8202-30 Level 3 Advanced Technical Diploma in Electrical Installation
8202-531 Level 3 Electrical Installation – Theory exam

June 2023 Mark Scheme

1	
List **three** organisations which issue cards that may be used on a construction site to prove a level of competency.	AO1 Total marks: 3
LO (unit title): Planning the requirements of work activities	Test spec: 301.01.02

Answers

Any three **(1 mark each)**;

- Electrotechnical Certification Scheme (or ECS)
- Construction Skills Certification Scheme (or CSCS)
- Joint Industry Board (or JIB)
- PASMA
- CPCS

Any other valid answer is acceptable, including CPS provider, or other relevant trades such as Gas Safe, but must **not** be a different name for the same scheme e.g. CPS provider and NICEIC.

Either words or abbreviations acceptable. Spelling mistakes accepted as long as the word is clear. Incorrect letters in abbreviations not accepted.

2	
Explain the operating principle of a 30 mA single-phase RCD.	AO2 Total marks: 3
LO (unit title): Principles of electrical science	Test spec: 302.03.04
Answers A coil detects the balance (1) between line and neutral current (1) and will trip the RCD if any imbalance exceeds 30 mA (1). Or An imbalance (1) between L-N (or due to an earth fault) (1) of more than 30 mA (1) will operate the coil/device. Answer must relate to imbalance. No mark for saying the RCD trips without a valid explanation. Any other answer that shows understanding of this principle. No marks for monitoring or measuring earth current. Accept alternative words for 'imbalance' such as 'difference'.	

3	
List the **three main** components of a UPS system supplying AC to a computer system.	AO1 Total marks: 3
LO (unit title): Principles of electrical science	Test spec: 302.01.02
Answers The three acceptable **(1 mark each)**: • AC to DC battery charger/rectifier • Battery • DC to AC Inverter	

4 – excluded from the paper

5	
List **three** ways that heat can be transferred from an electric fire to heat a room.	AO1
	Total marks: 3
LO (unit title): Principles of electrical science	Test spec: 302.05.01

Answers

The three acceptable **(1 mark each)**:

- Conduction
- Convection
- Radiation

Allow marks for any description of the above three methods or allow answers relating to fan pushing out air for 1 mark only to a maximum of 3 marks total.

6	
Determine the neutral current within a three-phase circuit where the current for each phase is L_1 = 70 A, L_2 = 90 A and L_3 = 35 A.	AO2
	Total marks: 4
LO (unit title): Principles of electrical science	Test spec: 302.02.04

Answers

$$N = \sqrt{\left(\left({L_1}^2 + {L_2}^2 + {L_3}^2\right) - \left((L_1 \times L_2)\right) + (L_1 \times L_3) + (L_2 \times L_3)\right)} \quad (1)$$

$$N = \sqrt{\left((70^2 + 90^2 + 35^2) - \left((70 \times 90) + (70 \times 35) + (90 \times 35)\right)\right)} \quad (1)$$

$$N = \sqrt{\left((4900 + 8100 + 1225) - (6300 + 2450 + 3150)\right)}$$

$$N = \sqrt{(14225 - 11900)} \ (1)$$

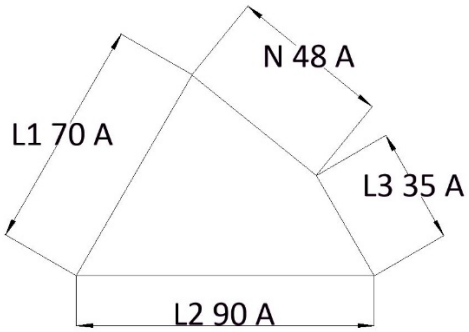
$$N = \sqrt{(2325)}$$

$$N = \ 48.22 \ (1) \ A$$

Variations of the formula allowed.
Do not award the last mark if the wrong unit is used.

Or

Candidates could use a scaled triangle (48 A) or phasor:



1 mark for correct angles, 1 mark for scaled values and 1 mark for scaled neutral value, 1 mark for 48 (within 1 A tolerance).

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.
Maximum 3 marks if the wrong unit is used.

