# IT 8 - ELECTRICAL INSPECTORS THEORY ANSWER SCHEDULE

Note: (1 mark) means that the preceding statement earns 1 mark.

This schedule sets out the expected answers to the examination questions. The marker can exercise their discretion and decide on the overall adequacy of any answer that is presented in the candidate's own words.

Key to abbreviated terms:

| | |
|---|---|
| S | Section of the Electricity Act 1992 |
| ER | Electricity Regulations 1997 |
| AS/NZS | Australia and New Zealand Joint Standard |
| NZS | New Zealand Standard |
| AS | Australian Standard |
| ECP | New Zealand Electrical Code of Practice |
| GK | General Knowledge |

**Question 1**

Each part is work 1 mark

(a) Any ONE of:

- Cost saving due to reduced maximum demand
- With respect to tariffs and equipment rating

GK

(b) Any ONE of:

- Improved system efficiency due to reduction
- Of current demand on supply equipment
- Smaller transformers and generators
- Less losses in the lines

GK

(c) Each lift or each group of lifts that is specifically required to operate for firefighting or other emergency purposes, shall be controlled and protected independently of all other lifts.

AS/NZS 3000: 7.10.3.4

(d) 0.4 seconds or 400ms

AS/NZS 3000: 1.7.4.3.4(a)(ii)

(e) Forthwith inform the Secretary.

EA 119 (3)(a)

(f) Not fewer than 4 persons.

EA: 154(1)

(g) Any ONE of:

- (The earthing contact of every socket-outlet that is provided with an earthing contact shall be earthed.) This requirement need not apply to socket-outlets supplied as a separated circuit in accordance with Clause 1.7.4.5.

  AS/NZS 3000: 5.7.3.2
- The source supplying a separated circuit shall be an isolating transformer complying with AS/NZS 3108; or

  AS/NZS 3000: 1.7.4.5.2(a)
- The source supplying a separated circuit shall be a source of current, e.g. a motor-generator set or uninterruptible power supply, that is selected and installed so that the output is separated from the input by double insulation or equivalent.

  AS/NZS 3000: 1.7.4.5.2(b)

(h) Any ONE of:-

- Thermoplastic or elastomer insulated and sheathed copper cables enclosed in flexible non-metallic conduit
- Thermoplastic or elastomer insulated and sheathed copper cables enclosed in heavy duty rigid non-metallic conduit
- Thermoplastic or elastomer insulated and sheathed copper cables enclosed in medium or heavy galvanised tube.
- Mineral insulated copper sheathed cables protected with a serving of PVC or polyethylene
- Armoured thermoplastic or elastomer insulated and sheathed copper cable protected by a serving of PVC or polyethylene.

  AS/NZS 3004: 2.1.2.1

(i) A copy of the certificate must be retained for 3 years.

ER 40(4)

(j) Electrical warrants of fitness shall be valid for a period of 4 years from the date of issue.

ER: 97(4A)

(k) A fine not exceeding $10,000**.**

ER 51

(l) $I_{sc} = \frac{230}{0.45}$

$= 511$ Amps (approx)

GK

(m) The voltage drop shall not exceed 10% at any point on the installation when all live conductors are carrying the circuit operating current.

AS/NZS 3000: 7.7.7

(n) Where that connection or supply is solely for the purpose of carrying out any testing and inspection.

S114(4)

(o) Any TWO of:-

- Circuit-breakers incorporating short-circuit and overload releases.
- Circuit-breaker fuse combinations.
- Enclosed fuse links.

AS/NZS 3000: 2.4.2

(p) Not less than 50 MΩ

NZS 3019: 4.8.5

(q) Any TWO of:

- The person has died
- The person has been registered or granted a provisional licence by reason of any false or fraudulent representation or declaration made either orally or in writing;
- The person is not entitled to be registered or, as the case may be, granted a provisional licence;
- The person is no longer employed in the situation to which his or her registration applies;
- His or her name is transferred to any such register on becoming entitled to the transfer.

EA90: (a), (b), (c), (d), (e)

(r) Not less than $4mm^2$.

