T-LEVELS | IfATE Institute for Apprenticeships and Technical Education

T Level Technical Qualification in Engineering and Manufacturing – Design and Development for Engineering and Manufacturing

8714-322 Electrical and Electronic Engineering Occupational Specialism

Grade Standard Exemplification Material

Pass - Summer 2025

Version 1-1

City & Guilds | eal

Version and date	Change detail	Section	Question
v1-0 31st October 2025	First published	N/A	
v1-1 24th November 2025	Amendments in relation to City & Guilds Limited	Back Cover	

Contents

Introduction

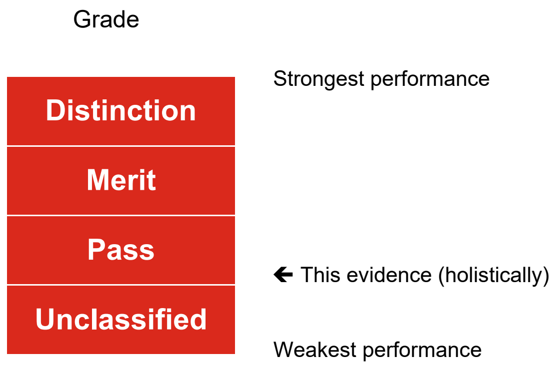
Summer 2025 Results

This document is aimed at providers and learners to help understand the standard that was required in the summer 2025 assessment series to achieve a pass grade for the 8714-322 Electrical and Electronic Engineering Occupational Specialism (OS).

The Grade Standard Exemplification Material (Grade SEM) evidence provided for the pass grade displays the holistic standard required across the tasks to achieve the pass grade boundary in the Summer 2025 series.

The aim of these materials is to provide examples of knowledge, skills and understanding that attested to pass standard (threshold competence) in Summer 2025. It is important to note that in live assessments a candidate's performance is very likely to exhibit a spikey profile and standard of performance will vary across tasks.

The Occupational Specialism is graded Distinction, Merit, Pass or Unclassified.



The pass grade boundary is based on a synoptic mark across all tasks. The materials in this Grade SEM are separated into two sections as described below. Materials are presented against a number of tasks from the assignment.

Task

This section details the tasks that the candidate has been asked to carry out. What needs to be submitted for marking and any additional evidence required including any photograph/video evidence. Candidate evidence that was or was not included in this Grade SEM has also been identified within this section.

In this Grade SEM there is candidate evidence from:

Task 1 Design
Task 2 Manufacture and test
Task 3 Peer review
Task 4 Evaluation and implementation

Candidate evidence

This section includes exemplars of candidate work, photographs of the work in production (or completed) and practical observation records of the assessment completed by provider assessors. This was evidence that was captured as part of the assessment and then internally marked by the provider assessor.

The Occupational Specialism brief and tasks can be downloaded from here.

Important things to note:

- We discussed the approach to standard setting/maintaining with Ofqual and the other awarding organisations before awarding this year. We have agreed to take account of the newness of qualifications in how we award this year to recognise that students and teachers are less familiar with the assessments (https://www.gov.uk/government/publications/ofqual-guide-for-schools-and-colleges-2025/ofqual-guide-for-schools-and-colleges-2025#grading), whilst also recognising the standards required for these qualifications.

- The evidence presented, as a whole, was sufficient to achieve the pass grade. However, performance across the tasks may vary (i.e. some tasks completed to a higher/lower standard than pass grade).

Grade descriptors

To achieve a pass (threshold competence), a candidate will be able to:

Demonstrate a basic use of software/ technologies to model, evaluate and produce electrical and electronic engineering diagrams and simulations that meets the requirements of the brief.

Demonstrate basic technical skills when developing models and prototypes, resulting in a prototype that may require some modifications.

Apply basic knowledge and understanding of testing processes, resulting in a prototype that has been tested against most of the design criteria.

Interpret information, plan, assess risk and follow safe working methods appropriately when applying practical skills to an acceptable standard in response to the requirements of the brief.

Apply basic knowledge and understanding of the design principles required for electrical and electronic engineering resulting in proposals and solutions that meet the minimum requirements of the brief.

Work safely showing an understanding and suitable level of awareness in the preparation and application of processes, selection and use of tools and manufacturing materials and components, resulting in tasks that are carried out with some minor errors.

Use industry and technical terminology accurately most of the time in both written and verbal contexts.

Task 1 Design

Assessment number (eg 1234-033)	8714-322
Assessment title	Electrical and Electronic Engineering Occupational Specialism

Candidate name	<first name> <surname>
City & Guilds candidate No.	ABC1234

Provider name	<provider name>
City & Guilds provider No.	999999a

Task(s)	1
Evidence title / description	Design specification Design calculations, including all working Selected sensors with justifications Circuit diagram and wiring diagram PCB layout Outcomes of the virtual modelling of the proposed circuit design, either as screen captures or printouts Record of outcome of testing the functionality of the physical model of the circuit Bill of materials, with justifications Any notes produced of research undertaken including citation of sources and internet search history
Date submitted by candidate	DD/MM/YY

Task 1

Assessment themes:

- Health and Safety
- Design and Planning
    - Documents
    - Drawings and diagrams
    - Virtual modelling

You must:

- produce a design specification that builds on the design criteria for the circuitry, including any references to research used
- generate a suitable design for the circuitry, including:
    - selection of appropriate sensors with justifications
    - calculations of the values required for successful operation, including the power required by the circuitry, values for at least two different types of components
    - configuration of the circuitry, including a circuit diagram and wiring diagram
    - printed circuitry board (PCB) layout for the circuitry.
- simulate the performance of the proposed design using CAD software
- assemble a physical model of the circuitry and test its functionality
- produce a bill of materials (BoM) listing all of the parts required in the final design proposal, with justifications.

Additional evidence of your performance that must be captured for marking:
None

Candidate evidence

Task 1

1.0 Introduction

1.1 monitoring system description

Monitoring systems are responsible for supervising the technology a company makes use of (hardware, networks and communications, operating systems or applications, among others) in order to analyse its performance, and to detect and alert about possible errors.

1.2 customers design brief

The locale engineering company asked for a monitoring system into their existing server room for it to make it easier for the shift supervisor to be able to monitor the room from the facilities.

This monitoring system must show when the servo room door is opened/closed and when any motion is detected inside the room.

And also, this system should turn off after a specified time period.

The system must detect the temperature of the server room and show what it is to help maintain the server room in a constant temperature to reduce damage to the servers.

A visual indicator like a buzz sound should go off must buzz once the temperature goes above or bellow the specified range.

2.0 design criteria

2.1 what would be used

So, for this design I will be using to detect motion in the room a PIR sensor the detects motion that will activate a light in the room that will sort of visualise the room I being use and automatically turn off once there is no motion detected after 20 seconds.

And for to know if the door is opened/closed I will be using a door sensor on the top of it that will indicate the state of the door at the moment via led light.

To indicated the temperature the room will be fitted with a temperature sensor that will be able to read the temperature of the room and will be connected to a blue light to show when the room is below 18° and when it goes above 18° red light will turn on.

But when it hits 24° a buzzer should start going off meaning that the temperature in the room has gone above the limit needed.

2.2 performance and components

input
1 pir sensor that detects motion
1 temperature sensor to show the temperature
1 door sensor
Output
2 LED lights: 1 RED 1 BLUE connected to the temperature sensor.
Buzzer connected to the temperature sensor.
1 led for connected to the PIR sensor once motion is detected.
1 led connected to the door sensor to show that the door is closed.
Wires to connect the components together.
Arduino to connect to the components and code.

2.2 Calculations

The circuit will be in parallel so it will have 5v voltage ran in parallel through the whole circuit
Pir sensor consumes need 5 voltage and 20mA
Door sensor need 5 volts and 1mA
Temperature sensor need 5 volts and 1mA
1 LED light 20mA
4 LED lights 80mA
Buzzer 30mA
Total resistance using ohms law
1/total R =1/220 + 1/220 + 1/220 + 1/220 + 1+220 = 5/220

Total R = 220/5 = 44

Using ohms law

I= voltage/total resistance

= 5/44=0.113A

= 113mA

Total current = 20mA + 80mA + 30mA + 113mA = 233mA

An Arduino can supply 1amp (used a small reference from chat gpt)

3.0 System processing and logic

Design 1

Arduino uno connected to a micro controller and coded to meet the requirements of the customer

In Arduino uno more idea and stuff can be implemented unlike logic gates as of I can code the Arduino and then protype it on a breadboard if the prototyping was successful, I can move on to making the microcontroller and milling it and then drilling it and fitting the components to it.

Design 2

I will be using logic gates for my other design as its far mor simpler and faster to make.

4.0 HEALTH AND SAFETY

In a work place health and safety legislation should be taken while working a d manufacturing a product so in it the engineer has got o think of a safe way to design the product without damaging the environment around him so starting off with.

The Environmental Protection Act of 1990

It is a fundamental piece of legislation that mandates businesses to exercise a duty of care in managing waste. It compels companies to proactively safeguard human health and the environment by ensuring proper waste disposal and implementing effective pollution control practices., it focuses on how the material and the components used waste electricity and emit heat waste and when going to waste how much damage it will cause the environment around it. Starting of the heat and electricity that will be immitted from the monitoring system will produce so when no one is using the room the monitoring system could be wasting electricity and emitting the why the leds should turn off once someone left the room but the pir sensor would still be on wasting electricity and emitting heat from it meaning but the amount produced would not be harmful for its environment. This waste can be prevented by using the 6Rs.

THE 6RS

Reduce: reduce as much wasteful components as you can and only use what us actually needed and reduce energy consumption of the product, and reduce heat emittion.

Recycle: make your product eligible for recycling when done using it.

Reuse: make the product reusable and if the customer doesn't want the product anymore make it the you can reuse the components

Rethink: rethink the materials being used because not because its cheap it safe for the environment

Repair make the devise repairable and easy to access the components.

Refuse; it for refusing any components that are not of use.

hasawa 1974

For straightforward guidance on how to comply with the health and safety law, go to the basics for your business.

The Health and Safety at Work etc Act 1974 is the primary piece of legislation covering occupational health and safety in Great Britain. It's sometimes referred to as HSWA, the HSW Act, the 1974 Act or HASAWA.

- It sets out the general duties which:
- employers have towards employees and members of the public
- employees have to themselves and to each other
- certain self-employed have towards themselves and others (got this from hse.gov.uk)

this means each work place should follow the health and safety regulation that people need to follow so if there is 2people standing next each other and one is not wearing a mask and glasses while soldering this is immediately a threat for health and safety and would cause a hazard so the means every one should follow the health and safety regulations and play around dangerous machines.