7	
Determine, showing all working, the kVA and power factor where a motor has a rating of 21 kW and 14 kVAr.	AO2 Total marks: 5
LO (unit title): Principles of electrical science	Test spec: 302.02.01

Answers

$$kVA^2 = kW^2 + kVAr^2$$
$$kVA = \sqrt{kW^2 + kVAr^2}\ (1)$$
$$kVA = \sqrt{21^2 + 14^2}\ (1)$$
$$kVA = \sqrt{637}$$
$$kVA = 25.24\ (1)$$

$$pf = \frac{kW}{kVA}\ (1)$$
$$pf = \frac{21}{25.24}$$
$$pf = 0.83\ (1)$$

Candidates can use any valid method including a scale diagram.
Only reduce marks by 1 overall if an error is carried over but subsequent results reflect the error correctly.

1 mark for recalling each formula.
1 mark for processing kVA formula (1 mark for correct kVA given with no working).
1 mark for each answer (1 mark for correct power factor given with no working).

8	
Explain how a shaver socket, used in a domestic bathroom, provides shock protection when somebody comes into contact with a live part.	AO2 Total marks: 3
LO (unit title): Electrical design and installation practices and procedures	Test spec: 303.02.03

Answers

An isolating (1) transformer is used to remove the neutral to earth reference (1) and thus remove the risk of a shock to earth (1).

Any answer which covers these points. Must be an isolation (or double-wound) transformer for full marks.

9	
List **three** exposed conductive parts likely to be present in an industrial electrical installation.	AO1 Total marks: 3
LO (unit title): Principles of electrical science	Test spec: 303.02.02

Answers

Any three from **(1 mark each)**;

- Cable tray
- Basket
- Metallic conduit
- Metallic trunking
- Metallic enclosure of a distribution board
- Metallic enclosure of equipment
- Metallic accessories (descriptions of accessories such as metallic socket-outlet, face-plates etc. may be given but only award 1 mark where multiple accessories are listed)

Or any other suitable answer.
Accept steel or stainless steel instead of metal or metallic. Each item must be clearly metallic and different from other items listed for a mark.

10	
Explain when a Type B circuit breaker should be used in preference to a Type C or Type D.	AO2 Total marks: 3
LO (unit title): Electrical design and installation practices and procedures	Test spec: 303.03.02

Answers

Where there is no significant inrush (1) current into equipment (1) within the circuit protected (1).

Accept any other answer which shows the candidate understands this principle but it must be not limited to specific equipment e.g. the absence of fluorescent luminaires/lights. The answer must relate to equipment downstream of the device, not in the installation in general, for full marks.

11		
State the **minimum** IP level to provide basic protection for a) the side of a domestic consumer unit. b) the accessible top horizontal surface of a distribution board. c) steel trunking containing unsheathed low-voltage cables.		AO1 Total marks: 3
LO (unit title): Principles of inspection, testing and commissioning electrical systems	Test spec: 304.01.07	
Answers a) IP2X (or IPXXB) (1) b) IP4X (or IPXXD) (1) c) IP4X (or IPXXD) (1) Either IP2X etc. or IPXXB etc. are acceptable.		

12		
Explain why live conductor polarity must be verified at each 230 V BS 1363 socket-outlet in a domestic installation.		AO2 Total marks: 3
LO (unit title): Principles of inspection, testing and commissioning electrical systems	Test spec: 304.02.06	
Answers If the polarity of line and neutral are swapped (1), the plug-top fuse (1) will be in the neutral. (1) Accept any answer that shows the candidate understands this principle but it must relate to the live conductors and specifically the plug (top) fuse (not circuit protection) for marks. No marks for incorrect function of any appliance.		

13

Explain why the entire domestic installation must be safely isolated when carrying out an external earth fault loop impedance Z_e test for the premises.

AO2

Total marks: 3

LO (unit title): Principles of inspection, testing and commissioning electrical systems	Test spec: 304.03.02

Answers

The earthing conductor (1) must be disconnected (1) to remove parallel paths (1) from the reading.

Or

To enable the earthing conductor to be removed safely (1) to get accurate readings (1) and the installation will not be earthed (1).

Accept any other suitable answer.
Award one mark if a candidate responds with 'as the installation will not be earthed during the test'.
Do not accept a simple statement such as ‘prevent electric shock’ without justification.

14

State the missing values by completing the table.

AO1

Total marks: 3

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		1.0
Above 500 V	1000	

Table 1

LO (unit title): Electrical system fault diagnosis and rectification.	Test spec: 306.04.04

Answers

As in table below **(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	
List **three** materials which would require disposal as hazardous materials, if present within equipment replaced during electrical fault rectification.	AO1 Total marks: 3
LO (unit title): Electrical system fault diagnosis and rectification	Test spec: 306.05.03

Answers

Any three from **(1 mark each)**;

- Asbestos.
- Phosphorous.
- Mercury.
- Acid (or alkali).
- Lithium.
- Lead.

