



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
20 June 2009
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:

- Electricity Act 1992 reprint dated 19 August 2005
- Electricity Regulations 1997 reprint dated 2 September 2005
- AS 60529 or AS 1939 Supplement 1-1990; AS/NZS 3000:2000 and Amendments 1, 2 and 3 **or** AS/NZS 3000:2007; AS/NZS 3001:2001 **or** AS/NZS 3001:2008; AS/NZS 3004:2002 **or** AS/NZS 3004:2008 parts 1 and 2; AS/NZS 3760:2003 and Amendment 1; NZS 3019:2004 **or** AS/NZS 3019:2007
- ECP 34; ECP 35; ECP 51

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM

(turn over)

Question 1

- (a) Refer to the Electricity Regulations and explain the difference between “low voltage” and “standard low voltage” with respect a single phase a.c. **MEN** system.

(1 mark)

Ref:

- (b) Refer to the Electricity Regulations and state which of the following types of work are deemed **NOT** to be prescribed electrical work:

- The switching of electrical installations
- The maintenance of electrical appliances
- The rewinding of armatures
- The installations of conductors

(1 mark)

Ref:

(turn over)

Question 1 continued

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

(i) Refresher courses in testing to ensure safety.

(1/2 mark)

Ref:

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

(1/2 mark)

Ref:

(d) Prescribed electrical work has been completed on the mains and final subcircuits in a building. Refer to the Electricity Regulations and state:

(i) The Standard and section of that Standard that details the testing required to be carried out on the prescribed electrical work.

(1/2 mark)

Ref:

(ii) The Standard and section of that Standard that details the inspections required to be carried out on the prescribed electrical work.

(1/2 mark)

Ref:

(turn over)

Question 1 continued

- (e) 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. Refer to the Electricity Regulations and state who is required to give the Certificate of Compliance to the owner of the residence?

(1 mark)

Ref:

- (f) Refer to the Electricity Regulations and state the maximum interval allowed between safety checks for animal stunning electrical appliances?

(1 mark)

Ref:

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

(1 mark)

Ref:

(turn over)

Question 1 continued

(h) An inspector notices that the door on the external switchboard is missing and that rain is entering the switchboard, creating an immediate danger to anyone using the switchboard. Refer to the Electricity Regulations state the **TWO** actions the inspector obliged to take as soon as possible?

(1 mark)

(1) _____

(2) _____

Ref:

(i) Refer to AS/NZS 3000 and state whether a combined protective earthing and neutral (PEN) conductor can be switched. Include a reference to support your answer.

(1 mark)

Ref:

(turn over)

Question 1 continued

(j) Refer to AS/NZS 3000 and state the circumstances in which a main switchboard can be installed:

(i) Near a swimming pool. (1/2 mark)

Ref:

(ii) Near an automatic fire sprinkler. (1/2 mark)

Ref:

(k) Refer to AS/NZS 3000 and state **TWO** alternative protection methods for the protection of wiring systems that are located within a concrete or similar floor at a depth of less than 50 mm from any surface.

(1 mark)

(1) _____

(2) _____

Ref:

(turn over)

Question 1 continued

- (l) Refer to AS/NZS 3000 and state the main reason why interlocks are used in the load changeover device for the switching of the mains supply and the standby generator output (that is, for an alternative supply).

(1 mark)

Ref:

- (m) The mains for an electrical installation are larger than required to carry the maximum demand because of voltage drop. Refer to AS/NZS 3000 and state how the minimum size copper main earthing conductor can be determined.

(1 mark)

Ref:

- (n) Refer to AS/NZS 3000 and state the minimum size bonding conductor permitted for the bonding of metallic piping, cable sheaths and wiring enclosures.

(1 mark)

Ref:

(turn over)

Question 1 continued

(o) Refer to AS/NZS 3000 and state the minimum test voltage required for the insulation resistance test of a cable supplying a:

(1 mark)

(i) 400V distribution switchboard _____

(ii) 230V motor _____

Ref:

(p) Refer to AS/NZS 3000, state the **TWO** requirements for ELV socket outlets installed in a low voltage domestic electrical installation

(1 mark)

(1) _____

(2) _____

Ref:

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

(1 mark)

Ref:

(turn over)

Question 1 continued

- (r) Refer to AS/NZS 3000 and state the connection requirement for the isolating switch for an automatically controlled fire pump motor.

(1 mark)

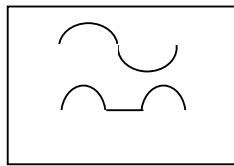
Ref:

- (s) There are two motor control circuits, one incorporating a thermistor the other incorporating a thermal overload. In all other respects the two circuits are identical.

Explain the differences between the two motor control circuits.

(1 mark)

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



What do these symbols mean?

(1 mark)

(turn over)

Question 2

(a) Consider a fault of negligible impedance from a phase or live conductor to any adjacent earthed exposed metal on a final subcircuit.