AS/NZS 3000: 5.5.1.2(c)

(s) A fine not exceeding $10,000:

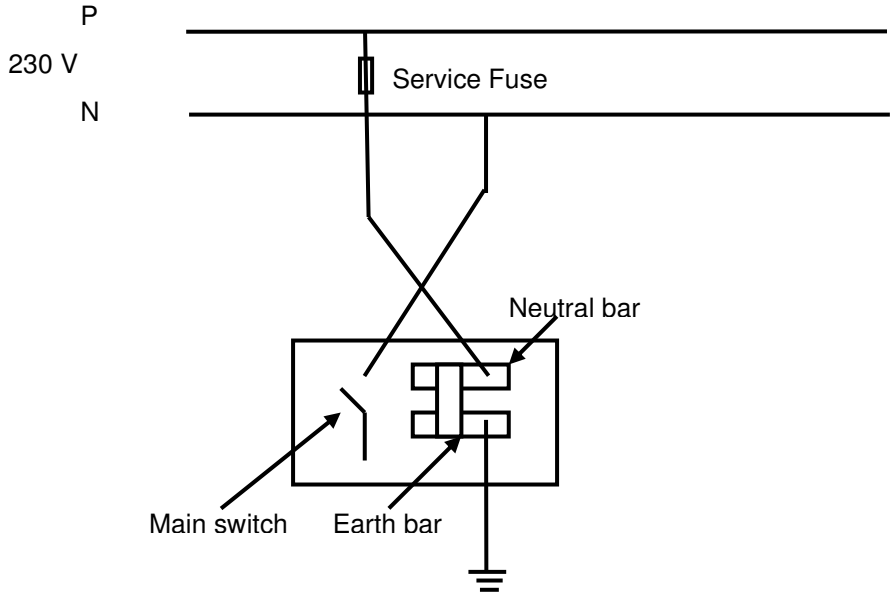
EA 20(d)

(t) 20.6 A or 4.75kW or 50% connected load

AS/NZS 3000: Table C1

**Question 2**

(a) (i)




Single-phase consumer

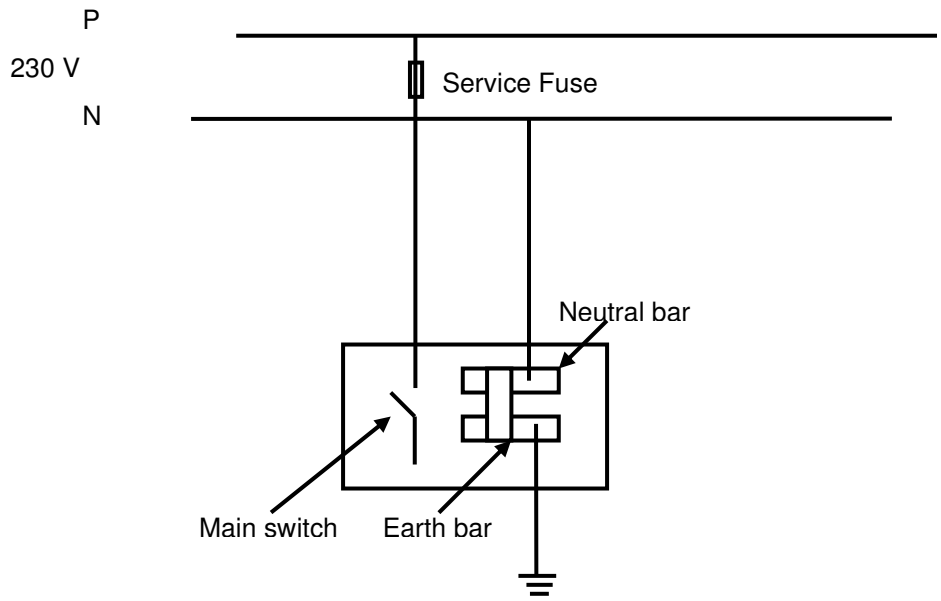
(2 marks)

(ii) Any TWO of:

- All associated metalwork could be alive at 230V to earth
- If the earth path is of high impedance the main fuse may not blow
- The mains protection may operate
- Shock or fire hazard
- Not isolate any appliances when the switch is operated

GK
(2 marks)

b (i)




Single-phase consumer

Diagram altered to show one of the testing versions in (ii)

(3 marks)

(ii) Check (stating what type of test instrument/voltage tester) between:-

V1 A remote earth and the exterior of the metallic meter box or

V2 A remote earth and the line side of the meter isolating switch with the switch off, or

V3 Remove Earth-Neutral link;

- test Ph – E, Ph – N - voltage should be present
- Test N – E - no voltage should be present

(Accept similar valid answers)

GK

(3 marks)

