

ER 90 – 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.

Question 1	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
<p>(a) Any ONE of:</p> <ul style="list-style-type: none"> • If, at the time it is first made available for use by the hirer, lessee or occupier, it is supplied with electricity through a portable RCD, or through a circuit protected by an electrically safe RCD that provides protection from electric shock. • If it is part of an installation and it complies with AS/NZS 3019 • If it complies with AS/NZS 3820 • If it it complies with whichever official standard listed in Schedule 4 applies to the fitting or appliance. • In relation to an appliance imported into New Zealand in purported compliance with the Conformity Cooperation Agreement, it complies with the requirements of that Agreement. • If it is a used appliance it has been disabled and marked in accordance with AS/NZS 4701 • If it is a used appliance in the case of a used electrical medical device, it is tested and marked in accordance with AS/NZ 3551 	(2 marks)	<p style="text-align: center;">ESR 26(3)(b)</p> <p style="text-align: center;">ESR 26(4)</p> <p style="text-align: center;">ESR 80(2)(a)(i) ESR 80(2)(a)(ii)</p> <p style="text-align: center;">ESR 80(2)(b)</p> <p style="text-align: center;">ESR 80(3)(b)</p> <p style="text-align: center;">ESR 80(3)(c)</p>	
<p>(b) Any TWO of:</p> <ul style="list-style-type: none"> • Low voltage domestic installations with a maximum demand at or below 80A per phase if single-phase • Low voltage domestic installations with a maximum demand at or below 50A per phase if multi-phase • An installation or part installation intended for use with electrical medical devices. • An installation or part installation in a hazardous area. • A connectable installation or part of a connectable installation in a mobile electrical facility. • A connectable installation or part of a connectable installation in a 	(2 marks)	<p style="text-align: center;">ESR 59(1)(a)</p> <p style="text-align: center;">ESR 59(1)(b)</p> <p style="text-align: center;">ESR 60(1)(a)</p> <p style="text-align: center;">ESR 60(1)(b)</p> <p style="text-align: center;">ESR 60(1)(c)</p> <p style="text-align: center;">ESR 60(1)(d)</p>	

Question 1	Marks	Reference	Marking notes
<ul style="list-style-type: none"> • pleasure vessel. • All other connectable installation or parts of connectable installation • A site installation or part of a site installation that is in a marina • A site installation or part of a site installation that is in a show or carnival. • A site installation or part of a site installation that is intended to supply connectable installations in mobile electrical facilities a show or carnival. • A site installation or part of a site installation that is intended to supply other connectable installations. 		<p style="text-align: center;">ESR 60(1)(e)</p> <p style="text-align: center;">ESR 60(1)(f)(i)</p> <p style="text-align: center;">ESR 60(1)(f)(ii)</p> <p style="text-align: center;">ESR 60(1)(f)(iii)</p> <p style="text-align: center;">ESR 60(1)(f)(iv)</p>	
<p>(c) Any TWO of:</p> <ul style="list-style-type: none"> • It was issued no earlier than 6 months before the date of reconnection. • It certifies that the installation is suitable for continued use. • It is given by a person authorised to certify mains work • A person reconnecting or restoring supply to an installation or part installation is entitled (if acting in good faith) to rely on a written confirmation by the owner of the installation or part installation that no general or high-risk prescribed electrical work has been done on it since it was last disconnected or isolated. • It is given by a person authorised to inspect high-risk prescribed electrical work • It is given by a person authorised to inspect high-risk prescribed under an employer licence. 	(2 marks)	<p style="text-align: center;">ESR 74(2)(a)</p> <p style="text-align: center;">ESR 74(2)(b)</p> <p style="text-align: center;">ESR 74(2)(c)</p> <p style="text-align: center;">ESR 74(3)</p> <p style="text-align: center;">ESR 71(1)(a)</p> <p style="text-align: center;">ESR 71(1)(b)</p>	