Electrical Safety Regulations (2017)

- These regulations ensure the safe installation, operation, and maintenance of electrical systems.
- **Compliance with Wiring Regulations (BS 7671)**: Electrical wiring for the monitoring system, including power supply and lighting controls, must comply with the UK's **IET Wiring Regulations (BS 7671)**.
- **Installation of Low Voltage Systems**: Ensure that the system operates within safe low-voltage limits (usually below 50V AC or 120V DC for safety).

(taken from hse.gov)

So, this means while creating the circuit you should make sure it consumes as low voltage as you can not affecting the performance of the system and the wiring should be safe preventing any shorts that can cause in the future any burns by fire hazards in the system.

PPE personal protective equipment (2002)

Ppe is protective equipment the must be worn by people in a work place and should always be handed to the worker or a person to prevent any injuries happening in a work place because of a Hazzard. This means that every task taken in the process.

The PPE that are needed for this system tobe made are glasses to protect the eyes from flying praticles and damgeing it form the solder station, masks to protct the lungs from breathing in chimical particls the an ahheft the lungs in the long term while miling the copper board. Gloves to protect the hand from getting hurt while driling and cutting and soldering.

Reporting of Injuries Diseases Dangerous Occurrences Regulation (RIDDOR)

RIDDOR is the law that requires employers, and other people in charge of work premises to report and keep records of all:

- work-related fatalities
- work-related injuries
- diagnosed cases of reportable occupational diseases
- certain dangerous occurrences (incidents with the potential to cause harm)

this means that any injury tat happens in the work placement should be reported and what's the cause of it and the reasoning to know why did it happen and can it be fixed and prevented in the future, and for diseases is to prevent them from spreading amongst the people in the work placement.

5.0 COSTS

Pir sensor £2.19(amazon)
Temperature sensor TMP36 £2.10(PIMORONI)
Door sensor £3.99(amazon)
4 LEDS £0.10p (amazon it's a 100 led for 3.30£)
5 resistors £0.10p (amazon pack of 100 for 3.19£)
Copper board £1.90(123-d.co.uk)
Arduino uno £5 (ebey)
Wires £1(amazon for 100 wires)

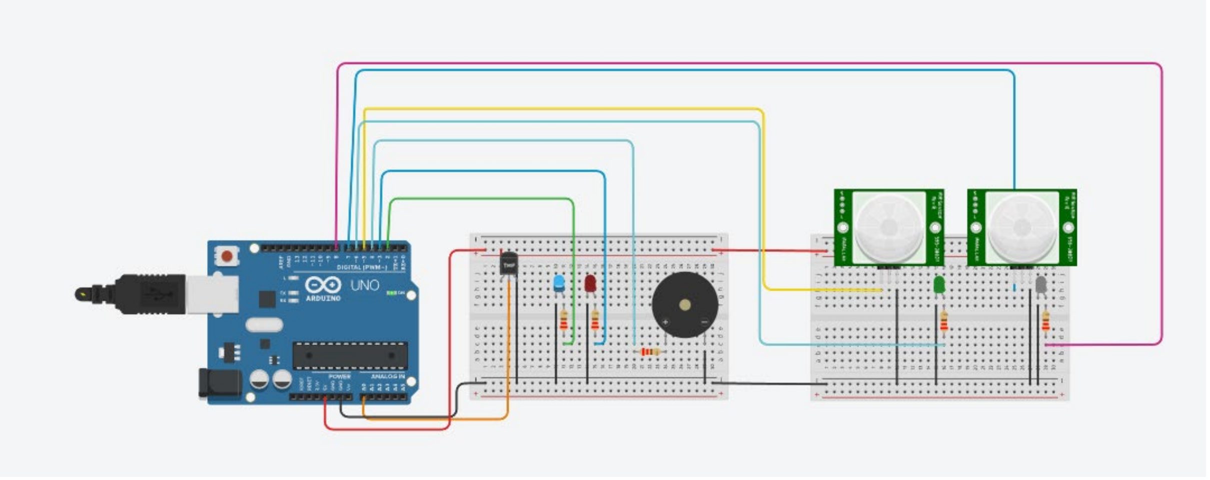
Plastic cover £2.20

Total cost 18.48

Charge the customer £22

6.0 VIRTUAL MODELING

For virtual modelling I have decide to use a cad software to simulate the Arduino pcb microcontroller I will be using and I also implemented on circuit wizard to be able to print it on a physical design, and also this cad design helps me when I need to prototype my design and helps know where there could be a fault in my design.



This a picture of my design I have done on tinker cad where I have used 3 systems to implement what the customer wanted on it so I used a temperature sensor to know the temperature and used to LED one blue one red that, and the blue turns on when under 18C and the red one turns on when its 18 and more, and used a buzzer when the temperature reaches 24C and starts buzzing showing that the temperature has reached its limits, the per sensor is for detecting motion and when motion is detected the green led turns on and then turns off after 30 seconds after no motion is detected, the other pir sensors used to act as a door sensor when activated the white led turns on meaning that there is someone in the room.

6.2CODE

int baselineTemp = 0;

int celsius = 0;

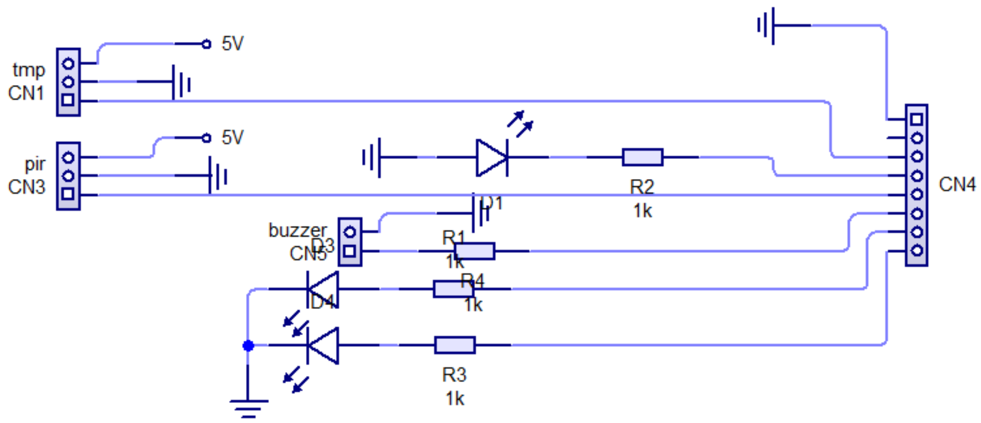
int BLUE = 3 ;

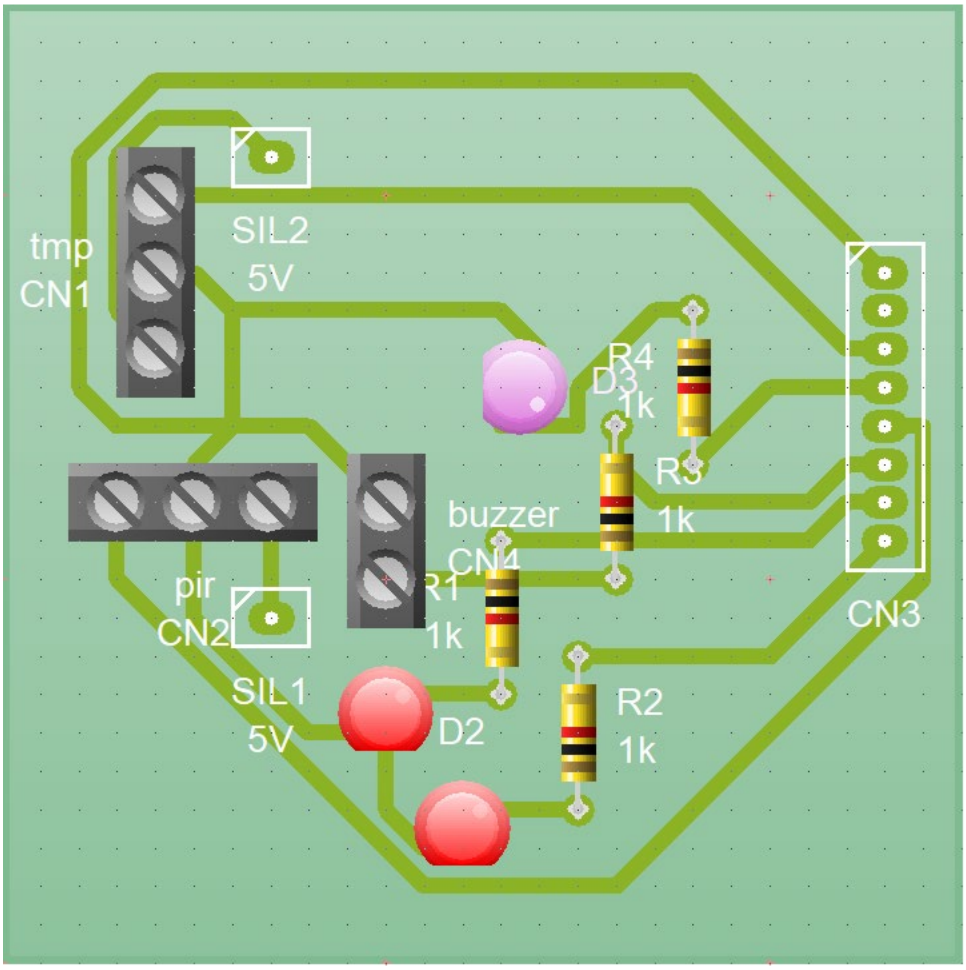
int RED = 2;

```
int GREEN=6;
int BUZZER = 4;
int sensorState = 0;
int sensorState1 = 0;
int WHITE = 8;
void setup()
{
pinMode(A0, INPUT);
pinMode(5,INPUT);
pinMode(7,INPUT);
Serial.begin(9600);
pinMode(BLUE, OUTPUT);
pinMode(RED, OUTPUT);
pinMode(BUZZER, OUTPUT);
pinMode(GREEN,OUTPUT);
digitalWrite(RED,LOW);
digitalWrite(BLUE,LOW);
digitalWrite(GREEN,LOW);
}
void loop()
{
sensorState = digitalRead(5);
sensorState1 = digitalRead(7);
baselineTemp = 8;
celsius = map(((analogRead(A0) - 20) * 3.04), 0, 1023, -40, 125);
Serial.print(celsius);
Serial.print(" C, ");
if (sensorState == HIGH) {
digitalWrite(GREEN,HIGH);
delay(30000);
} else {
digitalWrite(GREEN,LOW);
}
if (sensorState1 == HIGH) {
digitalWrite(8,HIGH);
```

```
} else {
digitalWrite(8,LOW);
}
if (celsius < baselineTemp) {
digitalWrite(RED, HIGH);
digitalWrite(BLUE, LOW);
}
if (celsius >= baselineTemp && celsius < baselineTemp + 10) {
digitalWrite(RED, HIGH);
digitalWrite(BLUE, LOW);
}
if (celsius >= baselineTemp + 10 && celsius < baselineTemp + 20) {
digitalWrite(RED, LOW);
digitalWrite(BLUE, HIGH);
}
if (celsius >= baselineTemp + 15) {
digitalWrite(RED, LOW);
digitalWrite(BLUE, HIGH);
tone (BUZZER, 1200);
delay (500);
noTone (BUZZER);
delay (500);
}
delay(1000);
}
```

