

(c) Any TWO of:

- Limited to such work as the Board may specify, also the circumstance in which the person may do that work. EA 127(2)(d)
- Limited to work only on approved premises EA 127(2)(d)
- Limited to work only in the employ of an approved employer. EA 127(2)(d)
- Registration suspended for such a period as the Board thinks fit. EA 127(2)(c)
- Registration suspended until passes specified examination EA 127(2)(c)
- Registration suspended until completes specified period of training EA 127(2)(c)
- Registration suspended until attends specified course of instruction. EA 127(2)(c)
(1 mark)

(d) (i) At intervals not exceeding 14 months

ER26(4)
(½ mark)

(ii) At intervals not exceeding 7 months

ER26(4)
(½ mark)

(e) Any ONE of:

- Where the fault current density of conductors 0.5 mm^2 or smaller is greater than 1 amp/mm^2 .
- Where the supply to the installation is derived from the tapping of a stator of an electrical motor or from an auto-transformer.

ER 91 (b) and (c)
(1 mark)

(f) ANY ONE of:

From AS/NZS 3000:2000: 1.7.4.5.2

- Where the circuit is supplied from an isolating transformer complying with AS/NZS 3108
- The source of current is so selected that the output is separated from the input by means of double insulation or equivalent.

OR

From AS/NZS 3000:2007: 7.4.2

- Where the circuit is supplied from an isolating transformer complying with AS/NZS 61558 so that the output is separated from the input by double insulation or equivalent
- A generator output that it is installed so that the output is separated from the frame of the generator

(1 mark)

(g) Any TWO of:

From AS/NZS 3000:2000: 2.3.2

- Enclosed fuse-links (HRC fuses) complying with the appropriate Standard(s) in the AS 2005 series.
- Miniature overcurrent circuit-breakers complying with AS 3111 or AS/NZS 4898.
- Moulded-case circuit-breakers complying with AS 3947.2.
- Residual current devices complying with AS 3190, AS/NZS 3175 or AS/NZS 61009.1.
- Any other device having characteristics similar to any of the devices listed above that it is not of the automatically reclosing type.

Or

From AS/NZS 3000:2007: 2.4.3

- Enclosed fuse-links (HRC fuses) complying with the appropriate Standard(s) in the AS 60269 series.
- Miniature overcurrent circuit-breakers complying with AS/NZS 60898 or AS 3111
- Moulded-case circuit-breakers complying with AS 60947.2.
- Residual current devices complying with AS 3190, AS/NZS 61008.1 or AS/NZS 6009.1.
- Other devices with no automatic reclose function, having characteristics similar to any of the devices listed above.

(1 mark)

(h) Bare conductors

AS/NZS 3000:2000: Table 3.8
AS/NZS 3000:2007: Table 3.8
(1 mark)

(i) (i) From AS/NZS 3000:2000 3.11.3.4

Any ONE of:

- Orange marker tape
- The wiring enclosure is light orange in colour
- Light-orange coloured polymeric cable strip

Or

From AS/NZS 3000:2007 3.11.4.5

- Orange marker tape

(½ mark)

(ii) From AS/NZS 3000:2000 3.11.3.5

- Marker signs where cable enters or leaves a building

Or

From AS/NZS 3000:2007 3.11.4.6

Any ONE of:

- 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.

(½ mark)

(j) Any ONE of:

From AS/NZS 3000:2000

- The resistance of protective earthing conductors shall be low enough to permit the passage of current necessary to operate the protective device.
AS/NZS 3000: 1.11.2.2
- 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

Or

From AS/NZS 3000:2007

- Shall be low enough to permit the passage of current necessary to operate the circuit protective device.
AS/NZS 3000: 8.3.5.2
(1 mark)

(k) (i) Zone 3

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

(ii) Zone 0

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

(l) Any ONE of:

From AS/NZS 3000:2000: 7.5.4.2

- Will not be affected by the method of hosing, materials used, temperature and pressure of the hosing medium.
- Does not provide pockets or channels in which moisture might accumulate or through which it might pass into electrical equipment.

Or

From AS/NZS 3000:2007: 6.7.4.3

- Will not be affected by the method of hosing, materials used, temperature and pressure of the hosing medium.
- Is protected against moisture that might accumulate.
- Does not provide pockets or channels in which moisture might accumulate or through which it might pass into electrical equipment.

(1 mark)

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

The fuses or circuit-breakers shall be installed in all the active conductors.

