

Version 2 - ER 21 – Electrician Regulations Answer Schedule

- Notes:
- (1 mark) means that the preceding statement/answer earns 1 mark.
 - 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.
 - Symbols and terms - alternatives
Power W or P
Voltage V or E or U
Phase Active
 - 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
 - Those parts of an answer that are under-lined indicate the parts required to be covered by a candidate.

Question 1

- (a) (i) Lodge a written complaint with the Registrar
- EA 119
(1 mark)
- (ii) Any TWO of:
- Remove the name from the register
 - Suspend registration–subject to conditions
 - Restrict work/premises/employer
 - Fine up to \$5,000
 - Censure
 - Make no order
- EA: 127(2)
(1 mark)
- (b) (i) 6%
- (ii) 6%
- ER 53
(2 marks)

(c) Any TWO of:

- The appliance is a fixed wired appliance connected through a continuous flexible cord to a supply of electricity from a source isolated from earth with a voltage between conductors not exceeding 230 volts.
- The appliance is supplied with electricity from a safety extra-low voltage source.
- The appliance is double insulated and is supplied with electricity from a residual current device (RCD).

ER 77 (3) (a) (b) (c)
(2 marks)

(d) Any TWO of:

- The name of the person so notifying and the place at which that person may be contacted (including where possible a telephone number and facsimile number):
- The place, date, and time of the accident:
- A complete description of the accident:
- A description of any injuries, damage, or losses resulting from the accident:
- Where known, the names and contact information of any witness, investigator at the scene, or other person who could provide cogent information on the accident:
- Possible causative factors (if any are known):
- Any resuscitation applied, including the method, the length of time applied, the reason for discontinuing, and the person that applied the resuscitation:
- Any associated equipment involved, including the type, whether or not it operated correctly, and any reasons why it did not operate correctly:
- The condition of the associated equipment involved, including its age:
- Where known, the name, age, sex, occupation, and residential address of the victim.

ER 106(1)
(2 marks)

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

AS/NZS 3000: 3.9.4.6
(2 marks)

- (f) Any FOUR of:
- Earth electrode. AS/NZS 3000: 5.6.1(a)
 - Main earthing conductor. AS/NZS 3000: 5.6.1(b)
AS/NZS 3000: 5.6.4.1(a)
 - Main earthing terminal/connection or bar. AS/NZS 3000: 5.6.1(c)
 - MEN link. AS/NZS 3000: 5.6.1(d)
AS/NZS 3000: 5.6.4.1(b)
 - Protective earthing conductors. AS/NZS 3000: 5.6.1(e)
AS/NZS 3000: 5.6.4.1(c)
 - Equipotential bonding. AS/NZS 3000: 5.6.1(f)
AS/NZS 3000: 5.6.4.1(e)
 - Functional earthing conductors AS/NZS 3000: 5.6.4.1(d)
(2 marks)
- (g) • Protection by means of obstacles
• Protection by placing out of reach AS/NZS 3000: 7.5.3.2
(2 marks)
- (h) Any ONE of:
- The circuit shall be protected at its origin against overload
 - Shall be installed in all the active conductors AS/NZS 3000: 7.7.9
(2 marks)
- (i) (i) 16 amps (1 mark)
- (ii) 20 amps (1 mark)
- AS/NZS 3000 Table B4.1.
(2 marks)
- (j) A type where tripping is ensured for residual alternating current and residual pulsating direct current. AS/NZS 3000: 2.5.2.2
6.3.3.6.1(a)
(2 marks)

Question 2

(a) (i) 6mm² copper (or Cu)

Note: No marks are to be awarded if the candidate does not state that this is a copper conductor.

AS/NZS 3000: Table 5.1
(1 mark)

(ii) 4 mm²

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

(b) Any TWO of:

- Sprinkler pipes
- Gas pipes
- Water pipes
- Pipes conveying flammable liquid
- Pipes conveying non-electrical services

AS/NZS 3000: 5.6.7.5.1
(2 marks)

(c) Any ONE of:

- Where they are unavoidably in contact with the exposed conductive parts of wiring enclosures, cable components or other electrical equipment
AS/NZS 3000: 5.8.2.3
- Where metallic water piping is:
 - installed within the building containing the electrical installation; and
 - metallically continuous from inside the building to the point of contact with the ground.

AS/NZS 3000: 5.8.2.2
(2 marks)

(d) 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
- Special electrical connections intended to bring exposed conductive parts or extraneous conductive parts to the same or approximately the same potential, but not intended to carry current in normal service.

