



Candidate Code No.		Version of AS/NZS 3000 used	
For Board Use Only		(tick <u>ONE</u> Box)	
Result		2000	
Date		2007	
Int			

**ELECTRICAL WORKERS REGISTRATION BOARD
ELECTRICAL INSPECTOR EXAMINATION
21 June 2008**

QUESTION AND ANSWER BOOKLET

Time Allowed: Three hours

INSTRUCTIONS – READ CAREFULLY

You have 10 minutes to read this paper but do not start writing until you are told to do so by the supervisor.

Write your Candidate Code Number in the box provided above. Your name must NOT appear anywhere in this paper.

Answer all questions.

The pass mark for this examination is 60 marks.

Use a pen for written answers. **Do not** use pencils or red pens.

Drawing instruments and pencils may be used when diagrams are required. Marks are allocated on the basis of correctness.

Do not use correcting fluid or correcting tape.

Non-programmable calculators may be used.

It is recommended that the reference source for your answers be included in the space provided if a question can be answered from the Act, Regulations, Standard or Code of Practice. However, just stating a reference only will earn no marks.

For calculation questions all workings, including formulae, must be shown to gain full marks.

Warning – You could get 0 marks for any question, or part of a question, if you show anything hazardous or dangerous in your answer.

You may need to use the following documents in this examination:

- The Electricity Act 1992 reprint dated 19 August 2005.
- The Electricity Regulations 1997 reprint dated 5 September 2005.
- AS 60529 or AS 1939 supplement 1 – 1990; AS/NZS 3000:2000 or AS/NZS 3000:2007; AS/NZS 3001:2001; AS/NZS 3004:2002; NZS 3019 (Int):2002 or NZS 3019:2004; AS/NZS 3760:2001 or; AS/NZS 3760:2003.
- ECP 34, 35, 51 and ECP 54.

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM

(turn over)

Question 1

- (a) Refer to the Electricity Act and briefly **ONE** situation that constitutes a "serious injury"

(1 mark)

Ref:

- (b) Refer to the Electricity Act and list **TWO** situations - other than taking disciplinary action - where the Board may direct the Registrar to remove a name from any register or cancel the provisional licence held by any person.

(1 mark)

(1) _____

(2) _____

Ref:

- (c) Registered persons found guilty of a **disciplinary** offence by the Board can have restrictions imposed on their registration. Refer to the Electricity Act and state **TWO** of those restrictions.

(1 mark)

(1) _____

(2) _____

Ref:

(turn over)

Question 1 continued

(d) Refer to Electricity Regulations and state the intervals at which an electrical inspector working on distribution systems (works) is required to undertake:

(i) Refresher courses in testing to ensure safety.

(½ mark)

Ref:

(ii) Refresher courses in cardio-pulmonary resuscitation (CPR).

(½ mark)

Ref:

(e) Refer to the Electricity Regulations and state **ONE** method of supply to an extra-low voltage electrical installation that is deemed not to be electrically safe.

(1 mark)

Ref:

(f) Refer to AS/NZS 3000 and state **ONE** source of supply that can be used to supply an electrically separated (isolated) circuit.

(1 mark)

Ref:

(turn over)

Question 1 continued

(g) Refer to AS/NZS 3000 and state **TWO** types of protective devices (fittings) that can be used to provide the automatic disconnection of the supply. (1 mark)

(1) _____

(2) _____

Ref:

(h) Refer to AS/NZS 3000 and state the type of overhead electric line that cannot be installed above a swimming pool. (1 mark)

Ref:

(i) Refer to AS/NZS 3000 and state **ONE** method:

(i) Of identifying underground wiring. (1/2 mark)

Ref:

(ii) Of marking or recording that an underground cable enters or leaves a building. (1/2 mark)

Ref:

(turn over)

Question 1 continued

(j) Refer to AS/NZS 3000 and state the resistance requirements for the protective earthing conductor of a final subcircuit in a low voltage electrical installation.