Or

From AS/NZS 3000:2007: 7.5.9.1

The fuses or circuit-breakers shall be installed in all unearthed conductors.

(1 mark)

(n) Overhead lines and entry points show no insulation deterioration, anchorage rusting, or deterioration of line connector boxes.

NZS 3019: 5(k)

(1 mark)

(o) (i) 4 metres

NZCEP 34: 5.2.1

(½ mark)

(ii) 1 metre

NZCEP 34: Table 6

(½ mark)

- (p) • Isolation transformers
• Optocoupler

NZCEP 35: 5.4.2
(1 mark)

(q) Any TWO of:

- Lower current demand on supply equipment
- Smaller transformers and generators
- Less line losses

GK
(1 mark)

(r) Any TWO of:

- Any metal not normally live could be live at up to 230V.
- If the earth fault path is of high impedance the main fuse may not blow
- The main switch does not isolate the incoming supply for the installation.
- A fire hazard could exist at any high resistance joint in the MEN system or if the neutral bar insulation is inadequate.
- The main neutral is being switched.
- A standard isolation test will not identify that the neutral is connected to the incoming phase.

(GK)
(1 mark)

(s) The power factor.

GK
1 mark)

(t) Any ONE of:

- A Type A RCD
- The RCD is sensitive to residual a.c. current and residual pulsating d.c. current

GK
(1 mark)

Question 2

- (a) (i) NZECP 51 – New Zealand Electrical Code of Practice for Homeowner/Occupier’s Electrical Wiring Work in Domestic Installations.

(½ mark)

GK

(ii) Lighting circuit.	1 mm ²
Socket outlet circuit	2.5 mm ²
Permanently connected dishwasher	2.5 mm ²
Range hob	4 mm ²
Wall oven	4 mm ²

NZECP 51: Table 3
(2½ marks)

- (iii) • Minimum size of 0.75 mm²
• Flexible cord of the sheathed, rounded type

NZECP 51: 5.3.3
(1 mark)

(iv) The lighting circuit	RCCB and MCB	(1 mark)
The socket outlet circuit	RCCB and MCB	(1 mark)
The permanently connected dishwasher	MCB	(½ mark)
The range hob	MCB	(½ mark)
The wall oven	MCB	(½ mark)

GK

- (b) (i) NZS 3019

ER 47(c)(ii)
(½ mark)

- (ii) Any TWO of:

- Earth continuity test
NZS 3019: Appendix B, B4
- Insulation resistance test
NZS 3019: Appendix B, B7
- Earth loop impedance test
NZS 3019: Appendix B, B6
- Polarity test
NZS 3019: Appendix B, B8
(1 mark)

(c) Lighting Circuit	1Ω	AS/NZS 3000:2007: Table 8.2
Or Lighting Circuit	1Ω	NZS 3019: Table 1 (½ mark)
Socket outlet circuit	1Ω	AS/NZS 3000:2007: Table 8.2
Or Socket outlet circuit	0.5Ω	NZS 3019: Table 1 (½ mark)

Question 3

- (a) (i) • In Zone 3 of the bath
AS/NZS 3000:2000 Figure 7.1A(c)
AS/NZS 3000:2007 Figure 6.1
(1 mark)
- In Zone 2 of the shower
AS/NZS 3000:2000 Figure 7.1A(d)
AS/NZS 3000:2007 Figure 6.3
(1 mark)
- (ii) IPX4
AS/NZS 3000:2000 7.1.4.1 (b) or Table 7.1
AS/NZS 3000:2007 6.2.4.5 (b) or Table 6.1
(1 mark)
- (b) (i) In Zone 2 of the bath
AS/NZS 3000:2000 Figure 7.1A(c)
AS/NZS 3000:2007 Figure 6.1
(1 mark)
- In Zone 3 of the shower
AS/NZS 3000:2000: Figure 7.1A(d)
AS/NZS 3000:2007 Figure 6.3
(1 mark)
- (ii) IPX4
AS/NZS 3000:2000 7.1.4.1 (b) or Table 7.1
AS/NZS 3000:2007 6.2.4.5 (b) or Table 6.1
(1 mark)
- (c) (i) In Zone 3 of the bath
AS/NZS 3000:2000 Figure 7.1A(c)
AS/NZS 3000:2007 Figure 6.1
(1 mark)
- Zone 3 of the shower
AS/NZS 3000: 2000: Figure 7.1A(c)
AS/NZS 3000:2007 Figure 6.1
(1 mark)
- (ii) The socket outlet must be:
- (1) Outside the Zone 2 area as depicted in AS/NZS 3000:2000 Figure 7.1C or AS/NZS 3000:2007: Figure 6.10.
(1 mark)
- (2) Protected by a RCD with a maximum rated residual current of 30 mA
AS/NZS 3000:2000: 7.1.4.2(c)
AS/NZS 3000:2007: 6.2.4.1(c)
(1 mark)

