ELECTRICAL WORKERS REGISTRATION BOARD

Safety • Competency

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

ELECTRICAL INSPECTOR THEORY EXAMINATION
18 November 2006
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. Show answers to TWO decimal places.

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; 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

Answer all parts of this question. Each part is worth 1 mark.

(a) If a practising licence was issued on 1st January 2007, on what date will it expire?

_____

_

Ref: .....

(b) Refer to the Electricity Act and state the circumstances under which certification is not required when connecting an electrical installation to the supply?

_____

_

_____

_

_____

_

Ref: .....

(c) Refer to the Electricity Act and state who the Registrar has to inform if a complaint has been received against a registered electrician.

_____

_

Ref: .....

(d) Refer to the Electricity Regulations and state the intervals at which electrical workers working on the construction and maintenance of distribution systems are required to undertake refresher courses in safe working practices, testing, basic first aid, and cardio-pulmonary resuscitation?

_____

_

_____

_

_____

_

_____

_

Ref: .....

(turn over)

Question 1 continued

(e) State the **TWO** safety precautions specified in the Electricity Regulations which can be used in a low voltage installation to safeguard against unintentional re-livening after isolation.

(1) _____

(2) _____

Ref: .....

(f) An electrician has completed the wiring of a domestic residence and has certified the work on a certificate of compliance. An electrical inspector has inspected the relevant work and certified the inspection on the certificate of compliance. Who is required to give the certificate of compliance to the owner of the residence?

_____

_____

Ref: .....

(g) Refer to the Electricity Regulations and state **ONE** condition under which a homeowner can relocate existing switches, socket outlets and lighting outlets.

_____

_____

_____

Ref: .....

(turn over)

Question 1 continued

(h) Refer to AS/NZS 3000 and state **TWO** types of fittings that are suitable for protection against both overload and short circuit currents.

(1) _____

_____

(2) _____

_____

Ref: .....

(i) Refer to AS/NZS 3000 and state the switching requirements for a generating set used as an alternative supply for an electrical installation connected to a supply system

_____

_____

_____

_____

Ref: .....

(j) Refer to AS/NZS 3000 and state the minimum resistance required for a protective earthing conductor continuity test in an electrical installation.

_____

_____

_____

Ref: .....

(turn over)

Question 1 continued

(k) (i) State the required test voltage for an insulation resistance test of a single phase 230 V MEN installation?

_____

Ref: .....

(ii) State the required test voltage for an insulation resistance test of a three phase 400 V MEN installation?

_____

Ref: .....

(l) Refer to AS/NZS 3000 and state **ONE** method of protection against electric shock that is prohibited in refrigeration rooms.

_____

_____

Ref: .....

(m) Refer to AS/NZS 3000 and state the maximum voltage drop permitted in an extra-low voltage electrical installation.

_____

_____

Ref: .....

(n) Refer to AS/NZS 3000, state **ONE** requirement for extra-low voltage socket outlets installed in a low voltage electrical installation

_____

_____

Ref: .....

(turn over)

Question 1 continued

(o) Refer to AS/NZS 3000 and state the main control and protection requirements for special lifts specifically required to operate for emergency and fire fighting purposes.

_____

_____

Ref: .....

(p) Refer to NZS 3019 and state the minimum insulation resistance for socket-outlets connected to an isolating transformer.

_____

Ref: .....

(q) Refer to AS/NZS 3001 and state **TWO** requirements for the types of cables or cords used for fixed wiring in a caravan.

(1) _____

_____

(2) _____

_____

Ref: .....

(r) Refer to AS/NZS 3004 and state the circumstances under which aerial conductors are prohibited in a marina.

_____

_____

_____

_____

Ref: .....

(turn over)

Question 1 continued

(s) Briefly explain the basic principle of operation of a test instrument suitable for testing an RCD.

