IT 13 – ELECTRICAL INSPECTOR EXAMINATION ANSWER SCHEDULE

Notes:1. (1 mark) means that the preceding statement/answer earns 1 mark.

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

3. Symbols and terms - alternatives

Power	W or P
Voltage	V or E or U
Phase	Active

4. Key to abbreviated terms:

EA	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

5. Those parts of an answer that are under-lined indicate the parts required to be covered by a candidate.

Question 1

(a) Inform the Secretary

EA 119 (3)(a)
(2 marks)

(b) Within 20 working days

EA 141
(2 marks)

(c) Any TWO of:

- Sight the certificate of verification
- 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(a), (c),(d),(e),(f)
(2 marks)

(d) (i) 1 year.
(ii) 5 years.

ER 46 (2)(e), (g)
(2 marks)

(e)
- The Secretary
- The owner or occupier of the property.

ER 50
(2 marks)

(f) (i) Yes. By failing to properly certify the work under regulation 39.
Regulation 51(b)

(1 mark)

(ii) A fine not exceeding $10,000.

ER 51(a)
(1 mark)

(g) None, Ref. AS/NZS 3000: Tables 3.6 and 3.7

(2 marks)

(h) Any TWO of:

- Must be multi-stranded insulated or sheathed
- Have not less than seven strands
- Have a cross-sectional area of not less than 1 mm^2

AS/NZS 3001: 3.4.1
(2 marks)

(i) $Isc = \frac{230}{0.38}$
$= 605.26$ A

GK
(2 marks)

(j) The power factor.

GK
(2 marks)

Question 2

(a) Regulation %

$$= \frac{V1 - V2}{V1} \times \frac{100}{1}$$

$$= \frac{400 - 387}{400} \times \frac{100}{1}$$

(½ mark)

$$= 3.25\%$$

(1 mark)

Fault MVA rating of busbars

$$= \frac{400000}{0.0325}$$

(½ mark)

$$= 12.31 \text{ MVA}$$

(1 mark)
GK

Prospective short circuit current

$$= \frac{MVA \times 10^6}{\sqrt{3} \times V_L}$$

(½ mark)

$$= \frac{1231000}{\sqrt{3} \times V_L}$$

(½ mark)

$$= 17.77 \text{ kA}$$

(1 mark)

(b) (i) The current reduces

(1 mark)

(ii) The overloads need to be set to running current values.

(1 mark)

(c) Any TWO of

- To ensure the protection can clear the fault current
- To ensure the protection operates within the required time.
- To ensure equipment can carry the prospective short circuit current without damage.

(2 marks)
GK

(d) $4mm^2$ Copper (Cu)

AS/NZS 3000: 5.8.3.2(a)
(1 mark)

Question 3

(a)
- Neutral current out of balance with the phase current.

(1 mark)

- A magnetic field is induced into the iron core.

(1 mark)

- The induced magnetic field induces a current in the sensing coil

(1 mark)

- The tripping coil is energised, isolating the circuit

(1 mark)

(b) (i) A Type A RCD

(½ mark)

(ii)
- It has a residual operating current of 30 mA or less.
- Provides protection against residual alternating current
- Provides protection against a residual pulsating direct current.

(1½ marks)
GK

(c) Any TWO of:

- Install an SRCD on the first socket outlet on the final subcircuit and protect all socket outlets downstream with the SRCD
- Install an SRCD on the first socket outlet in the kitchen and protect the other socket outlets from this outlet.
- Install SRCDs on each socket outlet

AS/NZS 3000: 2.5.3.4
GK
(4 marks)

Question 4

(a) Loading

Buried direct	Surface mounted (touching)	
From Table 12, column 14, rating of 10 mm^2 is 81A	From Table 12, column 4, rating of 16 mm^2 is 78A	(½ mark)
From Table 27(2) the derating factor is 1	From Tables 27(2) the derating factor is 0.94	(½ mark)
I_{max} = 81 x 1 = 81A	I_{max} = 78 x 0.94 = 73.32A	(½ mark)
Based on loading, a 10 mm^2 cable buried direct is suitable.	Based on loading, a 16 mm^2 cable surface mounted is suitable	(1 mark)