Question 4

- (a) (i) The installation does not comply with the Standard because:
- The maximum length of cable (½ mark)
 - for this cable size, and (½ mark)
 - for this protective device (½ mark)
 - exceeds the maximum length permitted (1 mark)
 - by Table B5.1 of AS/NZS 3000:2000 or Table B1 of AS/NZS 3000:2007. (½ mark)
- (ii) • The earth fault loop impedance may be too high. (1 mark)
- The protection will may not operate as required. (1 mark)
GK
- (iii) • Install 100A HRC fuses.
• Install a 125A. Type C circuit breaker.
• Install an RCD in addition to the 125A HRC fuses (3 marks)
GK
- (b) • The gM fuse links will withstand motor starting currents. (1 mark)
- Typically up to 7 times full load current. (1 mark)
GK

Question 5

(a) A 25 mm² is the minimum size cable. (1 mark)

(b) (i) $I_{(FL)} = \frac{P}{\sqrt{3} \times V}$ (1/2 mark)

$= \frac{48,500}{\sqrt{3} \times 400}$ (1/2 mark)

$= 70 \text{ amps}$ (1 mark)

Allowance for growth = $70 + (70 \times 15\%) = 80.5A$ (1 mark)

From table 12, the minimum size cable is 25 mm². The cable is rated for 104 amps. (1 mark)

The correction factor from table 27(1) is 0.94. (1/2 mark)

The cable rating would be $104 \times 0.94 = 97.76A$. (1 mark)

A 25 mm² cable is the minimum size cable that will satisfy the load requirements

(ii) The maximum voltage drop permitted = $400 \times 1.5\% = 6V$ (1 mark)

From table 42, a 25 mm² cable, with an operating temperature of 75 °C, has a 1.54 mV/A.m (1/2 mark)

Voltage drop = $\frac{V/A.m \times \text{amps} \times \text{metres}}{1000}$ (1/2 mark)

$= \frac{1.54 \times 80.5 \times 37.5}{1000}$ (1/2 mark)

$= 4.65V$ (1 mark)

A 25 mm² is the minimum size cable that will satisfy the voltage drop requirements

Question 6

- (a) (i) The supply lead must be connected to the line terminals of an overcurrent circuit breaker.
AS/NZS 3001: 3.2.2(a)
(1 mark)
- (ii) A suitable means of storage for the lead must be provided.
AS/NZS 3001: 3.2.2(iii)
(1 mark)
- (iii) The lead must be rated at not less than the maximum demand of the caravan.
AS/NZS 3001: 3.2.2(iv)
(1 mark)
- (b) • For caravans with one or more RCDs fitted to protect all final subcircuits, a neutral/earth link or connection in the caravan shall not be installed.
• For caravans with an in-line RCD in the supply lead, a neutral/earth link or connection in the caravan shall not be installed and the supply lead shall not be detachable.
• For caravans where any final subcircuit is not protected by an RCDs, a neutral/earth link or connection shall be installed.
NZS 3019: 7.3.10
(3 marks)
- (c) (i) • When one supply source is connected, the second supply source is isolated with respect to all live (active and neutral) conductors in the caravan.
• The changeover switch provides a "break-before-make" action.
NZS 3019: 7.5.1
(2 marks)
- (ii) The neutral connection of the generator or inverter shall only be connected to the earth system of the caravan, when it is supplying the caravan.
NZS 3019: 7.5.2
(2 marks)

Question 7

(a) Any FOUR of:

- Touch voltage in flats may rise to dangerous levels
- High current flow in main earth conductor
- Rise in the supply voltage
- Unstable supply voltage
- Current flow through the MEN system of adjacent installations

GK
(2 marks)

(b) Any TWO of:-

- Determine the prospective short circuit current at the point in an installation
- Determine that the correct type and current rating of circuit protection is installed
- Determine the fault loop impedance of the circuit

