8202-30 Level 3 Advanced Technical Diploma in Electrical Installation (450)
8202-531 Level 3 Electrical Installation - Theory exam

April 2022 Mark Scheme

Base mark: 75

1	
List **three** things that need to be checked regarding the materials, given on a material schedule, before they are obtained and installed.	AO1 (3 marks)
LO (unit title): 301 Planning and overseeing work activities.	Test spec: 8202.301.03.02
Answers Any three; **(1 mark each)** • the right type • fit for purpose • in the correct quantity • suitable for work to be completed cost efficiently • suitable availability for delivery in time • Any other suitable answer but do not allow duplicate marks where same check is given more than one name.	
Simple recall question - accept single word answers if plausible. Do not accept generic answers such as 'suitable' unless justified, e.g. suitable for location. Answers must relate to a schedule, not an actual item or accessory having been delivered.	

2	
List **three** methods of generating electricity using renewable energy.	AO1 (3 marks)
LO (unit title): 302 Principles of electrical science.	Test spec: 8202.302.01.02
Answers Any three; **(1 mark each)** • Solar • Wind • CHP • Tidal • Hydro (but not pumped storage)	
Simple recall question - accept single word answers if plausible.	

3	
Explain **one** reason why AC is used in preference to DC for most electrical distribution in the UK.	AO2 (3 marks)
LO (unit title): 302 Principles of electrical science.	Test spec: 8202.302.01.01
Answers; • AC voltage can easily be stepped up and down **(1)** using transformers **(1)** to minimise losses and voltage drop **(1).** Alternative answer; • AC can easily be converted to DC **(1)** to power DC items of equipment **(1)** but is much harder to convert DC to AC **(1).** Accept any answer that shows the candidate understands an advantage.	
A level of understanding must be shown for full marks. **1 mark** for recall may be awarded if transformers are mentioned.	

4	
List **three** types of AC motor controller.	AO1 (3 marks)
LO (unit title): 302 Principles of electrical science.	Test spec: 8202.302.03.03
Answers Any **three (1 mark each);** • direct-on-line • star-delta • rotor-resistance • soft-start • variable frequency • other suitable	
Simple recall question - accept single word answers if plausible.	

5	
Determine the neutral current within a three-phase circuit where the current for each phase is L_1 = 80 A, L_2 = 60 A and L_3 = 40 A.	AO2 (4 marks)
LO (unit title): 302 Principles of electrical science.	Test spec: 8202.302.02.04
Answers Any **three (1 mark each);** $$N = \sqrt{\left(\left({L_1}^2 + {L_2}^2 + {L_3}^2\right) - \left((L_1 \times L_2)\right) + (L_1 \times L_3) + (L_2 \times L_3)\right)}$$ (1) $$N = \sqrt{\left((80^2 + 60^2 + 40^2) - \left((80 \times 60) + (80 \times 40) + (60 \times 40)\right)\right)}$$ (2) $$N = 34.64\ A$$ (1) Candidates could use a scaled triangle (35 A). Variations of the formula allowed.	
Max **1 mark** only where basic recall of formula without values or basic recall of triangle with correct angles. Max **2 marks** for basic recall of formula with some values entered or incorrect answers given. Only reduce marks by 1 overall if an error is carried over but subsequent results reflect the error correctly.	

6	
A 0.28 H inductor has a resistance of 80 Ω and is connected in series with a capacitor of 38 μF. They are connected to an AC 230 V supply at 50 Hz. Calculate the circuit current.	AO2 (5 marks)
LO (unit title): 302 Principles of electrical science.	Test spec: 8202.302.02.02
Answers; $X_L = 2\pi fL \; so \; 2\pi \times 50 \times 0.28 = 87.96\,\Omega$ **(1 mark)** $X_c = \frac{1}{2\pi fC} so \quad \frac{1}{2\pi \times 50 \times 38 \times 10^{-6}} = 83.77\,\Omega$ **(1 mark)** $(X_L - X_C) \; = (87.96 - 83.77) = 4.19\,\Omega$ **(1 mark)** $Z = \sqrt{R^2 + (X_L - X_C)^2} \; so \; \sqrt{80^2 + 4.19^2} = 80.11\,\Omega$ **(1 mark)** $I \; = \frac{V}{Z} so \frac{230}{80.11} = \; 2.87\,A$ **(1 mark)**	
Max **1 mark** only where basic recall of formula without values Max **2 marks** for basic recall of formula with some values entered or incorrect answers given. Only reduce marks by 1 overall if an error is carried over but subsequent results reflect the error correctly.	

