (MSDS) ○ ensure that any used fluid is safely disposed of in accordance with the guidance in the MSDS ○ follow the safe storage guidance given in the MSDS • Injury through flash to steam of system heat transfer fluid ○ risk assessment ○ method statement ○ permit to work ○ isolate other heat sources if working on installed systems ○ do not break joints on the sealed circuit solar-loop pipework when the system is subject to high levels of solar radiation • Fall from height ○ risk assessment ○ method statement ○ permit to work ○ use appropriate access equipment (working from ladders is not a suitable system of work) ○ ensure that any working platform at roof level is of sufficient size to enable safe handling of solar collectors ○ use personal fall arrest equipment or other methods of preventing a fall such as safety nets • Personal injury though component/equipment handling ○ risk assessment ○ method statement ○ permit to work

Assessment criteria	Content – What needs to be covered
	○ where handling is unavoidable, use mechanical lifting/handling equipment as a first choice ○ where manual handling is proposed, assess the load and the route and only use a manual handling technique if safe to do so ○ use appropriate PPE

Learning outcome 2 – Know the requirements of relevant regulations/standards relating to practical installation, testing, and commissioning activities for solar thermal system installation work.

Assessment criteria	Content – What needs to be covered
2.1 Interpret building regulation/ building standards guidance documentation as relevant to solar thermal system installation work to identify the requirements in relation to: • maintaining the structural integrity of the building • maintaining the fire-resistant integrity of the building • the prevention of moisture ingress (building water tightness) • notification of work requirements • control of temperature in primary and secondary circuits including primary circuits connected to unvented hot water storage systems • energy conservation • testing and commissioning requirements • compliance certification.	• Maintaining the structural integrity of the building structure ○ Approved Document A • Maintaining the fire-resistant integrity of the building ○ Approved Document B • The prevention of moisture ingress (building water tightness) ○ site preparation and resistance to contaminates and moisture ○ Approved Document C • Notification of work requirements ○ planning/Listed Building Consent (LBC)/permitted development • Control of temperature in primary and secondary circuits including primary circuits connected to unvented hot water storage systems ○ sanitation, hot water safety and water efficiency ○ Approved Document G • Energy conservation of fuel and power ○ Approved Document L • Testing and commissioning requirements, manufacturer's instructions • Compliance certification ○ MIS 3001 The Solar Thermal Standard (Installation) solar thermal installation – installer handover checklist
2.2 Interpret industry recognised water regulation/byelaw guidance	• Prevention of contamination of the wholesome water supply ○ selection of pipes, pipe fittings and joints

Assessment criteria	Content – What needs to be covered
documentation as relevant to solar thermal system installation work to identify the requirements in relation to: • prevention of contamination of the wholesome water supply • energy conservation • safe operation • testing and commissioning requirements.	○ distribution temperature of cold water – relative positions of horizontal cold and hot water pipes ○ redundant fittings and dead legs – this may be relevant when installing a solar thermal hot water system to an existing building ○ avoidance of cross-connections between pipes conveying wholesome water and pipes conveying non-wholesome water • Energy conservation ○ maximum lengths of uninsulated hot water pipes – the maximum permitted length of uninsulated hot water pipe is 12 metres for a 15 mm diameter pipe • Safe operation of unvented hot water systems ○ maximum temperature of hot water within a storage system of 60 °C ○ hot water distribution temperatures: minimum of 55 °C ○ temperature of hot water supplies at terminal fittings and on surfaces of hot water pipes in public buildings: 43 °C ○ discharge pipes from safety devices ○ sizing, routing and termination of vent pipes • Testing and commissioning requirements ○ hydraulic testing of systems containing rigid pipework ○ hydraulic testing of systems containing plastic pipework

Learning outcome 3 – Know the types and layouts of solar thermal system.

