Qualification: 8202-20 Level 2 Technical Certificate in Electrical Installation

Assessment: Level 3 Electrical Installation - Theory exam

June 2018

<table>
<tr><td rowspan="3">1</td><td colspan="3">State three documents that should be available to a site electrician during the construction phase of an electrical installation.</td></tr>
<tr><td>Acceptable answer(s)</td><td>Guidance</td><td>mks</td></tr>
<tr><td>Any three; (1 mark each)
Risk assessment
Method Statement
Design specification
Site plan / building plan
Manufacturer's instructions / Data sheets
Quotation
BS7671 or other guidance
Building regulations
Planning docs (bar chart, CPA)</td><td>Any other suitable answer but do not allow duplicate marks where same document is given more than one name.
Only give 1 mark for test documentation if three given.
Only give 1 mark for items such as BS 7671 or OSG if three given. Not including building regs
1 mark for planning documents such as critical path/bar chart if both given</td><td>3</td></tr>
<tr><td rowspan="3">2</td><td colspan="3">State three types of inductive transformer.</td></tr>
<tr><td>Acceptable answer(s)</td><td>Guidance</td><td>mks</td></tr>
<tr><td>Any three; (1 mark each)
Isolation / separation
Laminated core
Toroidal
Autotransformer (will accept auto)
Current Transformer (CT)
Voltage Transformer (VT)
Single phase
Poly/multi/three phase</td><td>Accept 1 use as question is specific to type so if answers are all uses such as step up, transmission, SELV etc. are given max 1 mark</td><td>3</td></tr>
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3	Explain why pumped storage electricity generation is used, in preference to traditional fuel sources, to provide supply flexibility when demand fluctuates.

Acceptable answer(s)	Guidance	mks
To include reference to traditional fuel sources (coal/gas/nuclear etc.) that are slow to start and stop the generation process (1 mark) whereas water turbines (1 mark) can be put on and off line rapidly (1 mark).	Answer must show understanding and not just list the correct words. No marks for environmental reasons as item is specific about demand	3

4	A single-phase electric motor has a rating of 2.55 kW and the current lags the voltage by 32°. Calculate the apparent power and reactive power for this motor.

Acceptable answer(s)	Guidance	mks
Pf = $\cos_{ø}$ $\cos_{ø}$ = Cos(32) $\cos_{ø}$ = 0.85 **(1 mark)** kVA = kW / $\cos_{ø}$ (or pf) KVA = 2.55 / 0.85 **(1 mark)** = 3kVA **(1 mark)** kVAr = $\sqrt{kVA^2 - kW^2}$ **(1 mark)** kVAr = $\sqrt{3^2 - 2.55^2}$ = 1.59kVAr **(1 mark)**	Any valid method allowed, including use of a diagram. Max 2 marks for correct formulae (regardless of method). Candidates can get both of these even if calculation is incorrect.	5

5	Explain why all Live conductors of the same A.C. circuit **must** enter a steel-cased consumer unit through one single hole.

Acceptable answer(s)	Guidance	mks
Model answer- As the magnetic fields induced by each conductor are offset by the opposing fields. If they are not, then eddy currents induced will create a heating effect and vibration. Answers to include magnetic fields **(1 mark)**, Current in each conductor that offsets the magnetic field around the other **(1 mark)**, causes heating effect to the enclosure **(1 mark)** and causes vibration of the enclosure **(1 mark)**.	Answers simply mentioning eddy currents **(max. 1 mark)**.	4

6	State **three** gases or metallic vapours commonly used in discharge lamps.		
	Acceptable answer(s)	**Guidance**	**mks**
	Any three; (1 mark each) Neon Argon Hydrogen Helium Mercury Sodium Magnesium	phosphor not accepted as this is a powder High pressure sodium and low pressure sodium 1 mark only as the question is asking for gasses	3
7	Explain why star-delta motor control equipment is used in preference to direct-on-line.		
	Acceptable answer(s)	**Guidance**	**mks**
	Star configuration reduces the line current during start-up (1 mark) then delta configuration increases the torque whilst running (1 mark), whereas direct-on-line both start and run in delta (1 mark). Other suitable answers, simply relating to reducing start up current (max. 1 mark).	n/a	3
8	Explain the drawbacks of BS 3036 fuses.		
	Acceptable answer(s)	**Guidance**	**mks**
	Poor fusing factor and cables need to be de-rated (1 mark), as they may over-heat (1 mark) Fuse wire can be easily replaced with the wrong size or type (1 mark), which may lead to over-heating of the cable, potentially resulting in a fire and/ or damage to cable (1 mark). Carriers have poor prospective fault carrying properties (1 mark) which may explode under fault conditions (1 mark)	Accept answers relating to difficulty in obtaining fuse wire for 1 mark	