AS/NZS 3000: 1.4.49
(2 marks)

(e) 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 less than 63 A, or handheld equipment, or portable equipment intended for manual movement during operation.
 - 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: 5.4.3
- The resistance of protective earthing conductors shall be low enough to permit the passage of current necessary to operate the overcurrent protective device.
AS/NZS 3000: 6.3.3.2.2
- Clause 1.7.4.3.3 requires that each circuit is protected such that automatic disconnection of supply will occur within a specified disconnection time when a fault of negligible impedance occurs between an active conductor and a protective earthing conductor or an exposed conductive part anywhere in the electrical installation. This condition is met when 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
(1 mark)

(f) Any ONE of:

- 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
(1 mark)

Question 3

(a) Cable size based on loading

Buried direct

From Table 12, column 14, rating of 16 mm² copper (or Cu) is 106A
From Tables 27(2) the derating factor is 1

(½ mark)

$$\begin{aligned} I_{\max} &= 106A \times 1 \\ &= 106A \end{aligned}$$

Based on loading, a 16 mm² copper (or Cu) cable buried direct is suitable.

(1 mark)

Surface mounted (touching)

From Table 12, column 4, rating of 25 mm² copper (or Cu) is 104A
From Table 27(1) the derating factor is 0.94

(½ mark)

$$\begin{aligned} I_{\max} &= 104A \times 0.94 \\ &= 97.96A \end{aligned}$$

Based on loading, a 35 mm² copper (or Cu) cable surface mounted is suitable.

(1 mark)

or

From table 12, a 35 mm² copper (or Cu) cable is rated for 125 amps.

(1 mark)

The correction factor from table 27(1) is 0.94. The cable rating would to be
125 x 0.94 = 117.56 amps.

(1 mark)

The 35 mm² copper (or Cu) cable is the correct size.

(1 mark)

(b) Cable size based on volt drop

Maximum volt drop permitted in 10 volts.

Buried direct

From Table 42, $V_d/A.m = 2.43$ for 16 mm² copper (or Cu) cable

$$\text{Volt drop} = \frac{V_d/A.m \times I \times L}{1000} \quad (1/2 \text{ mark})$$

$$= \frac{2.43 \times 103.2 \times 45}{1000} \quad (1/2 \text{ mark})$$

$$= 11.28 \text{ V} \quad (1/2 \text{ mark})$$

This is above the 10 V max. volt drop permitted.

(1 mark)

Therefore, a 25 mm² copper (or Cu) cable buried direct meets the volt drop requirements

(1 mark)

Or

From Table 42, $V_d/A.m = 1.54$ for 25 mm² copper (or Cu) cable

(1/2 mark)

$$\text{Volt drop} = \frac{V_d/A.m \times I \times L}{1000} \quad (1/2 \text{ mark})$$

$$= \frac{1.54 \times 103.2 \times 45}{1000} \quad (1/2 \text{ mark})$$

$$= 7.15 \text{ V} \quad (1/2 \text{ mark})$$

This is below the 10 V max. volt drop permitted.

(1 mark)

Therefore, a 25 mm² copper (or Cu) cable buried direct meets the volt drop requirements

(1 mark)

Surface mounted (touching)

From Table 42, $V_d/A.m = 1.11$ for 35 mm² copper (or Cu) cable

(1/2 mark)

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

(1/2 mark)

$$= \frac{1.11 \times 103.2 \times 45}{1000}$$

(1/2 mark)

$$= 5.15 \text{ V}$$

This is below the 10 V max. volt drop permitted.

(1 mark)

- (c) • A 25 mm² copper (or Cu) cable buried direct is suitable

Or

- A 35 mm² copper (or Cu) cable surface-mounted is suitable

(1/2 mark)

Question 4

(a) Any THREE of:

- To ensure that no shock hazard arises from the incorrect connection of active, neutral and earthing conductors
- To prevent the transposition of active and neutral conductors of the consumers mains or submains (with MEN connection at outbuilding or detached portion) resulting in the electrical installation earthing system becoming energized
- To prevent combinations of incorrect active, neutral and earthing conductor connections resulting in the exposed conductive parts of the electrical installation becoming energized
- To prevent the connection of switches in neutral conductors, resulting in parts of appliances, such as heating elements and lampholders, remaining energized when the switches are in the 'OFF' position.

AS/NZS 3000: 6.3.3.4.1
(3 marks)

- (b)
- Voltage tester
 - Temporary earth
 - Trailing lead

GK
(3 marks)

- (c) (i)
- Install the remote earth and connect the trailing lead to it (1 mark)
 - Turn off the main switch (1 mark)
 - Take a voltage test between the supply side of the main switch and the remote (or temporary or independent) earth. (½ mark)
 - Take a voltage test between the earth/neutral bar and the remote (or temporary or independent) earth. (½ mark)

(ii) If a transposition has taken place:

- The reading at the main switch should be about 0 V, but due to voltage gradients between the remote (temporary) earth and the installation earth the voltage could be as high as 115 volts. In any case the voltage will be significantly less than 230V (½ mark)
- The reading at the neutral/earth bar should be about 230V, but due to voltage gradients between the remote (temporary) earth and the

installation earth the voltage could be as low as 115 volts. In any case the voltage will be significantly more than 0V

(1/2 mark)

Note: 1. The removal of the MEN link with the installation live is hazardous.