Assessment criteria	Content – What needs to be covered
3.1 Identify the following solar thermal system types: • fully filled (active) • drain back (active) • passive (thermos-siphon).	• Fully filled (active) • Drain back (active) • Passive (thermos-siphon)
3.2 Identify the following solar thermal system storage vessel types and collector circuit arrangements: • direct (fully filled) DHW storage cylinder only	• Direct (fully filled) DHW storage cylinder only • Indirect, sealed collector circuit, DHW storage cylinder only (solar primary coil only) • Indirect, sealed collector circuit, DHW storage cylinder only (dual coil)

Assessment criteria	Content – What needs to be covered
• indirect, sealed collector circuit, DHW storage cylinder only (solar primary coil only) • indirect, sealed collector circuit, DHW storage cylinder only (dual coil) • indirect, sealed collector circuit, pre-heat cylinder and DHW storage cylinder • indirect, sealed collector circuit, thermal store.	• Indirect, sealed collector circuit, pre-heat cylinder and DHW storage cylinder • Indirect, sealed collector circuit, thermal store.

Learning outcome 5 – Know the types and key operating principles of solar collectors.

Assessment criteria	Content – What needs to be covered

5.1 Identify the following types of solar collector:
• unglazed collector
• flat plate glazed collector
• roof integrated glazed collector
• evacuated tube collector – direct flow
• evacuated tube collector – heat pipe.
	• Unglazed collector
	  ○ absorber contains multiple flow tubes that are connected to a header at the top and inlet flow tube at the base
	• Flat plate glazed collector
	  ○ absorber arrangement is completely enclosed in sealed enclosure which passes a heat transfer fluid through the collector which absorbs energy from sun
	• Roof integrated glazed collector
	  ○ absorber arrangement is completely enclosed in a sealed enclosure which passes a heat transfer fluid through the collector which absorbs energy from sun.
	  ○ forms part of the roof structure
	• Evacuated tube collector – direct flow
	  ○ system heat transfer fluid passes through the insulated manifold/header pipe and also flows through a tube contained within each individual collector tube
	• Evacuated tube collector – heat pipe
	  ○ system heat transfer fluid passes through the insulated manifold/header pipe, but it does not flow through the individual collector tubes

5.2 Identify the key operating principles for:	• Flat plate collectors ○ unglazed

Assessment criteria	Content – What needs to be covered
• flat plate collectors • evacuated tube collector – direct flow • evacuated tube collector – heat pipe.	▪ type of collector that has the collector absorber open to the atmosphere ▪ typically made from a pure black co-polymer (polypropylene/polyethylene) material with an ultraviolet (UV) stabiliser added ▪ absorber contains multiple flow tubes that are connected to a header at the top and an inlet flow tube at the base. The absorber is welded to the header tube and inlet flow tube ▪ works by passing a heat transfer fluid through the collector which absorbs energy from sun ○ glazed ▪ not dissimilar to unglazed collectors in that they comprise an absorber that is connected to inlet and outlet header pipes ▪ entire absorber arrangement is completely enclosed in a glazed, sealed and insulated enclosure ▪ works by passing a heat transfer fluid through the collector which absorbs energy from sun • Evacuated tube collector ○ direct flow ▪ system heat transfer fluid passes through the insulated manifold/header pipe and also flows through a tube contained within each individual direct flow collector tube ○ heat pipe ▪ system heat transfer fluid passes through the insulated manifold/header pipe, but it does not flow through the individual collector tubes; each heat pipe contains a small quantity of a liquid medium – typically purified water and some special additives
5.3 Identify the effect that the temperature difference between the solar primary circuit/collector temperature and the ambient temperature has on the relative efficiency of the following types of solar collector:	• As the temperature difference (ΔT – Delta T) between the collector fluid and the ambient air increases, heat losses from the collector also increase • Unglazed collector: typically a simple absorber plate without insulation or glazing (eg plastic or rubber mat) ○ effect of ΔT ▪ highly sensitive to temperature difference

