

ER 23 – 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) • The operation of electrical installations
• The rewinding of armatures

ER 17
(2 marks)

- (b) Any TWO of:

- Repair/replacement of faulty/damaged conductor
- Replacement of fuse carrier with appropriate circuit breaker
- Replacement of a fitting in accordance with ER 39(2)(c)
- Installation of revenue metering/associated load control equipment of mains.

ER 39(2)
(2 marks)

(c) Any TWO of:

- An earth electrode.
- An earthing lead.
- An earth continuity busbar for the connection of earth continuity conductors within the installation.
- Where the installation is operating at standard low voltage, bonding of any available metallic water supply pipes to the earth continuity busbar.
- A removable link between the earth continuity busbar and the supply neutral.

ER 86
(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) • The earth conductor shall be green or green/yellow.

- The phase conductors can be any colour except green/yellow, green, black or light blue.

AS/NZS 3000: 3.8.1 and Table 3.5
(2 marks)

(f) Protected by an RCD with a maximum rated residual current of 30 mA.

AS/NZS 3000: 3.9.4.6
(2 marks)

(g) (1) Identified by an orange marker tape positioned above the cable.

AS/NZS 3000: 3.11.3.4

(2) Marker signs where the cable enters or leaves the building

AS/NZS 3000 3.11.3.5
(2 marks)

(h) Any TWO of:

- Protective earthing conductors that are part of other circuits.
- Other live parts
- Other circuits.
- Earth
- Earthing conductors or exposed conductive parts of another system
- Extraneous conductive parts, except that where electrical equipment is inherently required to be connected to extraneous conductive parts it is ensured that those parts cannot attain a voltage exceeding that of the SELV circuit.

AS/NZS 3000: 7.7.5
(3 marks)

- (i) (i) 16 amps (1 mark)
(ii) 20 amps (1 mark)

AS/NZS 3000 Table B4.1.

- (j) (1) Lines are not accessible without the use of a climbing device. ECP 34: 7.3.1

- (2) No climbing step shall be placed at a height of less than 3 metres above ground level. ECP 34: 7.3.2
(2 marks)

Question 2

- (a) • Additional lights in a hallway supplied from existing final subcircuits not protected by an RCD – AS/NZS 3000: 2.5.3.4(c)
- A new 30A socket outlet for a new range in a different position from the existing range (the existing range and final subcircuit is to be removed). AS/NZS 3000: 2.5.3.1

(2 marks)

- (b) (i) • The new final subcircuit comprising 4 socket outlets in a new bedroom - AS/NZS 3000 :2.5.3.2(b)
- The new socket outlet final subcircuit in Zone 2 in a bathroom – AS/NZS 3000: 7.2.4.3(d)(iii)

(2 marks)

- (ii) • Install an SRCD on the first socket outlet supplying the bathroom circuit and protect all socket outlets downstream from the first with the SRCD
- Install an SRCD on the first socket outlet supplying the new bedroom circuit and protect all socket outlets downstream from the first with the SRCD

GK
(4 marks)

- (c) • Neutral current equals the phase current. There is no out of balance current so no magnetic field is induced into the iron core.

(1 mark)

- Because there is no induced magnetic field there is no induced current in the tripping coil

(1 mark)
GK

Question 3

- (a) • Insulation
• Barriers
• Obstacles
• Placing out of reach

AS/NZS 3000: 1.7.3.2
(4 marks)

- (b) • A key or tool is required.
• An interlocking device is fitted
• An intermediate barrier is provided

AS/NZS 3000: 1.7.3.4.3
(3 marks)

- (c) (i) A degree of protection in accordance with AS 1939 or AS 60529.

AS/NZS 3000 1.4.58
(1 mark)

- (ii) Protection against solid objects and of persons against access to live parts.

AS/NZS 3000 1.4.58
(1 mark)

- (iii) Protection against entry of water with harmful effects.

AS/NZS 3000 1.4.58
(1 mark)

Question 4

- (a) (i) In Zone 2 of the bath
AS/NZS 3000: Figure 7.1A(c)
(1 mark)
- (ii) IPX4
AS/NZS 3000: 7.1.4.1 (b)
(1 mark)
- (b) (i) In Zone 2 of the bath
AS/NZS 3000: Figure 7.1A(c)
(1 mark)
- In Zone 3 of the shower
AS/NZS 3000: Figure 7.1A(d)
(1 mark)
- (ii) IPX4
AS/NZS 3000: 7.1.4.1 (b)
(1 mark)
- (c) (i) Zone 2 of the basin
AS/NZS 3000: Figure 7.1C(a)
(1 mark)
- Zone 3 of the shower bath
AS/NZS 3000: Figure 7.1A(c)
(1 mark)
- (ii) IPX4
AS/NZS 3000: 7.1.4.1 (b)
(1 mark)
- (iii) The socket outlet must be:
- Protected by a RCD with a maximum rated residual current of 30 mA
 - Enclosed in a cupboard provided that the enclosure is maintained during the normal operation of the connected equipment.
- AS/NZS 3000: 7.1.4.2 (b)(ii)(iii)
(2 marks)

Question 5

(a) The total load is $21\text{A} + 20\% = 25.2\text{A}$ (1/2 mark)

From Table 9 the current rating for 2.5 mm^2 is 30 amps (column 4) (1/2 mark)

