VERSION 3 - ER 19 – Electrician Regulations 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) (i) A supervisor of electrical work

EA 109(b)
(1 mark)

(ii) Any ONE of:

- The work must be within limits set in the regulations.

EA 109(a)

- The work is not connected to a power supply.

EA 109(c)

- The work must be tested in accordance with the regulations

EA 109(d)

- The work must be tested by a supervisor of electrical work

EA 109(d)

- The work must be connected by a supervisor of electrical work.

EA 109(d)
(1 mark)

(b) Minimum voltage 216.2 V
Maximum voltage 243.8 V

ER 53(1)(b)
(2 marks)

(c) Any TWO of:

- Where socket-outlets are added to a final subcircuit, provided that the existing subcircuit is not RCD protected.
- Where socket-outlets are added to a final subcircuit, provided that the existing socket-outlets on the circuit are not RCD protected.
- Where points are added to a final subcircuit in a domestic or residential-type area of an electrical installation, provided that the existing final subcircuit is not RCD protected.
- Where socket-outlets or points that are not RCD protected are replaced.
- Where all points on a new final subcircuit are protected by an RCD installed at the first point of that new final subcircuit.

AS/NZS 3000: 2.5.3.4
(2 marks)

(d) An isolating switch located remote from the electrical equipment it controls shall be provided with means for securing it in the open position.

AS/NZS 3000 2.8.3.1
(2 marks)

(e) (i) Red and any colour except Black, Light Blue, Green or Green/Yellow.

AS/NZS 3000: 3.8.1
AS/NZS 3000: Table 3.5
(1 mark)

(ii) Equipotential bonding conductors shall be identified in the same manner as provided for an earthing conductor, i.e. Green or Green/Yellow combination.

AS/NZS 3000: 3.8.1
AS/NZS 3000: Table 3.5
(1 mark)

(f) Any TWO of:

- Provided with adequate mechanical protection to prevent damage.
  AS/NZS 3000: 3.9.4.6
- Provided with an earthed metallic armouring.
  AS/NZS 3000: 3.9.4.6
- Provided with an earthed metallic screen.
  AS/NZS 3000: 3.9.4.6
- Provided with an earthed metallic covering.
  AS/NZS 3000: 3.9.4.6
- Provided with an earthed metallic enclosure.
  AS/NZS 3000: 3.9.4.6
- Protected by an RCD with a maximum rated residual current of 30 mA.
  AS/NZS 3000: 3.9.4.6
- ***Armoured sheathed cables may be installed in concrete without protection of a wiring enclosure or restriction on the length or direction of the cable run.***
  AS/NZS 3000: 3.9.8.2.(a)
- ***Unarmoured sheathed cables may be installed in concrete provided that the cables are contained in an appropriate wiring enclosure and installed in accordance with Clauses 3.3.7 and 3.9.4.***
  AS/NZS 3000: 3.9.8.2(b)
- ***MIMS cables shall be protected by a suitable serving where they are buried in concrete.***
  AS/NZS 3000: 3.9.8.3.1(a)

(2 marks)

(g) (i) 4 mm^2 copper (Cu)
AS/NZS 3000: 5.5.1.2(c)
(1 mark)

(ii) 4 mm^2 copper (Cu)
AS/NZS 3000: 5.8.3.2(a)
(1 mark)

(h) Precautions shall be taken to ensure the safety of persons and to avoid damage to property and the electrical installation equipment during inspection and testing.
AS/NZS 3000: 6.1
(2 marks)

(i)
- Where equipment is specially designed for operation with a voltage drop greater than 10%
- Where steady state conditions are not applicable such as during motor starting, solenoid closing or other similar applications where high transient currents may be expected.