Question 1	Marks	Reference	Marking notes
(d) (i) AS/NZS 3001.	(1 mark)	ESR 78(2)	
(ii) AS/NZS 3004.2	(1 mark)	ESR 78(2)(a)	
(e) Any ONE of: <ul style="list-style-type: none"> • The neutral conductor shall be marked at switchboards to identify associated active conductors in accordance with clause 2.9.5.5. • Where a common neutral; is used for two or more different circuits it shall be legibly and permanently marked to identify the associated active conductors. 	(2 marks)	AS/NZS 3000 2.2.1.2(c) AS/NZS 3000 2.9.5.5	
(f) Any ONE of: <ul style="list-style-type: none"> • All cables or each conductor of a multicore cable are insulated for the highest voltage present. • Conductors of different safety services shall not be incorporated with each other or of any other system with a multi-core cable. 	(2 marks)	AS/NZS 3000 3.9.8.3(b) AS/NZS 3000 7.2.8.3	
<ul style="list-style-type: none"> • All live parts of a separated circuit shall be reliably and effectively electrically separated from all other circuits, including other separated circuits and earth. • Live parts of SELV and PELV circuits shall be electrically separated from each other and from other higher voltage circuits. 		AS/NZS 3000 7.4.3(b) AS/NZS 3000 7.5.4	

Question 1	Marks	Reference	Marking notes
(g) Any TWO of: <ul style="list-style-type: none"> • Shall be so located as to be easily operated by the person in charge of the motor. • Shall be provided where danger is likely to occur because of the presence of moving parts. • The stopping device shall remain effective in the event of a fault in a motor-control circuit. • Where electrical equipment is remotely controlled devices shall be provided for stopping motors at all points where danger is likely to occur. • Arrangements for emergency stopping of motors shall comply with clause 2.3.5. 	(2 marks)	AS/NZS 3000 4.13.1.3	
(h) Any ONE of: <ul style="list-style-type: none"> • To minimize the risk associated with the occurrence of voltage differences between exposed conductive parts of electrical equipment and extraneous conductive parts • To bring exposed conductive parts or extraneous parts to the same or approximately the same potential. • Bonding of extraneous conductive parts and their connection to the earthing system may be used to reduce the earth fault-loop impedance. • To avoid any potential differences that may occur between electrical equipment connected to the electrical installation earthing system and any conductive piping that may independently be in contact with the mass of earth. 	(2 marks)	AS/NZS 3000: 5.6.1 AS/NZS 3000: 1.4.52 AS/NZS 3000 1.5.5.3(e)	
(i) (i) 16 A Type C MCB	(1 mark)	AS/NZS 3000 Table 8.2	
(ii) 20 A HRC fuse	(1 mark)	AS/NZS 3000 Table 8.1	

Question 1	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
<p>(j) Any ONE of:</p> <ul style="list-style-type: none"> • To confirm that the resistance of the protective earth circuit is sufficiently low to ensure the correct operation of the circuit protecting device. • The resistance to earth from protectively earthed parts in Class I equipment has to be low enough to permit adequate fault current to flow to earth, thereby ensuring that the overcurrent protection device in the final sub-circuit (that is, fixed wiring) opens quickly in the event of insulation failure. 	(2 marks)	<p>AS/NZS 3760 2.3.3.1</p> <p>AS/NZS 3760 Appendix A4</p>	