6.2 PCB DESIGN

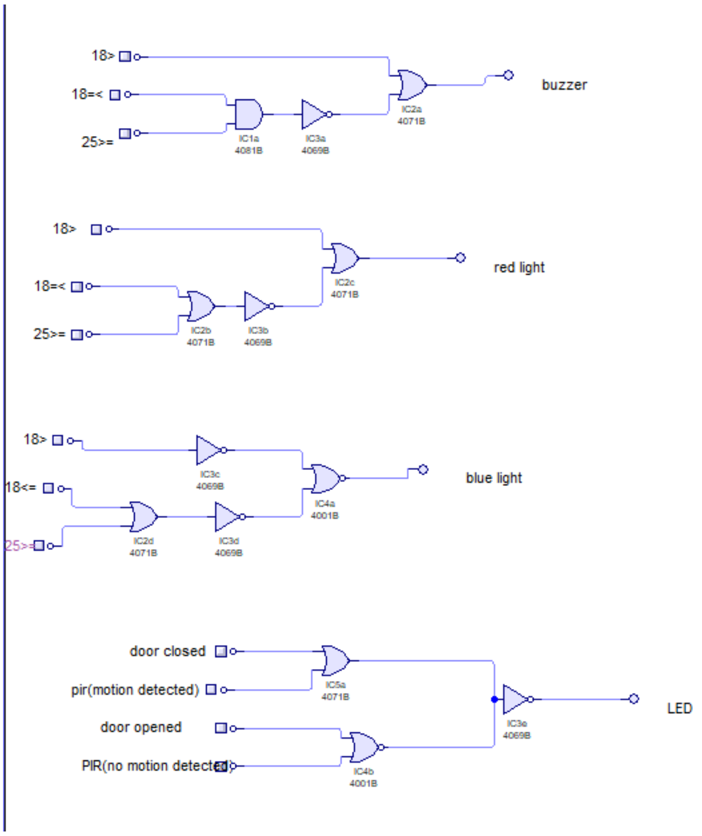




I have transformed my tinker cad design into an PCB circuit design allowing me now to get the Gerber file and printing it on a physical board.

6.3LOGIC GATES

Logic gates are very fast and simple to make but its very limited in what you can do with a logic gate design



This is my logic gates design that I have dove it is very limited on what I can simply do that why I chose to do an Arduino design as my main design.

7.0 COMPARISON

Logic Gates	Arduino Microcontroller
Logic gates are limited in what you can do with them	Arduinos are more open in what you can do with them as long as you got the ability to code them
Logic gates are cheap for just using simple and or nor gates	while Arduinos are expensive to make and you have to fit them with components that may cost too much
Are fast and simple to make	May take a bit of time to create but is still more effective
Logic gates can get complicated in the wiring process if there were so many logic gates	Is simple to wire and a mill the connection into a copper board
Logic gates tend to consume less power	While Arduino needs so much power to power up the circuit
Could be a bit mor complicated to implement on a physical circuit	Easier once done all the virtual modelling

so, in conclusion I will be using an Arduino microcontroller for being much more effective in what I am making and opens up so many new ideas for me to implement on the circuit and its much easier to create on the physical level of the circuit.

8.0 prototyping

Health and safety you should be always aware for what hazards there are cause they may always be a problem that can happen like now I accidently connected the temperature sensor the wrong way around and it ended up over heating and burning my finger with it so always check the pins while connecting to the bread board, and always let the Arduino rest for to prevent over heating and make sure to always have the right resistors connected to the circuit or else current consumption and flow would be too much. And during the wiring a use a clipper but there is a risk to cut your yourself so you for all of these a recommend to wear PPE of gloves to prevent yourself from getting injured.

Testing it was getting multimeter and see each resistor how much resistance it has and each wire if can flow current through to check if there were any faults that will affect my prototyping.
For the prototype I have everything working the red led implements the door light going off when it detects that the door is shut through magnet inside the door sensor , then the blue light is implementing that there is motion cause the pir sensor is detecting motion next to it , and the round thing is the buzzer it goes off once there is temperature detected over 24C , and when temperature detects more the 18C the red light goes on and the green light turns off, and when the temperature detects 18C and under the green light turns off.

9.0 testing

1. Test Microcontroller and Wiring
Objective: Ensure that the microcontroller is properly set up and can communicate with the sensors and outputs.

Procedure:

Power the microcontroller (e.g., Arduino Uno or Raspberry Pi).

Upload a simple test program (e.g., blink an LED or print a message on the serial monitor) to ensure the microcontroller is functional.

Ensure the wiring connections for loose or incorrect pins.

2. Test the Sensors
a. Door Sensor (Magnetic Reed Switch)
Objective: Test that the door sensor turns on the system correctly.

Procedure:

Close and open the door, and ensure the reed switch detects the change.

Connect the reed switch to a digital pin on the microcontroller and write a simple program to read the door status.

Check whether the system detects when the door is open or closed and can act accordingly.

b. Motion Sensor (PIR Sensor)
Objective: Test that the motion sensor detects movement well.

Procedure:

Place the PIR sensor within the server room and switch it on.

Walk about the room and check whether the sensor can sense movement.

Use the microcontroller to turn on an output or a test LED when the sensor detects movement.

Test the range of the sensor so that it covers the entire server room.
c. Temperature Sensor (DHT22 or LM35)
Objective: Check the temperature sensor is reading the correct temperature.
Procedure

Place the sensor in the server room and check if it gives accurate readings.

Test the sensor at different known temperatures (e.g., using a hair dryer or ice to heat or cool the room) to ensure it responds correctly.

Check if the temperature readings align with the specifications of the sensor.

If using an analog sensor (like the LM35), ensure it's connected correctly to the analog pins of the microcontroller.

3. Test the Outputs
a. Temperature Visual Indicators (LEDs)

Objective: Check that the blue LED is lit when the temperature is less than 18°C, and the red LED is lit when the temperature is more than 24°C.

Procedure:

Enter temperature less than 18°C and check the blue LED is lit.

Enter temperature more than 24°C and check the red LED is lit.

Make sure the LEDs turn off as soon as the temperature drops back into the acceptable range (18°C to 24°C).

b. Audio Output (Buzzer)
Objective: Check the speaker or buzzer beeps out when the temperature is outside of the given range.

Procedure:

Test the system by varying the temperature to be above 24°C or below 18°C.

The buzzer should beep a signal to the effect that the temperature is not in range (used a reference from ai)

The students or workers should always be fitted with PPE and also each task should include a health and safety legislation in it for starters this table show the risk assessment each task and what are the hazards that could happen in it

hazard	Cause	Likely	Severty	Solution
Carpal tunnel syndrome	Typing to much in task 1 can cause pain the hand	Very likely	Niglible	Taking breaks every hour
Blue light redation	Looking at a screen too mych can cause headaches and damage the eye in the llong term	likely	Minor	Can be solved by either taking breakes each or hour ot wearing blue light prtection glasses
Inhaling the dust from the milling and drilling machine	Inhaling the dust from a copper board can cause lung damege in the long term	Possible	Significant	Wearing a mask and activating the vacccume in the milling machine
Solder particles and drilling dust going to eyes	It will cause and eye burn and damage the eye causing diraprive vission	Possible	Sugnificant	Wearing eye protection glasses can protect the eyes

PPE(Personal protective equipment)

Task 2 Manufacture and Test

Assessment number (eg 1234-033)	8714-322
Assessment title	Electrical and Electronic Engineering Occupational Specialism

Candidate name	<first name> <surname>
City & Guilds candidate No.	ABC1234

Provider name	<provider name>
City & Guilds provider No.	999999a

Task(s)	2
Evidence title / description	Completed risk assessment Test records for the results of testing the circuitry Assessor observation Photographic evidence
Date submitted by candidate	DD/MM/YY

Task 2

Assessment themes:

- Health and Safety
- Manufacturing
    - Prototype/model
    - Developing
    - Testing
- Reports
    - Implementation
    - Record/reports

You must:

- produce and complete a risk assessment for the production of the PCB and the construction of the soldered prototype
- produce the PCB for the design
- build a soldered prototype working circuitry from your design
- test the operation of the circuitry.

Additional evidence of your performance that must be captured for marking:

- assessor observation of:
    - the production of the PCB
    - building of the soldered prototype
    - testing of the circuitry.
- photographic evidence which shows:
    - unassembled PCB clearly showing the track layout
    - back of the assembled PCB showing all soldered joints
    - front of the assembled PCB showing positioning and fitting of components.

Candidate evidence

Risk assessment

hazard	cause	likely	severity	prevention
Carpel tunnel syndrome	While in the research task setting on the computer too long and typing a lot can cause carpel tunnel syndrome which is when typing with you fingers for too long your finger start hurting	Very likely	Nigible	A person can prevent this by taking break every now and then like 10 minutes break every hour
Blue light radiation	When sitting and staring at a screen for too long the human eyes will be exposed to blue light radiation for too long and that can cause damage in a person's eye or cause headaches	likely	Minor	A person can be taking breaks from time to time or he can also wear glasses the blocks blue light radiation and that can really prevent any damages, and can activate a setting on the computer the lowers the blue light in the screen
Inhaling dust particles from the milling machine	Dust particles can be inhaled if not worn the right ppe on the milling machine and that can really cause	likely	Significant	A mask can be worn to prevent this and the milling machine come fitted with a vacuum cleaner that can suck

	damage to the lungs that can affect a person in the long term.			the particles out the milling machine.
Soldering particles and drilling dust gong into the eyes	This can damage the vision of a person if not prevented and it would really be bad in the long term	Likely	Significant	eye protective glasses can be worn to prevent this from happening
Drilling dust going into lungs		Likely	Significant	Can be prevented by wearing a mask
Burning hand while soldering	While the soldering the soldering machine can get to really high temperatures and if not hold correctly the hand will get burnt and hurt	Possible	minor	Can be prevented by holding it from the plastic side and wearing gloves
Water spilling on electronics causing a fire or someone getting electrocuted	Some people like keeping their water bottles next to them for to stay hydrated but when working with electronics water can be really dangerous and cause damage and might	Possible	minor	By avoiding putting a water bottle next to electronics

	electrocute someone			
Fires happening form a short circuit	Sometimes overloading a circuit, a cause, a short circuit and that may cause fires	Unlikely	Significant	Testing the circuit an keeping a fire extenuator next to the circuit
Hurting someone else while soldering	While soldering in a room full of people hazards can be caused by people moving around close to each others and by that someone can get hurt	possible	minor	Setting and distance where no one can get close to you while soldering
Bad posture	While using the computer bad posture would cause back pain and even when sitting on the computer for to long	Very likely	naggable	Stretching and fixing the posture would help and taking breaks as well will