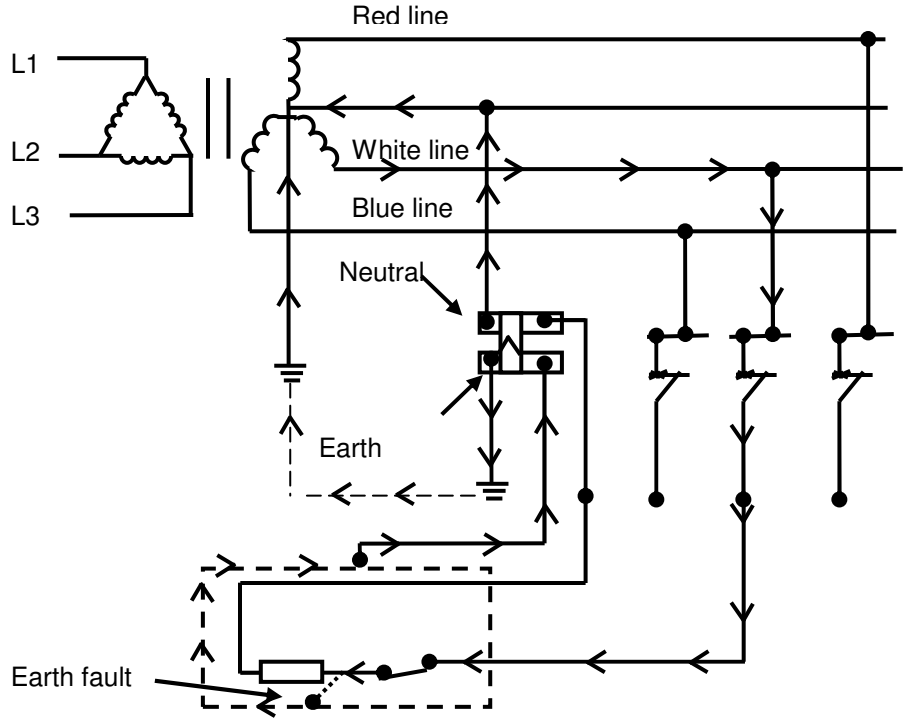
AS/NZS 3000 7:7.7
(2 marks)

(j) (i) 4 metres
ECP 34: 5.2.1
(1 mark)

(ii) 1 metre
ECP 34: Table 6
(1 mark)

Question 2

(a)



(i)
- MEN system
  - Star point earthed. (½ mark)
  - The consumer's main earth connected to the earth bar. (½ mark)
  - MEN link between earth and neutral bars. (½ mark)
  - Main neutral connected to consumer's neutral bar. (½ mark)
- Final sub-circuit MCBs in phases or actives (1 mark)
- Correct distribution system (1 mark)

(ii) Accurate earth fault loop (1 mark)

Note: The path between the star-point and the installation earth need not be shown. The path via the neutral must be shown.

AS/NZS 3000: B4.3

(b) Any ONE of:

- The fault-loop impedance is low enough to allow sufficient current to flow in the fault loop to cause the protective device to operate within the specified disconnection time.

  AS/NZS 3000: B4.2
- In the event of a fault between a live part and an exposed conductive part which could give rise to a prospective touch voltage exceeding 50 V a.c. or 120 V ripple-free d.c., a protective device shall automatically disconnect the supply to the circuit or electrical equipment concerned.

  AS/NZS 3000: 1.7.4.3.2
- The characteristics of protective devices and the earthing system impedance shall be such that, if a fault of negligible impedance occurs anywhere in the electrical installation between an active conductor and a protective earthing conductor or exposed conductive part, automatic disconnection of the supply will occur within the specified time.

  AS/NZS 3000: 1.7.4.3.3
- The maximum disconnection time for 230/240 V supply voltage shall not exceed the following:
  - 0.4 s for final subcircuits
  - 5 s for other circuits including submains and final subcircuits

  AS/NZS 3000: 1.7.4.3.4
- The resistance from any point on the electrical installation required to be earthed to the point where the main earthing conductor is connected to the neutral conductor of the supply system shall be low enough to permit the passage of current necessary to operate the circuit protective devices.

  AS/NZS 3000: 5.343.

(1 mark)

(c) (i) 0.4 seconds

AS/NZS 3000: 1.7.4.3.4
(1 mark)

(ii) 1.53Ω

AS/NZS 3000: Table B4.1
(1 mark)

(d) Any ONE of:

- Supplementary bonding of extraneous conductive parts

  AS/NZS 3000: 1.7.4.3.5
- Increase the size of the final subcircuit conductor
- Increase the size of the final subcircuit protective earthing conductor

(1 mark)

(e) 50 V a.c.
120 V ripple-free d.c.

AS/NZS 3000: 1.7.4.3.2
(1 mark)

Question 3

(a) Load growth = 90 + 20% = 108 amps

(½ mark)

From Table 12 the rating for 16 mm^2 is 106 amps.

(½ mark)

From Table 27(2), the re-rating factor for 10^0C is1.04

(½ mark)

The maximum load can be carried by the 16 mm^2 cable is:

= 106 x 1.04
= 110.25A

(1 mark)

The 16 mm^2 will satisfy the load requirements.

