V3-CHANGES-ER 36 - 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) 0.4 seconds (400 milliseconds)

ER 64 (3)
(2 marks)

(b) 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)

(c) (1) Current rating of a fixed setting circuit breaker
(2) Load setting of an adjustable circuit breaker

AS/NZS 3000:2000: 1.8.3.5
AS/NZS 3000:2007: 2.2.2(d)
(2 marks)

(d) From AS/NZS 3000:2000: 2.5.3.1

- Socket-outlet final subcircuits:
- Lighting final subcircuits.

From AS/NZS 3000:2007: 2.6.3.1

Any TWO of:

- Socket-outlet final subcircuits:
- Lighting final subcircuits.
- Directly connected hand-held electrical equipment

(2 marks)

(e) From AS/NZS 3000:2000: 3.11.3.5

Any TWO of:

- Orange marker tape
- Light-orange coloured polymeric cable strip
- Marker signs where the cable enters or leaves the building

From AS/NZS 3000:2007: 3.11.4.5 & 6

Any TWO of:

- Orange marker tape
- Permanent cable marker signs shall be provided to indicate the point where cable enters or leaves a structure.
- Recorded on a plan, and the plan located at the switchboard from where the cable originates.

(2 marks)

(f) Any ONE of:

From AS/NZS 3000:2000

- Suitable protective measures shall be taken where a drop in voltage or the loss of, and subsequent restoration of voltage could cause danger.
  AS/NZS 3000:2000: 2.7.1
- Where the reclosure of a protective device is likely to create a dangerous situation, the reclosure shall not be automatic
  AS/NZS 3000:2000: 2.7.2
- Each electric motor shall be provided with a means to prevent automatic restarting after stopping due to a drop in voltage or the failure of the supply, where unexpected restarting of the motor might cause danger.
  AS/NZS 3000:2000: 4.2.1.2

From AS/NZS 3000:2007

- Suitable protective measures shall be taken where –
  (a) the loss and subsequent restoration of voltage; or.
  (b) a drop in voltage;
  could cause danger to persons and property.
  AS/NZS 3000:2007: 2.8.1
- Where the reclosure of a protective device is likely to create a dangerous situation, the reclosure shall not be automatic
  AS/NZS 3000:2007: 2.8.2
- Where unexpected restarting of a motor might cause danger, each electric motor shall be provided with a means to prevent automatic restarting after stopping
  AS/NZS 3000:2007: 4.13.1.4

(2 marks)

(g) No connection, other than that made by an earthing conductor, shall be made between the primary and secondary windings.

AS/NZS 3000:2000: 4.5.5
AS/NZS 3000:2007: 4.14.5
(2 marks)

(h) From AS/NZS 3000:2000: 5.8.2.2

Where it is not metallically continuous from inside the building to the point of contact with the ground.

From AS/NZS 3000:2007

Any ONE of:

- Where it is not accessible within the building containing the electrical installation; and

  AS/NZS 3000:2007: 5.6.2.2
- Where it is not metallically continuous from inside the building to the point of contact with the ground.

  AS/NZS 3000:2007: 5.6.2.2
- Where the piping system is effectively earthed by connection to an associated item of electrical equipment.

  AS/NZS 3000:2007: 5.6.2.3

(2 marks)

(i) From AS/NZS 3000:2000: 7.7.9

Shall be installed in all active conductors

Or

From AS/NZS 3000:2007: 7.5.9.1

Shall be installed in all the unearthed conductors

(2 marks)

(j) It shall be connected on the supply side of the pump motor controller.

AS/NZS 3000:2000: 7.10.9.1
AS/NZS 3000:2007: 7.2.9.1
(2 marks)

Question 2

(a) From AS/NZS 3000:2000: 1.7.4.2

- Automatic disconnection of supply
- The use of Class II equipment or equivalent insulation
- Electrical separation (or isolated supply)

From AS/NZS 3000:2007:1.5.5.2

Any THREE of:

- Automatically disconnect the supply on the occurrence of a fault likely to cause a current flow through a body in contact with exposed conductive parts, where the value of that current is equal to or greater that the shock current.
- Prevent a fault passing through a body by the use of Class II equipment or equivalent insulation
- Prevent a fault passing through a body by the use of electrical separation (or isolated supply)
- Limit the fault current that can pass through a body to a value lower than the shock current.

(1½ marks)

(b) Automatic disconnection
When a fault current flows, this operates the protective device by blowing a fuse or tripping an MCB or an RCD to disconnect the supply.

Double insulation
The use of double insulation construction makes it impossible to touch exposed conductive parts that may be live.

Electrical separation
The use of electrical separation to supply the load removes any reference to earth on the supply. If an earth fault occurs there will be no voltage or current to earth.

