

VERSION 2 - ER 17 – 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) Effectively connected to the general mass of Earth (1 mark)
- (b) In relation to fittings or electrical appliances, means that the fittings or appliances are deliberately disconnected from any source of electricity. (1 mark)
ER2

Question 2

Any TWO of:

- An earth electrode; and
 - An earthing lead; and
 - An earth continuity busbar for the connection of earth continuity conductors within the installation; and
 - Where the installation is operating at standard low voltage, bonding of any available metallic water supply pipes to the earth continuity busbar; and
 - A removable link between the earth continuity busbar and the supply neutral.
- ER86 (1)(a) to (e)
(2 marks)

Question 3

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

ER 53(3)

Question 4

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 5

Any TWO of:

- Provided with adequate mechanical protection to prevent damage.
- Provided with earthed metallic armouring, screen, covering or enclosure.
- Protected by an RCD with a maximum rated residual current of 30 mA.

AS/NZS 3000: 3.9.4.6
(2 marks)

Question 6

Any TWO of:

- 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
(2 marks)

Question 7

- Identified by an orange marker tape positioned above the cable.
- Marker signs where the cable enters or leaves the building

AS/NZS 3000: 3.11.3.4

AS/NZS 3000 3.11.3.5
(2 marks)

Question 8

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 9

2.5 mm²

AS/NZS 3000: Table 5.1
(2 marks)

Question 10

Any TWO of:

- Sprinkler pipes
- Pipes conveying gas.
- Pipes conveying water.
- Pipes conveying flammable liquid.

AS/NZS 3000: 5.6.7.5.1
(2 marks)

Question 11

May operate in one less conductor than the number of conductors in a circuit.

AS/NZS 3000: 7.7.8.2

Question 12

Any ONE of:

- Shall be installed in all active conductors
AS/NZS 3000: 7.7.9
- **Shall be placed at the origin of every circuit.**
AS/NZS 3000: 2.4.1
- **Shall be placed at each point where a reduction occurs in the current-carrying capacity of the conductors.**
AS/NZS 3000: 2.4.1
- **An over current device may be placed at another point in the conductor where protection against short-circuit currents is provided in accordance with Clause 2.4.4.**
AS/NZS 3000: 2.4.3.3(a)
- **An over current device may be placed at another point in the conductor where the conductor is not greater than 3 m in length; and has no branch circuits or socket-outlets; and is constructed in such a way as to exclude all risk of fault as far as can reasonably be expected; and is not located in the vicinity of flammable materials.**
AS/NZS 3000: 2.4.3.3(b)
- **A device providing protection against short-circuit current may be placed at another point in the circuit provided the part of the wiring between that point and the origin of the circuit or the point of reduction in current-carrying capacity is such that—**
 - **its length does not exceed 3 m; and**

- it is protected mechanically or otherwise so that the risk of short-circuit is reduced to a minimum; and
- it is installed in such a manner as to reduce to a minimum the risk of fire or other danger to persons, livestock and property.
- AS/NZS 3000: 2.4.4.4**
- A short-circuit protective device may be placed at any point in a branch conductor provided the corresponding preceding device affords effective protection for the circuit up to that point.

AS/NZS 3000: 2.4.4.4

(2 marks)

Question 13

(a) 30 mA

AS/NZS 3001: 2.3.2.4.5(b)
(1 mark)

(b) 16A and 32A.

AS/NZS 3001: 2.3.2.4.4(b)
(1 mark)

Question 14

Any TWO of:

- Must be multi-stranded, insulated and sheathed.
- Shall have not less than seven strands.
- Must have a cross-sectional area of not less than 1 mm².