Documentation

In the manufacturing process I had to follow steps to achieve the monitoring system the customer wanted so first off I have done a pcb design on circuit wizard which I was able to upload into a Gerber file that was sent to the milling machine where I milled the connections of the pcb to it, while using the milling machine I had to use a mask for not to inhale toxic particles from the copper particles and there was a turned on vacuum inside of it that sucked up the particles, on the first try my pcb failed because the tape holding the board was loose and cause issues in the board, on the second try the milling machine somehow created new lines that effected the connections I was able to find that out while testing the faults with a multi meter, so when the milling succeeded on the third time I was able to move on the second step and that is drilling the holes on the pcb board and so I had to wear gloves and glasses and a mask to protect my eyes and lung from flying particles and my hands from getting hurt and some particles stuck on them, I used a 0.5mm drill hole and a 0.8mm drill hole to be able and fit all the component in after, after fitting all the components in I tested them and found out 2 of resistors are not working so I had to replace them, moving on to the next step that is soldering wore glasses and a mask for health and safety where I soldered every bit to the board , after finishing I tested it and found every bit where the solder went wrong so I fixed it and now its working fine, the lasts step is in connect the wiring to the Arduino that I coded in task 1 that was working on the prototyping, at first every thing was working but in the next day the Bedford college team replace the Arduino and got my code wrong once they fixed it and put my code to the arduino everything was working the way it. so the end result was the red led light up on temperatures above 18C and the buzzer activates when it is more than 24C and when the temp Is below 18C the green led lights up and when motion is detected by the pir the blue led lights up . I was not able to fit the door sensor in the circuit cause I have no space in it left but it was working with the prototyping.*

Task 2 Practical observation form

8714-322 Design and Development: Electrical and Electronic - Summer 2025

Candidate name	Candidate number
Provider name	**Date**

Complete the table below referring to the relevant marking grid, found in the assessment pack.

Do not allocate marks at this stage.

This observation must cover	Assessor observation should include:	Assessment Themes
Manufacture and Test	• the production of the PCB • building of the soldered prototype • testing of the circuitry.	• Health and Safety • Manufacturing

Notes – *detailed, accurate and differentiating notes which identify areas of strength and weakness are necessary to distinguish between different qualities of performance and to facilitate accurate allocation of marks once all evidence has been submitted.*

Production of the PCB:

The candidate wore appropriate PPE (eye protection, face mask, etc.) while operating the milling machine and followed all safety protocols, including ensuring the extraction system was turned on. During the first attempt, the PCB material was not correctly loaded or aligned in the milling machine, resulting in an unsuccessful output. However, on the second attempt, the student correctly loaded and aligned the PCB material, selected the appropriate milling settings (tool size, speed, etc.), and demonstrated a clear understanding of the software and toolpath generation process.

The candidate handled tools and machinery safely at all times and showed a strong awareness of health and safety practices. The second milling attempt resulted in a PCB that was visually perfect and free from errors. After completing the milling process, the student thoroughly cleaned the work area. Additionally, the candidate produced a detailed risk assessment that addressed all associated risks within this manufacturing task.

Building of the soldered prototype:

The candidate ensured the workstation was clean and well-organized prior to circuit assembly. The PCB was checked for defects both visually and using appropriate test equipment before beginning the assembly process. The candidate identified and prepared the correct components, following anti-static precautions throughout (e.g., using ESD mats in the soldering area).

Components were handled with care and precision. The candidate used the soldering iron safely and appropriately, applying correct soldering methods at all times. A tidy and hazard-free work area was maintained, and appropriate safety gear—such as safety glasses and ventilation from a fume hood—was used during the soldering process.

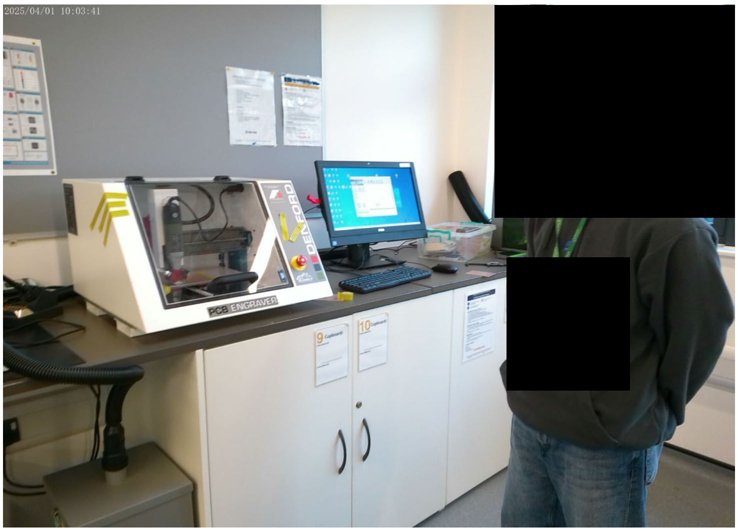
The candidate demonstrated good soldering technique, applying the correct temperature and timing. The resulting solder joints were clean and secure, with no major issues noted. The candidate’s soldering of the PCB was found to be good during this stage. After completing the task, the candidate cleaned the soldering area and returned all tools to their designated locations.

Testing of the circuitry:

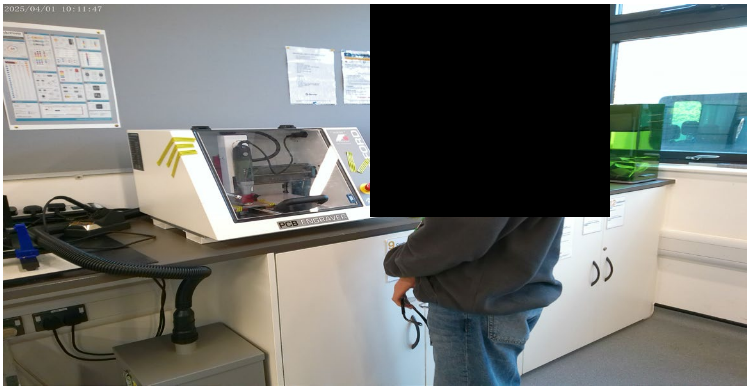
The candidate consistently maintained safe working habits throughout all stages of the testing process, adhering to all relevant lab safety protocols. A visual inspection of the circuit was carried out to identify any potential faults, followed by continuity and connection checks using a multimeter.

The candidate powered up the circuit safely, ensuring the correct power supply was used. Upon observing the circuit's behavior, the candidate identified operational issues and proceeded to apply effective troubleshooting techniques. This included desoldering and replacing several components as needed.

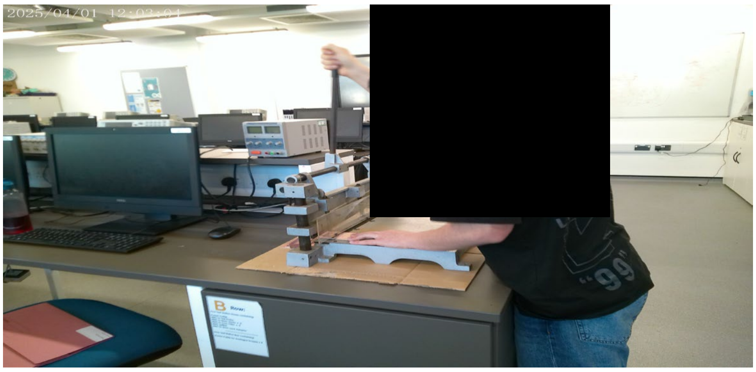
Following these corrective actions, the candidate re-tested the circuit, which then appeared to be functioning as expected. The candidate demonstrated a methodical approach to testing and repair, while continuing to prioritise safety and safe handling of tools and components at all times.



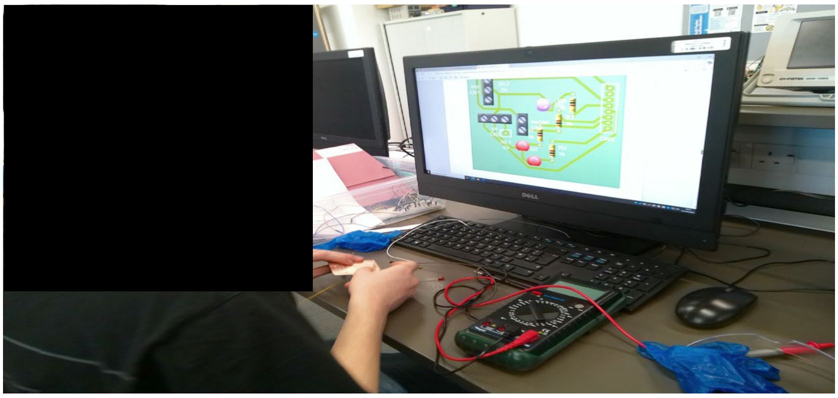
Full PPE during the production and manufacturing (HS)



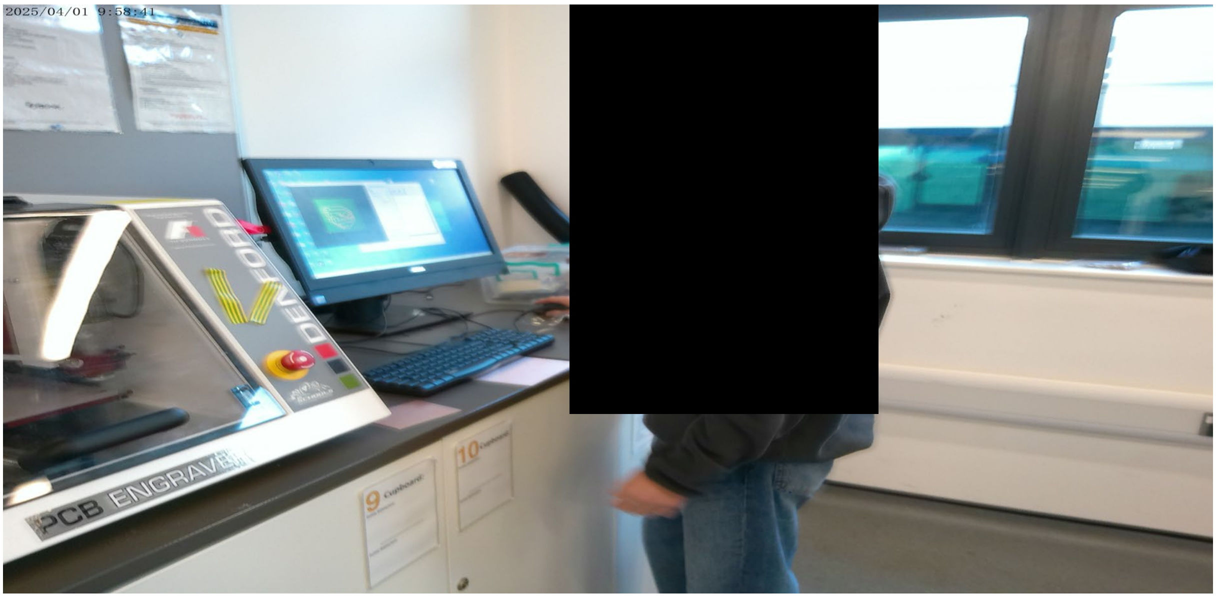
Appropriate selection and use of tools, equipment and processes for PCB production. e.g. etching and milling (M).