Assessment criteria	Content – What needs to be covered
• unglazed collector • flat plate glazed collector • evacuated tube collector.	▪ efficiency drops rapidly as ΔT increases due to high convective and radiative losses ▪ best suited for low efficiency, low temperature situations ▪ low-temperature applications like swimming pool heating in warm climates • Flat plate glazed collector: insulated box with a dark absorber plate and a transparent glass cover (glazing) ○ effect of ΔT ▪ moderate sensitivity to temperature difference ▪ glazing reduces convective losses, but efficiency still declines as ΔT increases ▪ commonly best suited for domestic hot water in moderate climates and domestic hot water and space heating in temperate climates • Evacuated tube collector: series of glass tubes with vacuum insulation around the absorber ○ effect of ΔT ▪ least affected by temperature difference ▪ vacuum insulation minimises heat loss, maintaining high efficiency even at high ΔT ▪ best suited for high-temperature applications or cold climates with low solar irradiance ▪ highly sensitive to temperature difference ▪ high efficiency – good for year-round use

Learning outcome 6 – Know the information requirements to enable system component selection and sizing.

Assessment criteria	Content – What needs to be covered
6.3 Identify the information requirements in relation to: • building occupancy • required hot water usage pattern.	• Building occupancy ○ building design ○ number of occupants (typical occupancy in relation to the number of bedrooms) ○ building dimensions/angles ○ building location and orientation ○ building fabric/material details ○ existing input services ○ existing hot water/heating systems • Required hot water usage pattern

Assessment criteria	Content – What needs to be covered
	○ optimal usage pattern for solar thermal ○ morning: light usage, stored heat from previous day may be cooler ○ midday: moderate usage, solar gain begins to replenish cylinder ○ afternoon: peak usage, cylinder is at highest temperature ○ evening: controlled usage, solar input drops

Learning outcome 7 – Know the fundamental techniques used to select, size and position components for solar thermal systems.

Assessment criteria	Content – What needs to be covered
7.2 Identify how to determine typical domestic hot water system collector area requirements in relation to: • building occupancy • proposed angle of collector installation • proposed orientation of collector installation • shading that may affect collector performance.	• Building occupancy ○ collector area requirement (m²) = (number of occupants × collector area per occupant (m²)) ÷ orientation/tilt angle factor ○ number of occupants – 45l (max) per person (hot water association guidance) • Proposed angle of collector installation ○ tilt angle = latitude-based angle and seasonal adjustments, fixed versus adjustable mounts, roof pitch • Proposed orientation of collector installation ○ in the northern hemisphere, the optimum orientation to achieve maximum solar energy absorption is due south ○ southeast or southwest orientation can achieve reasonable annual solar energy absorption • Shading that may affect collector performance ○ overshading or partial overshading of a solar collector array should be avoided wherever possible – where heavy overshading exists, the performance of a solar collector can be affected by up to 50% ○ where avoidance is not possible, an overshading factor is required to enable the collector array area requirement to be corrected
7.3 Identify the annual irradiation yield as a % of optimum in relation to: • collector orientation • collector angle • proposed orientation of collector installation	• Collector orientation ○ solar collectors should ideally face true south in the northern hemisphere to maximize exposure to sunlight ○ deviating from the optimal orientation can reduce efficiency, eg orienting the collectors 45 degrees off true south can reduce performance by up to 6% in winter

Assessment criteria	Content – What needs to be covered

• shading that may affect collector performance.	• Collector angle
	  ○ the tilt angle should generally match the latitude of the installation site
	  ○ adjusting the angle seasonally can further optimize performance
	  ○ a tilt of 35 – 40 degrees is often used for domestic systems to balance performance across seasons
	• Proposed orientation of collector installation
	  ○ true south (northern hemisphere): solar collectors facing true south receive the maximum possible solar radiation throughout the year. This orientation is considered 100% optimal. Percentage reduces otherwise
	• Shading that may affect collector performance
	  ○ collectors should be free from shading throughout the day, especially during peak sunlight hours
	  ○ eg shading that covers 10% of the collector area can reduce output by more than 10% due to the way shading affects the entire system

7.4 State typical recommended solar primary circuit circulation rates.	• Refer to the manufacturer's instructions ○ to ensure efficiency of heat removal, flow rates in the region of 0.01 to 0.02 kilograms per second (kg/s) per square metre of collector area are found to be reasonable when the fluid is water or water based