GK
GK
GK
(2 marks)

(c) 25 mm² copper

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

AS/NZS 3000:2000: Table 5.1
AS/NZS 3000:2007: Table 5.1
(1 mark)

$$(d) (i) \text{ MVA} = \frac{200}{1000} \times \frac{100}{5}$$

$$= 4\text{MVA}$$

(1/2 mark)

(1 mark)

or

$$\text{kVA} = \frac{200 \times 100}{5}$$

$$= 4000\text{kVA}$$

$$(ii) \text{ I}_{sc} = \frac{4000\text{kVA}}{\sqrt{3} \times 400\text{v}}$$

$$= 5.77\text{kA}$$

(1/2 mark)

(1 mark)

(e) (i) The current in the cable between the switchboard and the motor reduces.
(1 mark)

(ii) The thermal overloads need to be reset to the reduced value.

(1 mark)

GK

Question 8

The heaviest loaded phase must have 3 residences connected to it.

However, the interpretation of Table C1, column 3 means that there are 2 different solutions that can be provided because there are 2 possible solutions each for load groups A and C. These are:

- Load group A 6A (total for all three units)
- Load group C 15A (total for all three units)

- Load group A 18A (6A for each unit)
- Load group C 45A (15A for each unit)

Solution 1

- Load group A 18A (6A for each unit)
- Load group C 45A (15A for each unit)

Load Group	Calculation	Load (A)	
<u>Group A</u>			
Lighting	6.0×3	18	(1 mark)
<u>Group B</u>			
Socket outlets	$10 + (5.0 \times 3)$	25	(1 mark)
<u>Group C</u>			
Oven	15.0×3	45	(1 mark)
<u>Group D</u>			
Air conditioning	$3000 \div 230 \times 0.75 \times 3$	29.35	(1½ marks)
<u>Group F</u>			
Storage water heater	6×3	18	(1 mark)
Heaviest loaded phase		135.35	(1½ marks)

(b) From Table 12 the rating for 35 mm² is 165 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 35 mm² cable is:

$$= 165 \times 0.95$$

$$= 156.75A \quad (1 \text{ mark})$$

Therefore, a 35 mm² cable will satisfy the load requirements. (1 mark)

Solution 2

- Load group A 6A (total for all three units)
- Load group B 25A (total for all three units)
- Load group C 15A (total for all three units)

Load Group	Calculation	Load (A)	
<u>Group A</u>			
Lighting	6.0	6	(1 mark)
<u>Group B</u>			
Socket outlets	$10 + (5.0 \times 3)$	25	(1 mark)
<u>Group C</u>			
Oven	15.0	15	(1 mark)
<u>Group D</u>			
Air conditioning	$3000 \div 230 \times 0.75 \times 3$	29.35	(1½ marks)
<u>Group F</u>			
Storage water heater	6×3	18	(1 mark)
Heaviest loaded phase		93.35	(1½ marks)

(b) From Table 12 the rating for 16 mm² is 106 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 16 mm² cable is:

$$\begin{aligned}
 &= 106 \times 0.95 \\
 &= 100.7A
 \end{aligned}$$

(1 mark)

Therefore, a 16 mm² cable will satisfy the load requirements. (1 mark)

Question 9

- (a) (i) • Yes, because it is a requirement of AS/NZS 3000: 2000: 2.5.3.1 or AS/NZS 3000:2007: 2.6.3.1. (1 mark)
- The final subcircuits supply the lights operate at low voltage GK (1 mark)
- (ii) • No. AS/NZS 3000:2000: 2.5.3.2 does not require such circuits to be RCD protected.
- Or
- Yes. AS/NZS 3000:2007: 2.6.3.1(c) requires such circuits to be RCD protected. (1 mark)
- (b) (i) • No. NZECP 54: 2.1.2(b) does not permit this. (1 mark)
- The installation of the luminaries shall not degrade structural building elements. (1 mark)
- (ii) • They can be installed provided the lampholder of the luminaire (1 mark)
- is a least 500 mm from any building element. (1 mark)
- NZECP 54: 2.3.2
- (iii) It can be modified by the installation of a heat dispersal cover (1 mark)
- that is rated CA or CS is accordance with the manufacturer's instructions (1 mark)
- NZECP 54: Table 1 and 3.5.3
- (iv) They can be installed if a purpose built box or structure is mounted over the luminaire. NZECP 54: 2.6.3 (1 mark)