**Question 3**

(a) (i) Short circuit fault MVA rating of busbars

$$= \frac{\sqrt{3} \times VL \times \text{Short circuit current}}{10^6}$$

$$= \frac{1.732 \times 400 \times 14{,}420}{1{,}000{,}000}$$

$$= 10 \text{ MVA}$$

or

$$= \frac{\text{Transformer kVA}}{\%\ Z \times 1000}$$

$$= \frac{500 \times 1000}{0.05 \times 1000000}$$

$$= 10\text{MVA}$$

GK
(3 marks)

(ii) Regulation % $= \frac{V1 - V2}{V1} \times \frac{100}{1}$

$$= \frac{400 - 380}{400} \times \frac{100}{1}$$

$$= 5\%$$

The voltage drop with 721 amps or full load flowing = 5%
In short circuit conditions the voltage drop is 100%

PSC current $= \frac{100}{5} \times 721$

$= 14{,}420$ Amps

or

$Z = \frac{20 \text{ volts}}{721\text{A}}$

$= 0.0277392\ \Omega$

$I_{psc} = \frac{400}{.0277392}$

$= 14420$ Amps

GK
(3 marks)

(b) Power Factor is the factor that kVA is multiplied by to give true power or kW.

or

$Pf = \frac{\textbf{kW}}{\text{kVA}}$

or

Power factor is the ratio of the true power to Apparent Power

(1 mark)

(c) When motors have capacitors connected across their terminals the current from this point back to the switchboard is reduced. The overloads need to be set to this reduced value.

(3 marks)

**Question 4**

(a) (i) Any THREE of:

- Where effective protection for a conductor is afforded by a protective device located on the supply side of its origin or the point of reduction in current-carrying capacity.
- Where short-circuit protection for a conductor is provided in accordance with Clause 2.4.4.
- Where a conductor has no branch circuits or socket-outlets; and
- Where electrical equipment supplied by a conductor is not capable of causing overload currents.
- Installations for telecommunication, control, signalling, and the like.
- A conductor within a switchboard or busway that supplies one or more circuits that are individually protected against overload where —
  (i) short-circuit protection of the conductor is provided in accordance with Clause 2.4.4; and
  (ii) overload protection of the conductor is provided when the sum of the current ratings of the circuit protective devices is not more than the current-carrying capacity of the conductor.

AS/NZS 3000: 2.4.3.4
(3 marks)

(ii)
- Have an inverse time characteristic.
- Be rated, or in the case of circuit-breakers be set, to —
  (i) carry 125% of the full-load motor current continuously; and
  (ii) open the circuit in not less than 20 s at 600% of the full-load motor current.

AS/NZS 3000: 7.10.9.2
(3 marks)

(b)
- The current rating, utilisation category and breaking capacity are appropriate for the circuits they protect.

NZS 3019: 3.3(a)
(1 mark)

- Semi-enclosed rewireable fuses have not deteriorated due to arcing and have no exposed live parts when the removable part of the fuse fitting is fitted into the fuse base.

NZS 3019: 3.3(b)
(2 marks)

- Are clearly labelled showing the circuit type they protect.

NZS 3019: 3.3(b)
(1 mark)

**Question 5**

(a) Certificate of Verification

ER43A(a)
(1 mark)

(b)
- Ensure that the polarity and phase rotation of the supply is correct
- Ensure that the protection of the supply is correctly rated
- Verify the safety of revenue meters and associated load control fittings of mains
- Verify that there is a main earthing system, if the supply is from a MEN system.

ER43A(c),(d),(e),(f)
(4 marks)

(c) (i)
- Overhead lines and their entry points into buildings show no signs of insulation deterioration, rusting of anchorages or deterioration of line-connection boxes.

NZS 3019: 5.1(k)

- Safety distance clearances have not been compromised by the introduction of, or modification to, any structures or by increased ground level build-up.

NZS 3019: 5.1(l)
(2 marks)

(ii) The exposed portions of the earth electrode show no evidence of corrosion, damage or poor connection of the main earthing conductor that could adversely affect the earthing system.

NZS 3019: 5.1(b)
(1 mark)

(iii) Cables show no undue evidence of insulation or sheath deterioration

NZS 3019: 5.1(a)
(1 mark)

(iv) Covers of fixed-wired appliances are not broken or missing, giving access to live parts or basic insulation

NZS 3019: 5.1(j)
(1 mark)

**Question 6**

(a) $I_{(FL)} = \frac{P}{\sqrt{3} \times V}$

(½ mark)

$= \frac{70{,}000}{\sqrt{3} \times 400}$

(½ mark)

$= 101.04$ A

(1 mark)

(Total - 2 marks)

(b) From table 12, the minimum size cable is 25 $mm^2$. The cable is rated for 104 amps.