_____

_____

(t) If a fault of negligible impedance occurs between a live conductor and exposed earthed metal on a final subcircuit, what is the minimum fault current that must flow in the protective earthing conductor to operate a 20 amp fuse with a gG utilisation category?

_____

(turn over)

Question 2

(a) You are to carry out an earth fault loop impedance test on a single phase socket outlet.

Draw and label a figure that represents a three-phase supply from a 230/400V MEN distribution system to a consumer's installation. Include:

- The MEN main earthing system
- The consumers neutral and earth bars and main earthing system.
- A final sub-circuit MCB for each of the three phases.
- A single-phase socket outlet.
- The Earth Fault Loop Impedance tester

You do not need to show the main switch, metering or an RCD (this is an existing installation).

Indicate on the figure by using arrows or colour, the earth fault impedance path created when the Earth Fault Loop Impedance tester is operated.

(5 marks)

Ref: .....

(turn over)

Question 2 continued

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

(2 marks)

(1) _____

_____

_____

(2) _____

_____

_____

Ref: .....

(c) Refer to AS/NZS 3000 and state the minimum size and type of a main earthing conductor earth for an electrical installation supplied by a four core 95mm² aluminium 400/230v cable.

(1 mark)

_____

Ref: .....

(d) A 300kVA 11kV/400V three-phase transformer has a 5% impedance.

(i) Determine the fault level which could be produced by the transformer

(1 mark)

(turn over)

Question 2 continued

(ii) Determine the prospective short circuit current that would flow if a short circuit of negligible impedance occurs across the transformer output terminals.

(1 mark)

(turn over)

Question 3

A PVC insulated three-core copper cable is to be used to supply a 65 kW, three-phase, 400 V furnace in a foundry. The following are the conditions that must be met:

- The cable is to be clipped direct (touching).
- The protective earthing conductor is to be run adjacent to the cable
- The ambient air temperature is 35 °C.
- The distance between the switchboard and the furnace is 45 metres
- The cable is to be protected by HRC fuses.
- The maximum permitted voltage drop is 3% for the cable.
- An allowance for a 10% load growth is to be included.
- Assume the conductor temperature to be 75 °C.

Using the information above and from the tables below, answer the following:

(a) Calculate the minimum current rating of the cable.

(2 marks)

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

(3 marks)

(turn over)

Question 3 continued

(c) Calculate whether the cable you have selected to supply the load meets the voltage drop requirements.

(4 marks)

(d) Refer to AS/NZS 3000 and state the minimum size protective earthing conductor permitted for the cable you have selected. State the reference in your answer.

(1 mark)

_____

_____

Ref: .....

(turn over)

Question 3 continued

The following are extracts from AS/NZS 3008.1.2.

Table 9

Current Carrying Capacities of Two-Core O.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
	Current carrying capacity A															
	Unenclosed				**Enclosed**								**Buried Direct**		**Underground non-metallic wiring enclosure**	
Conductor size	**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**	**Al**
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^oC ambient air temperature and 15^oC ambient soil temperature

(turn over)

Question 3 continued

Table 12

Current Carrying Capacities of Three-Core and Four-Core O.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
	Current carrying capacity A															
	Unenclosed				**Enclosed**								**Buried Direct**		**Underground non-metallic wiring enclosure**	
Conductor size	**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**	**Al**
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 30^0C ambient air temperature and 15^0C 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 ^{0}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 3 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 ^{0}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 mm^2	**Three-phase voltage drop at 50 Hz, mV/A.m**									
	Conductor temperature, ^{0}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 4

(a) The Electricity Regulations state that fittings supplying electricity to connectable installations must be installed and maintained so they operate safely. Refer to the Electricity Regulations and answer the following:

(i) State **TWO** special requirements of an outlet in a caravan park or marina for the supply of electricity at standard low voltage to a connectable installation

(2 marks)

(1) _____

_____

_____

(2) _____

_____

_____

Ref: ……..

