



Candidate Code No.	
For Board Use Only	
Result	Result
Date	Date
Int	Int

**ELECTRICAL WORKERS REGISTRATION BOARD
ELECTRICAL INSPECTOR EXAMINATION
17 November 2007
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 will need to use some of 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; 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 state who the Registrar has to inform if a complaint has been received against a registered electrician.

(2 marks)

Ref:

- (b) Refer to the Electricity Act and state the time frame within which a person can lodge an appeal against any decision made under the Electricity Act?

(2 marks)

Ref:

- (c) An electrical inspector has been requested by an electricity retailer to inspect and reconnect an electrical installation that has been disconnected for 8 months. No prescribed electrical work has been carried out. Refer to the Electricity Regulations and state **TWO** tests and checks that the electrical inspector is required to carry out before connecting the installation to the supply.

(2 marks)

(1) _____

(2) _____

Ref:

(turn over)

Question 1 continued

(d) The Electricity Regulations require periodic inspections for particular types of installations and electrical appliances. List the **PERIODIC** intervals for the following:

(2 marks)

(i) Carnivals and fair grounds.

(ii) Caravan parks.

Ref:

(e) Refer to the Electricity Regulations and state who an electrical inspector must advise when they have discovered that part of an electrical installation presents an immediate danger to life

(2 marks)

Ref:

(turn over)

Question 1 continued

(f) Refer to the Electricity Regulations and state:

(i) Whether a registered electrical inspector can be convicted for failing to comply with regulation 47(1)(e)(ii). State a reason for your answer
(1 mark)

Ref:

(ii) The level of fine that can be imposed on a registered electrical inspector for failing to comply with regulation 36.
(1 mark)

Ref:

(g) Refer to AS/NZS 3000 and determine whether a neutral screen cable that is marked "underground" on the cable sheath requires additional protection against mechanical damage when used in a category B system. Include a reference source to support of your answer.
(2 marks)

Ref:

(h) Refer to AS/NZS 3001 and state **TWO** characteristics of cables or cords used for fixed wiring in a caravan.
(2 marks)

(1) _____

(2) _____

Ref:

(turn over)

Question 1 continued

- (i) An earth loop test made on a single phase 230 volt socket outlet adjacent to a distribution board is measured at 0.38Ω . If a short circuit of negligible impedance occurs between the phase and earth continuity conductors at the socket outlet, determine by calculation the minimum fault current.

(2 marks)

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

(2 marks)

Ref:

(turn over)

Question 2

- (a) You have been requested to inspect an industrial development that includes a new switchboard adjacent to a 400kVA, three-phase 400/230V distribution transformer, and you wish to confirm the MVA fault rating of the busbars and main MCB.

You have been advised by the network company that the phase to phase no-load voltage is 400V and with the full load current flowing, the line voltage is 387V.

Calculate:

- The fault MVA rating of the busbars.
- The prospective short circuit current.

(5 marks)

(turn over)

Question 2 continued

(b) Some three-phase motors have power factor correction capacitors connected across the motor terminals.

(i) What effect do these power factor correction capacitors have on the line current to the motor?

(1 mark)

(ii) What must be taken into account when setting the overloads for these motors?

(1 mark)

(c) State **TWO** reasons why an earth fault loop impedance test is carried out on an electrical installation

(2 marks)

(1) _____

(2) _____

Ref:

(d) Refer to AS/NZS 3000 and state the minimum size and type of bonding conductor permitted for the bonding of metallic piping, cable sheaths and wiring enclosures within this installation.

(1 mark)

Ref:

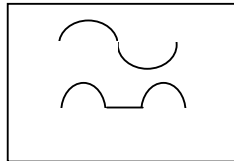
(turn over)

Question 3

- (a) Describe the operation of an RCD when there is a phase to earth fault on the circuit the device protects.

(4 marks)

- (b) An RCD for personal protection is marked with the following symbols:



- (i) State the type of RCD.

(½ mark)

- (ii) Describe the operating characteristics of this type of RCD.

(1½ marks)

(turn over)

Question 3 continued

- (c) An electrician has contacted you for advice regarding work in an existing kitchen that is being renovated.

There is one existing final subcircuit supplying 4 socket outlets. This circuit is not RCD protected. Two existing socket outlets are in the kitchen and are the last two on the circuit. The other two socket outlets are in a bedroom adjacent to the kitchen.

