

ER 15 – Electrician Regulations Answer Schedule (Changes in italics)

Note: (1 mark) means that the preceding statement 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.

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

Question 1

- The *construction (installation)* or maintenance of electrical wiring.
- The connection or disconnection of fittings to or from electrical wiring.
- The maintenance of electrical appliances

EA 2
(2 marks)

Question 2

Any TWO of:

- Limited to such work as the Board may specify
- Limited to work on only approved premises
- Limited to work only in the employ of an approved employer

EA 127(2)(f)
(2 marks)

Question 3

Certification is required for shifting the wall light.

ER 39(1)(b)
(2 marks)

Question 4

Any TWO of:

- Registered line mechanic
- Qualified engineer
- Provisional licence holder
- Person authorised under an employer licence.

ER 39 (4)
(2 marks)

Question 5

- (a) 5% of 230 volts = 11.5 volts
- (b) 5% of 400 volts = 20 volts

ER 53(3)
(2 marks)

Question 6

Any TWO of:

- If in normal use, or in the event of abnormal operation, it functions unsafely so as to cause danger to persons, property, or animals.
ER76A(1)(a)
- If it has inadequate protection against direct contact or indirect contact; or
ER76A(1)(b)
- If its unearthed conductive parts are separated from live parts only by basic insulation.
ER76A(1)(c)
- If the voltage at which the appliances operates is not adequately marked on the appliance; or
ER76A(2)(a)
- If it is used for a use other than its normal use, and is not provided, or used in conjunction, with suitable safeguards; or
ER76A(2)(b)
- If it is constructed that it is not safe under both normal and abnormal conditions of use.
ER76A(2)(c)
- There is a significant risk of injury or death.
ER69(2)
- There is a significant risk of damage to property.
ER69(2)

- They do not offer protection from the ingress of moisture which could result in a hazard of electric shock. ER90(a)
- In the case of electrical appliances, they are proposed to be supplied with electricity from socket outlets in areas that are to be immersed in or splashed with water, and those outlets do not have personal electrical protection, such as an RCD, or such as being supplied by an individual isolating transformer or being supplied at extra-low voltage from an individual transformer. ER90(b)
- Unprotected switchboards are located in damp situations. ER90(c)
- *The characteristics of any fittings are impaired in construction; or* ER87(1)(a)
- *Connections between conductors, and between conductors and other fittings, are not safe and reliable; or* ER87(1)(c)
- *Fittings are installed in such a way that any designed cooling conditions are impaired; or* 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; or* ER87(1)(e)
- *There is insufficient space, access, or lighting to operate, maintain, repair, test, or inspect all fittings of the works or electrical installation, other than cables, in a safe manner.* ER87(1)(h)
(2 marks)

Question 7

Any ONE of:

- They must be insulated for at least 20 metres from the building
- or insulated for their whole length, if the line is less than 20 metres long. ER 92
(2 marks)

Question 8

Any TWO of:

- Provision of a system of earthing in which exposed conductive parts are connected to a protective earthing conductor; and AS/NZS 3000: 1.7.4.3.1(a)

- Disconnection of the fault by an overcurrent protective device or a residual current device (RCD).
AS/NZS 3000: 1.7.4.3.1(b)
- Enclosed fuse-links complying with the appropriate Standard(s) in the AS 2005 series.
AS/NZS 3000: 2.3.2(a)
- Miniature overcurrent circuit-breakers complying with AS 3111 or AS/NZS 4898.
AS/NZS 3000: 2.3.2(b)
- Moulded-case circuit-breakers complying with AS 3947.2.
AS/NZS 3000: 2.3.2(c)
- Residual current devices complying with AS 3190, AS/NZS 3175 or AS/NZS 61009.1.
AS/NZS 3000: 2.3.2(d)
- Any other device having characteristics similar to any of the devices listed in Items (a) to (d) provided that it is not of the automatically reclosing type.
AS/NZS 3000: 2.3.2(e)
(2 marks)

Question 9

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

AS/NZS 3000: 1.8.3.5
(2 marks)

Question 10

Any ONE of:

- 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
- In the case of electrical equipment that is remotely controlled, devices shall be provided for stopping the motors at all points where danger is likely to occur.
AS/NZS 3000 4.2.1.1
(2 marks)

Question 11

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: 4.2.1.2
(2 marks)

Question 12

- (a) Main earthing conductor: 4 mm²

AS/NZS 3000: 5.5.1.2(c)

- (b) Bonding conductor for metal pipes 4 mm²

AS/NZS 3000: 5.8.3.2(a)
(2 marks)

Note: If a candidate answers either (a) or (b) correctly, award 2 marks.