(1 mark)

(b) Maximum volt drop permitted = 12 V (400 x 3%)

(1 mark)

From Table 42 the mV/A.m for 16 mm^2 is 2.43

(½ mark)

$$V_d = \frac{mV \times A \times m}{1000}$$

(½ mark)

$$= \frac{2.43 \times 108 \times 70}{1000}$$

(½ mark)

= 18.37V

(1 mark)

(c) ***From (a), the 16 mm^2 cable meets the load requirements***

From Table 42 mV/A.m for 25 mm^2 is 1.54

(½ mark)

$$V_d = \frac{mV \times A \times m}{1000}$$

(½ mark)

$$= \frac{1.54 \times 108 \times 70}{1000}$$

(½ mark)

= 11.64 V

(1 mark)

A 25 mm^2 cable is the minimum size that satisfies both the load and voltage drop requirements.

(½ mark)

Question 4

(a) (i) Zone 2

AS/NZS 3000: Figure 7.1A(c)
(1 mark)

(ii) IPX4

AS/NZS 3000: 7.1.4.1 (b)
(1 mark)

(b) (i) Zone 3

AS/NZS 3000: Figure 7.1A(c)
(1 mark)

(ii) None required

AS/NZS 3000: 7.1.4.1 (c)
(1 mark)

(c) (i) Outside of Zone 2 of the basin

AS/NZS 3000: Figure 7.1C(a)

or
Zone 3 of the shower bath

AS/NZS 3000: Figure 7.1A(c)
(1 mark)

(ii) None required

AS/NZS 3000: 7.1.4.1 (c)
(1 mark)

(iii) Any ONE of:

- Protected by a RCD with a maximum rated residual current of 30 mA
- Supplied individually as a separated circuit in accordance with Clause 1.7.4.5
- Supplied as a SELV or PELV system in accordance with Clause 7.7.

AS/NZS 3000: 7.1.4.2 (c)
(1 mark)

(d) (i) Zone 3 of the shower bath

AS/NZS 3000: Figure 7.1A(c)
(1 mark)

(ii) None required

AS/NZS 3000: 7.1.4.1 (c)
(1 mark)

(e) None required

AS/NZS 3000: 7.1.4.1 (c)
(1 mark)

Question 5

(a) (i)
- Continuity of the earthing system (earth resistance of the main earthing conductor, protective earthing conductors and bonding conductors).
- Insulation resistance.
- Polarity.
- Correct circuit connections.
- Operation of residual current devices (RCDs).

AS/NZS 3000: 6.3.3.1
(2½ marks)

(ii) Any FIVE of:

- Location, e.g. access and egress.
- Protective devices, e.g. overload and residual current rating, fault current rating.
- Isolating devices, e.g. main switches.
- Connecting devices, e.g. neutral bars, earth bars and active links.
- Connection and fixing of wiring and switchgear.
- Identification and labelling of electrical equipment.
- Protection against external influences.

AS/NZS 3000: 6.2.2(c)
(2½ marks)

(b) Any FOUR of:

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

ER 43A
(4 marks)

(c) The person supplying the electricity

ER 44
(1 mark)

Question 6

(a) Any THREE of:

- The value of earthing resistance is in accordance with the protective and functional requirements of the electrical installation and expected to be continuously effective.
  AS/NZS 3000: 5.2.5
- Earth-fault currents and earth-leakage currents can be carried without danger, particularly from thermal, thermo-mechanical and electromechanical stresses; and
  AS/NZS 3000: 5.2.5
- It is adequately robust or has additional mechanical protection appropriate to the assessed conditions of external influence in accordance with Clause 3.3.
  AS/NZS 3000: 5.2.5
- Earth resistance tests are necessary to ensure that the earthing system has been installed in a manner that will cause circuit protective devices to operate if there is a fault between live parts, other than the neutral, and the mass of earth.
  AS/NZS 3000: 6.3.3.2.1
- An effective earthing system will ensure that electrical equipment parts that are earthed do not reach dangerous voltages when such faults occur.
  AS/NZS 3000: 6.3.3.2.1

(3 marks)

(b) The earthing conductor shall be determined in relation to the cross-sectional area of the largest active conductor to be protected.

AS/NZS 3000: 5.5.1.2(a)(i)
(2 marks)

(c)
- Fixing by means of clamps, clips, saddles, clouts or similar devices, which shall not pass between the strands of the conductor or damage the conductor.
- Guarding by metallic barriers or other suitable robust material.
- Installing in a wiring enclosure in accordance with Clause 3.10.2.

AS/NZS 3000: 5.5.4.2
(3 marks)

(d)
- Not used for the earthing of electrical equipment which is supplied from another switchboard; or
- Not used for the provision of earthing facilities for another distribution board.