AS/NZS 3001: 3.4.1
(2 marks)

Question 15

30 metres

AS/NZS 3001: Table 5.1
(2 marks)

Question 16

Any **TWO** of – from AS/NZS 3760:2001:

- Check for obvious damage or defects in the accessories, connectors, plugs or extension outlet sockets.
- Check that flexible cords are effectively anchored to equipment, plugs and cord extension sockets.
- Check that the inner cores of flexible supply cords are not exposed or twisted;
- Check that the external sheaths are not cut, abraded, twisted, or damaged to such an extent that the insulation of the inner cores is visible
- Check that unprotected conductors or insulation tape are not in evidence.
- Check that any controls are in good working order i.e. they are secure, aligned and appropriately identified.
- Check that covers, guards and the like are secured in the manner intended by the manufacturer or supplier.
- Check that safety facilities and devices are in good working order.
- Check that ventilation inlets and exhausts are unobstructed.

AS/NZS 3760: 2.3.2
(2 marks)

Or

Any **TWO** of – from AS/NZS 3760:2003:

- Check for obvious damage or defects in the accessories, connectors, plugs or extension outlet sockets; and for discolouration that may indicate exposure to heat, chemicals and moisture.
- Check that flexible cords are effectively anchored to equipment, plugs and cord extension sockets.
- Check that the inner cores of flexible supply cords are not exposed or twisted;
- Check that the external sheaths are not cut, abraded, twisted, or damaged to such an extent that the insulation of the inner cores is visible
- Check that unprotected conductors or banding insulation tape are not in evidence.
- Check that any operating controls are in good working order i.e. they are secure, aligned and appropriately identified.
- Check that covers, guards and the like are secured in the manner intended by the manufacturer or supplier.
- Check that ventilation inlets and exhausts are unobstructed.
- The pins of insulated pin plugs should be inspected for damage to the insulation of the pins, and, if fitted, the shroud on cord extension sockets.

AS/NZS 3760: 2.3.2
(2 marks)

Question 17

- (a) Protective earthing conductor continuity test
Max 1 ohm resistance

(1 mark)

AS/NZS 3760: 2001 : 2.3.3.1

AS/NZS 3760: 2003 : 2.3.3.1

- (b) Insulation resistance test
Min 1 Mohm

(1 mark)

AS/NZS 3760: 2001 : 2.3.3.2

AS/NZS 3760: 2003 : 2.3.3.2 and Table 2

Section 2

Question 18

The objective of this question is to test a candidates' ability to work within the parameters given in the providing a supply to a commercial development. It also tests ability to apply and use the information given to arrive at a reasonable solution.

The Tables provided for in the examination paper for this question are extracts from AS/NZS 3008.1.2. The barest of information from that Standard is provided. However, candidates can use the information given with the question or can use the Standard.

If the information provided with the question is used, then solution 1 is the required answer.

However, if the information from AS/NZS 3008.1.2 is used then either solution 2 or solution 3 can be the correct answer. This difference arises because of the following:

- The question states that the ambient temperature is 20°C. However, it is not stated whether this is “ambient air temperature” or “ambient soil temperature”
- If the information is taken as being the “ambient air temperature”, then this can be discounted as it will have no effect on a buried cable. Solution 2 uses this approach.
- If the information is taken as being the “ambient soil temperature”, then the information in Table 27(2) must be considered. Solution 3 uses this approach.

Solution 1 *derived from information given in the examination paper.*

$$\begin{aligned} \text{(a) } V_d &= \frac{mV \times A \times m}{1000} && \text{(1/2 mark)} \\ &= \frac{1.11 \times 170 \times 37}{1000} && \text{(1/2 mark)} \\ &= 6.98 \text{ volts} && \text{(1 mark)} \end{aligned}$$

The cable meets the voltage drop requirements because the maximum V_d permitted is 3% of 400 = 12V. (1 mark)

$$\begin{aligned} \text{(b) From Table 12, column 14, current rating for a } 35 \text{ mm}^2 \text{ cable is } 165 \text{ amps} &&& \text{(1/2 mark)} \\ \text{From Table 27(1) the rating for } 20^\circ\text{C is } 1.12 &&& \text{(1/2 mark)} \\ \text{Therefore, the maximum rating} &= 165 \times 1.12 && \\ &= 184.8 \text{ amps} && \text{(1 mark)} \end{aligned}$$

The load is 170 amps; therefore the cable satisfies the load requirements

Question 19

- (a)
- Insulation, in accordance with Clause 1.7.3.3.
 - Barriers or enclosures, in accordance with Clause 1.7.3.4.
 - Obstacles, in accordance with Clause 1.7.3.5.
 - Placing out of reach, in accordance with Clause 1.7.3.6.

