

ER 27 – 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) 30 June in the year it is stated to expire
EA 100 (2)(b)
(1 mark)
- (ii) The Registrar
EA 96(1) or 100(4)
- (b) Short-circuit and earth fault protection.
ER 62 (3)
(2 marks)

(c) Any TWO of:

- Fittings that in normal use, or in the event of abnormal operation, function unsafely so as to cause danger to persons, property, or animals.
ER76A (1)(a)
- Fittings that have inadequate protection against direct contact or indirect contact.
ER76A (1)(b)
- Fittings that have unearthed conductive parts separated from live parts only by basic insulation.
ER76A (1)(c)
- Fittings that are installed in such a way that any designed cooling conditions are impaired.
ER87(1)(d)
- Fittings which cause or are subject to high temperatures or electric arcs are placed in such a position or are unguarded so as to create a risk of ignition of flammable materials or of injury to persons or damage to property.
ER87(1)(e)
(2 marks)

(d) Any TWO of:

- Automatic disconnection of the supply in accordance with clause 1.7.4.3
- The use of Class II equipment of equivalent insulation, in accordance with clause 1.7.4.4
- Electrical separation in accordance with clause 1.7.4.5
AS/NZS 3000: 1.7.4.2
- Protection may be provided by the use of separated extra-low voltage (SELV)
- Protection may be provided by the use of protected extra-low voltage (PELV)
AS/NZS 3000: 1.7.2
(2 marks)

(e) • Socket-outlet final subcircuits:
• Lighting final subcircuits.

AS/NZS 3000: 2.5.3.1
(2 marks)

(f) The cords must be of a heavy duty type or a non-heavy duty type installed in a suitable wiring enclosure.

AS/NZS 3000: 3.9.8.4
(2 marks)

(g) (i) 6 times the cable diameter

(1 mark)

(ii) 12 times the cable diameter

(1 mark)

AS/NZS 3000: 3.9.7

(h) (i) • 10mm² - copper

AS/NZS 3000: Table 5.1

or

16mm² - aluminium

AS/NZS 3000: 5.5.6

(1 mark)

(ii) • 4 mm² - Copper

AS/NZS 3000: 5.8.3.2(a)

or

4 mm² - Solid aluminium

AS/NZS 3000: 5.5.6

(1 mark)

(i) • 4 mm²
• Copper (Cu)

AS/NZS 3000: 5.5.1.2(c)
(2 marks)

(j) Any ONE of:

- To minimize the risk associated with the occurrence of voltage differences between exposed conductive parts of electrical equipment and extraneous conductive parts.

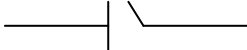
AS/NZS 3000: 5.8.1

- To bring exposed conductive parts or extraneous parts to the same or approximately the same potential.

AS/NZS 3000: 1.4.49
(2 marks)

Question 2

(a) (i) Any THREE of:

- Each heater shall have an individual functional switch
AS/NZS 3000: 4.3.5.1
- Each heater shall have an an individual isolating switch
AS/NZS 3000: 4.3.5.1
- The group of heaters shall be controlled by a functional switch
AS/NZS 3000: 4.3.5.1
- The group of heaters shall have a common isolating switch
AS/NZS 3000: 4.3.5.1
- In a.c. systems, a switching device shall interrupt all active conductors.
AS/NZS 3000: 2.8.3.2
- A group of circuits may be isolated by a common switch provided the service conditions allow this, and provided the appropriate safety measures are maintained.
AS/NZS 3000: 2.8.3.2
- 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: 2.8.3.2
- An isolation device shall be capable of withstanding an impulse voltage likely to occur at the point of installation, or shall have an appropriate contact gap.
AS/NZS 3000: 2.8.3.2
- An isolation device shall not be able to falsely indicate that the contacts are open.
AS/NZS 3000: 2.8.3.2
- Shall be capable of withstanding an impulse voltage
or
Shall have an appropriate contact gap
AS/NZS 3000: 2.8.3.2
- Shall not be able to falsely indicate that the contacts are open.
or
Shall be marked with the following symbol:

