# City & Guilds

**Qualification: 8202 Level 3 Advanced Technical Diploma in Electrical Installation (450)**
**Exam name: 8202-031 Level 3 Electrical Installation - Theory exam**
**Version: June 2017**
**Exam date: 21/06/2017**          **Exam time: 09:00 – 11:00**
**Base mark: 75**
Permitted reference material;
- BS 7671 2008 (2015)
- IET On-site Guide

| 1 | |
|---|---|
| State the simple steps an electrician will take to estimate the time required for an installation to be completed. | (3 marks) |
| Answer:<br>    1.      Break the job down into various tasks. (1 mark)<br>    2.      Allot a time to each task. (1 mark)<br>    3.      Total up the time for the job. (1 mark)<br><br>Steps need to indicate a basic logical approach rather than one inaccurate estimation. Candidates may use alternatives to task such as phases, first fix etc. | |

| 2 | |
|---|---|
| State **three** renewable energy sources utilised for producing electricity. | (3 marks) |
| Answers may include any of the following;<br>Solar (1 mark)<br>Wind (1 mark)<br>Hydro (1 mark)<br><br>Or any other suitable answer (tidal, wave)<br>Wood is **not** acceptable unless justified as Biomass or waste | |

| 3 | | |
|---|---|---|
| Complete the boxes in Table 1 by providing the correct match of colour codes used for conductor identification. | | (4 marks) |

| Function | Old conductor colour | New conductor colour |
|---|---|---|
| Line 1 of a.c. | | Brown |
| Line 2 of a.c. | | Black |
| Line 3 of a.c. | | |
| Neutral of a.c. | Black | Blue |
| Protective conductor | Green-and-yellow | Green-and-yellow |

**Table 1**

Answer:

| Function | Old conductor Colour | New conductor Colour |
|---|---|---|
| Line 1 of a.c. | Red (1 mark) | Brown |
| Line 2 of a.c. | Yellow (1 mark) | Black |
| Line 3 of a.c. | Blue (1 mark) | Grey (1 mark) |
| Neutral of a.c. | Black | Blue |
| Protective conductor | Green-and-yellow | Green-and-yellow |

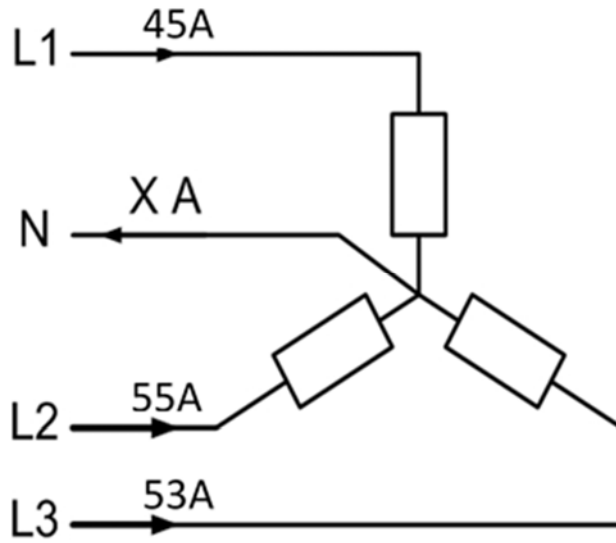| 4 | |
|---|---|
| Determine the neutral current from the circuit in Figure 1. | (3 marks) |



**Figure 1**

Answer:
Via calculation or drawing = 9.165A

Drawing method- drawing (1), values used (1) answer (1)

Calculation method- formula arranged correctly (1) values used (1) answer (1)

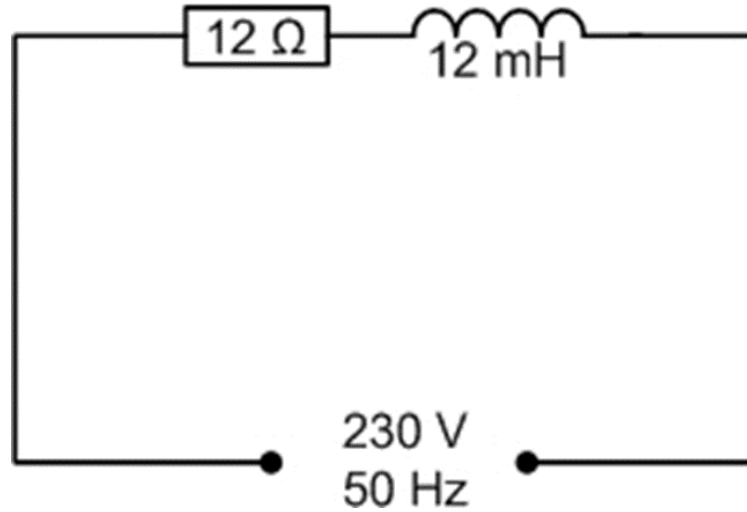| 5 | |
|---|---|
| Calculate the current flowing in the circuit shown in Figure 2. | (5 marks) |