7.5 Identify solar primary circuit pipe size requirements in relation to:
• primary circuit circulation rates
• collector area
• primary circuit pipework length.
	• Primary circuit circulation rates
	  ○ manufacturer's data should be consulted to confirm optimum flow rates
	• Collector area
	  ○ the total collector area directly influences the required flow rate and, consequently, the pipe size
	• Primary circuit pipework length
	  ○ the length of the pipework affects the pressure drop in the system. Longer pipe runs increase the pressure drop, which must be compensated for by selecting a larger pipe size (diameter) or a more powerful pump

7.6 Identify total solar primary circuit water content volume.	• Solar-loop fluid volume (litres) = Solar collector fluid volume + solar-loop pipework fluid volume + storage cylinder heat exchanger coil fluid volume + expansion vessel fluid volume

Assessment criteria	Content – What needs to be covered

7.7 Identify total solar primary circuit expansion vessel size requirements in relation to:
• primary circuit water content volume
• collector height above cylinder.
	• Primary circuit water content volume
	  ○ what is the total volume of the primary circuit water
	  ○ what is the pre charge pressure
	• Collector height above cylinder
	  ○ what is the height difference between the collector and the cylinder

7.8 Identify typical sizing requirements for drain back vessels in relation to:
• net collector area
• total volume of the system.
	• Net collector area
	  ○ solar collector array area (m^2)
	• Total volume of the system
	  ○ fluid volume of system
	  ○ air volume of system
	  ○ tidal volume the fluid volume in the drain back vessel which relates to the volume of fluid that is displaced from the vessel

7.9 Identify solar primary circuit dynamic pressure drop and circulating pump size requirements for:
• fully filled systems
• drain back systems.
	• Fully filled systems
	  ○ overall system dynamic pressure drop
	  ○ sum total of the pressure drop of the following
	  ▪ solar collector array
	  ▪ solar-loop flow and return pipework
	  ▪ solar-loop flow and return pipework fittings and valves
	  ▪ storage cylinder heat exchanger coil
	• Solar collector array pressure drop is determined using the collector manufacturer's data within the manufacturer instructions and taking into account the array connection arrangement
	• Pump size requirements: the circulating pump size must be selected to
	  ○ overcome the system pressure drop
	  ○ provide the required flow rate
	  ○ ensure that the circulation velocity does not exceed 2 metres per second (m/s) and is preferably less than 1 m/s
	• Once the system pressure drops and required flow rate have been determined, the circulating pump size and setting can be determined using a manufacturer's sizing graph
	• Drain back systems, the circulating pump must provide sufficient head to prime the system and lift fluid to the highest point

Learning outcome 8 – Know how the performance of solar hot water systems is measured.

Assessment criteria	Content – What needs to be covered
8.1 Identify the meaning of the term ‘solar fraction’.	• The amount of solar heat contribution in relation to the total heat required for DHW
8.2 Identify factors that affect the solar fraction.	• Collector area • Storage volume • Load demand • Climate and weather

Learning outcome 9 – Know the preparatory work required for solar thermal system installation work.

Assessment criteria	Content – What needs to be covered

9.1 Identify the requirements in relation to:
• authorisation for the work to proceed
• the availability of appropriate access to all required work areas.
	• Authorisation for the work to proceed. Planning permission is required when it doesn’t fall under permitted development rules
	  ○ location and building type
	  ▪ must be installed on a dwellinghouse, block of flats, or a building within their curtilage
	  ▪ applies to domestic and non-domestic buildings
	  ○ size and projection limits
	  ▪ must not project more than 0.2 metres beyond the plane of the wall or pitched roof
	  ▪ on a flat roof, the system must not exceed 0.6 metres above the highest part of the roof (excluding chimneys)
	  ○ height restrictions
	  ▪ must not be higher than the highest part of the roof, excluding chimneys
	  ○ designated land restrictions
	  ▪ not permitted on walls fronting a highway in
	  ▪ conservation areas
	  ▪ World Heritage Sites
	  ▪ not permitted on scheduled monuments
	  ▪ not permitted on listed buildings without listed building consent
	  ○ have permits been obtained
	• The availability of appropriate access to all required work areas. Safe access and egress routes available