AS/NZS 3000: 2.8.3.2
- The isolating position shall be clearly and reliably indicated.
AS/NZS 3000: 2.8.3.2
- Shall be designed so as to prevent unintentional closure.
AS/NZS 3000: 2.8.3.2
- Shall disconnect all active conductors of the relevant supply
AS/NZS 3000: 2.8.3.2

- Functional switching may be used where switching of electrical equipment or part of an electrical installation is required for operational reasons that do not involve safety.
AS/NZS 3000: 2.8.6.1
- A functional switching device shall be provided for each part of a circuit that may be required to be controlled independently of other parts of the electrical installation.
AS/NZS 3000: 2.8.6.1
- A single functional switching device may control several items of apparatus intended to operate simultaneously.
AS/NZS 3000: 2.8.6.1
- A functional switch shall be suitable for the most onerous of the duties that they might be required to perform.
AS/NZS 3000: 2.8.6.2
- A functional switch need not switch all active conductors of a circuit.
AS/NZS 3000: 2.8.6.2
- Where they can change-over the supply to alternative sources, a functional switch shall switch all active or live conductors as appropriate.
AS/NZS 3000: 2.8.6.2
- A functional switch shall only be capable of paralleling the source, if the electrical installation is specifically designed for this condition.
AS/NZS 3000: 2.8.6.2

(ii) Any TWO of:

- Immediately adjacent to an entrance to the room
(1 mark)
 - Incorporated in a temperature control device provided that it has a definite 'off' position.
(1 mark)
 - Installed on the switchboard at which final subcircuit originates.
(1 mark)
- AS/NZS 3000: 4.3.5.3

(b) (i) Any THREE of:

- Shall be capable of withstanding an impulse voltage
or
Shall have an appropriate contact gap
- Shall not be able to falsely indicate that the contacts are open.
or
Shall be marked with the following symbol:



- The isolating position shall be clearly and reliably indicated.
- Shall be designed so as to prevent unintentional closure.
- Shall disconnect all active conductors of the relevant supply

AS/NZS 3000: 2.8.3.2
(3 marks)

(ii) Any TWO of:

- Shall be suitable for the most onerous of the duties that they might be required to perform.
- Need not switch all active conductors of a circuit.
- Where they can change-over the supply to alternative sources, shall switch all active or live conductors as appropriate.
- Shall only be capable of paralleling the source, if the electrical installation is specifically designed for this condition.

AS/NZS 3000: 2.8.6.2
(3 marks)

Question 3

- (a) (i) (1) No — Because the trench:
- Is not deep enough to require permission, or
 - Is further than 2.2 metres away
- ECP 34: 2.2.1(b)
ECP 34: Figure 1
(1 mark)
- (2) 750 mm
- ECP 34: 2.2.1(b)
(1 mark)
- (3) Unstable batter is created
- ECP 34: 2.2.1(c)
(1 mark)
- (4) No material shall be deposited under or near an overhead electric line so as to reduce the conductor distance to ground to less than those distances required by Table 4 of this Code.
- ECP 34: 4.3.1
(1 mark)
- (ii) (1) Identified by an orange marker tape positioned above the cable.
- AS/NZS 3000: 3.11.3.4
(1 mark)
- (2) 0.5 m
- AS/NZS 3000: Table 3.7
(1 mark)
- (3) Shall be laid on a bed of not less than 50 mm of sand or friable soil free of sharp stone and covered by not less than 50 mm of the same material.
- AS/NZS 3000: 3.11.3.2
(2 marks)
- (b) • Sheathed and armoured and served (or “ved”) cables.
• Neutral screen cable suitable for underground (3.2 mm sheath).
- AS/NZS 3000: 3.11.2(f)
(2 marks)