The electrician has been requested to install three additional new socket outlets in the kitchen and ensure that all socket outlets in the kitchen are RCD protected.

The electrician has told you that:

- The existing final subcircuit in the kitchen has the capacity to supply all seven socket outlets.
- The method of construction of the house means that it would be extremely difficult and expensive to install a cable to an RCD protected circuit or to run a new circuit back to the switchboard.
- No alterations can be made to or near the switchboard

State **TWO** solutions either of which will enable the electrician to ensure that all socket outlets are protected by an RCD.

(4 marks)

(1) _____

(2) _____

Ref:

(turn over)

Question 4

You have been asked provide advice on the installation of a 4-core neutral screened copper cable at a craft village from an outdoor 400 V, three-phase distribution panel to a communal pottery kiln. There are two possible routes for the cable one buried direct, the other mounted on the surface (touching) of the structure. The information for each method is as follows:

<u>Buried direct</u>	<u>Surface mounted (touching)</u>
<ul style="list-style-type: none"> • The cable run length is 45 m. • The maximum demand is 63.75A. • The ambient soil temperature is 15 °C. • The voltage at the point of supply is 400 V. • The voltage drop on the mains between the point of supply and the main switchboard is 2%. • The voltage drop in the new cable cannot exceed 1.5% of the <u>lowest voltage</u> at the main switchboard. • The conductor temperature is not to exceed 75 °C 	<ul style="list-style-type: none"> • The cable run length is 45 m. • The maximum demand is 63.75A. • The ambient air temperature is 35 °C. • The voltage at the point of supply is 400 V. • The voltage drop on the mains between the point of supply and the main switchboard is 2%. • The voltage drop in the new cable cannot exceed 1.5% of the <u>lowest voltage</u> at the main switchboard. • The conductor temperature is not to exceed 75 °C

Using this information and the information in the following tables answer the following questions:

(turn over)

Question 4 continued

- (a) Calculate the minimum cable size for each installation method based on the maximum demand.

(2½ marks)

Buried direct	Surface mounted (touching)

(turn over)

Question 4 continued

- (b) Calculate the minimum cable size that will meet the volt drop requirements.
(5 marks)

Buried direct	Surface mounted (touching)

(turn over)

Question 4 continued

(c) From the information gathered in (a) and (b) above, determine:

- (i) The minimum size of cable that will meet both the load and volt drop requirements.

(2 marks)

- (ii) The preferable method of installation.

(½ mark)

(turn over)

Question 4 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 4 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 4 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 5

- (a) State **TWO** hazards that will result if a phase and neutral transposition occurs on a single-phase, low voltage electrical installation.

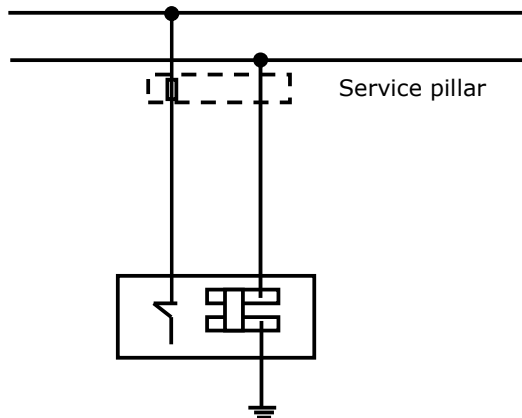
(2 marks)

(1) _____

(2) _____

- (b) (i) Demonstrate by drawing on the diagram below a method of testing the polarity of the mains between the distribution line and the MEN switchboard. Label each component. **The installation is live.**

(2 marks)



(turn over)

Question 5 continued

- (ii) Explain how you would carry out the method you have described in (b)(i). Include any equipment and the instrument used (2 marks)

- (iii) State the expected instrument readings when no transposition has taken place. (1 mark)

- (iv) State the expected instrument readings when a transposition has taken place. (1 mark)

- (c) An existing low voltage single phase electrical installation has been operating satisfactorily for the 10 years since it was new. No electrical work has been carried out on the installation or on the surrounding distribution network since the house was built.

The occupants have begun to receive electric shocks off their washing machine you have been called to investigate and make repairs for some. No transposition has occurred to the mains of the house.

State **TWO** likely causes of the problem.

(2 marks)

- (1) _____

- (2) _____

(turn over)

Question 6

(a) Refer to the Electricity Regulations: and state:

- (i) The specific requirements that apply to fittings supplying electricity to connectable installations.