Question 13

Any ONE of:

- An earth electrode, complying with Clause 5.6.2
Note: Instead of writing this, a type of earth electrode listed in clause 5.6.2.2 can be stated. That is – rods or pipes; or tapes or wires; or metallic reinforcement of concrete foundations embedded in the earth.
- An earthing conductor or terminal, provided by the electricity distributor

- The electricity distributor neutral bar or link within the electrical installation (e.g. at meter panel), if required by the electricity distributor.

AS/NZS 3000: 5.6.3.1
(2 marks)

Question 14

Any ONE of:

- Where they are 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
 - 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
- (2 marks)

Question 15

Any ONE of:

- 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
 - *Care may be required with the application of the insulation resistance test to electronic equipment and surge protective devices to prevent damage to the devices.*
AS/NZS 3000: 6.3.3.3.1: Note
- (2 marks)

Question 16

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
- (2 marks)

Question 17

Any TWO of:

- Plugs shall not be able to enter socket-outlets of other voltage systems.

- Socket-outlets shall not accept plugs of other voltage systems. AS/NZS 3000: 7.7.11
- Socket-outlets shall not have a contact for a protective earthing conductor. AS/NZS 3000: 7.7.11
- *Plugs and sockets outlets for SELV and PELV systems shall comply with clause 7.7.11.* AS/NZS 3000: 7.7.11

AS/NZS 3000: 4.9.1.3.2
(2 marks)

Section 2

Question 18

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.
(2 marks)
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
(2 marks)
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.
(2 marks)
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.*
(2 marks)
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.*
(2 marks)
AS/NZS 3000: 6.3.3.2.1

Question 19

- (a) • Relocation of main earth electrode. (1/2 mark)
• The new submain, switchboard, lights, socket outlets in the detached garage. (1/2 mark)
• The shortening of the mains cable and new point of supply. (1 mark)
ER 39 (1) (2)
- (b) The shortening of the mains cable and new point of supply. ER 41 (1) (c) (iii)
(1 mark)
- (c) • A registered electrical inspector.
• A person authorised to inspect that particular kind of work under an employer license.
ER41 (1)
(2 marks)
- (d) AS/NZS 3000
(1 mark)
ER 37(3)

Question 20

(a) Short-circuit and earth fault protection.

ER 62 (3)
(2 marks)

(b) Must be designed, installed, and set. to achieve the maximum practicable sensitivity and minimum practicable operating times in relation to the characteristics of the circuits or other fittings that those fittings protect.

ER 61
(3 marks)

(c) 0.4 seconds (400 milliseconds)

ER 64 (3)
(1 mark)

Question 21

$$\begin{aligned} \text{(a) Motor load} &= \frac{38 \times 10^3}{\sqrt{3} \times 400} \\ &= 54.84 \text{ A} \end{aligned}$$

(1 mark)

From Table 12: - 10 mm² = 58 amps

From Table 27(1) the rating factor for a 75⁰ C conductor temperature @ a 20⁰ C ambient temperature is 1.12

$$= 58 \times 1.12 = 64.96 \text{ A}$$

(1 mark)

Therefore, 10 mm² is the minimum size based on load

(1 mark)

$$\begin{aligned} \text{(b) From Table 42 – 3.86 mV/A.m is for 10 mm}^2 \text{ cable} \\ \text{Volts drop} &= \frac{3.86 \times 54.84 \times 42}{1000} \\ &= 8.89 \text{ V} \end{aligned}$$

(1 mark)

Maximum permissible volt drop is 12V which is 3% of 400 volts

Therefore 10 mm² cable is the minimum size cable based on volt drop

(1 mark)

(c) 10 mm² is the minimum size cable because it satisfies both the load and volt drop requirements.

(1 mark)

Question 22

(a) (i) *Any ONE of:*

- The maximum current the device is designed to carry continuously without deterioration.
- *The maximum level of protection for the circuit.*

General knowledge
(1 mark)

(ii) Utilisation category is a factor (number) by which the current rating can be multiplied to find the operating current of the device.

Or

The ratio between the operating current and the rated current

General knowledge
(1 mark)

(iii) A rating given to the device for the level of prospective short circuit current it is designed to interrupt safely.

General knowledge
(1 mark)

(b) 15 amps (1.6 factor)
16 amps (1.5 factor)
20 amps (1.25 factor)

General knowledge
(1 mark)

(c) Any TWO of:

Final subcircuits that supply:

- Socket-outlets having rated currents not exceeding 63A
- Hand-held Class I equipment
- Portable equipment intended for manual movement during use.

AS/NZS 3000: 1.7.4.3.4
(2 marks)

Question 23

- (a) Any colour except Black, Light Blue, Green or Green/Yellow.