(1 mark)

Ref:

(k) Light switches are being installed in a bathroom. Refer to AS/NZS 3000 and state:

(i) The Zone in which a light switch with no IP rating be installed.

(½ mark)

Ref:

(ii) The Zone in which installing a light switch is prohibited.

(½ mark)

Ref:

(l) Refer to AS/NZS 3000 and state **ONE** requirement for the installation of a wiring system in the classified zone of a hosing down area.

(1 mark)

Ref:

(turn over)

Question 1 continued

- (m) Refer to AS/NZS 3000 and state the requirement for overcurrent protection in an extra-low voltage electrical installation where the supply is earthed at the point of supply.

(1 mark)

Ref:

- (n) A registered electrical inspector is called to carry out checking and testing on an existing installation that has been disconnected for more than six months. Refer to NZS 3019 and state the specific checks that need to be made of the overhead electric line that supplies the installation.

(1 mark)

Ref:

- (o) A mobile crane is being operated in the vicinity of an 11 kV overhead electric line. Refer to NZECP 34 and state:

- (i) The minimum approach distance to the line the mobile crane can be operated **without** the consent of the owner of the line.

(½ mark)

Ref:

- (ii) The minimum approach distance to the line the mobile crane can be operated **with** the consent of the owner of the line.

(½ mark)

Ref:

(turn over)

Question 1 continued

(p) Refer to NZECP 35 and state the **TWO** methods of protecting telecommunication circuits from transferred earth potential rises in high voltage substations that incorporate an earth grid.

(1 mark)

(1) _____

(2) _____

Ref:

(q) State **TWO** benefits to the network operator of improving the power factor of an electrical installation.

(1 mark)

(1) _____

(2) _____

(r) State **TWO** hazards that will occur if there is a phase and neutral transposition on the consumers mains in a single-phase, low voltage electrical installation.

(1 mark)

(1) _____

(2) _____

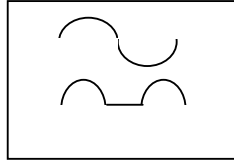
(s) If the applied voltage and maximum current drawn by a three-phase load is known, what else needs to be known to determine the kilowatt demand of the load?

(1 mark)

(turn over)

Question 1 continued

(t) An RCD is marked with the following symbols:



What does this symbol mean?

(1 mark)

(turn over)

Question 2

A homeowner has installed the wiring for a new kitchen in a new location in an existing home. The homeowner has requested that you test and certify all of the work in accordance with the Electricity Regulations.

(a) The homeowner has run new TPS twin and earth final subcircuits (but not connected them) back to the position of the existing switchboard for:

- 1 Lighting circuit.
- 1 Socket outlet circuit
- 1 Permanently connected dishwasher
- 1 Range hob
- 1 Wall oven

(i) In accordance with which document will you carry out the inspection (not testing with test instruments) of the work.

(1/2 mark)

(ii) Refer to the document you have stated in (a)(i) and state the minimum cable size the homeowner was required to install for each of the five circuits:

(2½ marks)

Lighting circuit. _____

Socket outlet circuit _____

Permanently connected dishwasher _____

Range hob _____

Wall oven _____

Ref:

(iii) Refer to the document you have stated in (a)(i) and state the minimum cable size and type of cable the homeowner was required to install for a lighting pendant fitted to a ceiling rose.

(1 mark)

Ref:

(turn over)

Question 2 continued

- (iv) The homeowner has installed the same number of circuits to the switchboard that were in the existing kitchen. The switchboard contains the necessary RCCBs and MCBs to which the new circuits can be connected. What protection would you connect to:

(3½ marks)

The lighting circuit. _____

The socket outlet circuit _____

The permanently connected dishwasher _____

The range hob _____

The wall oven _____

- (b) (i) In accordance with which document will you carry out the testing of the work with test instruments.