AS/NZS 3000: 1.7.3.2
(2 marks)

- (b)
- IPXXB or IP2X.
 - IP4X for horizontal top surfaces that are readily accessible.

AS/NZS 3000: 1.7.3.4.1
(1 mark)

- (c)
- The use of a key or tool is required.
 - An interlocking device is fitted which requires —
 - (i) switching off, or automatic disconnection, of the supply to all live parts protected by the barrier or enclosure, which might be touched accidentally during or after the removal, opening or withdrawal process; and
 - (ii) the barrier or enclosure to be replaced or closed before the supply can normally be switched on.
 - An intermediate barrier is provided which —
 - (i) prevents contact with all live parts when the barrier or enclosure is removed; and
 - (ii) is permanently in position or arranged so that it is automatically put in position when the barrier or enclosure is removed; and
 - (iii) requires the use of a key or tool to remove such intermediate barrier.

AS/NZS 3000: 1.7.3.4.2
(3 marks)

Question 20

(a) Any TWO of:

- Identified in accordance with clause 7.10.6 to indicate the electrical equipment that they control.
- Marked "IN THE EVENT OF A FIRE, DO NOT SWITCH OFF"
- Identified by colouring or other suitable means in accordance with clause 2.8.3.3.3.
AS/NZS 3000: 7.10.6.2
(2 marks)

(b) • Emergency warning and intercommunication systems.
• Central emergency evacuation lighting systems complying with AS/NZS 2293 series.
AS/NZS 3000: 7.10.2.2
(2 marks)

(c) Any TWO of:

- Separate from main switches used to control other parts of the electrical installation supplying other fire and smoke control equipment, evacuation equipment or lifts.
AS/NZS 3000: 7.10.3.1(a)
- Separate from main switches used to control parts of the general electrical installation.
AS/NZS 3000: 7.10.3.1(b)
- Shall be connected on the supply side of all general electrical installation main switches.
AS/NZS 3000: 7.10.4.1(a)
- Shall not be subject to the control of any general electrical installation main switches.
AS/NZS 3000: 7.10.4.1(b)
- Shall not control electrical equipment that is not regarded as fire and smoke control equipment, evacuation equipment or lifts.
AS/NZS 3000: 7.10.4.1(c)
(2 marks)

Question 21

- (a) • 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.

AS/NZS 3000: 2.9.8.4(c)
(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.

AS/NZS 3000: 2.9.6

or

Barriers and enclosures must provide a degree of protection of at least IPXXB or IPX2 under one of the following conditions:

- **The use of a key or tool is required.**
- **An interlocking device is fitted**
- **An intermediate barrier is provided**

AS/NZS 3000: 1.7.3.4.1 and 2

- 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: 2.9.6
(2 marks)

- (c) 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.