Accept any other valid answer, but must be hazardous. Accept equipment e.g. fluorescent tubes or batteries in the absence of specific materials, but not more than one item containing the same material(s).

16	
State what needs to be confirmed for supplementary bonding to be omitted in a location containing a bath.	AO2 Total marks: 3
LO (unit title): Requirements for electrical installations	Test spec: 307.05.01

Answers

All circuits comply with ADS (or 411.3.2). (1)
All circuits have RCD protection. (1)
All extraneous-conductive-parts of the location are effectively connected to protective bonding. (or comply with 411.3.1.2). (1)

Candidates showing greater understanding by applying 411.3.1.2 apply a mark accordingly.

17		
Explain why arc fault detection devices (AFDDs) are required to be installed at the origin of socket-outlet circuits within Houses in Multiple Occupation (HMOs).		AO2 Total marks: 5
LO (unit title): Requirements for electrical installations	Test spec: 307.02.01	
Answers AFDDs detect arc faults (1) which could be series (1) or parallel (1) faults and reduce the risk of fire (1) in buildings having multiple people/difficult evacuation (1). Or AFDDs detect arc faults (1) that could cause a fire (1) and may not be detected by other devices (1). People living in a HMO may not spot (1) and/or communicate (1) an issue with the electrical installation. Accept any other valid answer. Award marks for understanding of what AFDDs detect, why other devices may not and why the requirement is specific to, in this case, a HMO and not a domestic dwelling, for example.		

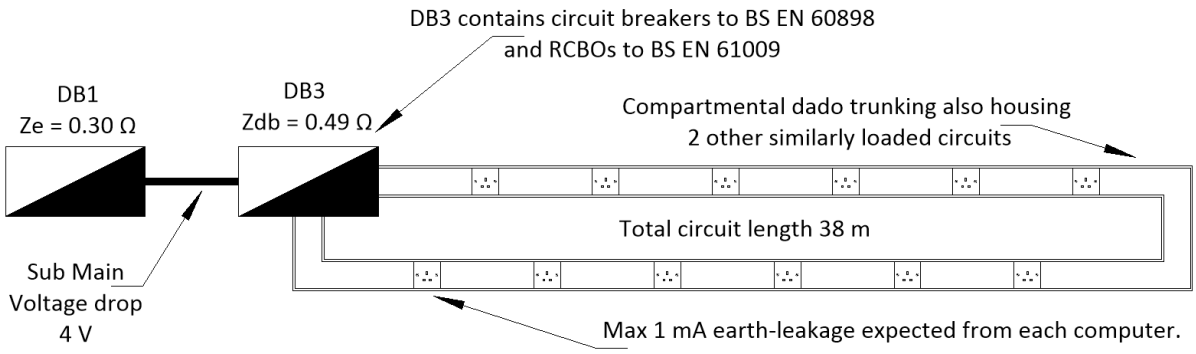
18		
State **two** sources for safety services as given in BS 7671.		AO1 Total marks: 2
LO (unit title): Requirements for electrical installations	Test spec: 307.01.04	
Answers Any two from **(1 mark each)**; • Storage batteries • Primary cells • Generators • Separate feeder		

19	
Explain why continuity of conductors must be tested prior to insulation resistance during the initial verification of a new circuit.	AO2 Total marks: 2
LO (unit title): Requirements for electrical installations	Test spec: 307.04.01

Answers

If the circuit isn't continuous (1) then an insulation fault after a break may not be detected (1).

Allow marks for answers that indicate:
- ensure complete circuit/not broken/nothing loose/other similar
- all circuit tested/no faults undetected/included in test.

20	
A ring final circuit is to be installed in a school to supply 12 computers via socket-outlets, as shown in Figure 2. The circuit is to be wired from DB3 using 70 °C thermoplastic flat profile cable with protective conductor.  **Figure 2** Justify the choice of a ring circuit for this installation and evaluate suitable circuit protection and a cable to comply with BS 7671.	AO4 Total marks: 15
LO (unit title): 303 Electrical design and installation practices and procedures	Test spec: 303.01.03 303.02.01 303.02.02 303.02.03 303.03.01 303.05.03 303.05.04 303.05.05 303.05.06

	303.05.07 303.05.08 303.03.01 303.05.02

Answers:

Band 1 (1-5 marks)
Poor coverage of the question with no or basic calculations undertaken but may have recalled some points in the process by showing basic formula required. Very few points considered with little relevance or sequence. Limited use of reference materials and little or no evidence that the relevant information can be used in the calculations. No conclusions drawn.