Question 4

- (a) (i) • The socket outlet must be not less than 0.3 metres from the floor
(1/2 mark)
AS/NZS 3000 7.1.4.2
- The socket outlet must have automatic switching, and
(1 mark)
Incorporated in a shaver supply socket complying with AS/NZS 3194.
(1 mark)
AS/NZS 3000 7.1.4.2 (b)(i)
- or
The socket outlet must be protected by an RCD, and
(1 mark)
have maximum residual rated current of 30 mA
(1 mark)
AS/NZS 3000 7.1.4.2 (b)(ii)
- The socket outlet must be enclosed in a cupboard during normal operation.
(1/2 mark)
AS/NZS 3000 7.1.4.2 (b)(iii)
- (ii) • The socket outlet must be not less than 0.3 metres from the floor
AS/NZS 3000 7.1.4.3
(1/2 mark)
- (ii) It must have a rating of IPX4
AS/NZS 3000 7.1.4.1(b)
- or
Must have the required degree of protection
AS/NZS 3000 7.1.4.3(b)
(1/2 mark)
- (b) Any TWO of:
- Areas that that are damp (kitchens and communal bathrooms)
 - Areas where electrical appliances are used outdoors (construction sites)
 - Areas where there is a high risk of damage to electrical appliances and equipment (construction sites)
 - Processing areas where the use of water is prevalent

GK

From AS/NZS 3000: 2.5.3.3

- Environmental conditions (e.g. wet areas).
- Type of equipment to be used (e.g. Class I).
- Method of use which creates wear and tear (e.g. hand-held tools subject to movement in use).

- Type of electrical installation and nature of processes being conducted in area (e.g. workshops and particular industrial activities). (2 marks)

(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 SRCD.
- Install SRCDs at each socket outlet

AS/NZS 3000: 2.5.3.4(e)
GK
(4 marks)

Question 5

- (a) (i) • The conductors or fittings are tested to ensure operational safety of the completed work
• In the case of additions, the work does not reduce the safety of existing electrical installation
• During testing, all practicable steps are taken to ensure the safety of persons, property, and the electrical installation.

ER 37(1)
(3 marks)

- (ii) • A registered electrical inspector
• ER41(1)

(1 mark)

- (iii) • A certificate of compliance

ER 39(6)
ER 43A(b)

- A certificate of verification

ER 43A(a)
(2 marks)

- (b) Any FOUR of:

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

AS/NZS 3000: 6.3.2

AS/NZS 3000: 6.3.3.1(a)

AS/NZS 3000: 6.3.3.1(b)

AS/NZS 3000: 6.3.3.1(c)

AS/NZS 3000: 6.3.3.1(d)

AS/NZS 3000: 6.3.3.1(e)
(4 marks)

Question 6

Solution 1-from column 3 of Table C1 of AS/NZS 3000

(a)

Load Group	Calculation	Load (A)	
<u>Group A</u>			
Lighting		6.0	(1 mark)
<u>Group B</u>			
Socket outlets		15.0	(1 mark)
<u>Group C</u>			
Oven		15.0	(1 mark)
<u>Group D</u>			
Air conditioning	$4000 \div 230 \times 0.75$	13.04	(1½ marks)
<u>Group F</u>			
Storage water heater		6	(1 mark)
Total maximum demand		55.04	(1½ marks)

(b) From Table 9 the rating for 4 mm² is 57 amps.

(½ mark)

From Table 27(2), the de-rating factor for 20°C is 0.95

(½ mark)

The maximum load can be carried by the 4 mm² cable is:

$$= 57 \times 0.95$$

$$= 54.15A$$

(1 mark)

Therefore, a 6 mm² cable will satisfy the load requirements.

(1 mark)

Solution 2-from column 2 of Table C1 of AS/NZS 3000

(a)

Load Group	Calculation	Load (A)	
<u>Group A</u>			
Lighting		5.0	(1 mark)
<u>Group B</u>			
Socket outlets		10.0	(1 mark)
<u>Group C</u>			
Oven		5.43	(1 mark)
<u>Group D</u>			
Air conditioning	$4000 \div 230 \times 0.75$	13.04	(1½ marks)
<u>Group F</u>			
Storage water heater		8.7	(1 mark)
Total maximum demand		42.17	(1½ marks)

(b) From Table 9 the rating for 2.5 mm² is 44 amps. (½ mark)

From Table 27(2), the de-rating factor for 20°C is 0.95 (½ mark)