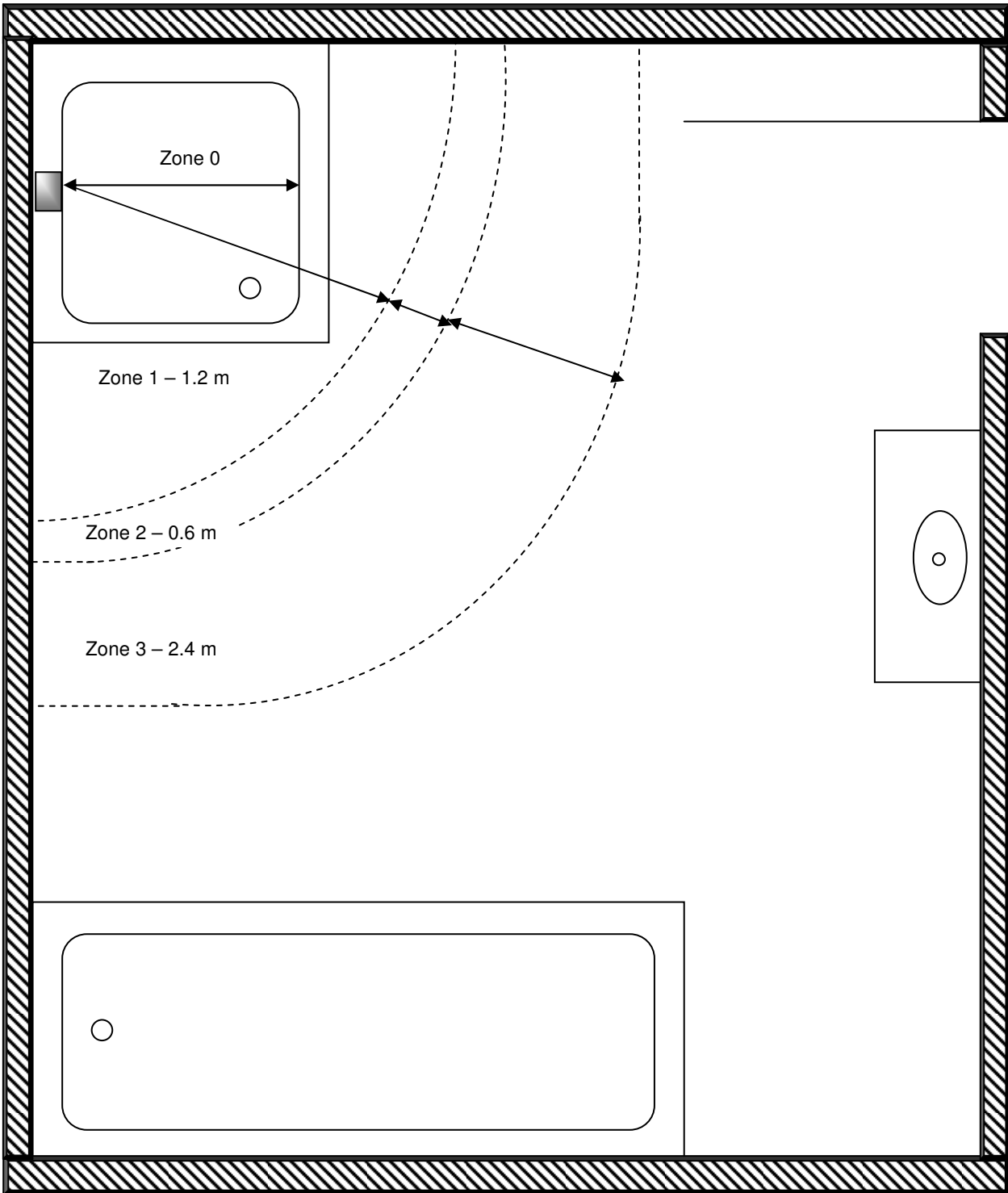
AS/NZS 3000: 2.9.8.3
(1 mark)

- (d) 0.75 m wide by 1.98 m high

AS/NZS 3000: 2.9.10(c)
(1 mark)

Question 22

(a)



- Zone 0 and the correct area shown (1 mark)
 - Zone 1 and the correct dimension stated (1 mark)
 - Zone 2 and the correct dimension stated (1 mark)
 - Zone 3 and the correct dimension stated (1 mark)
- AS/NZS 3000: Figure 7.1A

- (b)
- Specifically intended for use in a bath or water container; and
 - Supplied as an SELV or PELV system in accordance with Clause 7.7 except that —
 - the nominal voltage shall not exceed 12 V a.c. or 30 V ripple-free d.c.; and
 - the supply source shall be installed outside Zone 0.
- AS/NZS 3000: Figure 7.1.4.5
(2 marks)

Question 23

(a) Any THREE of:

- Section 1 of AS/NZS 3000
- Voltage drop
- Current-carrying capacity
- Reliability of connections.