(i) What minimum fault current must be able to flow in the earthing conductor to operate a 20 amp fuse with a gG utilisation category?
(1 mark)

(ii) State **ONE** reason why a minimum value of fault current is necessary?
(1 mark)

(b) You are to replace a blown HRC fuse cartridge on a switchboard. The blown cartridge has the marking "Class Q1" on it.

(i) What does the expression "Class Q1" mean?
(½ mark)

(ii) What type of HRC fuse would you use to replace it?
(½ mark)

(c) An earth loop impedance tester reads 0.18 ohms when connected to a 230V socket-outlet. Calculate the prospective short circuit current.
(2 marks)

(turn over)

Question 2 continued

- (d) Fuses and circuit breakers are labelled with some or all of the expressions set out below. Briefly describe the meaning of each expression, and indicate the type of protective device (or devices) on which they would be found.

(5 marks)

- (i) 415V, AC 80

- (ii) 6kA

- (iii) 63A

(turn over)

Question 3

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 17 single-phase living units and communal areas.

- The power factor is unity.
- **The demand for all lighting is to be determined on a connected load basis**
- The development and/or equipment loads will be balanced, wherever practical, over the three-phases.

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:

Each Living unit

15	100W incandescent lights
2	4 metre lighting tracks, with 2, 60W lamps per track
15	10 A socket outlets
1	7kW range
1	4 kW instantaneous water heater
1	2 kW storage water heater

Communal areas

1	Water pump - 6 kW (Nameplate 10.8A/phase)	Three-phase
1	Hot water cylinder - 6 kW	Three-phase
3	Clothes dryers - 2 kW each	Single-phase
30	Fluorescent lights- 56W each	Single-phase
9	Socket outlets - 10A rating	Single-phase

(10 marks)

(turn over)

Question 3 continued

Living unit calculation

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

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 =

(turn over)

Question 4

- (a) Draw and label a circuit diagram of a three-phase RCD used for personal protection that protects a 5-pin socket outlet in a workshop.

(5 marks)

(turn over)

Question 4 continued

(b) Refer to NZS 3019 or AS/NZS 3019 and state the requirements for the testing of three-phase RCDs.

(4 marks)

Ref:

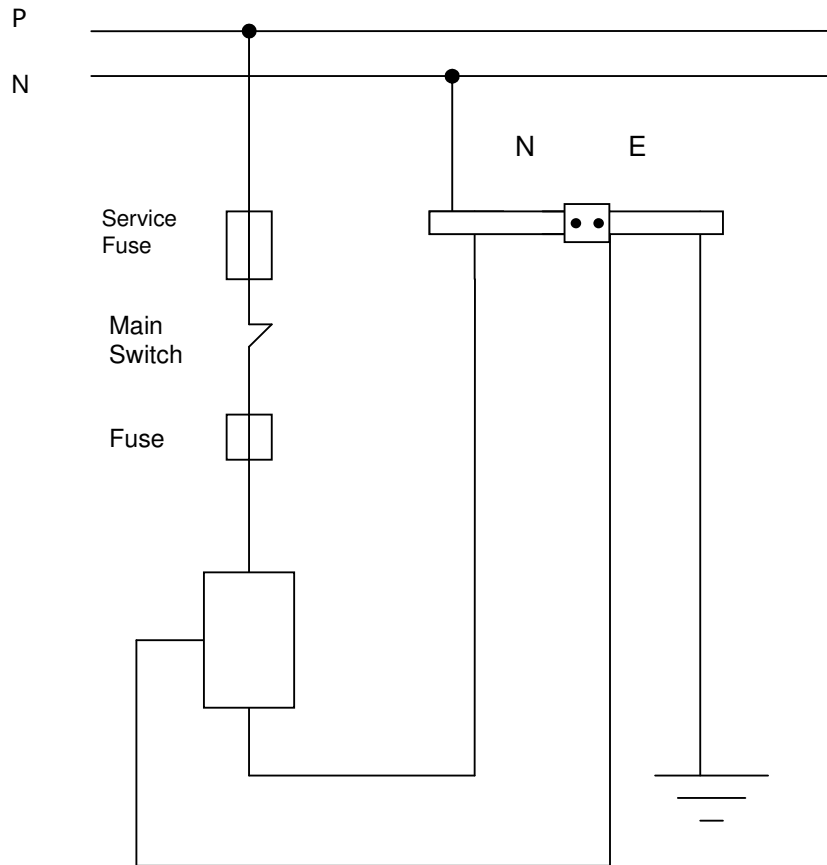
(c) Define the term "RCBO"

(1 mark)

(turn over)

Question 5

- (a) The diagram below represents a single phase domestic installation. The current in the phase is 20A, the neutral, 10A and the main earth, 10A.



- (i) State the circumstances that would cause the neutral and earth of the installation to equally share the load current? (3 marks)

(turn over)

Question 5 continued

- (ii) Is the main earth in the installation effective? Provide an explanation for your answer.