Assessment criteria	Content – What needs to be covered
	○ working at height access equipment suitable in relation to the hazards and risks ○ step ladder, suitable for low-level internal and external work ○ scissor lift, suitable for external work ○ extension ladder, used for access ○ tower scaffold, suitable for external work
9.2 Identify the requirements of pre-installation checks in relation to: • the suitability of the proposed location and position of the solar collector(s) for optimum collection capacity • the suitability of the building structure and the building fabric in relation to the installation of system components • verification that the generation capacity of the proposed solar hot water system installation is appropriate to the hot water system energy load and usage • the inspection of existing hot water/heating system installations • water quality • the availability of a suitable electrical input service • the proposed siting of key internal system components.	• The suitability of the proposed location and position of the solar collector(s) for optimum collection capacity ○ proposed collector orientation and tilt angle the best available ○ any existing or future overshading issues that have not been allowed for in the system design • The suitability of the building structure and the building fabric in relation to the installation of system components ○ roof area (m^2) sufficient, including any required clearances ○ roof covering (slates, tiles etc) in good condition ○ when existing timbers show signs of deflection or damage • Verification that the generation capacity of the proposed solar hot water system installation is appropriate to the hot water system energy load and usage ○ cylinder size suitable to meet volume daily (Vd) hot water requirements ○ cylinder size suitable to meet minimum regulatory solar volume (Vs) requirements • The inspection of existing hot water/heating system installations ○ existing system type compatible with the proposed solar thermal hot water system installation ○ existing system components compatible with the proposed solar thermal hot water system installation • Water quality ○ installation in a hard water area (above 200 ppm). Has a water conditioning device been specified • The availability of a suitable electrical input service ○ service of a suitable type and in a suitable location ○ services have the correct circuit overcurrent protection rating ○ 230 V AC single-phase, 50 Hz ○ dedicated circuit from the consumer unit

Assessment criteria	Content – What needs to be covered
	○ double-pole isolator must be installed • The proposed siting of key internal system components ○ proposed siting of components meet manufacturer's, regulatory and, where appropriate, the client's requirements ○ proposed siting structurally sound for the load that will be imposed and will it provide a suitable environment in which to site the component(s)

Learning outcome 10 – Know the requirements for connecting solar thermal system collector circuits to combination boiler domestic hot water circuits.

Assessment criteria	Content – What needs to be covered
10.1 Identify the suitability of combination boilers to receive preheated water.	• Solar compatible combination boiler ○ ensuring that the combination boiler receives water at the appropriate temperature
10.2 Identify the pipework layout and components required for connecting a solar thermal system to a combination boiler to include the: • arrangements for prevention of backflow • arrangements for ensuring that the combination boiler cold inlet supply water is provided at an appropriate temperature • arrangements for allowing stored hot water to be used directly from the store when the temperature of the stored water is appropriate.	• Method ○ use of a purpose-made solar diverter valve (or valves) ○ solar valves are typically a three, four or five port valve that enables the hydraulic connection of a solar thermal hot water system with a combination boiler ○ complex solar valves include thermostatic control to temper the temperature of the hot water that is distributed to the hot taps and also non-return valves to prevent backflow/cross flow • Arrangements for prevention of backflow hydraulic connection layout will typically include a means of ○ expansion vessel ○ pressure relief valve ○ air vents ○ double check valves • Arrangements for ensuring that the combination boiler cold inlet supply water is provided at an appropriate temperature ○ solar rated ○ installation of a thermostatic mixing valve to control temperature • Arrangements for allowing stored hot water to be used directly from the store when the temperature of the stored water is appropriate ○ hot water storage cylinder's controls system ○ configuration of these controls

Assessment criteria	Content – What needs to be covered
	○ how these controls enable solar heated water to be supplied

Learning outcome 11 – Know the requirements for installing solar collector arrays.