Question 5

(a) Yes

(½ mark)

- Every motor supply circuit shall be provided with an isolating switch that isolates the motor from the supply.

AS/NZS 3000: 2.8.3.5

- Electrical installations shall be provided with isolation devices to prevent or remove hazards associated with the electrical installation and to allow maintenance of electrical equipment.

AS/NZS 3000: 1.7.12

- Suitable means shall be provided to prevent electrically powered equipment from becoming unintentionally reactive during mechanical maintenance, unless the means of switching off is continuously under the control of the person performing such maintenance.

AS/NZS 3000: 2.8.4.1

- Electric motors shall be provided with suitable devices for starting and stopping, placed so as to be easily operated by the person in charge of the motor. In the event of a fault in a motor control circuit, the stopping device shall remain effective.

AS/NZS 3000: 4.2.11

(1½ marks)

or

No

(½ mark)

- Where a number of motors are required to function as a group or operate in a coordinated manner, a single switch may be used to isolate more than one motor.

(1½ marks)

AS/NZS 3000: 2.8.3.5

(b) 0.37 kW

AS/NZS 3000: 4.3.4.1

(1 mark)

(c) (i) 2.25 kW

AS/NZS 3000: 4.3.4.2.1(b)

(1 mark)

- (ii)
- Motors associated with emergency systems in accordance with Clause 7.10.9.3; or
 - Where the opening of the motor circuit could create a hazard.

AS/NZS 3000: 4.3.4.2.2

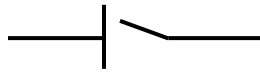
(2 marks)

- (d) The current rating shall be one-third of the rating of the motor circuit conductors or 135% of the rated current of the capacitor; whichever is the greater.

AS/NZS 3000: 4.6.2.3(i) and (ii)
(2 marks)

- (e) Any TWO of:

- 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
- Shall not be able to falsely indicate that the contacts are open.
or
Have this symbol –



AS/NZS 3000: 2.8.3.2

- A semiconductor (solid state) device shall not be used for isolation purposes.
AS/NZS 3000: 2.8.3.2
- The position shall be clearly and reliably indicated.
AS/NZS 3000: 2.8.3.2
- Shall be designed and installed 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
- If not capable of interrupting normal load current, suitable measures shall be taken to prevent it operating while carrying current.
AS/NZS 3000: 2.8.3.2
- In a.c. systems, a switching device shall interrupt all active conductors.
AS/NZS 3000: 2.8.3.1
- 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
- Where devices are provided for switching-off for mechanical maintenance, they shall be capable of interrupting the full-load current of the relevant part of the electrical installation.

AS/NZS 3000: 2.8.4.2
(2 marks)

Question 6

(a) Any FOUR of:

- Connections shall provide electrical continuity.
AS/NZS 3000: 3.7.1
Or
No loosening is likely due to vibration to which the connections are likely to be subjected in normal service.
AS/NZS 3000: 3.7.2.3
- Or
No loosening is likely due to alteration of materials to which the connections are likely to be subjected in normal service.
AS/NZS 3000: 3.7.2.3
- Or
No loosening is likely due to temperature variations to which the connections are likely to be subjected in normal service.
AS/NZS 3000: 3.7.2.3
- Connections shall provide adequate mechanical strength.
AS/NZS 3000: 3.7.1
Or
All cables and conductors shall be installed so that there is no undue mechanical stress on any connection.
AS/NZS 3000: 3.7.2.5
- Take account of the material of the conductor and its insulation.
AS/NZS 3000: 3.7.2.1(a)
- Take account of the number and shape of the wires forming the conductor.
AS/NZS 3000: 3.7.2.1(b)
- Take account of the cross-sectional area of the conductor.
AS/NZS 3000: 3.7.2.1(c)
- Take account of the number of conductors to be connected together.
AS/NZS 3000: 3.7.2.1(d)
- Take account of the temperature attained by terminals in normal service such that the effectiveness of the insulation of the conductors is not impaired.
AS/NZS 3000: 3.7.2.1(e)
- Take account of the prevention of entry of moisture and the siphoning of water through any cable or wiring enclosure.
AS/NZS 3000: 3.7.2.1(f)
- The insulation on a conductor shall not be removed any further than is necessary to make the connection.
AS/NZS 3000: 3.7.2.2