(b) Volt drop - Maximum volt drop permitted is:

Mains 400 x 0.02 = 8 volts (1 mark)

Sub-circuit 392 x 0.015 = 5.88 volts (1 mark)

Buried direct	Surface mounted (touching)	
From Table 42, V_d/A.m = 3.86 for 10 mm^2 cable	From Table 42, V_d/A.m = 2.43 for 16 mm^2 cable	(½ mark)
$Vd = \frac{V_d/A.m \times I \times L}{1000}$	$Vd = \frac{V_d/A.m \times I \times L}{1000}$	(½ mark)
$= \frac{3.86 \times 63.75 \times 45}{1000}$	$= \frac{2.43 \times 63.75 \times 45}{1000}$	(1 mark)
= 11.07 V	= 6.97 V	(1 mark)

(c) (i) From Table 42, Vd/A.m = 1.54 for 25 mm2 cable

$$\text{Volt drop} = \frac{\text{Vd/A.m} \times I \times L}{1000}$$

$$= \frac{1.54 \times 63.75 \times 45}{1000}$$

(½ mark)

$$= 4.42 \text{ V}$$

(1 mark)

Therefore, a 25 mm^2 cable is the minimum size of cable that meets the load and volt drop requirements.

(½ mark)

(ii) The cable can be surface mounted or buried direct.

(½ mark)

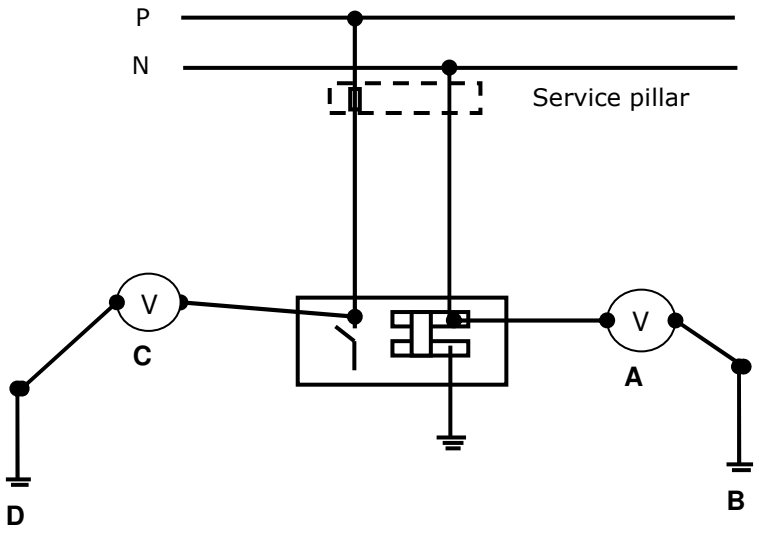
Question 5

(a) Any TWO of:

- Any metal not normally live could be live at up to 230V.
- If the earth fault path is of high impedance the main fuse may not blow
- The main switch does not isolate the incoming supply for the installation.
- A fire hazard could exist at any high resistance joint in the MEN system or if the neutral bar insulation is inadequate.
- An electrical worker interrupting the MEN circuit (including work on the earth bar, neutral bar or MEN link) is vulnerable.
- The main neutral is being switched.
- A standard isolation test will not identify that the neutral is connected to the incoming phase.

(2 marks)

(b) (i)



- A-B. Shows a test between neutral bar to a remote earth with a voltmeter.
- C-D. Shows a test between the supply side of main switch to a remote earth with a voltmeter

(2 marks)

(ii) Using the voltmeter, remote earth and trailing lead.