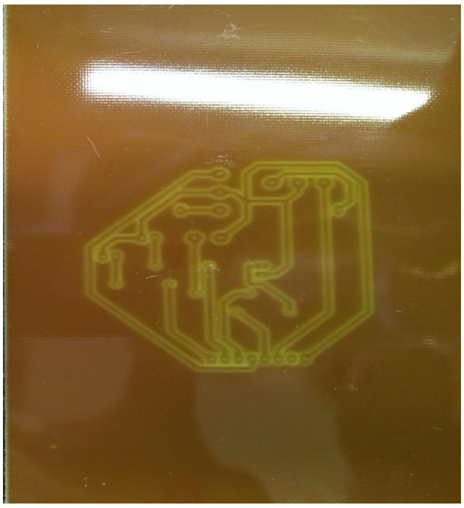
Appropriate selection and use of tools, equipment and processes for PCB production e.g. Cutting the PCB Board (M).



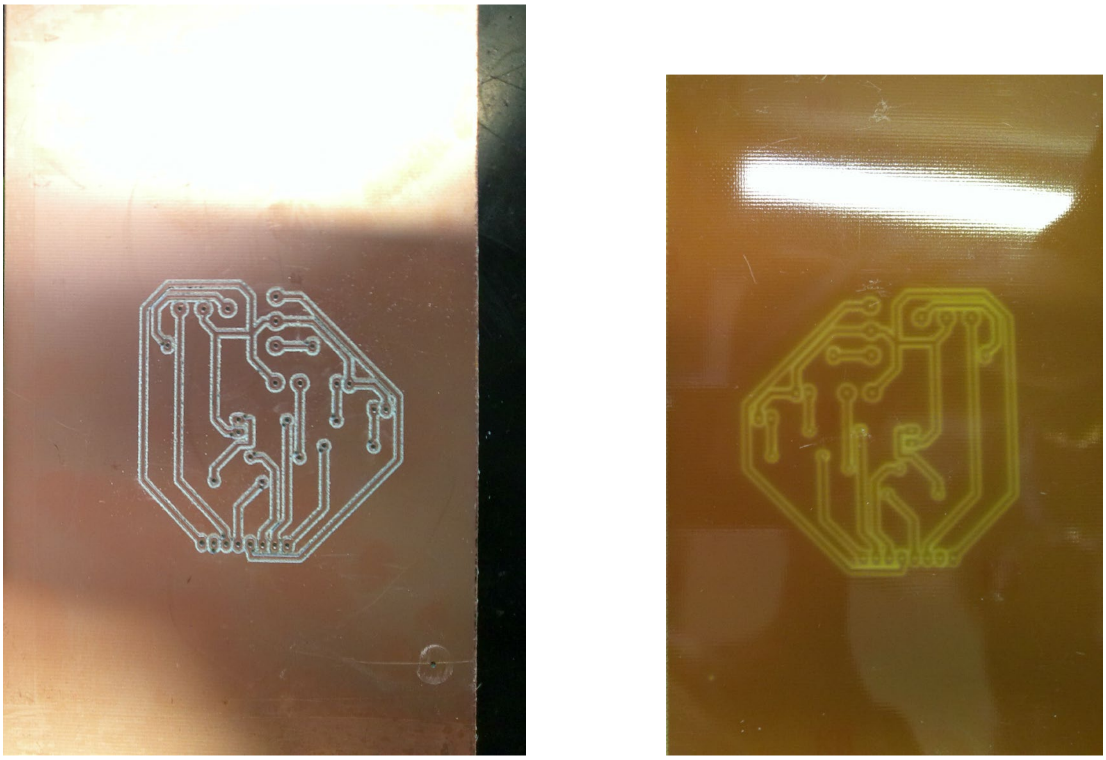
Appropriate selection and use of tools, equipment and processes for PCB production e.g. Capturing the circuit layout from the software.(M).



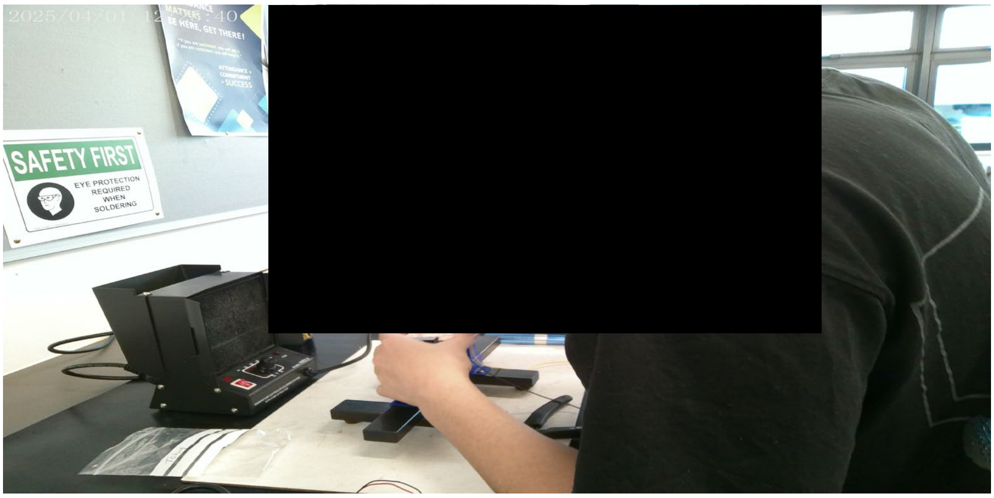
Appropriate selection and use of tools, equipment and processes for PCB production.
e.g. Using the milling machine tool and developing the Track (M).



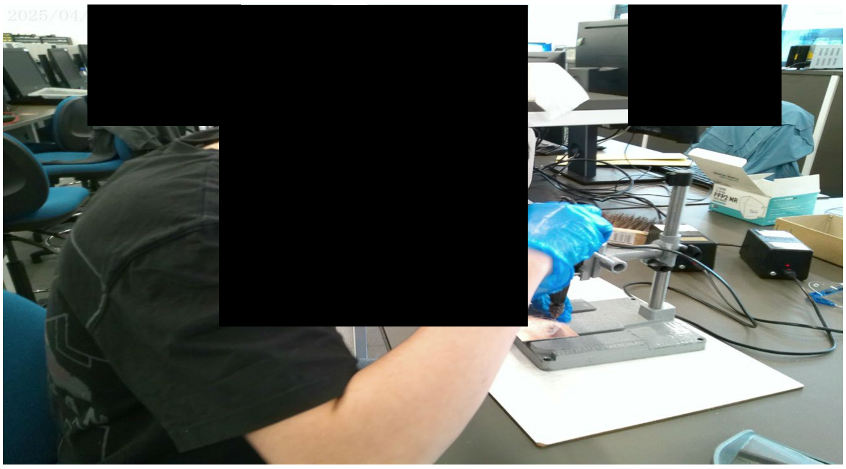
Appropriate selection and use of tools, equipment and processes for PCB production.
e.g. The overall developing process of the PCB (M).



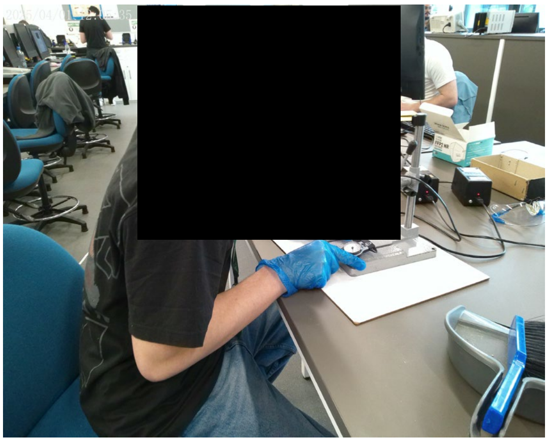
Front and back of the Manufactured PCB: Copper side and component side. (Without component & Soldering) (M)