Question 2	Marks	Reference	Marking notes
<p>(a) The light switch can be installed:</p> <ul style="list-style-type: none"> • On the east wall inside the bathroom • On the east wall outside the bathroom • A motion sensor or ceiling switch on the ceiling, just inside the door. A switch just outside the door. <p>Any ONE of:</p> <ul style="list-style-type: none"> • (i) On the east wall inside the bathroom. (1 mark) (ii) Zone 3 of the shower (1 mark) (iii) The switch has no IP rating (1 mark) • (i) On the east wall outside the bathroom. (ii) Outside a Zone (iii) The switch has no IP rating • (i) A motion sensor or ceiling switch on the ceiling, just inside the door. A switch just outside the door. (ii) Outside a Zone (iii) The switch has no IP rating 		<p>AS/NZS 3000 Figure 6.7 AS/NZS 3000: 6.2.4.1(c)</p> <p>AS/NZS 3000 Figure 6.7 AS/NZS 3000: 6.2.4.1(c)</p> <p>AS/NZS 3000 Figure 6.7 AS/NZS 3000: 6.2.4.1(c)</p>	<p>AS/NZS 3000: Table 6.1 can be used as a reference source</p>
<p>(b) (i) Any ONE of:</p> <ul style="list-style-type: none"> • The south wall. • The east wall <p>(ii) Zone 3 of the shower</p> <p>(iii) The heated towel rail and permanent connection unit have no IP rating</p>	<p>(1 mark)</p> <p>(1 mark)</p> <p>(1 mark)</p>	<p>AS/NZS 3000 Figure 6.7</p> <p>AS/NZS 3000: 6.2.4.5(b)</p>	<p>AS/NZS 3000: Table 6.1 can be used as a reference source</p>
<p>(c) (i) Any ONE of:</p> <ul style="list-style-type: none"> • The south wall. • The west wall, south of the sink <p>(ii) Zone 3 of the shower</p> <p>(iii) The socket outlet has no IP rating</p>	<p>(1 mark)</p> <p>(1 mark)</p> <p>(1 mark)</p>	<p>AS/NZS 3000 Figure 6.7</p> <p>AS/NZS 3000: 6.2.4.1(c)</p>	<p>AS/NZS 3000: Table 6.1 can be used as a reference source</p>

Question 2	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
(iv) The socket outlet must be at least 0.3m above the floor.	(1 mark)	AS/NZS 3000: 6.2.4.2	

Question 3*Marks**Reference**Marking notes*

Solution 1

Equipment	Load Group	Calculation	Load (A)	
50 8W LED lights	A	$(50 \times 8 \times 0.75) \div 230 = 1.3$	1.3	(1 mark)
10 75W fluorescent lights	A	$(10 \times 75 \times 0.75) \div 230 = 2.45$	2.45	(1 mark)
4 metres Lighting track	A	$4 \times 0.5 = 2 \times 0.75$	1.5	(1 mark)
5 10A double socket outlets 20 10A single socket outlets	B(i)	$10 + 20 = 30$ $(1000 + (29 \times 400)) \div 230 = 54.78$	54.78	(1½ marks)
1 8 kW gas/electric cooker	C	$8000 \div 230 = 34.78$	34.78	(1½ marks)
1 6 kW air conditioner	C	$(6000 \times 0.5) \div 230 = 13.04$	13.04	(1½ marks)
2 4 kW space heaters	G	$8000 \div 230 = 34.78$	34.78	(1½ marks)
Total			142.63	(1 mark)

Solution 2

Equipment	Load Group	Calculation	Load (A)	
50 8W LED lights	A	$(50 \times 8 \times 0.75) \div 230 = 1.3$	1.3	(1 mark)
10 75W fluorescent lights	A	$(10 \times 75 \times 0.75) \div 230 = 2.45$	2.45	(1 mark)
4 metres Lighting track	A	$4 \times 0.5 = 2 \times 0.75$	1.5	(1 mark)
5 10A double socket outlets 20 10A single socket outlets	B(i)	$10 + 20 = 30$ $(1000 + (29 \times 100)) \div 230 = 16.96$	16.96	(1½ marks)
1 8 kW gas/electric cooker	C	$8000 \div 230 = 34.78$	34.78	(1½ marks)
1 6 kW air conditioner	C	$(6000 \times 0.5) \div 230 = 13.04$	13.04	(1½ marks)
2 4 kW space heaters	G	$8000 \div 230 = 34.78$	34.78	(1½ marks)
Total			104.81	(1 mark)

AS/NZS 3000: Table C2: Column 2

Accept solutions that are with 3 A (above or below) of the total.