(½ mark)

Ref:

- (ii) Refer to the document you have stated in (b)(i) and state **TWO** tests using test instruments you will carry out on the final subcircuits installed by the homeowner.

(1 mark)

(1) _____

(2) _____

Ref:

- (c) The MCB on the switchboard for the lighting circuit is a 10A, Type C and for the socket outlet circuit 20A, Type C.

Refer to AS/NZS 3000 or NZS 3019 and state the maximum resistance for the protective earthing conductor of lighting circuit and the socket outlet circuit.

(1 mark)

Lighting circuit _____

Socket outlet circuit _____

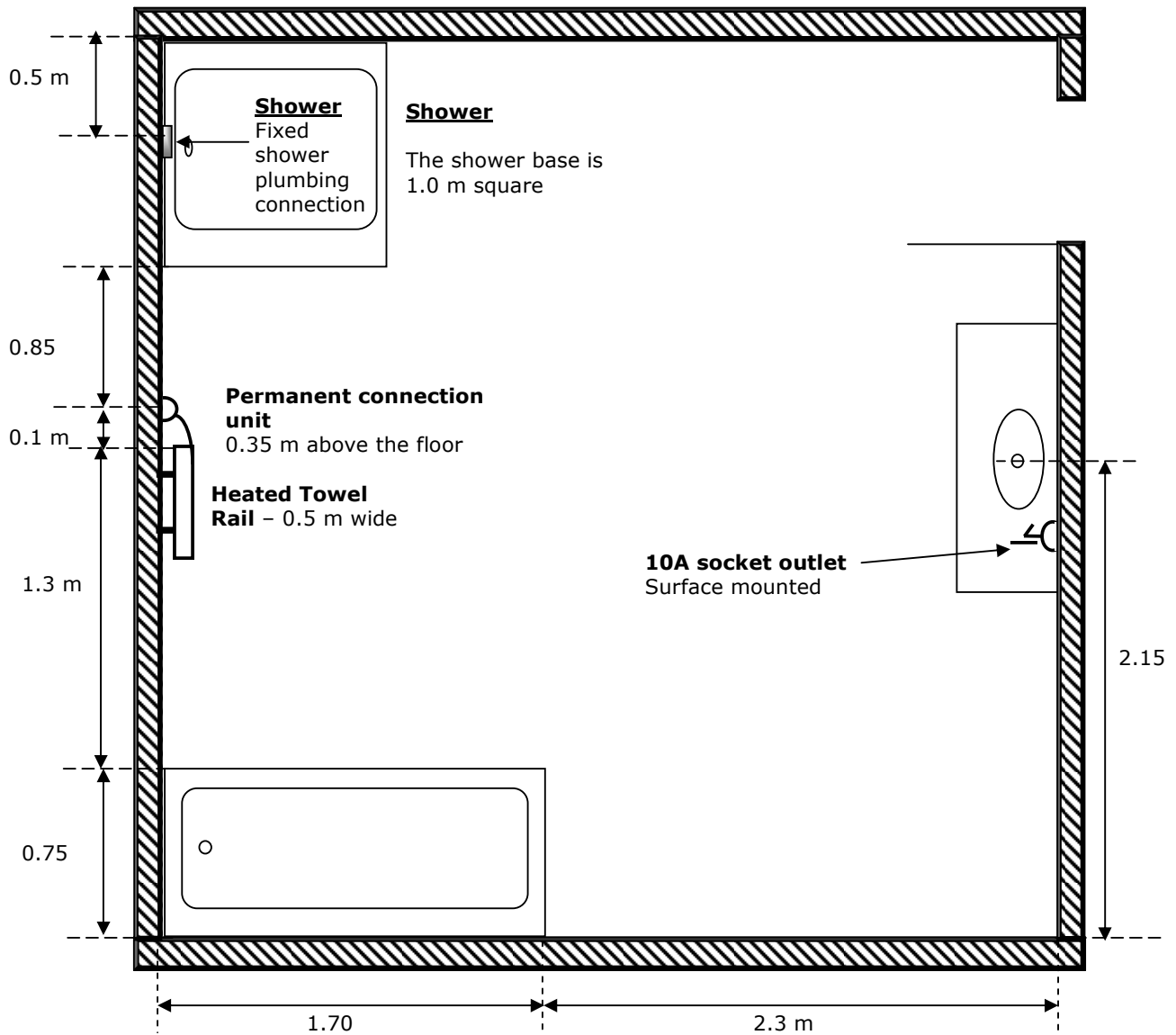
Ref:

(turn over)

Question 3

The following figure shows a bathroom floor plan. The scale is 1:35 (that is, 1m = 35mm)

- The bathroom is 4.0 metres square, internal measurements.
- The basin has a capacity of 30 litres.
- There is no partition or barrier around the shower.
- All electrical cables and fittings operate at 230V.



(turn over)

Question 3 continued

You have been asked to provide advice to a registered electrician who is having difficulty determining the zones and IP ratings of the electrical fittings in the bathroom.

The electrician has put the following questions to you. To give the electrician the required advice you need to use the information given in the figure above and apply the requirements of AS/NZS 3000.

- Note:
1. Some of the electrical fittings may be in two zones.
 2. "Plumbing fixture" includes the bath, shower and basin.

(a) Towel rail

- (i) In which Zone or Zones is the towel rail situated? State both the Zone and the plumbing fixture to which the Zone relates. (2 marks)

Ref:

- (ii) What is the minimum permitted IP rating for the towel rail? (1 mark)

Ref:

(b) Towel rail permanent connection unit

- (i) In which Zone is the towel rail permanent connection unit situated? State both the Zone and the plumbing fixture to which the Zone relates. (2 marks)

Ref:

(turn over)

Question 3 continued

- (ii) What is the minimum permitted IP rating for the permanent connection unit?

(1 mark)

Ref:

- (c) The surface mounted socket outlet

- (i) In which Zone or Zones is the socket outlet situated? State both the Zone and the plumbing fixture to which the Zone relates.

(2 marks)

Ref:

- (ii) The socket outlet is required to be installed above the vanity top.

- (1) Where must the socket outlet be installed to ensure it is not in any Zone of the vanity sink?

(1 mark)

Ref:

- (2) How is the socket outlet required to be protected?

(1 mark)

Ref:

(turn over)

Question 4

(a) You are inspecting the mains, main switchboard and main earthing system in a new three-phase, low voltage commercial complex with a maximum load of 95A. The mains cable is 35mm² copper and the main earthing conductor is 10 mm² copper. The cable is protected by 125A HRC fuses and is 65 metres in length.

(i) The installation does not comply with the protection requirements of AS/NZS 3000. Refer to AS/NZS 3000 and state the reasons why the installation as described does not comply. State a reference source for your answer.

(3 marks)

Ref:

(ii) If the installation as described was livened, what hazard is caused when an active (phase) to earth fault occurs on the installation?

(2 marks)

Ref:

(turn over)

Question 4 continued

(iii) Provide **THREE** solutions, any of which will ensure the installation complies with AS/NZS 3000. It is not possible to change the size of the cable or to reduce the load.

(3 marks)

(1) _____

(2) _____

(3) _____

Ref:

(b) An air compressor motor circuit is protected by fuses labelled gM at a switchboard. Describe the main characteristic of a fuse labelled gM that distinguishes it from a fuse labelled gG.

(2 marks)

(turn over)

Question 5

A PVC insulated multi-core copper cable is to be used for a three-phase low voltage supply a new moulding room in a foundry.

- (a) After completing the calculations in (b) below, state the minimum sized copper cable can be used to supply this installation.

(1 mark)

- (b) Use the information provided and the following tables.