- No loosening is likely due to vibration to which the connections are likely to be subjected in normal service.
AS/NZS 3000: 3.7.2.3
 - No loosening is likely due to alteration of materials to which the connections are likely to be subjected in normal service.
AS/NZS 3000: 3.7.2.3
 - No loosening is likely due to temperature variations to which the connections are likely to be subjected in normal service.
AS/NZS 3000: 3.7.2.3
 - The ends of stranded conductors shall be secured by suitable means so as to prevent spreading or escape of individual strands.
AS/NZS 3000: 3.7.2.4
 - Whether connection is by direct connection.
AS/NZS 3000: 4.11(a)
 - Whether connection is by socket-outlet.
AS/NZS 3000: 4.11(b)
 - Whether connection is by connecting device
AS/NZS 3000: 4.11(c)
(4 marks)
- (b)
- On the surface of a wall or on the underside of a ceiling.
 - In a space between a floor and the ground to which a person may gain entry.
 - In a ceiling space having an access space exceeding 0.6 m high.
 - Within 2.0 m of any access to any space to which a person may gain entry.
AS/NZS 3000: 3.9.5.2
(4 marks)
- (c)
- Change from one enclosure to another shall be made at a switchboard.
 - Change from one enclosure to another shall be made by means of a suitable device which provides for the complete protection of the conductor insulation and for continuity of the wiring enclosure.
AS/NZS 3000: 3.10.2.2
(2 marks)

Question 7

(a) Any FOUR of:

- Precast concrete slabs having a thickness of not less than 40 mm and a classification of not less than grade 15 in accordance with AS 3600.
- Concrete slabs cast on site having a thickness of not less than 100 mm.
- A continuous concrete pour having a thickness of not less than 75 mm.
- Fibrous cement slabs having a thickness of not less than 12 mm.
- Bricks manufactured specifically for the protection of electric cables.
- Polymeric cable cover strip complying with AS 4702.
- Other materials which offer the same degree of protection afforded by the materials above

AS/NZS 3000: 3.11.3.3
(4 marks)

- (b)
- The low voltage cables are of a type providing the equivalent of double insulation
 - All cables or each conductor of a multicore cable are insulated for the highest voltage present
 - The low voltage cables are installed in a separate compartment of a common cable trunking system and the compartment has fixed and continuous barriers.

AS/NZS 3000: 3.9.9.3
(3 marks)

(c) Any THREE of:

- Covers shall be able to be opened, where practicable.
AS/NZS 3000: 3.10.3.9(a)
- Covers shall be continuous when passing through walls or floors.
AS/NZS 3000: 3.10.3.9(b)
- Cable trunking shall be accessible through its entire length.
AS/NZS 3000: 3.10.3.9(c)
- Cables installed in a trunking shall not rely on any readily removable cover for support.
AS/NZS 3000: 3.10.3.9(d)
- Non-hygroscopic trunking shall be used to enclose insulated cables (without sheath).
AS/NZS 3000: 3.10.3.9(e)
- For the segregation of services the trunking is divided into separate channels by means of fixed and continuous barriers that provide effective segregation.

AS/NZS 3000: 7.10.8.1(a)
(3 marks)

Question 8

(a) (i) Final subcircuits supplying socket-outlets

AS/NZS 3000: 2.5.3.2
(1 mark)

(ii) • A socket-outlet installed more than 2.3 m above a floor for the connection of an appliance rated at not more than 150 W

AS/NZS 3000: 2.5.3.2 (b)
(1½ marks)

• A luminaire.

AS/NZS 3000: 2.5.3.2 (b)
(1½ marks)

(b) MCBs or HRC fuses (or overcurrent and short-circuit protection), because RCCBs do not have this type of function.

GK
(2 marks)

(c) Any FOUR 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
(4 marks)

Question 9

(a) Any SIX of:

- New underground mains from the plinth on the boundary to a new meter box.
- New internal mains between the internal switchboard.
- A new main switchboard.
- A new main earthing lead and earth electrode.
- The equipotential bonding conductors
- A new RCD protected socket outlet installed on the outside of the house.
- Additional lights and power points installed in the existing living areas.

(3 marks)
ER39(1),(2)

(b) All of the work.

ER37(3)
(1 mark)

(c) • New underground mains from the plinth on the boundary to a new meter box.

(½ mark)

• New internal mains between the new meter box and new main switchboard.

(½ mark)

• A new main switchboard.

(½ mark)
ER41(1)(c)(i)(ii)(vii)

(d) (i) 1 day

ER39(5)
(½ mark)

(ii) 20 working days

ER40(2), 42(1)
(½ mark)

(iii) The electrical inspector

ER40(3), 42(1)
(½ mark)

(e) 3 years

ER40(4)
(1 mark)

(f) Any TWO of:

- The work to which regulation 39(1) applies. ER39(1)
- The fittings upon which the work has been done have been tested and are electrically safe; and ER39(7)(a)
- The work has been done in accordance with the Act and these regulations. ER39(7)b)
(2 marks)