Assessment criteria	Content – What needs to be covered
11.1 Identify the positioning and fixing requirements and where appropriate the weathering requirements for the following solar collector types: • flat plate, surface mounted, inclined roof with single lap roof covering • flat plate, surface mounted, inclined roof with double lap roof covering • flat plate, integrated, inclined single lap roof covering • flat plate, integrated, inclined double lap roof covering • evacuated tube, inclined single lap roof covering • evacuated tube, inclined double lap roof covering • frame mounted, inclined (roof, wall or ground) • frame mounted, horizontal (roof or ground).	• The manufacturer's information provided to the installer should clearly indicate how the product is installed with different solar panels and roof types including the type and number of fixings and maximum recommended spacing of brackets/rails • General ○ collector arrays on a building should be sited, so far as is practicable, to minimise the effect on the appearance of the building ○ collector arrays should be sited, so far as is practicable, to minimise the effect on the amenity of the area • Roof and wall-mounted collector arrays ○ collector arrays should not be installed above the ridgeline and should project no more than 200 mm from the roof or wall surface • Standalone collector arrays ○ collector array should be no higher than 4 m ○ collector array should be at least 5 m from boundaries ○ size of the collector array should not exceed 9 m^2 or 3 m wide and 3 m deep • Fixing of flat plate on-roof solar collectors ○ flat plate on-roof solar collectors are fixed using mounting brackets fixed directly to the rafters ○ manufacturers provide mounting brackets that simply hook over the top of the roof tile and roof batten rather than require direct fixing into the rafter • Fixing and weathering of flat plate in-roof solar collectors ○ installed using a collector mounting kit which includes brackets and flashings • Fixing evacuated tube solar collectors ○ installed using evacuated tube collector fixing straps • Fixing solar collectors using secondary frame structures ○ where a solar collector array needs to be installed on a flat roof or within the grounds

Assessment criteria	Content – What needs to be covered
	surrounding a building, a secondary frame structure may be used to support the collector and provide fixing points either for profiled mounting channels or a direct fixing point for collector clamps • All solar thermal hot water system pipework roof penetrations should be weathered using a purpose-made weathering component. • The solar collector array connection arrangement and pipework installation must be suitable for the system type
11.2 Identify the pipework layout, component requirements and component positioning requirements for the following system types and collector array connection arrangements: • fully filled system, collector array connected in series • fully filled system, collector array connected in parallel • fully filled system, collector array connected with east/west split • drain back system, single collector array.	• Fully filled system, collector array connected in series ○ in a series-connected solar thermal collector system, the heat transfer fluid (usually water or glycol) enters the first collector, absorbs solar energy and then flows into the next collector, repeating the process ○ fluid exits the final collector at a higher temperature than it entered ○ this type of connection typically results in a variable temperature gradient across the collector array and increased dynamic system pressure drop • Fully filled system, collector array connected in parallel ○ in a parallel-connected solar thermal collector system, the fluid is split into multiple branches, each feeding a separate collector ○ after passing through the collectors, the fluid streams recombine before entering the storage tank or heat exchanger ○ this arrangement normally achieves a similar temperature gradient across each collector and reduces the overall system dynamic pressure drop • Fully filled system, collector array ○ connected with east/west split, where the orientation of a building determines that an east/west split collector array arrangement is used ○ one hydraulic connection arrangement is to use two pumps • Drain back system, single collector array ○ must enable the heat transfer fluid in the solar collectors and solar-loop pipework that is supplying the collectors to fully drain when the solar-loop circulating pump is off

Assessment criteria	Content – What needs to be covered
11.3 Identify the requirements to achieve durable weather-tightness of buildings where collector array connection pipework passes through the building fabric.	• All solar thermal hot water system pipework roof penetrations should be weathered using a purpose-made weathering component • Pipework passing through a wall must be sleeved and sealed – use a rigid sleeve with flexible, weatherproof sealant and an external collar or grommet to prevent water ingress and allow for movement
11.4 Identify when specialist equipment is required in relation to preventing irradiation reaching collector absorbers during installation.	• When system installation or maintenance is being carried out during periods of medium to high level irradiation, solar collector(s) should be covered with a suitable material to prevent irradiation reaching the collector absorber(s)

Learning outcome 12 – Know the requirements for installing for solar thermal system pipework.