- (i) Calculate the minimum conductor size of cable that could be used to supply the proposed load.

- The cable is clipped direct (touching)
- The voltage at the switchboard is 400V
- The load is 48.5 kW.
- The allowance for load growth is 15%.
- The ambient temperature is 35 °C.
- The conductor temperature is 75 °C.

(5½ marks)

(turn over)

Question 5 continued

(ii) Calculate the minimum conductor size of cable that could be used to supply the proposed load within the voltage drop limit.

- The cable is 37.5 metres in length between the main switchboard and the new board.
- The voltage at the main switchboard is 400V
- The conductor temperature is 75 °C.
- The voltage drop in the cable is not to exceed 1.5%.

(3½ marks)

(turn over)

Question 5 continued

The following are extracts from AS/NZS 3008.1.2.

Table 9

Current Carrying Capacities of Two-Core 0.6/1 kV Insulated and Sheathed (including Neutral Screened) Cables with or without Earth Conductor, Armoured or Non-Armoured Cables

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Con duct or size	Current carrying capacity A															
	Unenclosed				Enclosed								Buried Direct		Underground non-metallic wiring enclosure	
	Spaced		Touching		Non-metallic wiring enclosures in air – round cable		Non-metallic wiring enclosures in air – flat cable		In non-metallic wiring enclosures or unenclosed partially surrounded by thermal insulation		Completely surrounded by thermal insulation					
	mm ²	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu
1	17	--	16	--	13	10	15	11	11	9	8	-	24	-	19	-
1.5	22	-	21	-	16	13	19	15	15	11	10	-	31	-	24	-
2.5	31	-	30	-	23	17	25	19	21	16	15	-	44	-	34	-
4	42	-	39	-	30	23	33	25	27	22	19	-	57	-	44	-
6	52	-	50	-	39	30	42	32	35	27	25	-	72	-	56	-
10	73	-	68	-	54	41	57	43	49	38	34	-	96	-	75	-
16	97	75	91	71	72	55	75	57	65	50	46	35	127	97	97	75
25	131	100	120	95	100	76	101	76	90	71	60	47	160	127	127	98
35	160	125	148	114	120	89	120	89	105	82	74	58	198	154	154	121

Note: The ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature

(turn over)

Question 5 continued

Table 12

Current Carrying Capacities of Three-Core And Four-Core 0.6/1 kV Insulated and Sheathed (including Neutral Screened) Cables with or without Earth Conductor, Armoured or Non-Armoured Cables

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Conductor size	Current carrying capacity A															
	Unenclosed				Enclosed								Buried Direct		Underground non-metallic wiring enclosure	
	Spaced		Touching		Non-metallic wiring enclosures in air - round cable		Non-metallic wiring enclosures in air - flat cable		In non-metallic wiring enclosures or unenclosed partially surrounded by thermal insulation		Completely surrounded by thermal insulation					
	mm ²	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu
1	15	--	14	--	11	9	14	10	11	8	7	-	21	-	17	-
1.5	18	-	17	-	15	11	17	13	14	11	9	-	26	-	21	-
2.5	26	-	25	-	21	16	23	17	19	15	13	-	37	-	29	-
4	35	-	33	-	27	21	30	23	25	19	17	-	48	-	37	-
6	46	-	42	-	35	27	39	30	33	25	22	-	61	-	47	-
10	52	-	58	-	48	38	52	40	44	34	29	-	81	-	63	-
16	82	64	78	60	64	49	68	52	59	46	39	30	106	83	81	64
25	111	86	104	81	90	68	95	72	82	64	52	40	138	107	106	83
35	137	106	125	99	105	80	105	80	96	74	64	49	165	127	127	100

Note: The ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature

Table 27(1)

Rating Factors for Variations in Ambient Temperature for Cables in Air or Heated Concrete Slabs and for Cables Buried Direct in the Ground or in Underground Wiring Enclosures – Air And Concrete Slab Temperatures