Limit fault current
The use of an ELV supply to reduce the fault current to below the IEC shock current limits.

(4 marks)

(c) Automatic disconnection

Any ONE of:

- Verify the earth fault loop impedance value is below the maximum permitted for the cable size used and the protective device rating used to supply the final subcircuit.
- Use of test equipment that causes the RCD to operate under residual a.c current and residual pulsating d.c current and that verifies that the RCD is suitable for personal protection.

Double insulation

Any ONE of:

- Ensure that the double insulation is free from mechanical damage.
- Carry out an insulation resistance test between the insulation and any exposed metal to verify the integrity of the insulation
- Carry out an earth leakage test to verify the integrity of the insulation

Electrical separation
Verify the separation insulation resistance values; primary winding to earthed case; primary winding to secondary winding; and secondary winding to earthed case are at least 1 MΩ.

Limit fault current
Verify that the ELV supply is below 50V in dry locations; below 25V in damp locations and under 12V when submerged in water.

(4 marks)

(d) 0.4 or 400 milliseconds

AS/NZS 3000:2000: 1.7.4.3.4
AS/NZS 3000:2007:1.5.5.3(d)
(½ mark)

Question 3

(a) (i) In Zone 2 or Zone 3 of the shower.

AS/NZS 3000:2000: Figure 7.1A(e)
AS/NZS 3000:2007: Figure 6.9
(1 mark)

(ii) Zone 2 The switch must be rated IPX 4
Zone 3 No IP rating required

AS/NZS 3000:2000: 7.1.4.1(b)
AS/NZS 3000:2007: 6.2.4.1(b)
(1 mark)

(iii) The switch must be at least 0.3m above the floor.

AS/NZS 3000:2000: 7.1.4.3
AS/NZS 3000:2007: 6.2.4.3
(½ mark)

(b) (i) In Zone 2 or Zone 3 of the shower.

AS/NZS 3000:2000: Figure 7.1A(e)
AS/NZS 3000:2007: Figure 6.9
(1 mark)

(ii) Zone 2 The towel rail and permanent connection unit must be rated IPX 4
Zone 3 No IP rating required

AS/NZS 3000:2000: 7.1.4.1(b)
AS/NZS 3000:2007: 6.2.4.1(b)
(1 mark)

(iii) Both must be at least 0.3m above the floor.

AS/NZS 3000:2000: 7.1.4.3
AS/NZS 3000:2007: 6.2.4.3
(½ mark)

(c) (i) In Zone 2 or Zone 3 of the shower.

AS/NZS 3000:2000: Figure 7.1A(e)
AS/NZS 3000:2007: Figure 6.9
(1 mark)

(ii) Zone 2 The wall heater and wall switch unit must be rated IPX 4
Zone 3 No IP rating required

AS/NZS 3000:2000: 7.1.4.1(b)
AS/NZS 3000:2007: 6.2.4.1(b)
(1 mark)

(iii) Both must be at least 0.3m above the floor.

AS/NZS 3000:2000: 7.1.4.3
AS/NZS 3000:2007: 6.2.4.3
(½ mark)

(d) (i) Any ONE of:

- In Zone 3 of the shower
- Outside Zone 2 of the basin.

AS/NZS 3000:2000: Figure 7.1A(e)
AS/NZS 3000:2007: Figure 6.9

(½ mark)

(ii) Zone 3 No IP rating required

AS/NZS 3000:2000: 7.1.4.1(b)
AS/NZS 3000:2007: 6.2.4.1(b)
(½ mark)

(iii) RCD protected or supplied from an isolated supply

AS/NZS 3000:2000: 7.1.4.2(c)
AS/NZS 3000:2007: 6.2.4.2(c)
(1 mark)

(iv) It must be at least 0.3m above the floor.

AS/NZS 3000:2000: 7.1.4.3
AS/NZS 3000:2007: 6.2.4.3
(½ mark)

Question 4

(a) (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.

AS/NZS 3000:2000: 6.3.3.3.2
AS/NZS 3000:2007: 8.3.6.1
(2 marks)

(ii)
- The oven
- The hob
- The water heater
- The installation with the oven, hob and water heater disconnected.

(2 marks)
GK

(iii)
- Insulation resistance tester

(1 mark)

- 500V d.c.

(1 mark)
GK

(iv)
- The oven – 10, 000Ω – minimum
- The hob – 10, 000Ω – minimum
- The water heater – 10, 000Ω – minimum
- The installation with the oven, hob and water heater disconnected -- 1 MΩ – minimum

AS/NZS 3000:2000: 6.3.3.3.2
AS/NZS 3000:2007: 8.3.6.2
(2 marks)

(b)
- A polarity test is necessary to ensure that no shock hazard arises from the incorrect connection of the active, neutral and earthing conductors.

