Qualification: 8202 Level 3 Advanced Technical Diploma in Electrical Installation (450)
Exam name: 8202-531 Level 3 Electrical Installation - Theory exam
Version: April 2018
Exam date: 20 April 2018 **Exam time: 09:30 – 12:00**
Base mark: 75

1
Answers Any 3 from • Number of operatives required • Progress against schedule • Levels of training or skills required • Sicknesses and absences • Industrial action • Any other suitable answer. Answers relating to resources for humans has also been accepted due to interpretations of the question including PPE, tools, equipment
2
Answer; The answer needs to explain the operating principles, to include any three of the following points: Wind Turbine Gear box Generator Model answer could be; The **wind** turns the **rotor-blades**, which are connected to the main shaft, which spins a **generator** to create electricity. Where candidates simply state any of the above key terms without an explanations, 1 mark only
3
Answers; $\boldsymbol{X_L = 2\pi fL\ so\ 2\pi \times 50 \times 0.318 = 100\ \Omega}$ **(1 mark)** $\boldsymbol{X_C = \frac{1}{2\pi fC}\ so\quad \frac{1}{2\pi \times 50 \times 38.9 \times 10^{-6}} = 82\ \Omega}$ **(1 mark)** $\boldsymbol{Z = \sqrt{R^2 + (Xl^2 - Xc^2)}\ so\ \sqrt{20^2 + (100^2 - 82^2)^2} = 26.9\ \Omega}$ **(2 marks)**

$PF = R/Z\ so\ 20/26.9 = 0.74$ **(1 mark)**

Summary of marks

Xl formula correct = 1 (answer does not need to be)
Xc formula correct = 1 (answer does not need to be)
Z calculation with correct values = 1
Z value = 1
PF value = 1
Therefore candidates may gain 2 marks for showing formula but incorrect answers
Extended response- use of $x10^{-3}$ shows recall only so 1 mark max
Correct use of H but maths errors or no X-X max 2 marks
Correct use of H but maths errors process correct 3 marks
Correct full procedure but errors 4 marks
Full marks for full understanding

4

Answers;
kVA = V x I
= 110 x 20 (1) = 2.2 kVA (1)

1 mark formula
1 mark answer
Extended response
Inclusion of power factor at any point 0 marks

5

Answers;
I = V/ Xl = 24/4000 (1) = 6 mA or 0.006 A (1)

1 mark correct formula
1 mark answer

6

Answer;
This is achieved by adding external RESISTANCES (1) to the ROTOR windings (1) via slip rings/brushes (1)

Where candidates state components without a strong description - 1 mark only
1 to 2 marks awarded to any response relating to a split phase/phase shift or explanation relating to relationship between rotor and windings depending on quality of response

7

Answer;

- Convection
- Conduction
- Radiation.

1 mark each
Marks have been given where candidates have given strong description of convection and the three parts of the cycle

8

Answers;

It monitors water temperature (1) either directly (bi-metal) or capillary (sealed spirit or InVar type) (1) and actuates a switch which controls the heating appliance (1).

Good depth of explanation of principle - 3 marks
Stating components without much description - 1 mark only
Answers relating to bi-metallic strip also accepted as some boiler stats use this process.
Marking depends on strength of answers.

9

Answer;
TN-C-S (1)
X = PEN conductor or CNE (1)
Y = Source/distributors/DNO electrode (1) –
Extended response
3 marks only for use of correct terminology incorrect terms not accepted

10

Answer;
1. Calculate design current = (4000/230) x 1.8 (1) = 31.30 A (1)
2. Select protective device rating = 32 A (1) Type C (1)

Extended response
No calculations and correct rating and type or basic P/V calculation 1 mark
Use of some calculations with wrong answer but correct type identified- 2 marks
Application of 1.8 factor with calculation 3 marks
Full use of calculation, 1.8, rating and type – 4 marks

11

Answer;

Adiabatic equation or $s = \sqrt{\frac{I^2T}{k}}$ (1)

Table 54.7 (1)
Only acceptable answers but accept 543.1.3 and 543.1.4 as answers from BS 7671

12

Answer;
Any three from (1 mark each):
BS 7671
Guidance Note 3 (GN3)
HSE GS38
On-site Guide (OSG)
Any other suitable answer.