(2 marks)

- (b) Explain the circumstances that would cause the neutral to carry 30A, and the earth to carry 10A

(3 marks)

- (c) State **TWO** technical reasons why the neutral in the New Zealand MEN system is earthed at the star point of a transformer and at the main switchboard of an installation?

(2 marks)

(1) _____

(2) _____

(turn over)

Question 6

(a) You are carrying out a Warrant of Electrical Fitness inspection of a **new** caravan.

(i) The caravan is supplied by means of a permanently connected supply lead (a non-detachable connection) to the caravan. Refer to AS/NZS 3001 and state:

(1) To where must the supply lead be connected.

(1 mark)

Ref:

(2) The requirement for the supply lead when not in use

(1 mark)

Ref:

(3) The requirement relating to the rating or the overcurrent protection rating of the supply lead.

(1 mark)

Ref:

(turn over)

Question 6 continued

(ii) AS/NZS 3001 requires the use of:

- A specific type of socket outlet to provide a supply to a caravan from a caravan park service pillar.
- A matching plug on the supply lead to the connectable installation (or relocatable premises or transportable structure) for connection to the service pillar mains power supply.

(1) Refer to AS/NZS 3001 and state the Standards to which approved type of socket outlets for a single-phase supply must comply.

(1 mark)

Ref:

(2) The reason why these requirements are made.

(2 marks)

(b) RCDs are required to be fitted to a connectable installation (transportable structure). and they must operate in all live (active and neutral) conductors. Refer to AS/NZS 3001 and state why is this requirement made.'

(1 mark)

Ref:

turn over)

Question 6 continued

- (c) The Electricity Regulations require a maximum rating for the circuit breaker protecting a socket outlet in a service pillar that is used to supply a connectable installation (transportable structure). State the reason for this requirement?

(1 mark)

- (d) In a caravan park, multiple sites for low consumption premises can be supplied from one socket outlet. Refer to AS/NZS 3001 and state **TWO** types of fittings, either of which cannot be included in low consumption premises.

(2 marks)

(1) _____

(2) _____

Ref:

(turn over)

Question 7

A house has been relocated onto a rural lifestyle block and requires inspection. It is proposed to install a three-phase underground mains cable from a dedicated 50kVA, three-phase, 11kV/400V transformer sited adjacent to the boundary fence.

- The cable run is 125 metres.
- The volt-drop is not to exceed 2.5% of the supply voltage between the installation point of supply and the main switchboard
- The load is 70A balanced per phase
- The ground temperature is 15°
- The conductor temperature is 75°

The underground mains cable is described in the table below:

Using this information and the information in the following tables and AS/NZS 3000 answer the following:

- (a) Calculate the maximum current per phase the transformer can deliver for the three-phase supply to the cottage.

(1½ marks)

- (b) Determine minimum sized copper cable that will meet the load current requirements.

(1 mark)

(turn over)

Question 7 continued

- (c) Determine the minimum sized copper cable that will meet the voltage drop requirements.

(5 marks)

- (d) Determine the minimum size copper main earthing conductor that can be used for this electrical installation. State a reason for your answer and provide a reference source to support that reason.

(2½ marks)

Ref:

(turn over)

Question 7 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 7 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 7 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 8

There is a low voltage, three-phase 400V supply from a distribution line to an electrical installation. The installation is live.

- (a) State **THREE** hazards that will occur if any one of the three phases and the neutral are transposed at a point between the distribution line and the main switchboard of the electrical installation.

(3 marks)

(1) _____

(2) _____

(3) _____

- (b) (i) Describe how you would carry out an instrument test to establish whether a phase/neutral transposition has taken place at a point between the distribution line and the main switchboard of the electrical installation.

Include in your description the type of instrument and equipment used.

(2 marks)

(turn over)

Question 8 continued

- (ii) State the expected instrument readings when a transposition has taken place.

Note: The reading stated must be able to be achieved by the test described in (b)(i)

(3 marks)

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

Note: The reading stated must be able to be achieved by the test described in (b)(i)

(2 marks)

(turn over)

Question 9

- (a) You are about to inspect a new industrial main switchboard adjacent to a 250kVA, three-phase 400/230V distribution transformer, and you need to verify that the MVA fault rating of the new main switchboard is sufficient to cater for the short circuit fault current.

You have been advised by the network company that the phase to phase no-load voltage on the secondary terminals of the transformer is 400V. When fully loaded, the line voltage on the transformer secondary terminals is 380V and there is 332A per phase flowing.

- (i) Calculate the short circuit fault MVA at the secondary terminals of the transformer.

(4 marks)

(turn over)

Question 9 continued

- (ii) Calculate the prospective short circuit current at the supply terminals of the main switchboard.

Note: Assume that the consumers' mains will not cause any reduction in the prospective short circuit current (the run length is very short).

(3 marks)

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

(3 marks)

(1) _____

(2) _____

(3) _____

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		