1	2	3	4	5	6	7	8	9	10	11
Conductor temperature °C	Rating Factor									
	Ambient temperature									
	15	20	25	30	35	40	45	50	55	60
150	1.07	1.05	1.03	1.00	0.98	0.96	0.94	0.91	0.89	0.87
110	1.08	1.06	1.03	1.00	0.97	0.93	0.90	0.87	0.83	0.79
90	1.15	1.09	1.05	1.00	0.95	0.91	0.85	0.80	0.74	0.66
80	1.17	1.12	1.06	1.00	0.95	0.89	0.82	0.75	0.68	0.59
75	1.18	1.12	1.06	1.00	0.94	0.88	0.80	0.72	0.63	0.53

((turn over))

Question 5 continued

Table 27(2)

Rating Factors for Variations in Ambient Temperature for Cables in Air or Heated Concrete Slabs and for Cables Buried Direct in the Ground or in Underground Wiring Enclosures – Soil Temperatures

1	2	3	4	5	6	7	8
Conductor temperature °C	Rating Factor						
	Ambient temperature						
	10	15	20	25	30	35	40
110	1.02	1.00	0.97	0.94	0.92	0.89	0.86
90	1.04	1.00	0.96	0.93	0.91	0.87	0.83
80	1.04	1.00	0.95	0.92	0.88	0.83	0.78
75	1.04	1.00	0.95	0.91	0.86	0.81	0.75

Table 42

Three-Phase Voltage Drop at 50Hz of Multicore Cables with Circular Copper Conductors

Conductor size mm²	Three-phase voltage drop at 50 Hz, mV/A.m									
	Conductor temperature, °C									
	45		60		75		90		110	
	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
1	40.3	-	42.5	-	44.7	-	46.8	-	49.7	-
1.5	25.9	-	27.3	-	28.6	-	30.0	-	31.9	-
2.5	14.1	-	14.9	-	15.6	-	16.4	-	17.4	-
4	8.77	-	9.24	-	9.71	-	10.2	-	10.8	-
6	5.86	-	6.18	-	6.49	-	6.80	-	7.22	-
10	3.49	-	3.67	-	3.86	-	4.05	-	4.29	-
16	2.19	-	2.31	-	2.43	-	2.55	-	2.70	-
25	1.39	-	1.47	-	1.54	-	1.61	-	1.71	-
35	1.01	-	1.06	-	1.11	-	1.17	-	1.24	-

Note: To convert to single-phase values multiply the three-phase value by 1.155

(turn over)

Question 6

(a) You are inspecting a new caravan. The caravan is supplied by a supply lead that is permanently connected to the caravan (that is, it is not supplied via an appliance connector and a cord connector arrangement). Refer to AS/NZS 3001 and state:

(i) To where must the supply lead be connected in the caravan. (1 mark)

Ref:

(ii) The requirement for the lead when not in use. (1 mark)

Ref:

(iii) The requirement relating to the rating of the lead. (1 mark)

Ref:

(turn over)

Question 6 continued

- (b) NZS 3019 permits various supply arrangements for caravans. Refer to NZS 3019 and state the **THREE** supply arrangements that are permitted for a caravan.

(3 marks)

(1) _____

(2) _____

(3) _____

Ref:

(turn over)

Question 6 continued

(c) A caravan can be supplied by dual electricity supply systems. Refer to NZS 3019 and state

(i) The **TWO** aspects relating to the changeover switch that must be verified by testing.

(2 marks)

(1) _____

(2) _____

Ref:

(ii) The requirements for the neutral connection where one of the electricity supplies is obtained from an on-board generator or inverter.

(2 marks)

Ref:

(turn over)

Question 7

- (a) A two core neutral screen aerial cable supplies a duplex unit comprising two flats. State **FOUR** hazards that may occur if the screen of the neutral screen aerial cable becomes open-circuited due to corrosion.