AS/NZS 3000:2000: 6.3.3.4
AS/NZS 3000:2007: 8.3.7.1
(1 mark)

- A correct circuit connections test is necessary to ensure that protective earthing conductors do not normally carry current.

AS/NZS 3000:2000: 6.3.3.5.1
AS/NZS 3000:2007: 8.3.8.1
(1 mark)

Question 5

(a) (i)
- The main neutral
- The MEN link
- The oven circuit neutral.
- The neutrals to the RCDs protecting the final subcircuits

(2 marks)

(ii)
- The out-going neutral from RCBO No.1
- The neutrals of the final subcircuits protected by RCBO No. 1

(1 mark)

(iii)
- The out-going neutral from RCBO No.2
- The neutrals of the final subcircuits protected by RCBO No. 2

(1 mark)
GK

(b) (i) The main neutral bar

(1 mark)

(ii) Neutral bar No. 1

(1 mark)

(iii) Load side of the main switch

(1 mark)

(iv) Any ONE of:

- Supply side of MCB bank No.1
- The phase of the final subcircuits protected by RCBO 1

(1 mark)
GK

(c) (i) The main neutral bar

(1 mark)

(ii) Neutral bar No. 2

(1 mark)
GK

Question 6

Solution 1

Load Group	Calculation	Load (A)	
Load Group A (i)			
60W lights	(60 x 16) ÷ 230 =	4.17	(1 mark)
100W lights	(100 x 17) ÷ 230 =	7.39	(1 mark)
6 metres of lighting track	0.5 x 6	3.00	(1 mark)
Load Group A(ii)			
3000W outside lights	(3000 ÷ 230) x 0.75	9.78	(1½ marks)
Load group B(i)			
15 double 10A 10 single 10A 1 single 10A (wh)	30 + 10 + 1 = 41 10 + 5 + 5 =	20.00	(1 marks)
Load Group C			
12kW range	(12000 ÷ 230) x 0.5	26.09	(1½ marks)
Load Group D			
6KW air_conditioner	(6000 ÷ 230) x 0.75	19.56	(1½ marks)
Total maximum demand		**89.99**	(1½ marks)

AS/NZS 3000:2000 Table C1
AS/NZS 3000:2007 Table C1

Note: The question was structured in such a way that a candidate could read it as "6 metres of lighting track powering 3kW of outside lights". Therefore the solution is either the lighting track at 3A or the outside lights at 9.78A

Therefore the alternative answers are 90.21A or 86.99A respectively.

Solution 2

Load Group	Calculation	Load (A)	
Load Group A (i)			
16, 60W lights	16 + 17 + 12 = 45		
17, 100W lights	3 + 2 + 2 = 7	7.00	(3 marks)
6 metres of lighting track			
Load Group A(ii)			
3000W outside lights	(3000 ÷ 230) x 0.75	9.78	(1½ marks)
Load group B(i)			
15 double 10A 10 single 10A 1 single 10A (wh)	30 + 10 + 1 = 41 10 + 5 + 5 =	20.00	(1 marks)
Load Group C			
12kW range	(12000 ÷ 230) x 0.5	26.09	(1½ marks)
Load Group D			
6KW air_conditioner	(6000 ÷ 230) x 0.75	19.56	(1½ marks)
Total maximum demand		82.43	(1½ marks)

AS/NZS 3000:2000 Table C1
AS/NZS 3000:2007 Table C1

Note: The question was structured in such a way that a candidate could read it as "6 metres of lighting track powering 3kW of outside lights". Therefore the solution is either the lighting track at 2A (6 x 2 poinst per metre) or the outside lights at 9.78A

Therefore the alternative answers are 72.65A or 84.99A respectively.

Question 7

(a) From AS/NZS 3000:2000: 2.9.8.4(c)

- The switchboard shall be separated from the other sections of the cupboard; and
- The switchboard shall be arranged so that access to the switchboard cannot be obstructed by the structure or contents of the cupboard.

From AS/NZS 3000:2007: 2.9.2.5(c)

Any TWO of:

- Installed in a section of the cupboard from other sections.
- Installed at the front of the switchboard section of the cupboard.
- Installed facing the cupboard door
- Arranged so there are no projections that obstruct access.

(2 marks)

(b)
- Live parts shall be arranged so that protection against direct contact is provided by barriers or enclosures in accordance with the provisions of Clause 1.7.3.4 (2000)
  Live parts shall be arranged so that protection against direct contact is provided by barriers or enclosures in accordance with the provisions of Clause 1.5.4.4 (2007)
- Live parts may be exposed provided that the switchboard is installed in an area which is accessible only to authorized persons and the means of access to such areas is provided with facilities for locking.