(ii) Who is responsible to ensure that a connectable installation has a current warrant of electrical fitness prior to being connected to a power supply?

(1 mark)

_____

_____

Ref: ……..

(iii) Who is responsible for issuing a warrant of electrical fitness for a connectable installation that is more than 4 years old?

(1 mark)

_____

_____

Ref: ……..

(turn over)

Question 4 continued

(iv) Which document and section of that document must an electrical inspector use as guidance for issuing a warrant of electrical fitness for a connectable installation?

(1 mark)

_____

Ref: ……..

(b) Refer to AS/NZS 3004 and state the **THREE** methods that are permitted to supply electricity to pleasure craft.

(3 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(3) _____

_____

_____

Ref: ……..

(c) Refer to NZS 3019 and state whether a caravan that is fitted with an IEC 60309 plug is required to have a neutral earth link in the distribution board.

(1 mark)

_____

_____

Ref: ……..

(turn over)

Question 4 continued

(d) Refer to AS/NZS 3001 and state the maximum resistance permitted between any point to be earthed and the earth contact of an appliance inlet, when testing a new caravan to ensure security of the earthing connections.

(1 mark)

_____

Ref: ……..

(turn over)

Question 5

(a) Work is being carried at a motel complex that involves the wiring of new motel units and alteration and repairs to the wiring in the existing motel units. Refer to AS/NZS 3000 and answer the following:

(i) On what type of circuits are Residual Current Devices (RCDs) required to be installed in the new motel units?

(1 mark)

_____

_____

Ref: .....

(ii) State **TWO** situations where RCDs are not required to be installed in the new motel units.

(2 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

Ref: .....

(turn over)

Question 5 continued

(iii) State the **FOUR** situations where RCD protection is **not** required to be installed on socket outlet circuits that are altered or repaired in the existing motel units:

(4 marks)

(1) _____

_____

(2) _____

_____

(3) _____

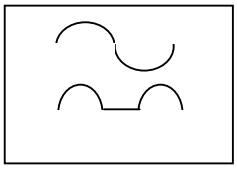
_____

(4) _____

_____

Ref: .....

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



(i) What does this symbol mean?

(1 mark)

_____

(ii) Refer to AS/NZS 3000 and describe the operating characteristics of the RCD.

(2 marks)

_____

_____

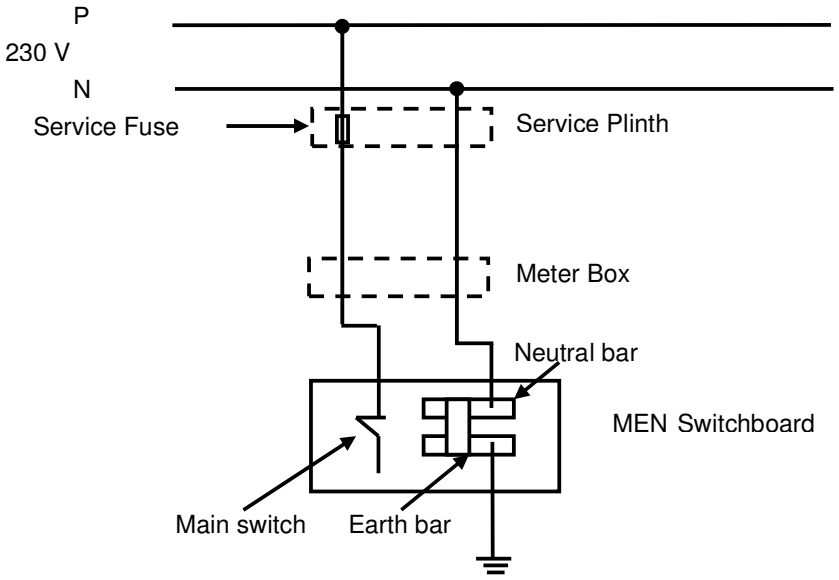
_____

Ref: .....