The maximum load can be carried by the 2.5 mm² cable is:

$$= 44 \times 0.95$$

$$= 41.8A \quad (1 \text{ mark})$$

Therefore, a 4 mm² cable will satisfy the load requirements. (1 mark)

Question 7

- (a) Section 6 of AS/NZS 3000
ER 37 (3)
(1 mark)
- (b) Section 3 of NZS 3019
ER 41(3)
(1 mark)
- (c) Building 1
All of the work
(1/2 mark)
- Building 2
- The new sub-main to the outbuilding.
 - The new distribution board and final subcircuits in the outbuilding.
(1/2 mark)
- Building 3
All of the work
(1/2 mark)
ER 39(1)
- (d) (i) 1 day after the completion of the work.
ER 39(5)
(1 mark)
- (ii) Within 20 working days after the completion of the certificate
ER 40(2)
(1 mark)
- (e) Building 1
The mains, main switchboard and main earthing system
(1 1/2 marks)
- Building 2
No work requires inspection
(1/2 mark)
- Building 3
The mains and main switchboard
(1 mark)
ER 41

(f) Any THREE of:

- Earth fault loop impedance test
- RCD testing
- Polarity test
- Phase rotation test

(1½ marks)
GK

Question 8

- (a) (i) Yes
Only the socket outlet for the connection of pool equipment is permitted –
AS/NZS 3000: 7.2.4.3(b)
(1 mark)
- (ii) No
Socket outlets that are not intended for the connection of pool equipment
are not permitted in Zone 1 – AS/NZS 3000: 7.2.4.3(c)
(1 mark)
- (iii) • Supplied individually as a separated circuit in accordance with clause
1.7.4.5.
AS/NZS 3000: 7.2.4.3(b)(iii)(A)
(1½ marks)
- Supplied by a residual-current device with a maximum rated residual
current of 30 mA
(1½ marks)
AS/NZS 3000: 7.2.4.3(b)(iii)(C)
- (b) (i) Any ONE of:
- Fan heater – Not in any Zone
AS/NZS 3000: 7.1.2.1(d)
 - Fan heater - Zone 2 of the shower
AS/NZS 3000: Figure 7.1A(e)
 - Fan Heater control switch - Zone 2 of the shower
AS/NZS 3000: Figure 7.1A(e)
(1 mark)
- (ii) IPX4
AS/NZS 3000: 7.1.4.1 (b)
(1 mark)
- (iii) Zone 3 of the shower
AS/NZS 3000: Figure 7.1A(e)
(1 mark)
- (iv) No rating specified
AS/NZS 3000: 7.1.4.1 (c)
(1 mark)

(v) Any ONE of:

- Zone 3 of the shower
- It is not in a Zone

AS/NZS 3000: Figure 7.1A(e)

(1 mark)

Note: The Standard it not clear as to whether the partition alters the shower zones in respect to the light switch. However, when a substantial partition is provided as shown, the possibility of water splashes from the shower is very low. Therefore, either answer is considered acceptable.

Question 9

(a) Calculate line current

$$I_L = \frac{70000}{\sqrt{3} \times 400}$$

$$= 101.04 \text{ A}$$

(½ mark)

(1 mark)

Allowance for future growth $101.04 + 10\% = 111.14\text{A}$

(1 mark)

From Table 12, column 4, rating of 25 mm^2 is 104 A

(½ mark)

From Table 27(1) the re-rating factor is 1.12

(½ mark)

$$I_{\max} = 104 \times 1.12$$
$$= 116.48\text{A}$$

(1 mark)

Based on loading a 25 mm^2 cable is suitable.

(1 mark)

(b) Cable size based on volt drop

Maximum volt drop permitted is 3.5 volts.

From Table 42, $V_d/A.m = 1.54$ for 25 mm^2 cable

(½ mark)

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

(½ mark)

$$= \frac{1.54 \times 111.14 \times 20}{1000}$$

(½ mark)

$$= 3.42 \text{ V}$$

(1 mark)

This is below the 3.5 V max. volt drop permitted.

Based on volt drop a 25 mm^2 cable is suitable.

(1 mark)

(c) The 25 mm^2 cable is minimum size cable required

(1 mark)