<table>
<tr><th>Assessment criteria</th><th>Content – What needs to be covered</th></tr>
<tr><td>12.2 Identify the requirements for pipework supports in relation to:
• suitable materials
• spacing of pipework supports.</td><td>• Suitable materials
○ stainless steel
○ copper
○ low carbon steel
○ silicon rubber
• Spacing of pipework supports
○ metallic pipework should be fixed using metal brackets
○ spacing of brackets should be in accordance with manufacturer’s instructions
<table>
<tr><td colspan="3">Recommended copper pipework supports</td></tr>
<tr><td>Tube Diameter (mm)</td><td>Intervals for vertical run (m)</td><td>Intervals for horizontal run (m)</td></tr>
<tr><td>15</td><td>1.8</td><td>1.2</td></tr>
<tr><td>22
28
35</td><td>2.4
2.4
3.0</td><td>1.8
1.8
2.4</td></tr>
</table></td></tr>
<tr><td>12.3 Identify suitable pipework jointing methods in relation to:
• system operating temperatures
• system operating pressures
• system chemicals.</td><td>• System operating temperatures
○ compression fittings
▪ ideal for high-temperature applications, especially with copper pipes
▪ can handle the high temperatures typically found in solar thermal systems
○ press fittings
▪ suitable for both copper and stainless-steel pipes</td></tr>
</table>

Assessment criteria	Content – What needs to be covered
	▪ provide a secure connection without the need for soldering, making them reliable under high temperatures • System operating pressures o brazed joints ▪ strong and durable, making them suitable for high-pressure applications ▪ involve melting a filler metal to join the pipes, providing a leak-proof seal o threaded fittings ▪ commonly used in lower pressure systems ▪ can be sealed with thread tape (polytetrafluoroethylene (PTFE)) or sealant to prevent leaks o welded joints ▪ ideal for high-pressure systems ▪ provide a robust and permanent connection • System chemicals o chemical-resistant compression fittings ▪ designed to withstand exposure to various chemicals used in solar thermal systems, such as glycol-based heat transfer fluids o flanged joints ▪ suitable for systems where chemical resistance is crucial ▪ allow for easy disassembly and maintenance o solvent welded joints ▪ used with plastic pipes ▪ resistant to many chemicals ▪ provide a strong bond
12.4 Identify the requirements for pipework insulation for solar thermal system installation work in relation to: • system operating temperatures • system efficiency and performance • potential exposure of the insulation to ultra-violet rays/light	• The solar-loop system pipework must be insulated using a material that o is rated for the temperatures that will occur during system use o has a heat loss value which does not exceed the maximum heat loss value given in the Domestic Building Service Compliance Guide for the pipe diameter being used o is resistant to any other conditions to which the insulation may be subjected • Depending upon its location in the system, solar-loop pipework insulation may also be subject to o rain and extreme weather conditions

Assessment criteria	Content – What needs to be covered
• potential exposure of the insulation to adverse weather • the sections of installations that must be insulated • the sections of installations that must not be insulated • resistance to vermin attack.	○ ultraviolet light ○ vermin and bird attack • Insulation that is used in solar thermal hot water systems typically needs to be resistant to degradation if exposed to any of the above • EPDM rubber • UV-resistant, weatherproof, flexible • Compliance ○ align to BS 5422 for thermal insulation
12.5 Identify the requirements for installing pressure relief valve discharge pipework in relation to: • routing of pipework • termination of pipework.	• Routing of pipework ○ discharge pipe should be run in a material that is suitable for the maximum temperature to which it will be subjected. ○ discharge pipes should be installed with a continuous fall ○ discharge pipework must be adequality supported • Termination of pipework ○ discharge must be conveyed to a safe, visible location ▪ discharge into a purpose-made discharge container ○ discharge to a safe, visible outside location ▪ where it does not pose a hazard to the health & safety of persons such as a floor drain, a waste pipe • Pipework must be installed as per manufacturer instructions

Learning outcome 13 – Know the requirements to test and commission solar thermal system installations.