13

Answers;

To confirm all **protective device (1)** and **single pole control devices** (1) are in the **line conductor only (1)**.

Descriptions such as ES lampholders no marks
Line connected to switch- 1
Line connected to breaker 1 Correct terminals/correct connection 1

14

Answers;

Description of any three answers from:
Personal appearance and hygiene is important – remember, you are representing your company.
Keep to appointment times.
Show a positive attitude and good company image at all times.
Don't use 'jargon' – keep it simple!
Respond to customer requests promptly.
Be tactful, discrete and courteous.
Keep the customer informed of any changes to arrangements.
Any other suitable answer

Each point needs to describe. If candidates simply state terms, such as 'be smart', 'be nice', without a description – maximum 1 mark only.
Extended response
Weak statements 1 mark max- weak descriptions 2 marks. strong descriptions 3 marks

15

Answers;
Any three which may include (1 mark each);
Safe use of tools and equipment
Safe and correct use of measuring instruments
Provision and use of PPE
Reporting of unsafe situations

Any other suitable answer.
Answers relating to a suitable hazard which needs to be assessed for risk also acceptable as 1 mark each

16

Answer;
Any three from (1 mark each):
Damage to cable, e.g. nail/screw in wall
Loose lamp holder leading to twisting of cables
Element in a lamp fusing
Object falling into accessory
Damage by fauna
Any other suitable answer.

17

Answer:
Insulation and/or barriers (1) prevent contact with parts (1) intended to be live in normal operation (1).
Or similar wording.
Or electric shock protection under fault free conditions- 2 marks including methods- 3 marks
Marks awarded for;

- Method of basic protection (1)
- Preventing contact (1)
- Normally live parts (1)

If a simple answer is given such as 'stops electric shock' or 'stops touching live parts' – maximum 1 mark only.

18

Answer
Conductive part of an electrical system (1) which can be touched and which is not normally live (1), but which can become live under fault conditions (1).

Marks awarded for definition

- Conductive parts of electrical system
- Touched in normal use
- Becomes live under fault

Simple answers such as examples or 'parts of the electrical system' etc – maximum 1 mark only. Any mention of extraneous parts in description- 0 marks

19

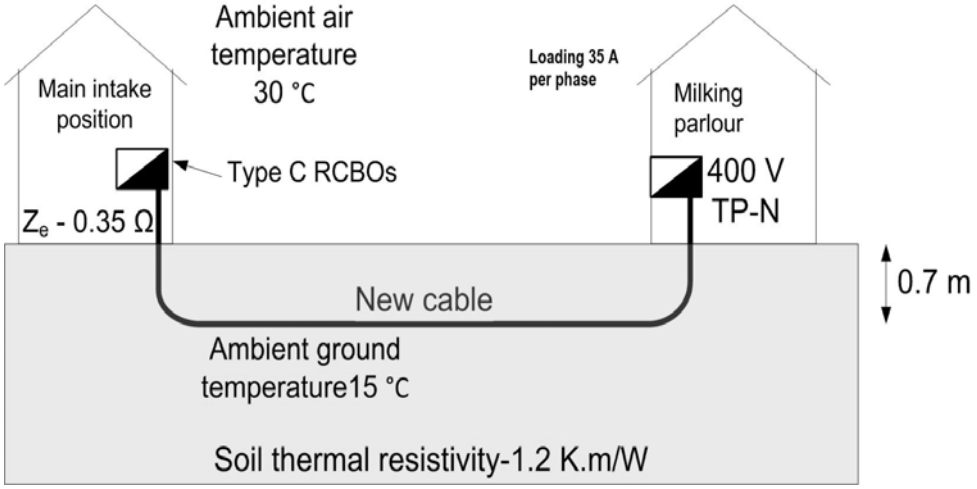
Answers;
Calculation
Measurement
Enquiry
1 mark each given for those who give characteristics of a supply and methods of obtaining the… look at earthing arrangement, Earth connected to sheath etc

20
Answers (1 mark each); New installation Alterations Additions **Or one suitable example for each of the above is acceptable.**

21 (CALCULATOR NEEDED)

You have been asked to be part of the design team for an electrical installation within a farm complex consisting of a main farm house, stables, garage, and out buildings.