AS/NZS 3000: Table 3.4, Note 1
(3 marks)

- (b)
- Shall have a current-carrying capacity of not less than that of the associated active conductor.
 - Where there is more than one active conductor, shall have a current-carrying capacity of not less than the total current to be carried by such conductors.

AS/NZS 3000: 3.5.2
(2 marks)

(c) Any ONE of:

- The minimum cross-sectional area of the conductor shall be 4 mm².
AS/NZS 3000: 3.4.3(a)
- The conductors shall be of the same material and cross-sectional area.
AS/NZS 3000: 3.4.3(b)
- The conductors shall be approximately the same length and shall follow substantially the same route.
AS/NZS 3000: 3.4.3(c)
- The ends of conductors shall be effectively joined by clamping, soldering or other suitable means.
AS/NZS 3000: 3.4.3(d)
- The current-carrying capacity of conductors shall be taken as the summation of the current-carrying capacities of the individual conductors taking into account the method of installation and applicable derating factors.
AS/NZS 3000: 3.4.3(e)
- The cross-sectional area of the individual conductors shall be sufficient to withstand the prospective fault-current available at the point of installation.
AS/NZS 3000: 3.4.3(f)
- The voltage drop for a circuit in which conductors are connected in parallel shall be taken as the voltage drop in one of the conductors when that conductor is carrying a current determined by dividing the value of current of the circuit determined in accordance with Clause 3.6.2 by the number of conductors in parallel.
AS/NZS 3000: 3.6.3

(1 mark)

Question 24

(a) Any FOUR of:

- Covers shall be able to be opened, where practicable.
- Covers shall be continuous when passing through walls or floors.
- Cable trunking shall be accessible through its entire length.
- Cables installed in a trunking shall not rely on any readily removable cover for support.
- Non-hygroscopic trunking shall be used to enclose insulated cables (without sheath).

AS/NZS 3000: 3.10.3.9
(2 marks)

- (b)
- 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)

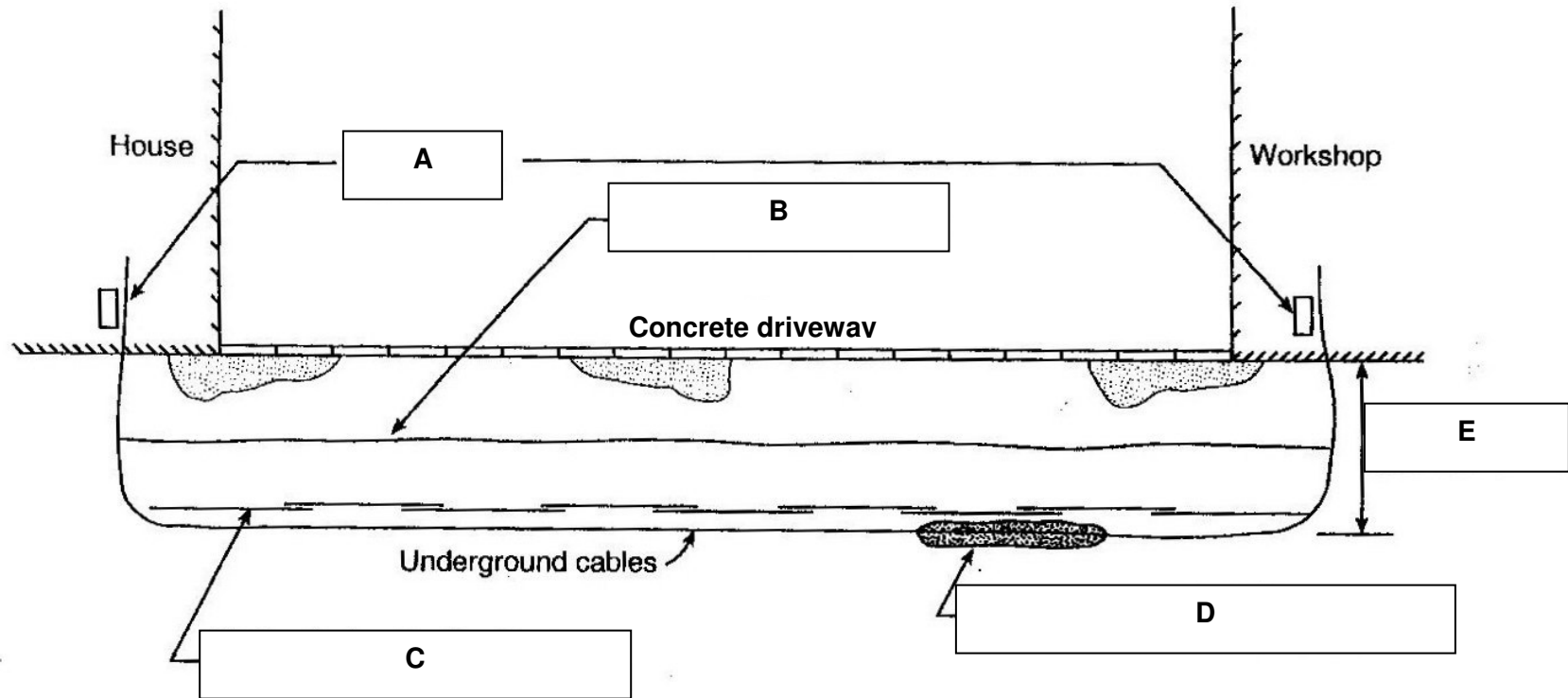
(c) Any TWO of:

- Heavy duty type.
- Non - heavy duty type installed in a suitable wiring enclosure.
- ***With insulation or sheath without fire-resistant properties (e.g. polyethylene insulated or sheathed cables) provided they are installed in fire-resistant enclosures.***

AS/NZS 3000: 3.9.8.4
AS/NZS 3000: 3.9.8.4
AS/NZS 3000: 3.10.1(b)
(2 marks)

Question 25

(a)



Solution 1

- A** Marker signs at either end of cable. AS/NZS 3000: 3.11.3.5
(1/2 mark)
- B**
- Marker tape (1/2 mark)
 - Positioned above or on top of the wiring (1/2 mark)
- AS/NZS 3000: 3.11.3.4
- C**
- Mechanical protection shown (1/2 mark)
 - 75 mm above cables (1/2 mark)
- AS/NZS 3000: 3.11.3.3
- D**
- Bedding material (1/2 mark)
 - 50 mm above and below (1/2 mark)
- AS/NZS 3000: 3.11.3.2
- E** 300 mm (1/2 mark)
AS/NZS 3000: Table 3.7

Solution 2

- A** *Marker signs at either end of cable.* AS/NZS 3000: 3.11.3.5
(1/2 mark)
- B** *Polymeric strip* (1 mark)
AS/NZS 3000: 3.11.3.3(f)
- C**
- *Polymeric strip* (1/2 mark)
 - *75 mm above cables* (1/2 mark)
- AS/NZS 3000: 3.11.3.3
- Note: The answer to “B” can be used as the answer for the 1st bullet point of “C”.*
- D**
- *Bedding material* (1/2 mark)
 - *50 mm above and below* (1/2 mark)

AS/NZS 3000: 3.11.3.2

E 300 mm

(1/2 mark)

AS/NZS 3000: Table 3.7

(b) Any TWO of:

- Shall be spaced not less than 100 mm from other underground services.
- Two or more underground wiring systems may be grouped together where they are associated with the same electrical installation.
- A number of services installed touching in a common trench provided each service is installed in a separate enclosure which identifies the service.

(2 marks)

AS/NZS 3000: 3.11.4

Question 26

(a) Any SIX of:

- New main neutral and earth bars
- The relocated meter box and fittings.
- The new internal mains.
- The new main earth lead.
- The new socket outlet on the outside of the house.
- The additional lights installed in the living areas.
- The additional power points installed in the living areas
- ***The new main switch***

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

(b) All of the work.