7	
Explain **why** electric immersion heaters in hot water cylinders must have a thermal cut-out within.	AO2 (3 marks)
LO (unit title): 302 Principles of electrical science.	Test spec: 8202.302.05.02
Answers; The thermal cut-out acts to prevent the cylinder overheating **(1)** and dangerously pressurising **(1)** in the event that the thermostat fails **(1).**	
Any valid answer that shows the candidate understands the cut-out is in addition to the thermostat and dangerous pressure may be built up in the cylinder. Basic answer such as 'to stop overheating' **1 mark** only. Pressure does not need mentioning if 'danger' is used in relation to overheating.	

8	
List **three** different devices that can provide overcurrent protection.	AO1 (3 marks)
LO (unit title): 303 Design and installation practices and procedures.	Test spec: 8202.303.03.02
Answers Any **three (1 mark each);** This question can be interpreted in different ways. Examples below. Answer one: Fuse, circuit breaker, thermal overload trip Answer two: Fuse for BS 88-3, Fuse to BS 3036, Circuit breaker to BE EN 60896 Any valid device. All three answers should be consistent with the way the question has been interpreted.	
Simple recall question - accept single word answers or BS numbers only if plausible. Older devices such as BS 3871 also acceptable as they are in OSG. RCD as a stand alone device is not acceptable as they do not offer overcurrent protection. Abbreviations such as CB or MCB (not both) and RCBO acceptable.	

9	
Explain why an IT earthing arrangement may be selected for an installation.	AO2 (3 marks)
LO (unit title): 303 Design and installation practices and procedures.	Test spec: 8202.303.01.01
Answers; Where unexpected **(1)** disconnection **(1)** of a circuit could cause danger **(1).**	
Any valid answer that shows the candidate understand the principle. Candidates alternatively may give examples **1 mark each** (max 3 marks). Recall for **1 mark** may be rewarded if isolated earth or impeded earth is given.	

10	
Explain why three-phase motor circuits do not usually include a neutral conductor.	AO2 (3 marks)
LO (unit title): 303 Design and installation practices and procedures.	Test spec: 8202.303.01.02
Answers; Because all three phases are balanced **(1),** there will be no neutral current **(1),** and thus a conductor is not required **(1).**	
Any valid answer that shows the candidate understand the principle. Recall of balance or balancing for **1 mark** may be given.	

11	
List, in the correct order, the first three tests to be performed during the initial verification of a new radial final circuit in accordance with BS 7671.	AO1 (3 marks)
LO (unit title): 304 Principles of inspection, testing and commissioning electrical systems.	Test spec: 8202.304.02.01
Answers (in correct order); • Continuity (of protective conductors) **(1)** • Insulation resistance **(1)** • Polarity **(1)**	
Accept 'continuity' but not if main bonding is included. Simple recall of all tests acceptable for two marks if not in order. Accept R1+R2 as an alternative to continuity.	

12	
Explain, giving an example, how the sense of touch could be used during an inspection of a metallic conduit system.	AO2 (3 marks)
LO (unit title): 304 Principles of inspection, testing and commissioning electrical systems.	Test spec: 8202.304.01.05/06
Answers Sample answer; The sense of touch may be used to check the conduit **(1)** is securely fastened to the wall **(1)** by trying to move it **(1).**	
Any valid answer that relates to **metallic conduit** and can reasonably use the sense of touch. For all three marks candidates must say what is being checked and how. If a strong answer is given for any other inspection - award **1 mark** as it does not fully answer the question.	

13	
Explain what is verified during the functional test of a passive infra-red movement detector controlling a number of outdoor luminaires.	AO2 (3 marks)
LO (unit title): 304 Principles of inspection, testing and commissioning electrical systems.	Test spec: 8202.304.03.05
Answers; • Switches the correct luminaires (lights) **(1)** • Senses movement in the right places **(1)** • Operates at the correct light level **(1)** Sample answer: You would check to make sure the correct lights operate **(1),** that the sensor detects movement in the right part of the room **(1)** and the light level is correctly set **(1).**	

Question does not quantify the amount of inspections so if only one area was discussed, such as ensuring it switched on all the lights, award **1 or 2 marks** based on strength.