One of the outbuildings is to be converted into a milking parlour. The supply and installation is to form a three-phase TN-C-S, 400 V supply, where Z_e is 0.35 Ω at the origin of the circuit. Protection for this circuit is by a Type C RCBO. Installation details are shown in the figure below.



Determine a suitable installation design that complies with BS 7671. (15 marks)

Due to error in question with missing data, this item has been marked on the strength of the responses using the information provided and their interpretations of BS 7671. Responses may provide a suitable design based on the factors affecting the design and selection of cable etc.

Answers

(this is a guide only and candidates may select other cables with justification)

Cable selection

Learners to suggest that as it is a farm you would expect to encounter a number of external influences (such as; temperature, high humidity, corrosion, mechanical damage, installation underground), which the cable must be suitable for, as well as being cost effective, suitable for etc. Therefore, the most suitable wiring system for the supply would be 70 °C thermosetting SWA 4 or 5-core cable (thermoplastic may be chosen but should be rated for 70 °C.) (1)

Stage 1- determine cable CSA

- **Design current;**
- **Rating of protective device**; (1)
- **Installation Reference Method;**

Table 4A2 Number 72 Reference method D (1)

- **Ambient temperature**;
  air 30 °C Table 4B1, $C_a = 1$
  ground 15 °C Table 4B2. $C_a = 1.05$ (1)
- **Cables buried in the ground;** 0.7 m
  Table 4B3, $C_s = 1.4$
  Depth of burial; no factor necessary. (1)

- **Current-carrying capacity of the cable**

$$Cable\ IT = \frac{IN}{Rating\ factors} = \frac{IN}{Ca\ x\ Cs} = \frac{40}{1.05\ x\ 1.4} = 1)$$

From Table 4D4A Column 7; Tabulated current-carrying capacity of 4 mm^2 carries 30 A, but need to satisfy $\mathbf{I_z \geq I_n}$, therefore, must select 6 mm^2 which can carry 38 A so

$38 \times 1.05 \times 1.4 = 55.9 \geq 40\ A\ therefor\ ok$

Candidates may select a 10 mm^2 cable based on $I_t \geq I_n$

Volt drop = mV/A/m x I_b x length (1)

Volt drop = $3.8^{x\ 10^{-3}}$ x 35 x 20 = 2.66 V

Volt-drop constraint is met.

Stage 2 Shock Protection (Zs)

$Z_s = Z_e + R1 + R2$

R1 + R2 OSG Appendix I based on a core used as cpc

showing formula with no values

$$\frac{6.16 \times 20 \times 1.2}{1000} = 0.147\ \Omega$$

showing formula with no values

$$\frac{3.66 \times 20 \times 1.2}{1000} = 0.08\ \Omega$$

Max permitted Z_s = 0.55 Ω constraint is met.

Fault Current

6/6 $\frac{230}{0.5} = 460\ A$

10/10 $\frac{230}{0.42} = 547\ A$

Stage 3 Disconnection Time and Adiabatic

Appendix 3 p 325 Time current characteristics

With 574.62 A flowing into a 40A Type C RCBO the device will interrupt in less than <0.1 S
Constraints met

Adiabatic based on 10 mm²
Regs p 164 - 165

$S = \sqrt{\frac{I^2 x\ t}{K}}$ (1) $S = \sqrt{\frac{574.62^2 \times 0.1}{51}} = 3.56$ mm² (10mm installed Constraints met)

Band 1	These candidates may provide answers that states a suitable wiring system, with reasons for their choice, and research protective device ratings, Installation methods and some rating factors from BS 7671.	**1-5 marks total** 1-3 basic selection 4-5 as above with some technical decisions
Band 2	These candidates will be able to determine most design requirements making assumptions of typical cable type and the application of temperature factors, rating factors Candidates show the design process with sample formula	**6-10 marks total** 6-8 good calculation process but mistakes made with values 9--10 as above with limited comparisons or justifications
Band 3	These candidates will be able to determine all design requirements making assumptions of typical cable type and the application of temperature factors, rating factors, calculate current carrying capacities of cables, volt drop, Z_s, disconnection times and thermal constraints in accordance with BS 7671. The will also make comparisons and evaluations justifying choice	**11- 15 marks** 11-13 Good design procedure with some mistakes and good justification/comparison made 14-15 good overall procedure with very few mistakes and strong justifications