**Figure 2**

Answer:

XL= 3.77 Ω   Z = 12.57 Ω    I = 18.298 A

Marks awarded for- $X_L$ formula arrangement (1)$X_L$ value (1) Z formula arrangement (1) Z value (1) I value (1)

If candidates do not calculate $X_L$ correctly and therefore Z and I are not correct, still award 2 marks if formulas are correct

| 6 | |
|---|---|
| State the equation required to calculate the synchronous speed if connected to a 50 Hz supply. | (1 mark) |

Answer

$$\frac{N_p}{f} \quad or \quad \frac{pairs\ of\ poles}{frequency} \quad or \quad \frac{N}{50}$$

Answer must indicate pairs of poles over frequency

| 7 | |
|---|---|
| Describe the function of the capacitor in a capacitor start motor. | (3 marks) |

Answer:
- Capacitor creates a phase shift/displacement (1 mark)
- Creating two phases over the start and run windings (1 mark)
- Inducing an opposing field in the rotor producing torque (1 mark)

If candidates demonstrate a recall such as use of the word displacement, shift, two-phase but the description doesn't display understanding, award only 1 mark.

| 8 | |
|---|---|
| State the type of gas used in the following types of lamps.<br>a) SON. | (1 mark) |
| b) Fluorescent. | (1 mark) |

Answer
a) Sodium
b) Mercury

No alternative answers accepted.

| 9 | |
|---|---|
| Describe the required relationship between the circuit design current, nominal rating of the overcurrent protective device and the current rating of circuit live conductors. | (3 marks) |

Answer:
$I_z > I_n \geq I_b$ candidate who apply this formula will have an understanding of co-ordination.(3)
OR
The use of a description such as-
Correct coordination between the cable rating being greater than (1) the protective device rating which must be greater or equal to (1) the design current.(1) (similar wording acceptable).

Candidates who simply recall that a fuse/device needs to protect the cable, or similar - only 1 mark.

| 10 |  |
|---|---|
| Determine the following rating factors: | |
| a) 70 °C thermoplastic cable at an ambient temperature of 35 °C. | (1 mark) |
| b) A cable surrounded by thermal insulators for a length of 400 mm. | (1 mark) |
| c) Where a protective device is a semi-enclosed fuse to BS 3036. | (1 mark) |

Answer:
a.  0.94 (1 mark)
b.  0.51 (1 mark)
c.  0.725 (1 mark)

| 11 |  |
|---|---|
| Calculate the voltage drop for a 5 kW single-phase circuit wired in 4 mm$^2$ single-core 70 °C thermoplastic cable. The circuit is 25 m in length and installed in accordance with method A. | (3 marks) |

Answer

5000/230 = 21.739A  (1)

$\dfrac{11 \times 21.739 \times 25}{1000}$  (1) = 5.978 V  (1)

Marks distribution;
Current value (1)
Application of voltage drop formula with or without values (without indicates recall) (1)
Final answer (1)

| 12 |  |
|---|---|
| State **three** pieces of equipment required to complete the safe isolation procedure. | (3 marks) |

Answers must include;

Voltage indicator (1mark), proving unit (1 mark), lock of kit (1mark).

Alternatively
If one item of hand tools is given, this can be accepted for 1 mark but no more than 1 piece.
There must be at least two of the essential 3 items for full marks

| 13 | |
|---|---|
| Describe how different earthing arrangements effect measured values of earth fault loop impedance. | (3 marks) |

Answers may include a description of the alternative earth return paths (PEN, sheath, mass of earth) or a description of the material being different resistance (soil, steel/lead, copper neutral). Where understanding details the paths or materials - 3 marks.

For recall answers such as 'the paths are different outside the installation' or 'the neutral and earth are combined or not' - 1 mark only.