ER37(3)
(½ mark)

(c) 20 days

ER40(2)
(½ mark)

- (d)
- The fittings upon which the work has been done have been tested and are electrically safe; and
 - The work has been done in accordance with the Act and these regulations.

ER39(7)
(2 marks)

Question 27

Load Group A(i)

42 lighting points

20 @ 3A

20 @ 2A

2 @ 2A

7A

(1/2 mark)

Load Group A (ii)

3000 watts of outdoor lighting

= $\frac{3000}{230}$

= 13.04A

Total @ 75%

9.78A

(1/2 mark)

(1/2 mark)

Load Group B

20 Double socket outlets

= 40 outlets

18 Single socket outlets

= 58 socket outlets

20 @ 10A

20 @ 5A

18 @ 5A

20A

(1/2 mark)

Load Group C

Electric Range 10 kW

= $\frac{10000}{230}$

= 43.47A

Total @ 50%

21.74A

(1/2 mark)

(1/2 mark)

Load Group E

Instantaneous Water Heater 4kW

= $\frac{4000}{230}$

= 17.39A

Total @ 33.3%

5.79A

(1/2 mark)

(1/2 mark)

Load Group G

Spa Pool 6 kW

= $\frac{6000}{230}$

$$= \frac{230}{26.086 \text{ amps}}$$

(1/2 mark)

$$\text{Total @ 75\%} \quad 19.56\text{A}$$

(1/2 mark)

$$\text{Total loading} = 83.87 \text{ amps}$$

(1 mark)

AS/NZS 3000: Table C1

Question 28

(a) Any FOUR of:

- 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
- Means of switching off shall be provided where mechanical maintenance of electrically-activated equipment might involve a risk of physical injury.
AS/NZS 3000: 2.8.4.1
- 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
- Switching devices for mechanical maintenance shall be clearly indicated where necessary.
AS/NZS 3000: 2.8.4.1
- 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. They need not interrupt all active conductors.
AS/NZS 3000: 2.8.4.2
- Interruption of a control circuit of a drive or the like may occur only where supplementary safeguards, such as mechanical restrainers are provided.
AS/NZS 3000: 2.8.4.2(a)
- Interruption of a control circuit of a drive or the like may occur only where direct interruption of the main supply is achieved by another means.
AS/NZS 3000: 2.8.4.2(a)
- Devices for switching-off for mechanical maintenance, or control switches for such devices, shall require manual operation.
AS/NZS 3000: 2.8.4.2
- The 'OFF' position shall be clearly and reliably indicated.
AS/NZS 3000: 2.8.4.2
- Devices for switching-off for mechanical maintenance shall be designed or installed so as to prevent unintentional closure.
AS/NZS 3000: 2.8.4.2
- Devices for switching-off for mechanical maintenance shall be inserted, where practicable, in the main circuit.
AS/NZS 3000: 2.8.4.3
- A device for switching-off for mechanical maintenance which is located remote from the electrical equipment it controls shall be provided with means for securing it in the open position.
AS/NZS 3000: 2.8.4.3
- Devices for switching-off for mechanical maintenance shall be placed and marked as to be readily identifiable and convenient for their intended use.
AS/NZS 3000: 2.8.4.4
- 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.
AS/NZS 3000: 4.2.1.1

- In the event of a fault in a motor control circuit, the stopping device shall remain effective.
AS/NZS 3000: 4.2.1.1
- Arrangements for emergency stopping of motors shall comply with Clause 2.8.5.
AS/NZS 3000: 4.2.1.1
- 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
- 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
- Where safety might be impaired by incorrect direction of rotation of a motor, suitable measures shall be taken to prevent danger from reversal of the direction of rotation.
AS/NZS 3000: 4.2.1.2

(4 marks)

(b) 0.37 kW

AS/NZS 3000: 4.3.4.1
(1 mark)

(c) Any ONE of:

- For motors associated with emergency systems in accordance with Clause 7.10.9.3
- Where the opening of the motor circuit could create a hazard.
AS/NZS 3000: 4.3.4.2.2
(1 mark)