Assessment criteria	Content – What needs to be covered
13.1 Identify the requirements to prepare for testing and commissioning in relation to: • compliance with the system design and specification • compliance with system/component manufacturer requirements	• Compliance with the system design and specification ○ correct type and grade of components have been installed ○ all components are installed in the positions and to the layout given in the system design and specification • Compliance with system/component manufacturer requirements ○ all components are installed in accordance with manufacturer's instructions

Assessment criteria	Content – What needs to be covered

• suitability of electrical supply circuit arrangements
• flushing the system of installation debris
• selection of suitable heat transfer fluid
• filling and venting the hydraulic circuits
• checking system water quality
• protection against freezing
• provision of system labelling.
	• Suitability of electrical supply circuit arrangements
	  ○ supply is of a suitable type and in a suitable location
	  ○ supply has the correct circuit overcurrent protection rating
	  ○ safe condition of the service has been confirmed
	• Flushing the system of installation debris
	  ○ installation has been flushed or will be flushed of all installation debris, including flushing of any cleaning product residues
	  ○ should be flushed using wholesome water
	• Selection of suitable heat transfer fluid
	  ○ proposed heat transfer fluid is compliant with component manufacturer's requirements
	  ○ proposed heat transfer fluid is compliant with the system designer's specification
	• Filling and venting the hydraulic circuits
	  ○ standard type hydraulic test pump is suitable for pressure testing a solar thermal hot water system installation
	  ○ a manual or electrical filling pump is required to fill indirect, fully-filled, sealed solar loop circuits and drain back solar-loop circuits
	• Checking system water quality
	  ○ if the installation is in a hard water area (above 200 ppm) a water conditioning device has been installed to protect all relevant system components against excess limescale formation
	• Protection against freezing
	  ○ all relevant sections of pipework are insulated using an appropriate grade of insulation (EPDM rubber, UV-resistant, weatherproof, flexible)
	  ○ freeze-tolerant components have been installed if specified (eg for direct systems)
	• Provision of system labelling
	  ○ solar collectors and the storage cylinder(s) are labelled in accordance with the requirements of the building regulations

13.2 Identify what specialist equipment is required in relation to:
• the introduction and checking of system freeze protection fluids
• setting system pressure
	• Introduction and checking of system freeze protection fluids
	  ○ setting system pressure
	  ○ checking the corrosion protection of the system
	  ○ refractometer is required to check that the glycol concentration of a water/glycol mix heat transfer fluid is correct
	• Setting system pressure
	  ○ pneumatic pump with a pressure gauge

Assessment criteria	Content – What needs to be covered

• checking the corrosion protection of the system.	• Checking the corrosion protection of the system
	  ○ pH value of the solar-loop heat transfer fluid in indirect solar-loop circuits is checked as part of the testing and commissioning process
	  ○ litmus paper and digital pH meter

13.3 Identify the testing requirements for hydraulic circuits within solar thermal system installations in relation to:
• hydraulic test pressure
• hydraulic test duration.
	Covering both **Hot Water Systems**
	• Test pressure
	  ○ system must be pressure tested at 1.5 times the operating pressure, unless otherwise specified by the manufacturer
	• Test medium
	  ○ water or an approved non-compressible fluid must be used for hydraulic testing
	• Duration
	  ○ test pressure must be maintained for a minimum of 10 minutes and monitored for any pressure drop or visible leaks
	  ○ longer durations may be required for larger systems or complex installations
	• Visual inspection
	  ○ while under pressure
	  ○ all joints, fittings, valves and pipework must be inspected for signs of leakage, deformation or stress
	  ○ all components must remain stable and leak-free
	• Documentation
	  ○ record the test pressure, duration and medium used and document results in the commissioning report
	  ○ any corrective actions taken must be documented
	• Compliance standards
	  ○ hydraulic testing must comply with BS EN 806 (specifications for installations inside buildings)
	Solar thermal system (collector and pipework)
	• Hydraulic test pressure
	  ○ pressure tested to a pressure at least 30% greater than the working pressure
	• Hydraulic test duration
	  ○ minimum of two hours duration
	• Hydraulic testing must comply with manufacturer instructions

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