AS/NZS 3000:2000: 2.9.6
AS/NZS 3000:2007: 2.9.3.1
(2 marks)

(c) From AS/NZS 3000:3000: 2.9.8.3

The location of the main switchboard shall be identified by means such as a permanent sign at a main entrance to the electrical installation or at the fire indicator panel.

From AS/NZS 3000:2007: 2.9.2.4

The location of the main switchboard shall be legibly and permanently indicated by a conspicuous notice at each entry to the building that may be used by emergency services personnel.

(2 marks)

(d) Yes. The minimum width of the doorway is 0.75m. AS/NZS3000:2000: 2.9.10(c). AS/NZS 3000:2007: 2.9.2.2(c)(iii)

(1 mark)

(e) 0.6m clear space with the switchboard doors open. AS/NZS3000:2000: 2.9.10(a). AS/NZS 3000:2007: 2.9.2.2(a)(i)

(2 marks)

(f) The link is at the main switchboard supplying the distribution board.

(1 mark)

GK

Question 8

(a) The allowance for load = 60 x 20% = 12A

(½ mark)

60 + 12 = 72A

(1 mark)

From Table 12, column 5, current rating for a 25 mm^2 cable is 81A (touching)

(½ mark)

From Table 12, column 13, current rating for a 16 mm^2 cable is 83A (buried direct)

(½ mark)

From Tables 27(1) and (2) the variation for ambient temperature (soil and air) is 1

(½ mark)

Therefore, a 25 mm^2 cable will supply the load current when installed surface mounted or buried direct.

(1 mark)

(b) Solution 1

Maximum permitted voltage drop = 400 x 1.5% = 6V

(1 mark)

From Table 45 the mV/A.m for a 25 mm^2 cable is 2.54

(½ mark)

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

(½ mark)

$$= \frac{2{,}54 \times 45 \times 72}{1000}$$

(½ mark)

$$= 8.23V$$

(½ mark)

From Table 45 the mV/A.m for a 35 mm^2 cable is 1.84

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

$$= \frac{1.84 \times 45 \times 72}{1000}$$

$$= 5.96V$$

(½ mark)

Therefore a 35 mm^2 cable will satisfy the voltage drop requirements.

(1 mark)

Solution 2

Maximum permitted voltage drop = 400 x 1.5% = 6V

(1 mark)

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

(½ mark)

$$= \frac{6 \times 1000}{45 \times 72}$$

(½ mark)

$$= 1.85 \text{ mV/A.m}$$

(1 mark)

From Table 45 the mV/A.m that can be used is for a 35 mm^2 cable

(½ mark)

Therefore a 35 mm^2 cable will satisfy the voltage drop requirements.

(1 mark)

(c) A 35 mm^2 aluminium cable will satisfy both the load current and voltage drop requirements

(1½ marks)

Question 9

(a) From AS/NZS 3000:2000: 5.2.5

- The value of earthing resistance is in accordance with the protective and functional requirements of the electrical installation and expected to be continuously effective.
- Earth-fault currents and earth-leakage currents can be carried without danger, particularly from thermal, thermo-mechanical and electromechanical stresses; and
- It is adequately robust or has additional mechanical protection appropriate to the assessed conditions of external influence in accordance with Clause 3.3.

From AS/NZS 3000:2007: 5.1.2

Any THREE of:

- Enable automatic disconnection of supply in the event of a short-circuit to earth fault or excessive earth leakage current in the protected part of the installation through protective earthing arrangements.
- Enable equipment requiring an earth reference to function correctly through functional earth arrangements.
- Mitigate voltage differences appearing between exposed conductive parts of equipment and extraneous conductive parts through equipotential bonding arrangements.
- Provide an effective and reliable low impedance fault path capable of carry earth fault and earth leakage current without danger or failure.
- Provide measures for the connection of exposed conductive parts and extraneous conductive parts.

(3 marks)

(b) Any ONE of

- $6mm^2$ Cu

AS/NZS3000:2000: Table 5.1
AS/NZS3000:2007: Table 5.1

- 16 mm^2 Al

AS/NZS3000:2000: 5.5.6(b)
AS/NZS3000:2007: 5.3.2.1.2
(1 mark)

(c) 48 metres

AS/NZS 3000:2000: Table B5.1
AS/NZS 3000:2007: Table B1
(1 mark)

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

AS/NZS 3000:2000 5.5.1.2(a)(i)
AS/NZS 3000:2007 5.3.3.2
(2 marks)

(e) (i) $kVA = \frac{100 \times 100}{5}$

(½ mark)

$= 2000$ kVA

(1 mark)

(ii) $ISC = \frac{2000}{\sqrt{3} \times 400}$

(½ mark)

$= 2887A$

(1 mark)