From Table 27(1) the derating factor is 0.94 (1/2 mark)

$$\begin{aligned}\text{Current rating} &= 30 \times 0.94 \\ &= 28.2\text{ A}\end{aligned}$$
(1/2 mark)

A 2.5 mm^2 cable will meet the load requirements (1 mark)

(b) The maximum voltage drop is $230\text{V} \times 2.5\% = 5.75$ (1/2 mark)

From Table 42 for a 2.5 mm^2 cable – $\text{mV/A.m} = 15.6 \times 1.155 = 18.01$ (1/2 mark)

$$\text{Voltage drop} = \frac{\text{mV/A.m} \times \text{amps} \times \text{metres}}{1000}$$
(1/2 mark)

$$= \frac{18.01 \times 25.2 \times 20}{1000}$$
(1/2 mark)

$$= 9.1\text{V}$$
(1 mark)

From Table 42 for a 4 mm^2 cable – $\text{mV/A.m} = 9.71 \times 1.155 = 11.22$ (1/2 mark)

$$\text{Voltage drop} = \frac{\text{mV/A.m} \times \text{amps} \times \text{metres}}{1000}$$
(1/2 mark)

$$= \frac{11.22 \times 25.2 \times 20}{1000}$$
(1 mark)

$$= 5.65\text{V}$$
(1 mark)

A 4 mm^2 cable will meet the volt drop requirements (1 mark)

(c) A 4 mm^2 cable will meet the customer's requirements (1 mark)

Question 6

(a) Any FOUR of:

- Continuity of earthing system
- Polarity
- Insulation resistance
- Visual inspection
- Correct circuit connections
- Operation of RCDs.

AS/NZS 3000 6.3.3.1
(2 marks)

- (b)
- AS/NZS 3000 requires a minimum test of 1 Mohm for the installation or parts of the installation.
 - The value may be obtained with appliances disconnected.
 - The 1 Mohm may be reduced to 10,000 ohms for sheathed heating elements

AS/NZS 3000 6.3.3.3.2
AS/NZS 3000 1.11.2.3(a)
(3 marks)

(c) Any FIVE of:

- Isolation and switching devices for protection against injury from mechanical movement devices and motors.
- Isolation and switching devices for protection against thermal effects e.g. motors, room heaters, water heaters.
- Switching devices for particular electrical equipment, e.g. socket outlets, cooking appliances.
- Particular installation conditions, e.g. locations affected by water, explosive atmospheres, extra-low voltage, high voltage.
- Compliance with required Standard.
- Connection, support and fixing.
- Protection against external influences.

AS/NZS 3000: 6.2.2(e)
(5 marks)

Question 7

- (a) It shall have a main switchboard for the location of the main switch or switches
AS/NZS 3000: 2.9.1
(1 mark)
- (b) (i)
 - Be installed in an area set aside for the purpose.
 - Be separated from the other sections of the cupboard; and
 - Access cannot be obstructed by the structure or contents of the cupboard.AS/NZS 3000: 2.9.8.4(c)
(3 marks)
- (ii)
 - It must be installed at least 3 metres from the centre of the shower rose.
 - It cannot be above or below the shower rose.AS/NZS 3000: 2.9.8.4(d)
(2 marks)
- (iii)
 - It must be installed outside any classified Zone
 - It cannot be above or below a classified ZoneAS/NZS 3000: 2.9.8.4(e)
(2 marks)
- (c) Any TWO of:
- Shall not be located within 1.2 m of the ground, floor or platform.
AS/NZS 3000: 2.9.8.4(a)
 - Shall not be installed above open water containers or fixed or stationary cooking appliances.
AS/NZS 3000: 2.9.8.4(b)
 - Shall not be installed within a sauna.
AS/NZS 3000: 2.9.8.4(e)
 - Shall not be installed within a fire-isolated stairway, passageway or ramp.
AS/NZS 3000: 2.9.8.4(f)
 - Shall not be installed within a cupboard containing a fire-hose reel.
AS/NZS 3000: 2.9.8.4(g)
(2 marks)

Question 8

- (a) • 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)

- (b) • 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)

- (c) 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)

- (d) (i) • Earth electrode
- Earthing lead
- Earth continuity busbar
- Metallic water supply pipes bonded to the earth continuity busbar.
- A removeable link between the earth continuity busbar and the supply neutral

ER 86(1)
(2½ marks)

- (ii) Earthing conductor – do not disconnect

ER 86(5)(b)
(½ mark)

Question 9

Load Group	Calculation	Load (A)	
<u>Group A</u>			
Lighting - 20 pts	1 x 3	3	(1 mark)
Lighting - 12 pts	1 x 2	2	(1 mark)
3 kW of outdoor lighting @ 75%	$(3000 \div 230) \times 0.75$	9.78	(1½ marks)
<u>Group B</u>			
10 double	10 x 1	10	(1 mark)
12 single	5 x 1	5	(1 mark)
<u>Group C</u>			
12 kW range	$(12000 \div 230) \times 0.5$	26.08	(1½ marks)
<u>Group G</u>			
6kw Spa Pool	$(6000 \div 230) \times 0.75$	19.56	(1½ marks)
<u>Group I</u>			
10A permanent connection unit	0	0	(½ mark)
Total maximum demand		75.4A	(1 mark)