(1 mark)

The correction factor from table 27(1) is 1.12. The cable rating would need to be 104 x 1.12 = 116.48 A.

(1 mark)

Therefore from Table 12, the minimum size cable is 35 $mm^2$, based on cable rating

(1 mark)

(Total - 3 marks)

(c) From table 42, a 25 $mm^2$ cable, with an operating temperature of 75 $^0$C, has a 1.11 mV/A.m

(½ mark)

Voltage drop = mV/A.m x amps x metres

(½ mark)

$= 1.54 \times 10^{-3} \times 101.4 \times 78$

(1 mark)

= 12.18 V

(1 mark)

(Total - 3 marks)

(d) From regulation 53(2)(b) maximum voltage drop is 5%.

(½ mark)

400 x 5% = 20 volts – volt drop from (c) within permissible limits

(½ mark)

(Total - 1 mark)

(e) 35 $mm^2$

(1 mark)

**Question 7**

(a) (i) **I**

ER39 (1)
ER41 (1) c (iii)

(ii) **R**

ER17(1) (b) ER49 (6)a
ER39 (2)c ER 17(1)a iv
ER18

(iii) **I**

ER97(5) (a)
ECP29:6.1.5

(iv) **E**

ER39 (1)

(v) **R**

ER39 (2) (c)
ER18(1)b ER17(1) a iv
ER17(2)b S95
(5 marks)

(b)
- A qualified engineer
- A provisional licence holder
- A person working under an employer licence

ER39 (3) (b,c,d)
(3 marks)

(c)
- Work must be tested according to ER37 and ER39(4)

(2 marks)

- The person must be satisfied that the fittings are safe to operate or

ER37 (1)

- Test any fittings in respect of that work in accordance with AS/NZS 3000

ER37 (3)

or

- The fittings on which the work has been carried out are electrically safe
- The Inspection has been carried out in accordance with these regulations

ER41(6)
(2 marks)

**Question 8**

(a) (i) (1) 35 amps
(2) 35 amps

(2 marks)

(ii) Any TWO of:

- To ensure that the protective device will operate within 400ms
- To make the faulty circuit dead
- To ensure the protection of persons or property from step and touch potentials
- To protect persons from injury and electric shock
- To protect property from fire & heat damage

(2 marks)

(b) (i) 415 AC 80
HRC fuse that will safely clear 80kA fault current at 415V ac

(ii) 6kA
Circuit breaker, maximum fault level 6kA

(iii) Class Q1
HRC fuse with fusing factor > 1.25 but < 1.5

(iv) 63A
All protective devices with rated current of 63A (continuous load)

GK
(4 marks)

(c) $I_{PSSC} = \frac{V}{ZL}$

$= \frac{230V}{0.18\Omega}$

$= 1278A$

(2 marks)

**Question 9**

Inductive Load

Load Group A – Lighting
100% of Fluorescent lighting – 15 x 40
100% 35 x 75W lights

(½ mark)

0.6 +2.625 = 3.225 kW

(½ mark)

Load Group B – Socket Outlets
18 x 10A outlets
1 kW for the 1st and 0.75 kW/socket thereafter

(½ mark)

1 + (17 x 0.75) = 13.75 kW

(½ mark)

10 x 15A outlets
3.45 kW for the 1st and 75% full load/socket thereafter

(½ mark)

3.45 + (9 x 0.75 x 3.45) = 26.74 kW

(½ mark)

Load Group D – Motors
100% of motor. 9 kW
75% of motor 9 kW x 75%
50% of 2 chillers machine 10 kW x 50%

(½ mark)

9 + 6.75 + 5.0 = 20.75 kW

(½ mark)

Total inductive load = = **64.465 kW**

(1 mark)

Non-inductive load

Load Group C
100% 15 kW kiln
75% of 3 x 4kW instantaneous water heater

(½ mark)

15 +9 kW = **24.00 kW**

(½ mark)

Total inductive load = 64.465 kW
pf = 0.935
ǿ = $\cos^{-1}$ x 0.935

= 20.77 x 0.935
= 19.42

(½ mark)

Q = P tanø
= 64.465 x tan 19.42

(½ mark)

= 22.72 kVAr

(1 mark)

Total kW = 64.465 + 24 = **88.465 kW**

(½ mark)

Total kVA = $\sqrt{88.465^2 + 22.72^2}$
= $\sqrt{7826.06 + 512.62}$

(½ mark)

= **91.32 kVA**

(1 mark)

(Total - 10 marks)
AS/NZS 3000: Table C2