(turn over)

Question 6

The figure below represents a low voltage single-phase supply to an electrical installation. **The installation is live.**



Single-phase consumer

(a) State **FOUR** hazards that could occur if the phase and neutral are transposed on the distribution line; or at the service plinth; or at the meter box; or at the MEN switchboard.

(4 marks)

(1) _____

_____

(2) _____

_____

(3) _____

_____

(4) _____

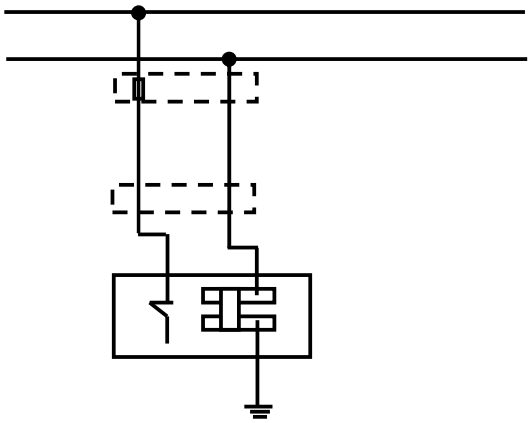
_____

(turn over)

Question 6 continued

(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)



(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)

_____

_____

(turn over)

Question 7

(a) An electrical inspector has been requested by an electricity retailer to reconnect an electrical installation that has been disconnected for 8 months.

Refer the Electricity Regulations and answer the following:

(i) Before connecting the installation, the electrical inspector must sight a specific type of document.

(1) What is this document?

(1 mark)

_____

Ref: .....

(2) Who can issue this document?

(1 mark)

_____

Ref: .....

(3) Name the Standard and section of that Standard that details the inspections and tests that <u>should</u> be carried out before the issue of this document.

(1 mark)

_____

Ref: .....

(ii) State the **FOUR** tests and checks that the electrical inspector is required to carry out before connecting the installation to the supply.

(4 marks)

(1) _____

(2) _____

(3) _____

(4) _____

Ref: .....

(turn over)

Question 7 continued

(b) The Electricity Regulations places **THREE** general requirements on any person with regard to the **testing of prescribed electrical work** on works or electrical installations. State those three requirements.

(3 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(3) _____

_____

_____

Ref: .....

(turn over)

Question 8

(a) Describe **FOUR** electrical hazards that may be present if the impedance of a low voltage installation main neutral is of a higher value than that of the main earth.

(4 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(3) _____

_____

_____

(4) _____

_____

_____

(b) (i) What are the two current ratings associated with distribution switchgear?

(1 mark)

_____

_____

(turn over)

Question 8 continued

(ii) State the meaning of the **TWO** current ratings that you have mentioned in (b)(i) above.

(3 marks)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(c) An air compressor motor circuit is protected by fuses labelled gM at a switchboard. How do fuses labelled gM differ from fuses labelled gG?

(2 marks)

_____

_____

_____

(turn over)

Question 9

A 230V/400V small engineering shop is being constructed and you have been requested to determine the maximum demand. The shop will have a three-phase supply and the load will be spread evenly across the three phases (as much as is possible).

Refer to AS/NZS 3000 and determine the maximum demand per phase (in amps) and the total maximum demand (in amps). Use the table on the next page for your calculations

The shop will comprise:

Single phase

70	250W Metal Halide lamps
6	0.75 kW drill presses (motors – nameplate rating; 3.1 amps)
12	15A socket outlets
11	10A socket outlets
2	3 kW water heaters

Three phase

4	5 kW lathes (motors – nameplate rating; 10.89 amps/phase)

(10 marks)

(turn over)

Question 9 continued

Equipment	Load Group	Calculation	Line 1	Line 2	Line 3
Halide lamps					
Drill presses					
15A socket outlets					
10A socket outlets					
Lathes					
Hot water heaters					

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		