For recall answers that give $Z_e$ values such as the 0.8 Ω, 0.35 Ω 0 marks unless they are justified and accompanied with a 'affect overall impedance' type statement (only 1 mark).

| 14 | |
|---|---|
| Explain the reasons for the method that **must** be used when verifying the continuity of the main and supplementary bonding conductors. | (3 marks) |

Answer to include an explanation such as;

As bonding doesn't follow a circuit ($R_1$) path (1) then a long wander lead (1) is required to obtain a reading over the length of the bonding (1)

Marks awarded for explanations that include;
Required to read at both ends or over length (1)
Wander or long lead required (1)
As there is no line or there is no path or the leads aren't log enough (1)

Recall answers such as to 'get a resistance', 'prove continuity', or check connection - 1 mark only.

No marks permitted for answers relating to parallel paths or earth path.

| **15** | |
|---|---|
| Describe how to test when locating an open circuit on a securely isolated radial circuit. | (4 marks) |

Answer must be a suitable description that indicates
- Meter preparation (low reading ohmmeter) (1 mark)
- Circuit preparation (isolated and link L-N or L-E or N-E depending on fault) (2 mark)
- Test connections (test at various locations between conductors linked)(1 mark)

Recall answers such as 'test continuity at different parts of circuit, or 'test continuity of the circuit' – only 1 mark

No marks for answers that include insulation resistance or live methods.

| **16** | |
|---|---|
| Evaluate the following two faults giving each a classification code which would be recorded on an Electrical Installation Condition Report. a) An earth fault loop impedance 2 Ω higher than that permitted. | (1 mark) |
| b) A damaged switch-plate leaving exposed live parts. | (1 mark) |

Answer:
C2 (1 mark)
C1 (1 mark)

No alternatives accepted.

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| 17 | |
|---|---|
| Describe what the requirements of BS 7671 is intended to protect. | (4 marks) |

Acceptable answer must be a suitable description that includes;

Persons (1mark)
Property (1 mark)
livestock (1 mark)
from the risk of danger or damage arising from the reasonable use of electrical installations (1 mark)

Or any other similar wording

Where candidates reference person and list a good range of dangers such as shock, fire and burns - 3 marks.

Where recall answers include 'protect people against shock or fire or burns' - 2 marks.
Where answers simply state protect against shock or protect against fire' - 1 mark.

| 18 | |
|---|---|
| State how BS 7671 defines double insulation. | (2 marks) |

Answer:
Insulation comprising BOTH BASIC (1) insulation and SUPPLIMENTARY/reinforced (1) insulation.

1 mark for basic.
1 mark for supplementary or reinforced or further layer.

| 19 | |
|---|---|
| Explain how to test to confirm protection by PELV. | (4 marks) |

Answer must include:

By testing using an Insulation resistance tester (1 mark) testing between SELV and primary circuit for 1 M-ohm separation (1) then between live conductors of PELV (1) and the values obtained shall be in accordance with Table 61 (1).

or any other similar answer that meets the above
distribution-
1 mark- insulation resistance tester
1 mark- test primary to secondary
1 mark- test live of SELV circuit
1 mark- test values must be 1/0.5 $M\Omega$ or to table 61

Recall answers such as test 250 V between conductors (2 marks) or insulation test L-N, L-E, N-E (1 mark)

| 20 | |
|---|---|
| Using the information contained in BS 7671, determine the **maximum** floor area served for the following circuits. | |
| a) 20 A radial final circuit | (1 mark) |
| b) 30/32 A radial final circuit. | (1 mark) |

Answers;

    a) 50 m$^2$
    b) 75 m$^2$

No other alternatives accepted

**21**



Single-core copper 70 °C thermoplastic insulated, non-sheathed cables, in PVC trunking with one other similar circuit.
Ambient temperature = 30 °C

9 kW 400 V three-phase motor
cosΘ = 0.95

Sub-station — 400/230 V 50 Hz — DNO service head — METER — RCD Main Switch — DB housing BS 88-2 devices

$L_1$   16 A   2.5 mm$^2$
$L_2$   16 A   2.5 mm$^2$
$L_3$   16 A   2.5 mm$^2$
N
E   2.5 mm$^2$