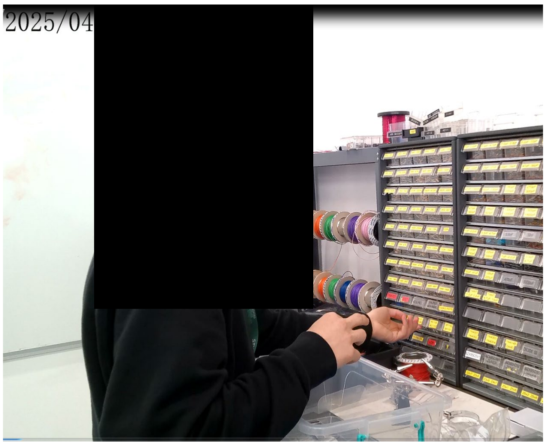


Safe construction and assembly of the PCB (HS) e.g PPE used during the soldering

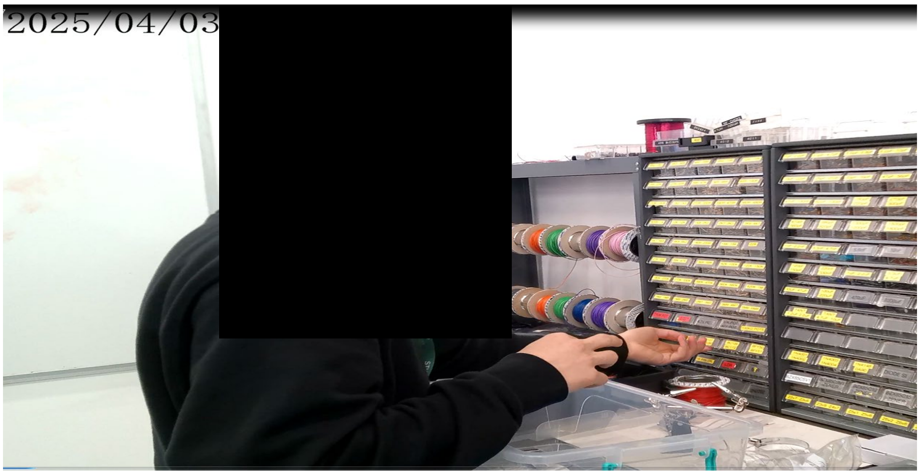


Safe construction and assembly of the PCB (HS) e.g Drilling the hole by driller

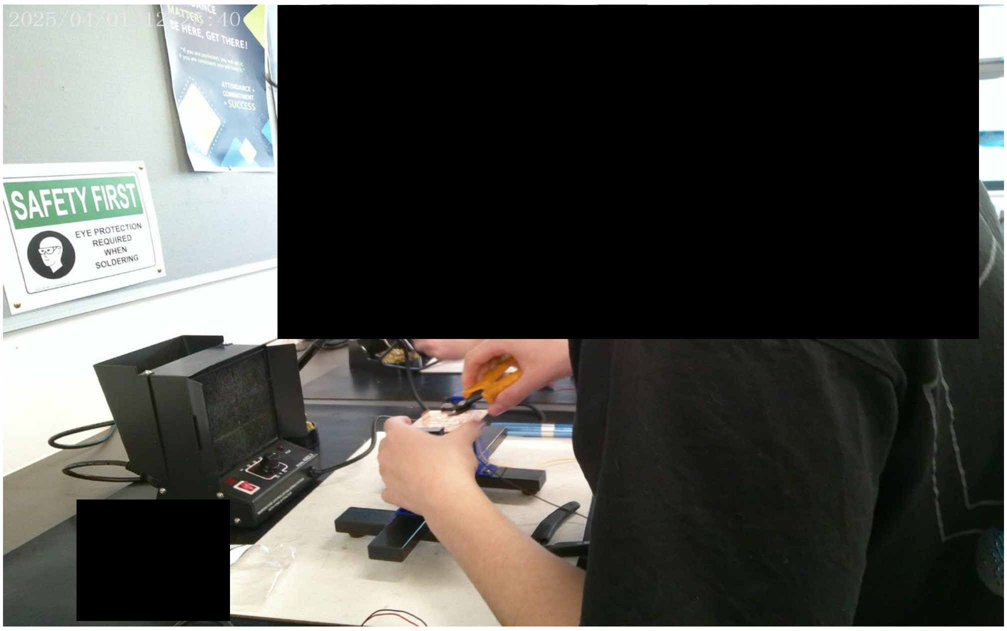




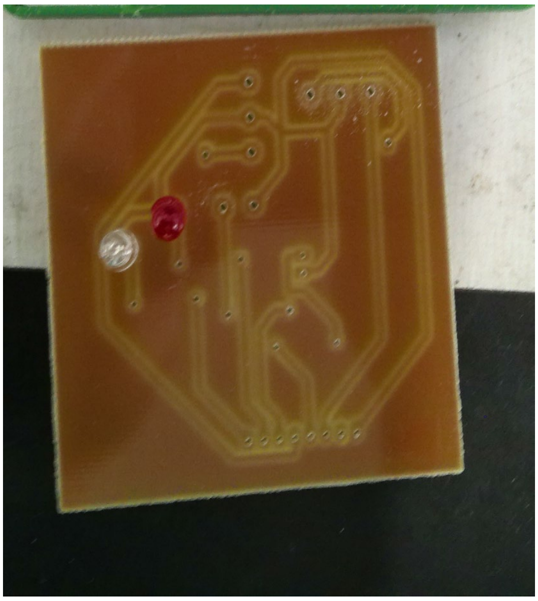
The candidate's selection and use of tools, equipment and processes to manufacture and assemble the PCB e.g. measuring and cutting of components, soldering of components(M)

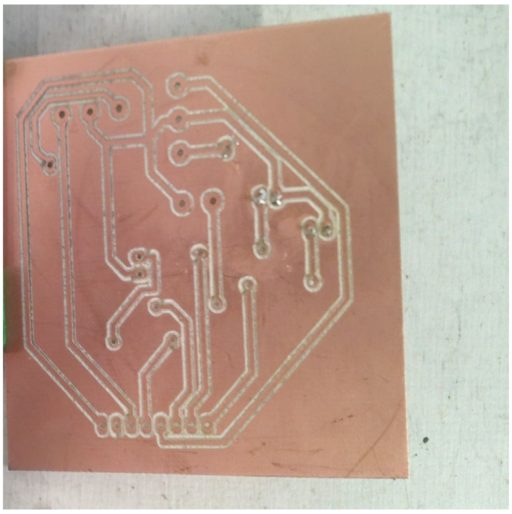


Selection of components for PCB assembly (M). e.g. Components going to use in the PCB

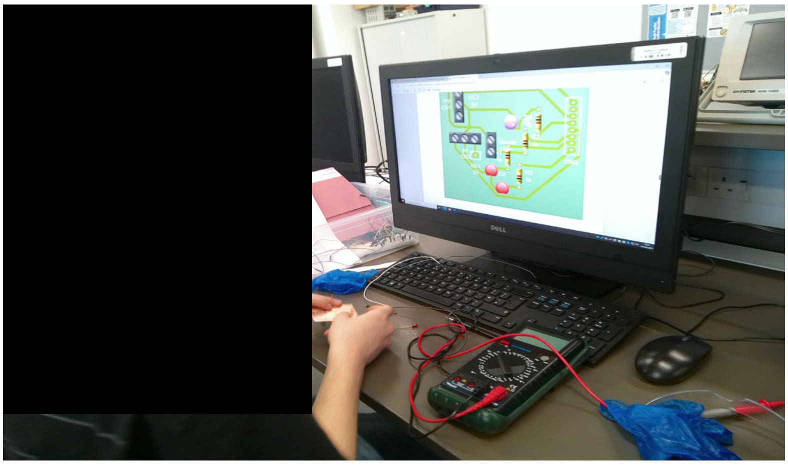


Positioning and fitting of components (M)

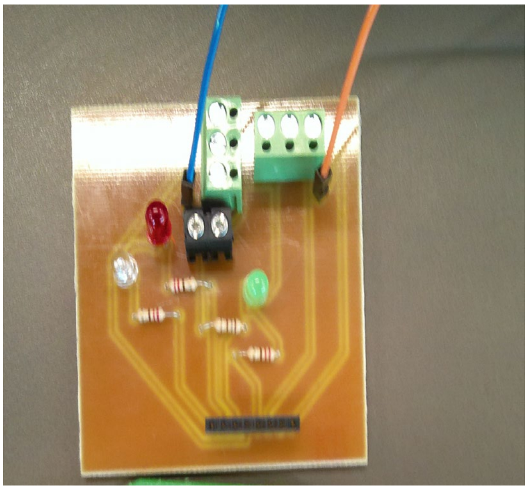


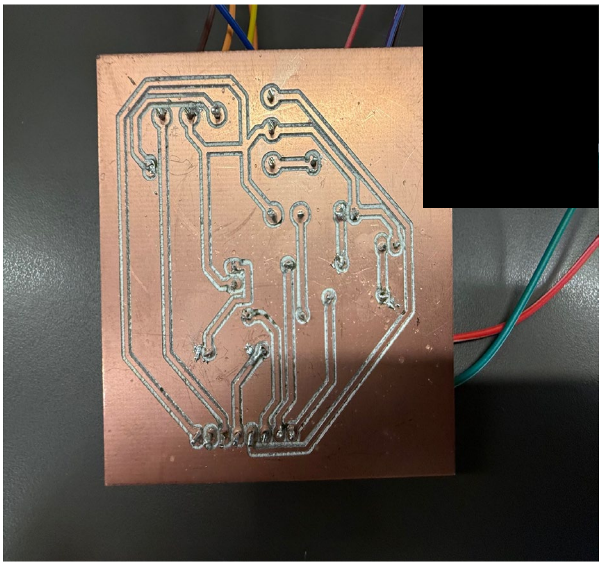


The candidates PCB assembling skills (M).

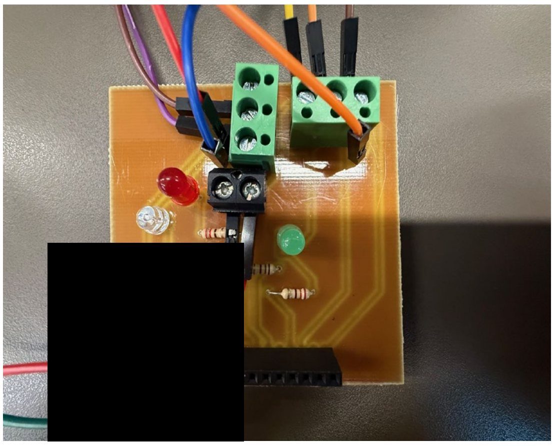


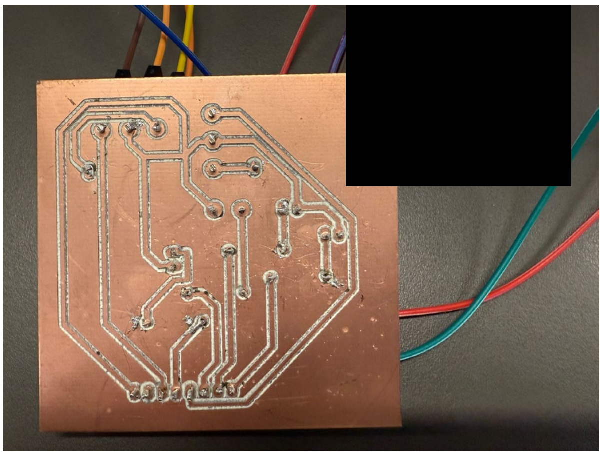
The candidates hand skills e.g. wiring, fitting input, process and output devices (M)