14	
State the missing values by completing Table 1. Minimum values of insulation resistance Circuit nominal voltage / Test voltage DC / Minimum insulation resistance (V) / (V) / (MΩ) SELV AND PELV / 250 / Up to and including 500 V / Above 500 V / 1000 / **Table 1**	AO1 (3 marks)
LO (unit title): 306 Electrical system fault diagnosis and rectification.	Test spec: 8202.306.04.04
Answers **(one mark each)**; Minimum values of insulation resistance Circuit nominal voltage / Test voltage DC / Minimum insulation resistance (V) / (V) / (MΩ) SELV AND PELV / 250 / 0.5 Up to and including 500 V / 500 / 1.0 Above 500 V / 1000 / 1.0	

15	
State **three** GS38 requirements for an approved voltage indicator used to safely isolate a circuit prior to fault diagnosis.	AO1 (3 marks)
LO (unit title): 306 Electrical system fault diagnosis and rectification.	Test spec: 8202.306.01.03
Answers Any **three (one mark each);** • Fused leads • Exposed tips no longer than 4mm (or 2mm) • Flexible and robust leads • Identifiable leads (accept colour coded) • Shrouded connectors • Function correctly (suitable)	
Accept answers relating to damage/not damaged for **1 mark**. Do not accept anything related to nulling etc., as this is a voltage indicator relating to GS 38.	

16	
State **two** sources for safety services as given in BS 7671.	AO1 (2 marks)
LO (unit title): 307 Requirements for electrical installations	Test spec: 8202.307.01.04
Answers Any **two (one mark each)**; • Storage batteries • Primary cells • Generators • Separate feeder	
Answers must relate to BS 7671.	

17	
State the **minimum** degree of IP protection for **each** zone in a location containing a bath.	AO1 (3 marks)
LO (unit title): 307 Requirements for electrical installations	Test spec: 8202.307.05.01
Answers; Any **two (one mark each)**: • Zone 2 – IPX4 • Zone 1 – IPX4 • Zone 0 – IPX7	
Only the above answers are accepted but X5 may be allowed if justified with water jets.	

18	
Explain where, within an installation, surge protective devices may be required.	AO1 (3 marks)
LO (unit title): 307 Requirements for electrical installations	Test spec: 8202.307.02.01
Answers; Surge protective devised may be required at the origin **(1)** of the installation, any sub distribution boards **(1)** and at socket-outlets **or** equipment terminals **(either - 1)**. Any valid answer that covers these key positions.	
Accept answers relating to Table 3.7.3 where dimensions of 1 m are given in relation to origin. Award a mark for recall of this information as the question does state 'where'. Also give marks if types are given against location. OSG states an assessment is made where direct lightning strokes on a structure can cause harm etc. Give **1 mark** for this as it is good recall but does not relate to where within an installation.	

19	
State **four** methods of supporting an SWA cable, installed above a suspended ceiling, in order to comply with Regulation 521.10.202	AO1 (4 marks)
LO (unit title): 307 Requirements for electrical installations	Test spec: 8202.307.03.01
Answers Any four of the following **(one mark each)**; • Metallic cleats • Metallic cable hangers • Metal ties on tray • Above tray (or just tray as long as metal or metal types given) • Other suitable	
Simple recall question - accept single word answers or short statements. Accept types of metal system as question is not specific to fixings of cable, only supporting so trunking, tray etc. are suitable.	

20

It is proposed to install an air source heat pump adjacent to a sports hall within school grounds. The 16 kW 400 V three-phase supply will be taken from the main distribution board in the main building. The quoted power factor is 0.9 and protection will be provided by a circuit breaker to BS EN 60898. Figure 1 shows the relative positions of the distribution board, the new buried cable and the air source heat pump.

(15 marks)