- Take a voltage test between the supply side of the main switch and the remote earth.

(1 mark)

- Take a voltage test between the earth/neutral bar and the remote earth.

(1 mark)

(iii) If no transposition has taken place:

- The reading at the main switch should be about 230 V

(½ mark)

- The reading at the neutral/earth bar should be about 0 V.

(½ mark)

(iv) If a transposition has taken place:

- The reading at the main switch should be about 0 V

(½ mark)

- The reading at the neutral/earth bar should be about 230 V.

(½ mark)

Note: The removal of the MEN link with the installation live is hazardous.

(c) Any TWO of:

- The main neutral in the house is open-circuited (or high resistance)
- The main distribution neutral is open-circuited (or high resistance)
- The earth at the distribution transformer is open-circuited (or high resistance)
- There is a voltage rise in the installation earthing system
- Spread earth pin on the socket outlet
- Faulty high resistance earth lead and an earth fault on the appliance ie washing machine

(or any other explanation that results in a high impedance neutral)

(2 marks)

Question 6

(a) (i) Must be installed and maintained so that they operate safely if used for their intended purpose.

ER 98 (1)
(1 mark)

(ii) Must have a rating that does not exceed the rating of the socket-outlet.

ER 98 (4)
(1 mark)

(b)
- Through a shore-mounted isolating transformers with the hull of metallic-hulled pleasure craft and conductive parts bonded together in accordance with Clause 4.3.1.
- Through an on-board isolating transformers with the hull of metallic-hulled pleasure craft and conductive parts bonded together in accordance with Clause 4.3.2.
- Connection without an isolating transformer in accordance with clause 4.3.3.

AS/NZS 3004: 1.8
(3 marks)

(c)
- Must comply with IEC 60309-2 (round pin)
- Rated at not less than 16 A
- Outlets rated at 32A or more shall be arranged to prevent the removal of the plug when energised.

AS/NZS 3004: 2.4.2.4.2
(3 marks)

(d) Any ONE of:

- MCBs
- Fully enclosed neutral links.

GK
(2 marks)

Question 7

(a) (i) Cables show no undue evidence of insulation or sheath deterioration.

NZS 3019: 5.1(a)
(1 mark)

(ii)
- Switchboard and electrical equipment have no conductor insulation deterioration.

NZS 3019: 5.1(f)
- MCBs, fuses and switches show no evidence of mechanical damage.

NZS 3019: 5.1(g)
- 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 base.

NZS 3019: 5.1(h)
- Switchboard equipment is correctly labelled.

NZS 3019: 5.1(i)
(4 marks)

(iii) 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)

(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)

Question 8

(a) (i) Any FOUR of:

(1) Touch voltage in flats may rise to dangerous levels
(2) High current flow in main earth conductor
(3) Rise in the supply voltage
(4) Unstable supply voltage
(5) Current flow through the MEN system of adjacent installations

GK
(2 marks)

(ii) ONE danger associated with (i)