Question 4	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
(a) (i) A certificate of compliance	(1 mark)	ESR 65(1)	
(ii) The person authorised to issue the certificate (that is, registered electrician).	(1 mark)	ESR 68(a)	
(iii) When the certificate of compliance has been issued for the work.	(1 mark)	ESR 65(3)	
(iv) • When the certificate of compliance has been issued for the work.	(1 mark)	ESR 65(4)	
• When the record of inspection has been issued for the work.	(1 mark)	ESR 65(4)	
(b) (i) An electrical safety certificate.	(1 mark)	ESR 74A(1)	
(ii) The installation is safe to use, on the grounds that is electrically safe and complies with the regulations.	(1 mark)	ESR 74A(1)(a)	
(iii) The work is complete only once the installation is connected to the power supply.	(1 mark)	ESR 74A(2)	
(iv) To the person who contracted for the prescribed electrical work.	(1 mark)	ESR 74G(1)(a)	
(c) Section 8 of AS/NZS 3000	(1 mark)	ESR 59(2)(a)	

Question 5	Marks	Reference	Marking notes
<p>(a) Any ONE of:</p> <ul style="list-style-type: none"> • Provide control or isolation of the electrical installation circuits or individual items of apparatus as required for the maintenance, testing, fault detection or repair. • Enable automatic disconnection of supply in the event of an overload, short-circuit, or excess earth leakage current in the protected part of the electrical installation. • Provide protection of the electrical installation against failure from overvoltage or undervoltage conditions. • Provide for switchgear and controlgear to be grouped and interconnected on switchboards, enclosed against external influences and located in accessible positions. • Separately control and protect the circuit arrangements without affecting the reliability of supply to, or failure of, other parts of the installation. • Electrical installations shall be provided with devices to prevent or remove hazards associated with the electrical installation and for maintenance of electrically operated equipment. • Electrical installations shall include all switching devices or other means of disconnection necessary to enable operations, repairs and maintenance work to be carried out with safety. • Every circuit shall be capable of being isolated from each of the supply conductors in accordance with clause 2.3.2.1.1 or 2.3.2.1.2 as appropriate. • Provision shall be made to enable isolation of electrical equipment and to prevent electrical equipment from being inadvertently energized. 	(2 marks)	<p>AS/NZS 3000: 2.1.2(a)</p> <p>AS/NZS 3000: 2.1.2(b)</p> <p>AS/NZS 3000: 2.1.2(c)</p> <p>AS/NZS 3000: 2.1.2(d)</p> <p>AS/NZS 3000: 2.1.2(e)</p> <p>AS/NZS 3000: 2.3.1.</p> <p>AS/NZS 3000: 2.3.1.</p> <p>AS/NZS 3000: 2.3.2.1</p> <p>AS/NZS 3000: 2.3.2.1</p>	

Question 5	Marks	Reference	Marking notes
<ul style="list-style-type: none"> • The means of isolation shall be such that a deliberate action in addition to the normal method of operation is required to energise the circuit. • Where an item of equipment or enclosure contains live parts connected to more than one supply, a notice shall be placed in such a position that any person gaining access to live parts will be warned of the need to isolate those parts from the various supplies. 		AS/NZS 3000: 2.3.2.1 AS/NZS 3000: 2.3.2.1	
(b) Any ONE of: <ul style="list-style-type: none"> • Shall be selected and installed to be suitable for the design current, taking into account any capacitive, inductive and harmonic effects. • Shall be selected and installed to be suitable for the current likely to flow in abnormal conditions for such periods of time as are determined by the characteristics of the protective devices concerned. 	(2 marks)	AS/NZS 3000: 2.2.4.3(a) AS/NZS 3000: 2.2.4.3(b)	
(c) Any TWO of: <ul style="list-style-type: none"> • Circuit-breakers incorporating short-circuit and overload releases. • Fuse combination units (CFS units). • Fuses having enclosed fuse links (HRC fuses). • Circuit-breakers in conjunction with fuses. 	(2 marks)	AS/NZS 3000: 2.5.2(a) AS/NZS 3000: 2.5.2(b) AS/NZS 3000: 2.5.2(c) AS/NZS 3000: 2.5.2(d)	
(d) Any TWO of: <ul style="list-style-type: none"> • Enclosed fuse-links complying with the appropriate Standard(s) in the AS 60269 series. • Miniature overcurrent circuit-breakers complying with AS/NZS 60898 or AS/NZS 3111 • Moulded-case circuit-breakers complying with AS 60947.2. • Fixed setting RCDs complying with AS 3190, AS/NZS 61008.1 or AS/NZS 61009.1. 	(2 marks)	AS/NZS 3000 2.4.3(a) AS/NZS 3000 2.4.3(b) AS/NZS 3000 2.4.3(c) AS/NZS 3000 2.4.3(c)	
(e) Any ONE of: <ul style="list-style-type: none"> • The live parts are arranged so that 	(2 marks)	AS/NZS 3000 2.9.3.1	