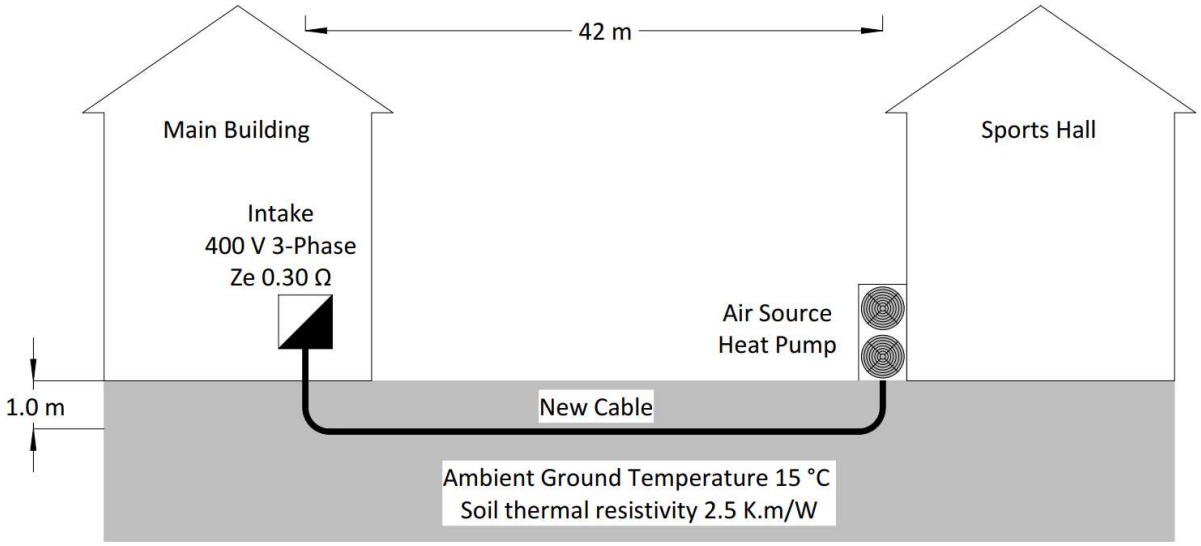

Figure 1 - Not to Scale

Design a suitable cable type and csa for this circuit.

Note for examiners:
The detail on the drawing above is not the same as the one in the actual paper. The one in the paper has more dimensions.

Test spec:
303.01.03
303.02.02
303.02.03
303.03.01
303.03.02
303.04.01
303.04.02
303.05.02
303.05.03
303.05.04
303.05.05
303.05.06
303.05.07
307.02.01
307.03.01
307.05.02

Answers;

Determine suitable cable size, including volt drop

- **Design current**: $I_b = \frac{16000}{\sqrt{3} \times 400 \times 0.9} =$ therefore $I_b = \mathbf{25.66\ A}$
- **Rating of protective device** I_n = 32 A Type C

- **Installation reference method**:
  Table 4A2 Reference Method D (Example direct in ground – Candidate my install in a duct if justified)

- **Ambient Temperature**:
  Ground 15 °C Table 4B2, Ca = 1.05

- **Other Rating factors:**
  Buried Cable Cc = 0.9
  Depth of Burial Cd = 0.97
  Soil thermal resistivity Cs = 1.00 (therefore negated)

- **Current-carrying capacity of the cable:**
  $I_t \geq \frac{I_n}{C_a \times C_d \times C_c}$ therefore $I_t \geq \frac{32}{1.05 \times 0.97 \times 0.9}$ therefore $I_t \geq 34.9\ A$

- **Conductor size:** (Assuming candidate chooses PVC SWA – other cables can be chosen with justification).

  Table 4D4A (Column 7) reference method D 6 mm^2 with an I_t of 38 A

- **Voltage drop:** (based on 45 m cable length including vertical sections)

  Table 4D4B (Column 3) mV/A/m = 6.4 mV
  $V_d = \frac{\text{mV/A/m} \times I_b \times L \times pf}{1000}$ therefore $V_d = \frac{6.4 \times 25.66 \times 45 \times 0.9}{1000}$ therefore V_d = 6.65 V

  Max Voltage drop is 5% of 400 V = 20 V therefore circuit complies.
  Application of power factor for voltage drop is optional.

Extended Response - Bands		
Band 1	Poor coverage of the question with no explanation and mainly isolated points. Very few points considered with little relevance. Limited use of reference materials and inappropriate use of formulae. No comparisons made to link responses. **Access higher marks** Very few conclusions drawn with few correctly identified points. Demonstrated limited ability in Determining the number of light fittings required, determining suitable design current, researching protective device ratings, installation methods and some rating factors from BS 7671.	**1-5 marks total**
Band 2	Some coverage of the question shown with limited explanations. Some coherent but isolated points. Some points considered with some accuracy showing relevance and possible arguments. Logical sequence followed, linking stages but with some inaccuracies. Appropriate considerations made through-out the process. Good calculation process but mistakes made with values.	**6-10 marks total**

	Access to higher marks Most points considered with accuracy and relevance. Logical sequence followed with most stages linked accurately. General analysis is accurate with some accurate references to permitted materials. These candidates will be able to determine most design requirements typical calculations for design current and the application of temperature factors, rating factors, calculate current carrying capacities of cables and voltage drop in accordance with BS 7671.	
Band 3	These candidates will be able to determine all design requirements accurate design current calculations, the application of temperature factors, rating factors, calculate current carrying capacities of cables and volt drop, in accordance with BS 7671. Detailed coverage shown with accurate explanations. All points considered were relevant. Logical sequence followed, correctly linked stages and accurate analysis made. Comparisons made between all points. Conclusions drawn are accurate. **Access to higher marks** Detailed coverage with accurate explanations on all valid and relevant points. Clear understanding of the subject and use of reference materials demonstrated. Conclusions drawn are all accurate and supported with by the workings, to show clear links between stages. These candidates will be able to determine all design requirements, accurate design current requirements and application of temperature factors, rating factors, calculate current carrying capacities of cables and voltage drop, in accordance with BS 7671. all comparisons made with detailed evaluations to justify choice.	**11-15 marks total**