AS/NZS 3000: 3.8.1
(1 mark)

- (b) 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
(1 mark)

- (c) Any FOUR of:

- Material of the conductor and its insulation. AS/NZS 3000 3.7.2.1(a)
- Number and shape of the wires forming the conductor. AS/NZS 3000 3.7.2.1(b)
- Cross-sectional area of the conductor. AS/NZS 3000 3.7.2.1(c)
- Number of conductors to be connected together. AS/NZS 3000 3.7.2.1(d)
- 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)
- 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
- *For connections between insulated conductors the connection shall be insulated to provide a degree of insulation not inferior to that of the conductors.* AS/NZS 3000 3.7.2.2
- *Any damaged insulation shall be reinstated.* AS/NZS 3000 3.7.2.2
- *Connections shall be made so that no loosening is likely due to vibration, alteration of materials or 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. They shall not be soft soldered before clamping under a screw or between metal surfaces.* AS/NZS 3000 3.7.2.4
- *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*

• *Where a soldered connection is used the design shall take account of creep, mechanical stress and temperature rise under fault conditions.*
 - AS/NZS 3000 3.7.2.6*

• *Flexible cords, except where used as fixed wiring, shall not be joined except by means of suitable cable couplers.*
 - AS/NZS 3000 3.7.2.7*

• *Connections between a flexible cord and fixed wiring shall be made in a suitable device containing suitable screwed or crimped terminals.*
 - AS/NZS 3000 3.7.2.7*

• *Any flexible cord shall be installed so that undue stress on its connections due to a pull on the cord is alleviated by a pillar, post, grip, tortuous path, or other effective means. Knotting of the flexible cord shall not be acceptable for this purpose.*
 - AS/NZS 3000 3.7.2.7*

• *Connections or joints in aerial conductors in tension shall be made without soldering.*
 - AS/NZS 3000 3.7.2.8*

• *Connections in underground wiring shall be sealed to prevent the entry of moisture.*
 - AS/NZS 3000 3.7.2.9*

• *In general for tunnel type connections, at least two screws shall be provided to maintain effective clamping of the conductors.*
 - AS/NZS 3000 3.7.2.10*

• *Where soldering is used for the jointing or connection of earthing conductors, the earthing conductors shall be retained in position by acceptable means independently of the solder.*
 - AS/NZS 3000 3.7.2.10*

• *The ends of conductors shall be effectively joined by clamping, soldering or other suitable means.*
- AS/NZS 3000 3.4.3(d)*
(4 marks)

Question 24

- (a) (1) Must be marked.
(2) Must be repaired or replaced not later than 3 months after the finding of the possibility of failure.

ER. 66(4)

or

- (1) As soon as practicable advise the owner or occupier of the property where the danger exists and
(2) Advise the secretary of that danger.

ER 50

- (b) (i) 0.5m
(ii) 0.3m

AS/NZS 3000: Table 3.7
(2 marks)

- (c) (i) 2.7 metres
(ii) 5.5 metres

ECP 34 Table 4

Question 25

- (a)
 - By introducing a loop in the cable immediately before the termination.
 - The size of the loop shall be determined by the cable size and severity of the vibration.

AS/NZS 3000: 3.9.8.3.2
(2 marks)
- (b) (i) 2.5 mm²

AS/NZS 3000: 3.16(e)
(1 mark)
- (ii) *Any ONE of:*
- Hazardous areas

AS/NZS 3000: 3.16(d)
 - *On circuits protected by RCDs*

AS/NZS 3000: 3.16 - Note
(1 mark)
- (iii) MEN system

AS/NZS 3000: 3.16(b)
(1 mark)
- (iv) Where the neutral and earthing conductors are connected to form the MEN connection.

AS/NZS 3000: 3.16(b)
(1 mark)

Question 26

- (a) Adequate space shall be provided around a switchboard on all sides where persons are to pass to enable all electrical equipment to be safely and effectively operated and adjusted.

AS/NZS 3000: 2.9.9

- (b) Any FOUR 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 the space contained by vertical planes 3 m from the centre of a shower rose and extending from the floor to the ceiling.
AS/NZS 3000: 2.9.8.4(d)
- Shall not be installed within or above any zone classified in accordance with Clause 7.2.2 for a swimming pool or spa pool.
AS/NZS 3000: 2.9.8.4(e)
- Shall not be installed within a sauna.
AS/NZS 3000: 2.9.8.4(e)
- Is not permitted to 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)
- *Shall not be installed in storage cupboards where:*
 - *There is not an area set aside for the purpose; and*
 - *It is not separated from the other sections of the cupboard; and*
 - *Can be obstructed by the structure or contents of the cupboard.*AS/NZS 3000: 2.9.8.4(c)
- *Main switchboards installed near automatic fire sprinklers and not suitably protected from the effects of the operation of the sprinkler system which may affect their operation.*
AS/NZS 3000: 2.9.8.4(h)(i)
- *Switchboards from which emergency systems originate in accordance with Clause 7.10 installed near automatic fire sprinklers and not suitably protected from the effects of the operation of the sprinkler system which may affect their operation*
AS/NZS 3000: 2.9.8.4(h)(ii)
- *Shall not be installed in suitable places, which are poorly ventilated and damp.*
AS/NZS 3000: 2.9.8.1(a)