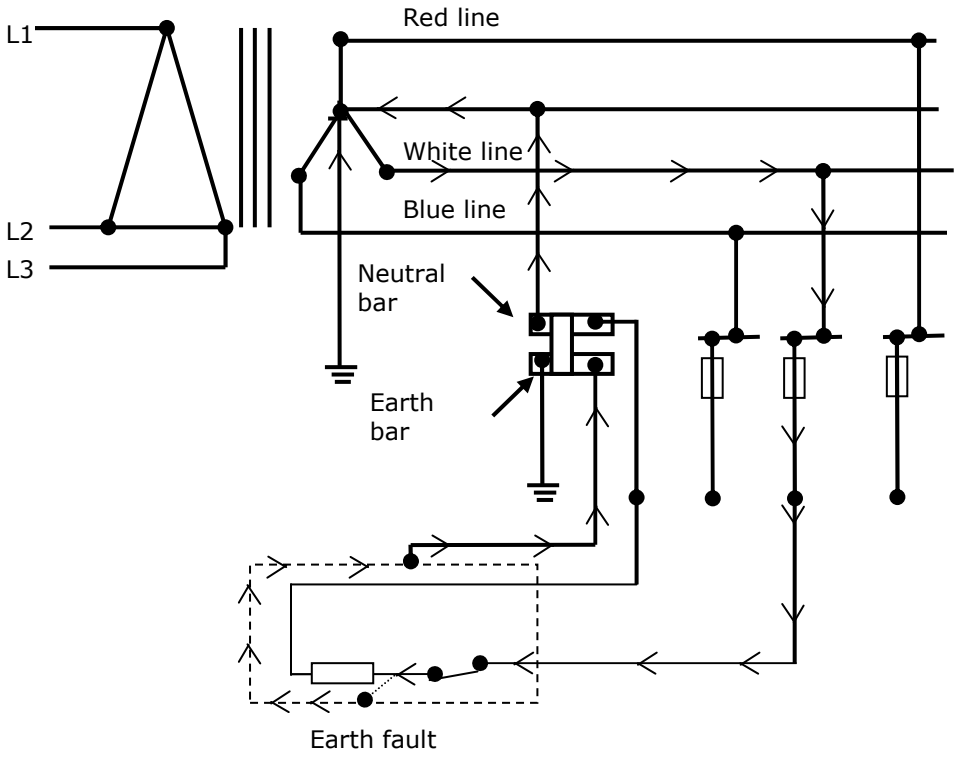
(1) • Shock hazard
(2) • Fire hazard
• Shock hazard
(3) • Equipment damage
• Fire hazard
• Shock hazard
(4) • Fire hazard
• Shock hazard
(5) • Fire hazard
• Shock hazard

GK
(2 marks)

(b) • Where the metal is not fully isolated from earth
• Where the metal is located within arms reach.

ER 84(2)
(2 marks)

(c) Figure B4.1 MEN system (simplified) showing fault (Ia) path



The path showing:

- From the fault through the protective earthing conductor, (PE), main earthing terminal bar and MEN link.

(1 mark)

- The neutral-return path, consisting of the neutral conductor, (N), between the main neutral terminal or bar and the neutral point at the transformer.

(1 mark)

- The path through the neutral point of the transformer and the transformer winding.

(1 mark)

- The active conductor as far as the point of the fault.

(1 mark)

AS/NZS 3000: Appendix B4.3

(4 marks)

Question 9

Living Units Calculation

Load Group	Calculation	Load (A)	
Group A			
Lighting	5 + (18 x 0.25)	9.50	(½ mark)
Group B			
Socket outlets	15 +(18 x 3.75)	82.50	(½ mark)
Group C			
Ovens	18 x 2.8	50.40	(1 mark)
Hobs	10 x 2.8	28.00	
Group E			
Instantaneous hot water	8 x 6	48.00	(½ mark)
Group F			
Storage water heaters	4 x 6	24.00	(½ mark)
Total		**242.40**	(1 mark)

Communal Areas Calculation

Load Group	Calculation	Load (A)	
Group H			
Lighting	(6000÷3) ÷ 230	8.7	(1 mark)
Group I			
Socket outlets	4 x 2=8A (highest phase, column 4)	8.00	(½ mark)
Group J(i)			
(i) Clothes dryer	20000 ÷3 = 6666.67W 6666.67÷230= 28.99A 28.99 ÷ 0.5 = 14.5A	14.5	(1 mark)
(ii) Hot water cylinders	(6000÷3) ÷ 230 = 8.7A 8.7 ÷ 0.5	4.35	
Group J(iii)			
Spa pools	17.39 x 0.75	17.39	(1 mark)
	17.39 x 0.25		
Group L			
Water pump		10.8	(½ mark)
Total		63.74	(1 mark)

Load of heaviest loaded phase = 306.14A

(1 mark)