Question 5	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
<p>basic protection is provided by barriers in accordance with the provisions of clause 1.5.4.4.</p> <ul style="list-style-type: none"> • The switchboard is installed in an area that is accessible only to authorised persons and the means of access to such areas is provided with facilities for locking. 		<p>Exception 1</p> <p>AS/NZS 3000 2.9.3.1 Exception 1</p>	

Question 6	Marks	Reference	Marking notes
(a) (i) • Type A. (ii) • Tripping is ensured for residual sinusoidal alternating currents. • Tripping is ensured for residual pulsating direct currents.	(1 mark) (1 mark) (1 mark)	AS/NZS 3000 2.6.2.2 Note 1(b) AS/NZS 3000 2.6.2.2 AS/NZS 3000 2.6.2.2	
(b) Any ONE of: <ul style="list-style-type: none"> • Not less than the maximum demand of the portion of the electrical installation being protected by the device. • Not less than the highest current rating of any overload device on the portion of the electrical installation being protected. 	(1 mark)	AS/NZS 3000: 2.6.2.1(a) AS/NZS 3000: 2.6.2.1(b)	
(c) Additional protection by RCDs as required by Clause 2.6 shall be provided for the final subcircuits supplied from that switchboard.	(2 marks)	AS/NZS 3000 2.6.3.4	
(d) Two	(1 mark)	AS/NZS 3000 2.6.2.4(a)	
(e) Three	(1 mark)	AS/NZS 3000 2.6.2.4(b)	
(f) Any TWO of: <ul style="list-style-type: none"> • Where socket outlets of lighting points that are not RCD protected are replaced. • Extensions to final subcircuits supplying lighting points only. • Where socket-outlets are added to an existing subcircuit under circumstances where an exception from either clause 2.6.3.1 or clause 2.6.3.2 applies. 	(2 marks)	AS/NZS 3000 2.6.3.4 Exception 1 AS/NZS 3000 2.6.3.4 Exception 2 AS/NZS 3000 2.6.3.4 Exception 3	

Question 6	<i>Marks</i>	<i>Reference</i>	<i>Marking notes</i>
<ul style="list-style-type: none"> • This requirement does not apply in medical treatment areas such as home dialysis installations detailed in AS/NZS 3003. • This need not apply to a socket outlet or a connecting device specifically for the connection of a fixed or stationary electric cooking appliance such as a range, oven, or hotplate unit, provided that the socket outlet is located in a position that is not likely to be accessed for general purposes. • This need not apply to a socket outlet or a connecting device specifically for the connection of a fixed or stationary electric cooking appliance such as a range, oven, or hotplate unit, provided that the socket outlet is clearly marked to indicate the restricted purpose of the socket outlet and that RCD protection is not provided. 		<p>AS/NZS 3000 2.6.3.1 Exception 1</p> <p>AS/NZS 3000 2.6.3.1 Exception 3(a)</p> <p>AS/NZS 3000 2.6.3.1 Exception 3(b)</p>	