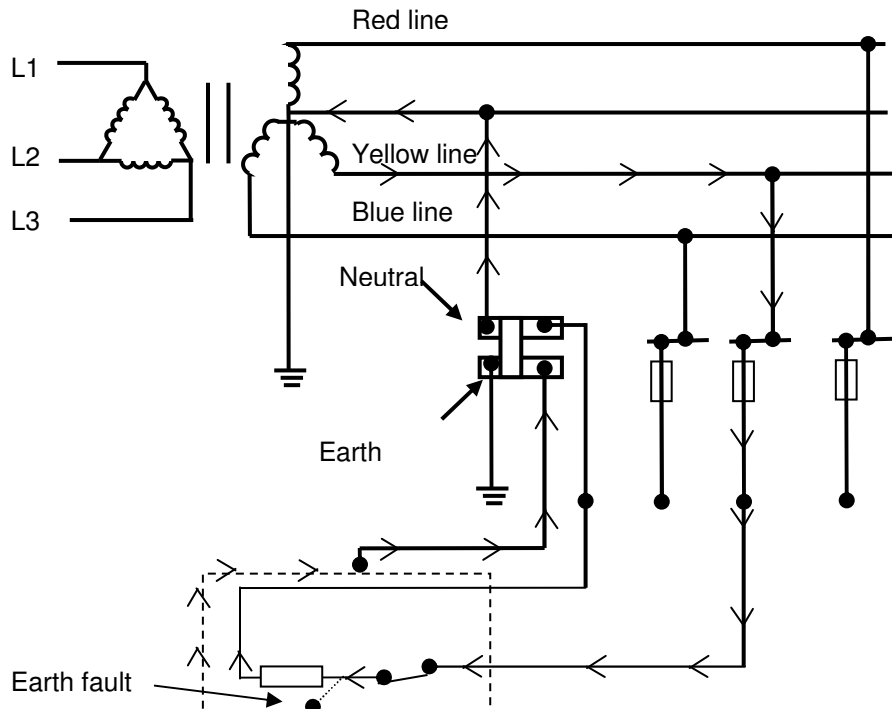
- *Shall not be located where access can be obstructed by the structure or contents of the building or by fittings and fixtures within the building.*
AS/NZS 3000: 2.9.8.1(b)
- *Shall not be located where there is inadequate space provided around a switchboard on all sides where persons are to pass to enable all electrical equipment to be safely and effectively operated and adjusted.*
AS/NZS 3000: 2.9.9
- *Shall not be installed where there are insufficient exit facilities to enable a person to leave the vicinity of a switchboard under emergency conditions.*
AS/NZS 3000: 2.9.10
- *Shall not be located where space is impeded around switchboards.*
AS/NZS 3000: 2.9.10(a)
- *Shall not be located where there is no egress path.*
AS/NZS 3000: 2.9.10(b)
- *Shall not be located where openings or doorways, to allow persons access to the switchboard are less than 0.75 m wide by 1.98 m high.*
AS/NZS 3000: 2.9.10(c)
- *Shall not be located where a switchroom door does not open in the direction of egress without the use, on the switchboard side of the door, of a key or tool.*

Note: For the last 11 bullet points, the candidate must rewrite the requirement in the negative.

(4 marks)

Question 27

(a) Figure B4.1 MEN system (simplified) showing fault (Ia) path



Note: If the parallel path between the installation earth and system earth is also shown, this does not affect the marks awarded.

The path showing:

- * From the fault through the protective earthing conductor, (PE), main earthing terminal bar and MEN link. (1 mark)
- * The neutral-return path, consisting of the neutral conductor, (N), between the main neutral terminal or bar and the neutral point at the transformer. (1 mark)
- * The path through the neutral point of the transformer and the transformer winding. (1 mark)
- * The active conductor as far as the point of the fault. (1 mark)

AS/NZS 3000: B4.3(a), (b), (c), (d)

(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 subcircuitsAS/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.

(2 marks)

Question 28

(a) (i) Three

GK
(1 mark)

(ii) MCBs or HRC fuses

GK
(1 mark)

(c) (i) 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.
- In New Zealand, 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)

(ii) Any ONE of:

- A socket-outlet or a connecting device installed in accordance with Clause 4.11 (c), for the connection of fixed or stationary electric cooking appliances, such as ranges, ovens or hotplates.
- 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 or a luminaire.

AS/NZS 3000: 2.5.3.1
AS/NZS 3000: 2.5.3.2(a)

AS/NZS 3000: 2.5.3.2(b)
(1 mark)

(iii) 30 mA

AS/NZS 3000: 2.5.3.1
(1 mark)