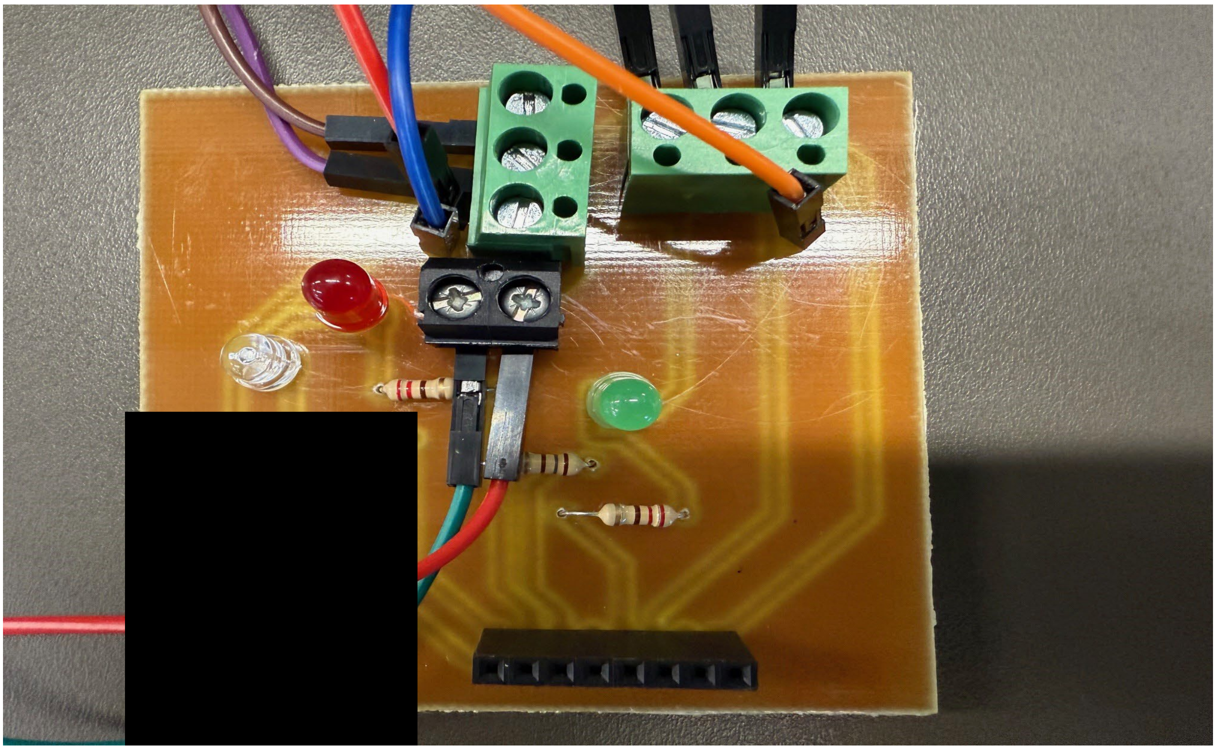


Back of the assembled PCB showing all soldered joints (M) Overall picture of the soldering joints





The quality of the formed soldered joints (M) Close up picture of the soldering joints

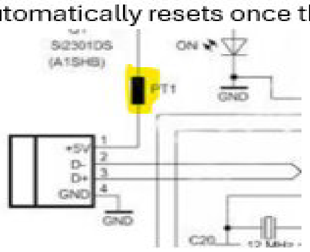


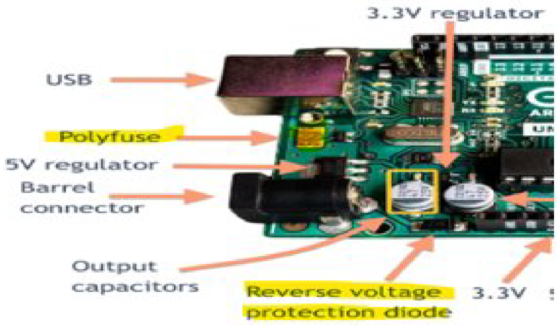
Appropriate use of colour coding of wiring (M) e.g. + and –ive power supply wires colour /any other relevant colour wires used

Uno Circuit Protection:

1. Overcurrent Protection (USB)

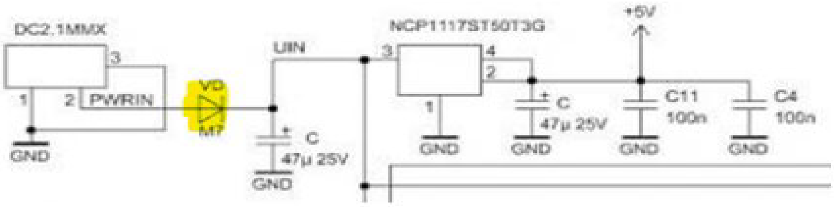
- **Polyfuse (resettable fuse)** on the USB power line.
- Limits current draw from the computer's USB port to about **500mA**.
- Automatically resets once the overload condition is removed.





2. Reverse Polarity Protection (Barrel Jack)

- A **diode (usually a 1N4007)** is placed in series with the **barrel jack input (VIN)**.
- Prevents damage if the power supply is connected with the wrong polarity.



3. Current Limiting

- The Uno has an onboard **I/O Pins limited to 40mA output current**

Appropriate circuit protection methods (M)

Task 3 Peer review

Assessment number (eg 1234-033)	8714-322
Assessment title	Electrical and Electronic Engineering Occupational specialism

Candidate name	<first name> <surname>
City & Guilds candidate No.	ABC1234

Provider name	<provider name>
City & Guilds provider No.	999999a

Task(s)	3
Evidence title / description	Peer review feedback form Feedback record form
Date submitted by candidate	DD/MM/YY

Task 3

Assessment themes:

- Reports

You must:

- prepare to present your design verbally using annotated sketches and diagrams.
- present and explain your design.
- peer reviewers will now have time to reflect on your design.
- discuss feedback from the group on your design presented in part b.
- peer reviewers will now complete the peer review feedback form.

Additional evidence of your performance that must be captured for marking:
None

Candidate evidence

Peer Review Form

Assessment ID	Qualification number
8714-322	8714-32
Candidate name	**Candidate number**
<first name> <surname>	ABC1234
Provider name	**Provider number**
<provider name>	999999a
Date	**Series**

Question	Feedback
Explain how well the diagrams/drawings meet the design criteria.	Very well. All diagrams match the criteria and have followed through into the design. All drawings are clear
Explain how well the diagrams/drawings meet the specification criteria.	All features Required from the specification have been included in the design and function properly
Explain how well the diagrams/drawings conform to the relevant conventions.	No crossed wires correct schematic Symbols. No Short circuits. Diagrams matched final product
Explain how the system could be optimised/improved.	Tidier wiring, reconnect green LED, better soldering

Candidate evidence

Peer Review Form

Assessment ID	Qualification number
8714-322	8714-32
Candidate name	**Candidate number**
<first name> <surname>	ABC1234
Provider name	**Provider number**
<provider name>	999999a
Date	**Series**

Question	Feedback
Explain how well the diagrams/drawings meet the design criteria.	Very well. All drawings clear and detailed with the content in the criteria and matched The design
Explain how well the diagrams/drawings meet the specification criteria.	PDS contains everything that is in the designs All features included in the diagrams are correct with the criteria
Explain how well the diagrams/drawings conform to the relevant conventions.	No short circuits and well placed components Good layout
Explain how the system could be optimised/improved.	Tidy the wiring. Reconnect the green LED Use less PCB board

Candidate evidence

Peer Review Form

Assessment ID	Qualification number
Candidate name	**Candidate number**
<first name> <surname>	ABC1234
Provider name	**Provider number**
<provider name>	999999a
Date	**Series**

Question	Feedback
Explain how well the diagrams/drawings meet the design criteria.	The designs contain all the content that was included in the design criteria.
Explain how well the diagrams/drawings meet the specification criteria.	PDS contains all of the infomation required. All designs meet the specification
Explain how well the diagrams/drawings conform to the relevant conventions.	No short circuits Correct design Includes all components needed
Explain how the system could be optimised/improved.	Neaten up everything • soldering • wiring Reconnect Green LED

Feedback Record Form

Assessment ID	Qualification number
8714-322	8714-32
Candidate name	**Candidate number**
<first name> <surname>	ABC1234
Provider name	**Provider number**
<provider name>	999999a
Date	**Series**

Candidate's notes
I have been givven the feedback from my classmates and got back that I have to neaten my soldering to components on the board, and improve the wiring from the pcb to the ardiuno, and also i have a faulty green LED that I should test components before using it. Other than that I have been given good feedback about how my diagrams meet the design criteria and the specification, and also my circuit has no shorts, and that it includes all components needed.

Task 4 Evaluation and Implementation

Assessment number (eg 1234-033)	8714-322
Assessment title	Electrical & Electronic Engineering Occupational specialism

Candidate name	<first name> <surname>
City & Guilds candidate No.	ABC1234

Provider name	<provider name>
City & Guilds provider No.	999999a

Task(s)	4
Evidence title / description	Outcomes of virtual modelling Revision control document Evaluation and implementation report
Date submitted by candidate	DD/MM/YY

Task 4

Assessment themes:

- Health and Safety
- Design and Planning

You must:

- update the virtual model of your final design using appropriate software to incorporate any changes made and research completed in response to feedback or as a result of manufacturing and testing
- produce a revision control document/report that is typically 500 words justifying why changes were made or not made as a result of the peer review feedback
- produce a report evaluating the design and development work completed. The report should typically be 800 words. This must include:
  - an explanation of the test methods used, reasons for their use and their limitations
  - a summary of the capabilities of the circuitry
  - an evaluation of the fitness for purpose of the design proposal and its conformance to the design criteria and specification
  - the information necessary for a third party to implement the prototype
- an outline of any additional factors that may need to be considered during the implementation, including:
  - cable types to be used to connect the sensors to the circuitry, if appropriate
  - health and safety considerations
  - applicable requirements from wiring regulations
- any further improvements or adaptions required to the prototype, including any reasoning and justifications if adaptions or improvements are not required.