(2 marks)

(1) _____

(2) _____

(3) _____

(4) _____

- (b) State **TWO** uses for the information gained from an earth fault loop impedance test

(2 marks)

(1) _____

(2) _____

(turn over)

Question 7 continued

- (c) It is proposed to use four single core aluminium cables to supply an industrial complex. Because of cable supply problems two active conductors and the neutral conductor are 95 mm². The other active conductor is 120 mm². Refer to AS/NZS 3000 and state the minimum size and type of a main earthing conductor earth for this electrical installation.
(1 mark)

Ref:

- (d) A 200kVA 11kV/400V three-phase transformer has a 5% impedance.
- (i) Determine the fault level which could be produced by the transformer
(1½ marks)
- (ii) Determine the prospective short circuit current that would flow if a short circuit of negligible impedance occurs across the transformer output terminals.
(1½ marks)

- (e) An existing three-phase motor has had new power factor correction capacitors connected across the motor terminals.
- (i) What will change when the power factor correction capacitors are connected?
(1 mark)

- (ii) What adjustments, if any, should be made to the motor protection?
(1 mark)

(turn over)

Question 8

A small three-phase low rise development contains 7, 230v domestic electrical installations. The intention is that the load be spread evenly, as much as is possible, over the three phases.

- (a) Refer to AS/NZS 3000 and determine the maximum demand in amperes of the heaviest loaded phase.

Each electrical installation has the following loads:

15	Lighting points	1	Electric oven – 2.5kW
4	Double socket outlets (10A)	1	Storage water heater – 2kW
6	Single socket outlets (10A)	1	Air-conditioning unit – 3kW

(7 marks)

Load Group	Calculation	Load (A)
<u>Group</u>		
<u>Group</u>		
<u>Group</u>		
<u>Group</u>		
Heaviest loaded phase		

Ref:

(turn over)

Question 8 continued

- (b) You have been requested to install copper consumer mains cable to the development for which you have calculated the maximum demand in part (a) above.

Calculate the size of the cable required based on the following information and the information contained in the Tables that follow Question 5:

- The cable will be buried direct.
- The load is the maximum demand calculated in part (a) above.
- The ambient soil temperature is 20° C
- The conductor temperature to be 75° C

Note: Voltage drop is not an issue as it is a short length of cable run.
(3 marks)

(turn over)

Question 9

An electrician is to wire a new domestic residence that includes recessed luminaires and has sought your advice regarding the installation of that equipment.

(a) Refer to AS/NZS 3000 and answer the following:

- (i) All of the recessed luminaires operate at extra-low voltage and are supplied by associated auxiliary transformers. The transformers are supplied by 230V final subcircuits.

Are these circuits required to be protected by an RCD? Include a reason and the reference source for your answer.

(2 marks)

- (ii) There is a final subcircuit to a bathroom that only supplies a permanently connected hair dryer. Is this circuit required to be protected by an RCD? Include a reason and the reference source for your answer.

(1 mark)

(b) Refer to NZECP 54 and answer the following:

- (i) Some ceiling battens and joists need to be "checked out" to allow the recessed luminaires to be installed. Is this permitted? Include a reason and the reference source for your answer.

(2 marks)

(turn over)

Question 9 continued

- (ii) If some of the recessed luminaries have no manufacturer's instructions, can they still be installed? Include a reason and the reference source for your answer.

(2 marks)

- (iii) Can an OA type recessed luminaires be modified to be installed in a moist area?

(2 marks)

Ref:

- (iv) Under what conditions can a recessed luminaire be installed in loose, sprayed or flammable insulation?

(1 mark)

Ref:

For Candidate's Use

In the box, write the number of **EXTRA** sheets you have used. Write **NIL** if you have not used any

For Examiner's Use Only		
Questions Answered	Marks	
1		
2		
3		
4		
5		
6		
7		
8		
9		
TOTAL		