(1 mark)

Ref:

- (ii) The requirement that applies to protective fittings of socket outlets supplying electricity to connectable installations.

(1 mark)

Ref:

(b) Refer to AS/NZS 3004 and state the **THREE** alternative methods of connecting a pleasure craft.

(3 marks)

(1) _____

(2) _____

(3) _____

Ref:

(turn over)

Question 6 continued

(c) Refer to AS/NZS 3004 and state the configuration and rating requirements for socket outlets supplying pleasure craft.

(3 marks)

(1) _____

(2) _____

(3) _____

Ref:

(d) AS/NZS 3004 states that fuses and unenclosed neutral links are the two types of protective devices not permitted to be installed in a pleasure craft. State **ONE** type of protective device that is permitted.

(2 marks)

(turn over)

Question 7

An existing house has just been sold.

(a) The new owner believes that prescribed electrical work has been carried out during the time the installation was disconnected, but no certificate of compliance can be located. The installation includes:

- An underground supply.
- A main MEN switchboard in the house and switchboard with a MEN link in a garage. Both switchboards contain a mix of MCB and rewireable fuses.
- A dishwasher and washing machine permanently connected (both Class I appliances).

The new owner has engaged you to carry out an inspection of the electrical installation to ensure it is safe to use. Refer to NZS 3019 and state what particular checking should to be made of:

(i) The underground supply.

(1 mark)

(ii) The MEN switchboard and garage switchboard.

(4 marks)

(turn over)

Question 7 continued

(iii) The dishwasher and washing machine.

(1 mark)

Ref.....

(b) The house has been disconnected from the electricity supply for 2 months. You have also been requested by the electricity retailer to reconnect the electrical installation. Refer to the Electricity Regulations and state the **FOUR** tests and checks you should carry out before connecting the installation to the supply.

(4 marks)

(1) _____

(2) _____

(3) _____

(4) _____

Ref:

(turn over)

Question 8

(a) A two core neutral screen aerial cable supplies a duplex unit comprising two flats.

(i) 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) _____

(ii) For each hazard you have detailed in (a)(i), state **ONE** danger associated with that hazard. (2 marks)

(1) _____

(2) _____

(3) _____

(4) _____

(b) Refer to the Electricity Regulations and state the **TWO** situations where metal must be connected to earth. (2 marks)

(1) _____

(2) _____

Ref:

(turn over)

Question 8 continued

- (c) With the aid of a labelled circuit diagram, show all the paths for the fault current from one phase of a power transformer, an installation and right through to a phase to frame fault on a Class I appliance supplied by a subcircuit from the MEN switchboard.

(4 marks)

Ref:

(turn over)

Question 9

As an electrical inspector you are asked to give advice on the sizing of mains and transformer capacity for a new three-phase, low voltage, low rise residential development. The development comprises 54 single-phase living units and communal areas.

- Assume a unity power factor.
- Assume that the development and/or equipment loads will be balanced, wherever practical, over the three-phases. Where balancing is not possible, apply the highest load to the heaviest load phase.

Refer to AS/NZS 3000 and determine the loading in amps (maximum demand) of the heaviest load phase by completing the tables on the following pages. The loads in each area are as follows:

Living units

Lighting	54 units
10A socket outlets	54 Units
Electric Ovens	54 units
Cooking hobs	30 units
Instantaneous hot water systems	24 units
Storage water heaters	10 units

Communal areas

1	Water pump - 6 kW (Nameplate 10.8A/phase)	Three-phase
2	Clothes dryers - 10 kW each	Three-phase
1	Hot water cylinder - 6 kW	Three-phase
30	Communal lights - 200W each	Single-phase
10	Socket outlets - 10A rating	Single-phase
2	Spa pools- 4kW each	Single-phase

(10 marks)

(turn over)

Question 9 continued

Living units calculation

Load Group	Calculation	Load (A)
<u>Group</u>		
<u>Group</u>		
<u>Group</u>		
<u>Group</u>		
Total		

(turn over)

Question 9 continued

Communal Areas Calculation

Load Group	Calculation	Load (A)
<u>Group</u>		
<u>Group</u>		
<u>Group</u>		
<u>Group</u>		
Total		

Total load of heaviest loaded phase =

For Candidate's Use

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

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Questions Answered	Marks	
1		
2		
3		
4		
5		
6		
7		
8		
9		
TOTAL		