Access higher marks
Very few calculations undertaken with few correctly identified stages in the process.
Demonstrated limited ability in researching values such as tabulated values, installation methods, voltage drop tolerances and some rating factors or data from BS 7671.

Band 2 (6 – 10 marks)
Some coverage of the question shown with limited calculations or near full coverage with in-accurate calculations. Logical sequence followed, linking stages but with some inaccuracies. Appropriate considerations made through-out the process.

Access to higher marks
Most stages of the process considered with more accuracy in calculations and relevance in researched data. Logical sequence followed with most stages linked. General analysis is appropriate with some accurate references to permitted materials. Some conclusions drawn at relevant points.

Band 3 (11 – 15 marks)
These candidates will be able to follow most design requirements but with minor errors. Candidates will give some consideration to the location when specifying circuit protection and installation method. The application of correct parameters for calculating Z_s and

Indicative Content

A ring final circuit could give an advantage due to the potential earth leakage (protective conductor) current being around 12 mA so for the requirements of Chapter 54 (543.7.2.201), the cpc could be wired as a ring to provide a high integrity protective conductor. In addition, the load (although not much) could be shared around the parallel routes and this also helps to reduce voltage drop for similar csa cables used in a radial circuit.

The rating of the protective device is expected to be 32 A, however candidates could choose alternative ratings with suitable justification.

Candidates can choose a BS EN 61009 RCBO. Choice of a BS EN 60898 with socket-outlets incorporating RCD protection would show a higher level of analytical thinking. Either of these should be Type B.

Calculation (assuming 32 A for protective device and design current). Other values would require justification:

Current carrying capacity:

$$I_n = I_b = 32\ A$$

Rating factor Cg = 0.70 from Table 4C1
(*Candidates could negate this by specifying the other circuits are in a different compartment.)*

Minimum current carrying capacity of 20 A used from regulation 433.1.204.

$$I_t = \frac{20}{Cg} = \frac{20}{0.7} = 28.6\ A$$

Reference method B

Therefore, 4 mm^2 from Table 4D5 Column 7 with I_t of 30 A

Voltage drop:

fault current or maximum Z_s in accordance with BS 7671. ***Access to higher marks*** These candidates will be able to determine **all** design requirements but with very few errors. Candidates will consider why a ring circuit meets the requirements for a high integrity protective conductor. The application of correct parameters for calculating Z_s and fault current and maximum Z_s in accordance with BS 7671. They will also make comparisons and evaluations, justifying choice.	$$V_d = \frac{mV/A/m \times Ib \times L}{1000} \times 0.25$$ $$V_d = \frac{11 \times 32 \times 38}{1000} \times 0.25$$ $$V_d = 3.34\,V$$ Max V_d = 11.5 V – 4 V = 7.5 V therefore 3.34 V OK. EFLI: $$(R_1 + R_2) = \frac{m\Omega/m \times F \times L}{1000} \times 0.25$$ $$(R_1 + R_2) = \frac{16.71 \times 1.2 \times 38}{1000} \times 0.25$$ $$(R_1 + R_2) = 0.19\,\Omega$$ $$Z_s = Z_{db} + (R_1 + R_2)$$ $$Z_s = 0.49 + 0.19$$ $$Z_s = 0.68\,\Omega$$ Accept the symbol Z_e instead of Z_{db} as long as the correct value given. Max Z_s = 1.37 Ω therefore OK at 0.68 Ω Thermal constraints: Circuit does not comply with Table 54.7 therefore $$I = \frac{V}{Z_s} = \frac{230}{0.68} = 338\,A$$ $$S = \frac{\sqrt{I^2 \times t}}{k}$$ Value of k = 115 from table 54.3 Value of t = 0.1 s from table 3A4 $$S = \frac{\sqrt{338^2 \times 0.1}}{115} = 0.93\,mm^2$$ The cpc csa is 1.5 mm^2 which is larger than 0.93 mm^2 so circuit complies for thermal constraints.