9	State **three** factors, given in BS 7671, to be taken into account when calculating the maximum demand of an installation.		
	Acceptable answer(s)	**Guidance**	**mks**
	Any three; (1 mark each) Location of points of power demand Loads to be expected Variation of demand (time of consumption) Special conditions e.g. harmonics Anticipated future demand, if specified Diversity Type of building	Do not give a mark for additional 20% etc. unless reference is made to it being specified.	3
10	A new passive infra-red occupancy sensor has been installed to control the lighting in a hotel corridor. Describe the process of carrying out functional testing of these sensors.		
	Acceptable answer(s)	**Guidance**	**mks**
	Sensors to be adjusted to test settings (1 mark), they must activate the appropriate lights when people move in appropriate locations(s) (1 mark) and must be correctly adjusted for time and light level (1 mark) Simple walk test (max 1 mark).		3
11	Describe **three** practical measures that can be taken to ensure the safety of other people, when carrying out inspection and testing.		
	Acceptable answer(s)	**Guidance**	**mks**
	References made to any three; (1 mark each) Inform people of dangers Post signs for awareness Barrier off areas to make people aware/ restrict access Provide adequate lighting for safe access/ egress Ensure lifts unoccupied (before isolation) Avoid trip hazards with test leads Working out of hours to minimise risks Safe isolation to minimise risk of contact with live parts.	Answers must be primarily for the protection of others (not the inspector). Basic protection as 416 accepted if specifically related to the user and at the DB where it is the only location where live parts may be found as full isolation should be carried out to minimise risk elsewhere.	3
12	Explain why a newly installed gas central heating boiler **must** be disconnected from a circuit before an insulation resistance test can be carried out.		
	Acceptable answer(s)	**Guidance**	**mks**
	Insulation resistance tests require a voltage to be applied to the circuit (1 mark) which may, if the boiler is left connected, produce false readings (1 mark) and/ or damage sensitive electronic components (1 mark).	n/a	3

13	State **three** hazardous materials that may require specialist disposal when undertaking fault rectification work.		
	Acceptable answer(s)	**Guidance**	**mks**
	Any three from; (1 mark each) Mercury (or items containing e.g. fluorescent lamps) CFC's (or items containing e.g. fridges) Asbestos Oil Batteries (Lead Acid, NiCd, lithium etc.) Any other suitable answer where it is harmful to the environment.	'Gasses' alone is not specific enough nor is flammable material If a response shows three duplicated items, 1 mark only. An example would be • Lead acid battery • NiCad battery • Lithium battery	3
14	Identify **three** pieces of verbal information an electrician should seek from a user when undertaking diagnosis of an intermittent electrical fault.		
	Acceptable answer(s)	**Guidance**	**mks**
	Any three; (1 mark each) How long has the fault been occurring How long does the fault last for Symptoms of fault How often does the fault occur Is anything else happening at the time the fault occurs Any other work carried out such as DIY Any other suitable answer.	Answers relating to requesting technical information from client not acceptable. Directly requesting 'where is the fault' or 'what is the fault' not acceptable.	3
15	State the upper voltage limits for Extra-Low Voltage.		
	Acceptable answer(s)	**Guidance**	**mks**
	50 V ac (1 mark) 120 V dc (1 mark)		2
16	Explain the effect of running a cable through 200 mm of thermal insulation.		
	Acceptable answer(s)	**Guidance**	**mks**
	The thermal insulation will reduce the ability of the cable to dissipate heat (1 mark) which will reduce the current carrying capacity (or damage cable if not reduced)(1 mark). The correction factor to be applied to take account of the reduced current carrying capacity, Ci, is 0.63 (1 mark) Simply stating the factor (max 1 mark).		3

17	Explain why Low Voltage circuits with surge protective devices may have the insulation resistance test voltage reduced.		
	Acceptable answer(s)	**Guidance**	**mks**
	Answers must include the following points; Low voltage circuits are normally tested at 500 V **(1 mark)**, which is sufficient to operate the surge protection **(1 mark)** leading to an inaccurate low reading **(1 mark).** Reducing the test voltage to 250 V will stop the operation of the surge protective device **(1 mark).** Candidates that just list the test voltages **(max 1 mark).**		4
18	State three special installations or locations other than those divided into zones.		
	Acceptable answer(s)	**Guidance**	**mks**
	Any three (1 mark each) from Part 7 of BS 7671 excluding 701,702 and 703.	Answers do not need to be word for word but must clearly be the location.	3