ground

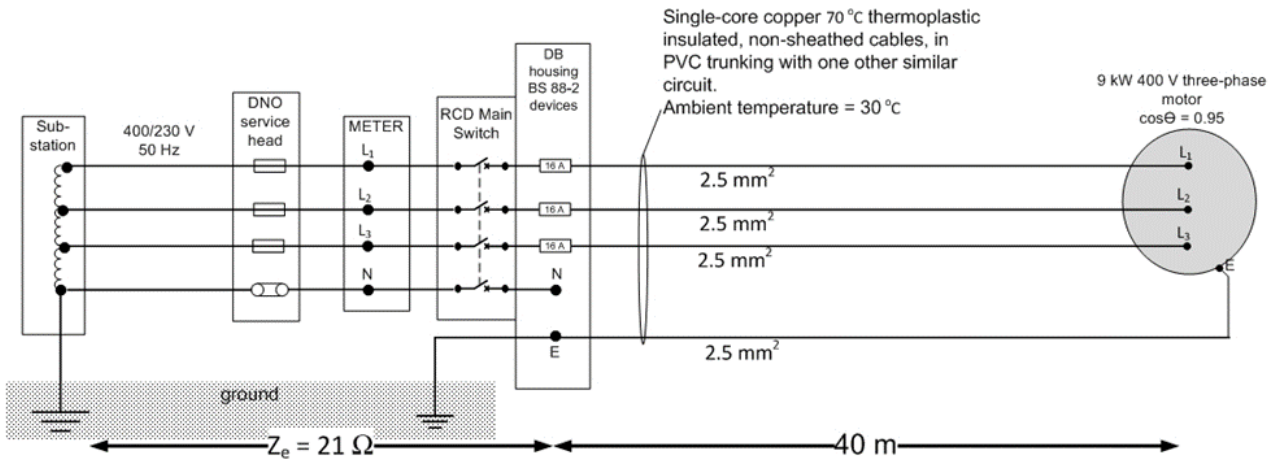$Z_e = 21\ \Omega$ ———— 40 m

**Figure 3**

The supply and final circuit arrangement shown in Figure 3 relate to questions 21 a) and b).

a) Identify three important characteristics of the supply for the installation.

(3 marks)

b) Evaluate the final circuit design, including the requirements for ADS, for compliance with BS 7671.

Your evaluation should also include recommendations relating to the residual current setting of the RCD main switch.

(12 marks)

Answers;

3

a) Answers may include for 1 mark each- sub-station, three-phase, 400 V, mass of earth path, TT, suppliers or source electrode, 21 Ω external loop.

Not acceptable are any characteristics within the installation or consumers electrode.

b)

Please note, coloured text indicates- research: Calculation/determination; evaluation.
Circuit design evaluation

$$\frac{9000}{\sqrt{3} \times 400 \times 0.95} = 13.67 \; A \; load \; current \; (I_b)$$

Protective device rating 16 A which is > 13.67 A therfore suitable

2.5 mm$^2$ live conductors installed as method B has a rating of 21 A
Factor for grouping of circuits – 0.8 $C_g$. No ambient temperature considerations
$I_z$ cable = 21 x 0.8 = 16.8 A

As $I_z$ (16.8 A) > $I_n$ (16 A) > $I_b$ (13.7 A) the circuit design is correct

ADS evaluation including RCD
IET OSG 2.5/2.5 $R_1+R_2$ = 14.82 and temperature factor for operating conditions = 1.2
$$\frac{14.82 \times 40 \times 1.2}{1000} = 0.71 \; \Omega \; (R_1 + R_2)$$
Total $Z_s$= 21+0.71=21.71 $\Omega$
Maximum $Z_s$ for 16 A BS 88-2 device = 2.43 $\Omega$ so too high and as this is a TT system, an RCD is required
Maximum RCD rating to fulful this using table 41.5 is 500 mA as 21.71 $\Omega$ is less than 100 $\Omega$
(Candidates may also confirm this by 50/21.71=2.3 A so any RCD under 2300 mA ok)

| Band 1 | **These candidates may provide answers that state that a 2.5 mm$^2$ cable is suitably protected by a 16 A circuit breaker without determining load current.** They may also give generic RCD values such as 30 mA or 100 mA without any justification **(basic comparison)**<br>**Research maximum $Z_s$ values from BS 7671** or cable ratings | 1-2<br><br><br><br><br>3-4 |
|---|---|---|
| Band 2 | Be able to determine load current OR total circuit earth loop impedance<br><br>Compare load values to device ratings OR circuit loop impedance to published data OR evaluate a correct RCD value (but not all parts) | 5-6<br><br><br>7-8 |
| Band 3 | Be able to determine all load characteristics and compare to all circuit criteria including all earth fault loop impedance values<br><br>Research all data, determine all criteria, compare cable ratings from BS 7671 making assumptions of typical cable type and the application of temperature factors<br><br>Please note for ALL bands. Calculations may not necessarily be correct, or data may be incorrect but a full process was shown for each band above then candidates can achieve scores the lower end marks in the band<br><br>Upper band marks are where data and calculations are correct with minor error or no error. | 9-10<br><br><br>11-12 |

Right column marks (top to bottom): 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2