Question 7	Marks	Reference	Marking notes
(a) • Automatic disconnection of supply on the occurrence of a fault.	(1 mark)	AS/NZS 3000: 1.5.5.2(a)	
• Use of electrical separation (isolation) of the supply	(1 mark)	AS/NZS 3000: 1.5.5.2(c)	
(b) • Automatic disconnection Any ONE of:	(2 marks)		
* 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.			GK
* Automatically disconnect the supply on the occurrence of a faulty likely to cause a current flow through a body in contact with exposed conductive parts, where the values of that current is equal to or greater than the shock current in accordance with clause 1.5.5.3		AS/NZS 3000: 1.5.5.2(a)	The first paragraph of 1.5.5.3(a) and the first paragraph of 2.4.2 are effectively the same as this.
* This method of protection shall be achieved by:		AS/NZS 3000: 1.5.5.3(a)	The second paragraph of 2.4.2 is effectively the same as this.
- Provision of a system of equipotential bonding in which exposed conductive parts are connected to a protective earthing conductor.			
- Disconnection of the fault by a protective device.			
• Electrical separation Any ONE of:	(2 marks)		
* 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.			GK
* Protection by electrical separation is intended, in an individual circuit, to prevent shock current through contact with exposed conductive parts that might be energised by a fault in the basic insulation of that circuit.		AS/NZS 3000: 1.5.5.5	

Question 7	Marks	Reference	Marking notes
(c) • Automatic disconnection Any ONE of: <ul style="list-style-type: none"> - 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. 	(2 marks)	AS/NZS 3000 8.3.9 AS/NZS 3000 8.3.10.2(b)	
• Electrical separation Any ONE of: <ul style="list-style-type: none"> - 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. - Separation shall be verified by measurement of the insulation resistance between the separated circuit and: <ul style="list-style-type: none"> * If a transformer is the source of the separated supply, the transformer primary winding. * Any other wiring. * Any other separated circuit. * Earth Insulation resistance values obtained shall not be less than 1 MΩ , when tested at a voltage of 500 V d.c.	(2 marks)	AS/NZS 3000 8.3.6 AS/NZS 3000 7.4.7.1	An answer from Appendix F of AS/NZS 3760 would also suffice.

Question 8	Marks	Reference	Marking notes
(a) (i) The impedance shall be in accordance with that required for a copper earthing conductor determined in accordance with clause 5.3.3.	(2 marks)	AS/NZS 3000 5.5.4.3	Accept answers relating to size and/or resistance or the calculation thereof from: - clause 5.3.3 - clause 5.7.4 - table 8.1
(ii) Any ONE of: <ul style="list-style-type: none"> • Shall be made automatically, before the live connections are made, when any plug portion is inserted in the corresponding socket outlet. • Shall be broken automatically, not before the live connections are broken, when any plug is withdrawn from the corresponding socket outlet 	(2 marks)	AS/NZS 3000 5.5.4.4(a) AS/NZS 3000 5.5.4.4(b)	
(b) Any ONE of: <ul style="list-style-type: none"> • The exposed conductive parts of electrical equipment supplied by flexible cord or flexible cable shall be earthed by connection to a protective earthing conductor incorporated with the associated live conductors in the sheath, braid or enclosure of the supply cord or cable • The minimum size of a protective earthing conductor in the form of a cable, flexible cable or flexible cord shall be selected in accordance with clause 5.3.3.1.2. • The minimum size of a copper earthing conductor in the form of a single-core insulated cable, flexible cable or flexible cord shall be 2.5 mm². • The minimum size of an earthing conductor incorporated with associated live conductors in a sheathed multi-core cable or flexible cable shall be 1 mm². 	(2 marks)	AS/NZS 3000 5.5.3.3 AS/NZS 3000 5.3.3.4 AS/NZS 3000 5.3.3.4(a) AS/NZS 3000 5.3.3.4(b)	