19	A new circuit is to be installed to an existing electrical installation within a motor vehicle repair workshop. The repair workshop undertakes a range of mechanical and body repairs to vehicles and the ambient temperature can be 35 °C during certain processes. The supply and installation form a 400 V, three-phase, TN-C-S system. The DNO has quoted the Ze to be 0.35 Ω. The new circuit is to supply a 7.4 kW three-phase paint-baking oven heater, 30 m from the origin of the installation, but must be contained in existing, galvanised trunking for 3 m of the run. Within this existing trunking are three other circuits. The circuit is to be wired in 70 °C thermoplastic single-core cable and protected by a type C circuit breaker to BS EN 60898. Determine a suitable cost-effective installation design that complies with BS 7671.		
	Acceptable answer(s)	**Guidance**	**mks**
	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. Access higher marks Very few calculations undertaken with few correctly identified stages in the process. Demonstrated limited ability in researching values such as protective device ratings, installation methods 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 some 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. These candidates will be able to follow most design requirements with but with minor errors, make assumptions of typical cable type and the application of temperature factors, rating factors, calculate current carrying capacities of cables, voltage drop, Zs and fault current or maximum Zs in accordance with BS 7671.	**Stage 1 – determine cable CSA** • Design current: $I_b = \frac{7400}{\sqrt{3}\ x\ V_L}$ therefore $I_b = \frac{7400}{\sqrt{3}\ x\ 400}$ therefore I_b = 10.7A • Rating of protective device I_n = 16A • Installation reference method: Table 4A2 Reference Method B • Ambient Temperature: Air 35°C Table 4B1, Ca = 0.94 • Grouping: Four Circuits Enclosed Table 4C1 Cg = 0.65 • Current-carrying capacity of the cable: $I_t = \frac{I_n}{C_a \times C_g}$ therefore $I_t = \frac{16}{0.94 \times 0.65}$ therefore $I_t = 26.2A$ Note – If candidate justifies the use of I_b, this is acceptable only if **both** Eq3 **and** Eq4 are used. • Conductor size: Table 4D1A Column 5 4mm2 with an Iz of 28A • Voltage drop: Table 4D1B Column 6 mV/A/m = 9.5mV $V_d = \frac{\text{mV/A/m} \times I_b \times L}{1000}$ therefore $V_d = \frac{9.5 \times 10.7 \times 30}{1000}$ therefore V_d = 3.05V Max Voltage drop Table 4Ab max 5% of 400V = 20V therefore circuit complies. **Stage 2 – Shock Protection (Zs)** Note candidates are expected to know they can use 1.5mm2 for the cpc. Larger sizes will not get full marks even if referenced to Table	15

	Band 3 (11-15 marks) Detailed coverage shown with accurate calculations. All points considered were relevant. Logical sequence followed, correctly linked stages and accurate analysis made. Comparisons made between all values and permitted values. Conclusions drawn are accurate. Access to higher marks Detailed coverage with accurate calculations on all valid and relevant stages in the process. 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, a well-defined process and data from permitted publications. These candidates will be able to determine all design requirements, making assumptions of typical cable type and application of temperature factors, rating factors, calculate current carrying capacities of cables, voltage drop, Zs disconnection times and thermal constraints in accordance with BS 7671. Comparisons made with detailed evaluations to justify choice.	54.7. Question specifically asks for a cost effective design. • Zs = Ze + (R1+R2) mΩ/m from Table I1 OSG for $4mm^2$ Line $1.5mm^2$ cpc = 16.71mΩ. Operating temperature multiplier (F) from OSG Table I3 = 1.2. $(R_1 + R_2) = \frac{m\Omega/m \times F \times L}{1000}$ therefore $(R_1 + R_2) = \frac{16.71 \times 1.2 \times 30}{1000}$ = 0.60Ω $Z_s = Z_e + (R_1 + R_2) = 0.95\Omega$ Max permitted Z_s from Table 41.3 = 1.37Ω therefore circuit complies. **Stage 3 – Disconnection Time and Adiabatic** • Fault current: $I = \frac{U_0}{Z_s} = \frac{230}{0.95}$ = 242A Appendix 3 Table 3A5 Disconnection time 0.1s • Adiabatic: From Table 54.3 k =115. $S = \frac{\sqrt{I^2 \times t}}{k} = \frac{\sqrt{242^2 \times 0.1}}{115} = 0.67mm^2$ Therefore 1.5mm2 complies	