AS/NZS 3000: 5.6.7.3
(2 marks)

Question 7

(a) Any TWO of:

- An earth sheath return (ESR) system; or
- Consumers mains; or
- A submain where the neutral is used for earthing of an electrical installation in an outbuilding in accordance with Clause 3.5.2(c); or
- A submain or final subcircuit in which the neutral conductor is solidly earthed.

AS/NZS 3000: 2.8.2.2
(2 marks)

(b) Any FOUR of:

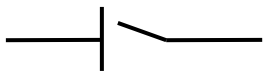
- They shall be capable of interrupting the full-load current of the relevant part of the electrical installation
- They need not interrupt all active conductors.
- Interruption of a control circuit of a drive or the like may occur only where supplementary safeguards, such as mechanical restrainers are provided.
- Interruption of a control circuit of a drive or the like may occur only where direct interruption of the main supply is achieved by another means.
- They require manual operation.
- The 'OFF' position shall be clearly and reliably indicated.
- Designed or installed so as to prevent unintentional closure.

AS/NZS 3000: 2.8.4.2
(4 marks)

(c) Any FOUR of:

From AS/NZS 3000: 2.8.3.2

- Shall be capable of withstanding an impulse voltage likely to occur at the point of installation, or shall have an appropriate contact gap.
- Shall not be able to falsely indicate that the contacts are open.
  or
  Have this symbol -



- A semiconductor (solid state) device shall not be used for isolation purposes.
- The position shall be clearly and reliably indicated.
- Shall be designed and installed so as to prevent unintentional closure.
- Shall disconnect all active conductors of the relevant supply.
- If not capable of interrupting normal load current, suitable measures shall be taken to prevent it operating while carrying current.

From AS/NZS 3000: 2.8.3.1

- ***In a.c. systems, a switching device shall interrupt all active conductors.***

- ***In d.c. systems, a switching device shall interrupt all poles, except in the case of a pole connected either to earth or to a protective earthing conductor.***
- ***An isolating switch located remote from the electrical equipment it controls shall be provided with means for securing it in the open position.***

(4 marks)

Question 8

(a) The physical distribution and intended usage of electrical equipment in the electrical installation and the manner in which the present requirements might vary.

AS/NZS 3000: 1.8.3.1
(2 marks)

(b)

Equipment	Load Group	Calculation	Load (Amps)	
25 - lighting points	A(i)	3 + 2	5	(½ mark)
10 metres of lighting track	A(i)	10 x 2 points Or 0.5A ./ metre	2 – (1) Or 5 – (2)	(½ mark)
10 – 150W outside lights	A(ii)	(1500÷230) x 0.75	4.89	(½ mark)
18 - double socket outlets (10 A)	B(i)	18 x 2 points	15	(½ mark)
10 - single socket outlets (10 A)	B(i)		5	(½ mark)
1 - 3 kW controlled water heater	F	3000 ÷ 230	13.04	(½ mark)
1 - electric range (6 kW)	C	(6000÷230) x 0.5	13.04	(½ mark)
2 – 10A space heaters	D	0 Or 75% of load	0 – (3) Or 15A – (4)	(½ mark)
1 – 4 kW air conditioner unit	D	(4000÷230) x 0.75	13.04	(½ mark)

Total maximum demand:

- (1) and (3) 71.01 A
- (1) and (4) 86.01 A
- (2) and (3) 74.01 A
- (2) and (4) 91.01 A

(½ mark)
AS/NZS 3000: Table C1

(c)
- By assessment

AS/NZS 3000: 1.8.3.3

- By measurement

AS/NZS 3000: 1.8.3.4

- By limitation

AS/NZS 3000: 1.8.3.5

Question 9

(a) (i) 1 Megohm

(1 mark)

(ii) Where appliances containing sheathed heating elements form part of the installation

(1 mark)

(iii) 10,000 ohms.

(1 mark)

AS/NZS 3000: 6.3.3.3.2

(b) (i) To ensure that the insulation resistance between all live conductors and earth or, as the case may be, all live parts and earth is adequate to ensure the integrity of the insulation.

(2 marks)

(ii)
- To prevent electric shock hazards from inadvertent contact
- To prevent fire hazards from short-circuits
- To prevent equipment damage.

(3 marks)

AS/NZS 3000: 6.3.3.3.1

(c) (i) 500V d.c.

(1 mark)

(ii) The insulation resistance tester used shall be able to maintain its terminal voltage within +20%, -10% of the nominal open-circuit terminal voltage, when measuring a resistance of 1 ṂΩ the 500 V range.

(1 mark)

AS/NZS 3000: 6.3.3.3.1