Additional evidence of your performance that must be captured for marking:
None

Candidate evidence

Evaluation and implementation of server room project report

Summary

As to finish my project and design and manufacture a good working and functioning circuit I had to first produce myself a virtual model to find out what components I am using for my project. I started off with tinker cad where I designed a good working prototype that got everything I need and it was fully working .then I turned it into a physical model on a bread board that was working with no problems at all I was able to test the component if they are working on a multi meter and the wires , after I saw that it was all working I created a circuit wizard design that went from a circuit into a pcb ,which I milled but encountered 2 problems while doing it so first off while milling the tape went loose and the machine failed, second time the drill was too deep it caused extra tracks to be milled on the circuit I was able to test the functionality of the board with a multi meter and prove that I had a problem, on my third attempt it went perfectly and was able to mill the design I wanted , for this task I had a mask and glasses as ppe and turned on the vacuum to suck up all the excess particles , after that I wrote my risk assessment where I included all the hazards that I can face during the process of this project and wrote what severity it has for example minor or naggable or significant, and also wrote for each hazard what I can do to prevent the hazard for happing and applied them all on my self on the process of manufacturing the pcb. After that I went to drill the holes on the pcb so I had to put on a mask to protect my self from inhaling small toxic copper particles that come out the board and I also had glasses to protect my eyes and gloves to protect my hands from any mistaces, I had to use a 1mm drill and a 0.8mm for each hole got a different size to be able to fit in different components in it .after that I chose the different components that I needed and tested them out before using them they way I tested them is for the resistors values I got a multi meter and connected the wires to the ohms and com bit to see the value of the resistor and that I got right, and for the LEDs I had the multi meter beep to see if its able to conduct and work same with all the wires I used. The step after was soldering where I also has to use ppe and watch for any hazards like burning myself so I used a mask and glasses to protect my eyes from the solder fumes the are toxic, and started soldering every bit together trying my best not to mess up anything but still got some flows that I was able to test out with the multimeter and how to conducts to see where I got it wrong so I place one wire from the multi meter on a pin and the other on the one it connects to and when it beeps it is working but when it doesn’t I that means I have a problem that I was able to fix the soldering in it .After everything was done I connected it to the Arduino but

I faced a problem that the college had the wrong code I had written for my Arduino so I waited for them to give me the right one then when my code was given to me and connected everything to the Arduino , I found that it was all working the way it is supposed to work.
All the test methods I used to see if its working realised on the multi meter mostly to see where I got a fault and where to fix it helped mostly in the soldering bit but I also tested out the functionality of the circuit so I heated up the temperature sensor that I used with my fingers and went the temperature went up above 18C the blue LED turned off and the red LED turned on , and went heated up more than 24C the buzzer started beeping showing the its working , and to cool off I used cold air to show that everything turns off and the blue LED turns on , And to test out the PIR sensor I simply just wave my hand for the LED to turn on and waited 30seconds for it to turn back off when no motion is detected.
So the capabilities for my circuit are simple I have a blue led that is turned on when the circuit is under 18C and a RED led that turns on when the temperature rises above 18C and also a buzzer that goes off after when the temperature hits 24C and that’s all is detected with a temperature sensor, and also got a PIR sensor connected to the circuit with a green LED light that lights up when motion is detected and turns off after 30secons when motion is no longer detected all are connected to an Arduino that I coded myself. All this takes 5v and 0.153amps and 0.765watts, the Arduino can produce 5v and also used resistors of 220ohms to restrict the current flow in the circuit.
And for the fitness for purpose of the circuit it meets all the criteria that the customer needed I have everything the customer wanted from the temperature detected in the room and visual signs showing if the temp in the room wither its under 18C or above and when its 24C and above a buzzer goes off and that what I have done with the blue LEDS turning on when under 18C and red LED above 18C and buzzer going of when the temperature is above 24C and all are detected by a temperature sensor, and for the motion detection in the room I used the pir and the green led, while for to know if the door is closed I did not have enough space for it in my design so next time if I did It again and was able to get more space I’d include it since its already included in the prototype fully coded and working.
The information needed for a third party to impelemnt the bleu led got a resistor of 220ohms and Is connected to pin2 on the arduino and also ground and the red LED also has a 220ohm resistor and connects to the 3rd pin of thr arduino the temp sensor connects to the analoge a0 and also connected to 5v power and ground, the buzzer is connected to pin 4 with a 220 resistor and ground as well , the pir is connected to pin 5th pin and aslo 5v power and ground and the green led is on he 6th pin .

For the connections I used jump wires to connect the circuit to the Arduino for them being able to be held tight to the circuit and are also not too messy for the circuit. And they also meet the wiring regulations since its easy for them to be changed and protect from any electrical shocks.

Health and safety I use are wearing ppe to not get and injuries and prevent any hazards and took hasawa as consideration and the electrical safety regulations.

And for improvements I have to improve my virtual design and redone my calculations and if had space I would’ve included the door sensor and improve my soldering.

Revision control document

Task 4 updated design based on feedback

So, on this document I am changing the recalculations from task 1

2.2 Calculations

The circuit will be in parallel so it will have 5v voltage ran in parallel through the whole circuit

Pir sensor consumes need 5 voltage and 20mA

Door sensor need 5 volts and 1mA

Temperature sensor need 5 volts and 1mA

1 LED light 20mA

4 LED lights 80mA

Buzzer 30mA

Total resistance using ohms law

1/total R =1/220 + 1/220 + 1/220 + 1/220 + 1+220 = 5/220

Total R = 220/5 = 44

Using ohms law

I= voltage/total resistance

= 5/44=0.113A

= 113mA

Total current = 20mA + 80mA + 30mA + 113mA = 233mA

An Arduino can supply 1amp (used a small reference from chat gpt)

That’s my old calculations where I got the amps wrong so in my new calculation

component	Current Draw	In amps
PIR Sensor	20ma	0.020A
Temp sensor	2ma	0.002A
4 220ohms resistors	91MA	0,091A
buzzer	40ma	0.0.40A
total	153ma	0.153A

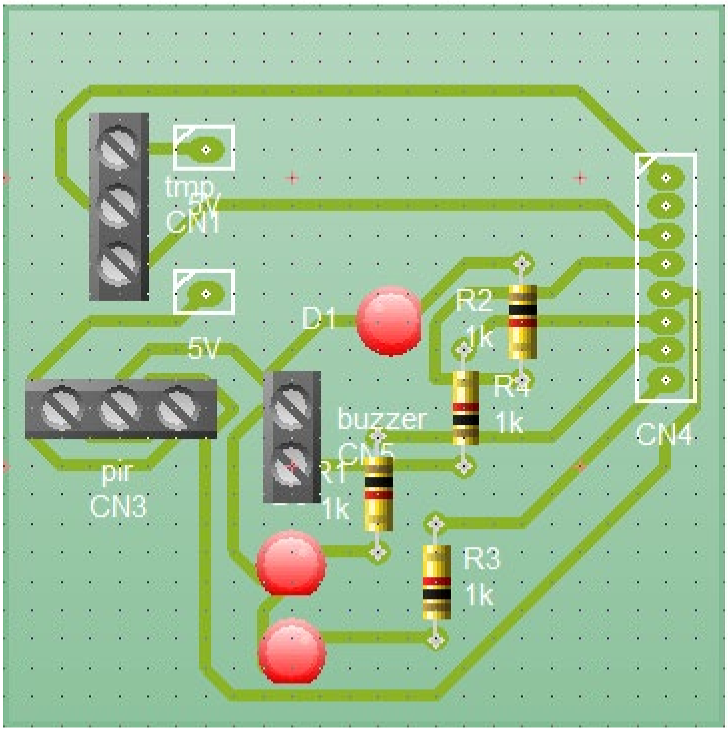
Voltage consumed across the circuit is 5v

Current consume 153ma 0.153

Power consumed = 0.765watts

Report 2

I made some changes on the pcb design I, the resistors are supposed to have 220 ohms nut I was not able to change it is supposed to match the value of the actual design I have. So, what I have changed in it is that on my old one all the components were close together and was hard for me when soldering and producing it to get it right so I spaced it out a little bit for it to be more free and less problems in the circuit.



So based on the feedback from the peer review I had to do some changes in my design and the pds I have made for the customer, So what I noticed I had to change my soldering it was a bit off and caused me some problems in my pcb that I was able to fix later but I have to work on it to provide a better and clean soldering for the pcb I have manufactured on my design, the pcb be was bit unorganised cause the connections were a bit close together same with the components causing bit of problems while fitting them and milling the board so I have decided to create a new design the is cleaner and works better than the last on I have done making it easier to solder and fit components, And I also realised that some of my calculations were a bit off so I had to recalculate the circuit making it more accurate to the final product I had .And for the testing bit I got from a peer review that I have to test the components before using them on the pcb.Thats all I had to change from my design and pds.And for the stuff I did not change first starting with the health and safety I had specified all the health and safety I needed in the process that I took to finalise my product and I applied them on my work wearing all the ppe resorting to the 6rs , making it environmentally friendly , and for the virtual modelling I have done a timecard prototype that worked perfectly that I transformed into a physical prototype design that worked perfect and also got good feedback for the the circuit diagram meets the design criteria and and specification and it also conform to the relevant conventions.

Principal Moderator Commentary

The candidate has considered the design brief/criteria and produced a basic overview with some basic solutions and electronic component suggestions, with limited discussion and analysis. This demonstrates that the candidate understands the basic principles of the design process. The candidate outlines the basic components needed, for example a buzzer and door sensor, however, there is no analysis or comparisons of these components. The candidate just gives one simple example of each component with no other solutions or contrasting suggestions.

There are limited calculations and bill of materials outlining generic components, for example a resistor and basic costings, which is brief and non-descriptive. Overall, the design specification is adequate, although brief and limited, but lists most of the key elements needed to satisfy the design criteria, which demonstrates some understanding of design methodologies.

Some basic use of software technologies is evident, for example one virtual model (not showing functionality), a wiring diagram and a PCB layout diagram. The candidate has demonstrated basic technical skills through the use of these diagrams to develop the prototype, and this is evident in Task 1.

Some basic knowledge of testing is demonstrated through the use of a very basic test plan. This only briefly covers the required objectives and outcomes, which demonstrates that most of the main components are operational, for example, buzzers and temperature sensor, satisfying the basic points of the design criteria. It is evident that the candidate used limited test methods and has a basic understanding of testing. There is some brief discussion of use of a meter to test, although this appears to be one superficial test to check the value of the resistors.

The candidate has followed safe working practices and procedures throughout the manufacturing process, this is evident through the use of a basic risk assessment outlining the main hazards, with some mitigations, and photographic evidence of the candidate wearing correct PPE (goggles, face mask etc) and utilising the tools. The risk assessment is not measurable, this could be improved by including the probabilities, and non-quantifiable wording has been used such as “minor” to describe the risks. This is an adequate risk assessment for this task.

The candidate has produced a basic prototype that satisfies some of the design criteria and shows some functionality. The candidate uses mostly accurate verbal language to describe the function of the prototype and has some understanding.

The peer review form has been completed, briefly, and this has been reflected in the revision control document. Only minor changes have been discussed in the revision control document, for example changes to soldering and component calculations, this will provide limited improvement to the final prototype. In the candidate's final evaluation, a summary of the assessment is discussed and there is very limited justifications and conclusive evidence outlined. The candidate's evaluation is a broadly superficial holistic summary of the assessment and uses basic terminology and language to describe the methods and processes used throughout the assessment. Although the candidate has not produced a thorough evaluation, the language and terminology used is adequate for the task.

Get in touch

The City & Guilds Quality team are here to answer any queries you may have regarding your T Level Technical Qualification delivery.

Should you require assistance, please contact us using the details below:

Monday - Friday | 08:30 - 17:00 GMT

T: 0300 303 53 52

E: **technicals.quality@cityandguilds.com**

W: **http://www.cityandguilds.com/tlevels**

Web chat available **here**.