Question 8	Marks	Reference	Marking notes
<ul style="list-style-type: none"> • The minimum size of an earthing conductor incorporated with associated live conductors in the sheath of a multi-core flexible cord shall be not less than the cross-sectional area of the largest associated active conductor provided that: <ul style="list-style-type: none"> * the cross-section area of the largest active conductor in the flexible cord is more than 0.5 mm² and less than 2.5mm². * The flexible cord is used to supply a hand-held or portable appliance. 		AS/NZS 3000 5.3.3.4(c)	
<p>(c) Any ONE of:</p> <ul style="list-style-type: none"> • Where electrical equipment situated in a classified zone is required to be earthed All extraneous conductive parts in Zone 0, 1 and 2 shall be connected together by equipotential bonding conductors and connected to the protective earthing conductor of the electrical equipment in accordance with clause 5.6.2.6. • The exposed conductive part of any electrical equipment in a classified pool zone. • Any exposed conductive parts of electrical equipment that are not separated from live parts by double insulation and that are in contact with the pool water, including water in the circulating or filtering system • Any conductive fittings within or attached to the pool such as pool ladders or diving boards. • Any fixed conductive material within arm's reach of the pool edge such as conductive fences, lamp standards and pipework. • Where the pool structure is conductive, all extraneous conductive parts, including the reinforcing metal of the pool, shell or deck shall be connected to an equipotential bonding connection point complying with clause 6.2.6.2.4. • A connection point shall be provided at the swimming pool location for the bonding connection 	(2 marks)	AS/NZS 3000 6.3.3.2 AS/NZS 3000 5.6.2.6.1(a) AS/NZS 3000 5.6.2.6.1(b) AS/NZS 3000 5.6.2.6.2(a) AS/NZS 3000 5.6.2.6.2(b) AS/NZS 3000 5.6.2.6.3 AS/NZS 3000 5.6.2.6.4	

Question 8	Marks	Reference	Marking notes
<p>to be made to the conductive parts of the pool structure.</p> <ul style="list-style-type: none"> • An equipotential bonding conductor in accordance with clause 5.6.3, shall be connected between: <ul style="list-style-type: none"> * The electrical equipment items described in clause 5.6.2.6.1. * The conductive fixtures and fittings in clause 5.6.2.6.2. * The conductive pool structure or bonding connection point in clause 5.6.2.6.3. * The earthing conductors associated with each circuit supplying the pool or the earthing bar at the switchboard at which the circuits originate. 		AS/NZS 3000 5.6.2.6.5	
<p>(d) Any ONE of:</p> <ul style="list-style-type: none"> • Location of the electrical equipment at a distance from the pool all plumbing connections being made of non-conductive materials. • Metal grids or barriers inserted in any plumbing connections between the electrical equipment and pool and connected to the equipotential bonding system • Use of an RCD with a fixed rated residual current not exceeding 30 mA to protect circuits supplying Class I equipment. 	(2 marks)	AS/NZS 3000 6.3.3.3(a) AS/NZS 3000 6.3.3.3(b) AS/NZS 3000 6.3.3.3(c)	

Question 9	Marks	Reference	Marking notes
<p>(a) $I = \frac{P}{V}$</p> <p>$I_L = \frac{20000}{230}$</p> <p>$= 86.96A$</p> <p>From Table 10, column 7, rating of 25 mm² is 95 A</p> <p>Based on loading a 25 mm² aluminium cable is suitable.</p>	<p>(½ mark)</p> <p>(½ mark)</p> <p>(1 mark)</p> <p>(½ mark)</p> <p>(1 mark)</p>		
<p>(b) Maximum volt drop permitted</p> <p>$= 230V \times 1.5\%$</p> <p>$= 3.45V$</p> <p>Volt drop $= \frac{V_d/A.m \times I \times L}{1000}$</p> <p>$3.45 = \frac{V_d/A.m \times 86.96 \times 30}{1000}$</p> <p>$V_d/A.m = 1.322$</p> <p>From Table 45 convert to three-phase</p> <p>$= \frac{1.322}{1.155}$</p> <p>$= 1.145 V_d/A.m$</p> <p>From Table 45 this equates to a 70 mm² aluminium cable.</p>	<p>(½ mark)</p> <p>(½ mark)</p> <p>(½ mark)</p> <p>(½ mark)</p> <p>(1 mark)</p> <p>(½ mark)</p> <p>(1 mark)</p> <p>(1 mark)</p>		
<p>(c) A 70 mm² aluminium cable is minimum size cable required to meet load and voltage drop requirements</p>	<p>(1 mark)</p>		