ELECTRICAL WORKERS REGISTRATION BOARD

Safety • Competency

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

ELECTRICIAN'S REGULATIONS EXAMINATION

30 June 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. Show answers to THREE significant figures.

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 (including amendments 1, 2, 3 and A); AS/NZS 3001:2001; NZS 3019 (Int):2002 or NZS 3019:2004; AS/NZS 3760:2001 or; AS/NZS 3760:2003.
- ECP 34, and ECP 54.

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM

(turn over)

Question 1

Each part of this question is worth 2 marks.

(a) The Electricity Act lists **SEVEN** classes of person who may do, or assist in doing prescribed electrical work. List **FOUR** of these classes.

(1) _____

(2) _____

(3) _____

(4) _____

Ref: ……

(b) Refer to the Electricity Regulations and state the acceptable minimum and maximum values - apart from the momentary fluctuations - at the point of supply to a standard low voltage single-phase installation for:

(i) Voltage Minimum _____ V Maximum _____ V

(ii) Frequency Minimum _____ Hz Maximum _____ Hz

Ref: ……

(c) Refer to the Electricity Regulations and state the **TWO** circumstances where metal must be earthed or connected to earth by a bonding system.

(1) _____

_____

(2) _____

_____

Ref: ……

(turn over)

Question 1 continued

(d) A caravan that is to be hired or leased out must comply with the Electricity Regulations. Name the **TWO** types of certificates that are issued to confirm that the caravan is electrically safe.

(1) _____

_____

(2) _____

_____

Ref: .....

(e) Refer to AS/NZS 3000 and state:

(i) The colours permitted to identify the active (phase) conductor of a single-phase circuit?

(1 mark)

_____

_____

Ref: .....

(ii) The colours permitted to identify equipotential bonding conductors?

(1 mark)

_____

Ref: .....

(turn over)

Question 1 continued

(f) A 10 mm^2 twin and earth PVC insulated cable is to be buried direct in the ground in a Category A system. Refer to AS/NZS 3000 and state the minimum depth it can be buried if:

(i) It has no further protection.

(1 mark)

_____

(ii) It is below 90 mm of continuous concrete.

(1 mark)

_____

Ref: …….

(g) 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) _____

_____

(2) _____

_____

Ref: …….

(h) Refer to AS/NZS 3000 and state the **TWO** requirements for plugs and socket outlets used in SELV or PELV systems.

(1) _____

_____

(2) _____

_____

Ref: …….

(turn over)

Question 1 continued

(i) An automatically controlled fire pump motor supplies a sprinkler system. Refer to AS/NZS 3000 and state **TWO** requirements for the isolating switch controlling the motor.

(1) _____

_____

(2) _____

_____

Ref: …….

(j) Metal poles for floodlights are being erected by a crane along a boundary fence of a sports field. There is an 11 kV overhead electric line supported by towers running parallel to and directly above the boundary fence. State the closest distance that the crane, and the crane's load (a metal pole), can be manoeuvred to the conductors of the 11 kV line:

(i) **without** the consent of the owner of the 11 kV line.

(1 mark)

_____

Ref: …….

(ii) **with** the consent of the owner of the 11 kV line.

(1 mark)

_____

Ref: …….

(turn over)

Question 2

(a) AS/NZS 3000 requires that RCDs be installed:

- On socket outlet and lighting final subcircuits in domestic installations.
- On socket outlet final subcircuits in other residential type installations.

However, RCDs are also required in other electrical installations.

Refer to AS/NZS 3000 and state **THREE** areas in commercial and industrial electrical installations where you consider additional personal protection should be provided by using an RCD for the protection of users of electrical appliances and equipment.

(3 marks)

(1) _____

(2) _____

(3 _____

Ref: ……

(b) You are carrying out additions and alterations to an existing domestic electrical installation.

(i) Refer to AS/NZS 3000 and state **THREE** situations where RCDs do not need to be installed after alterations, additions or repairs have been carried out.

(3 marks)

(1) _____

_____

(2) _____

_____

(3) _____

_____

Ref: ……

(turn over)

Question 2 continued

(ii) Part of the alterations involves the extending of an existing final subcircuit for a new socket outlet in an existing bathroom. The subcircuit is not protected by an RCD.

The socket outlet in the bathroom will be in Zone 3 of the bath and is required to be protected by an RCD.

There is no room on the switch board to connect the existing final sub-circuit to an existing RCD nor is there room to install an additional RCD.

State **TWO** solutions – other than the replacement of the switchboard - either of which will ensure that the socket outlet in the bathroom is protected by an RCD.

(4 marks)

(1) _____

_____

(2) _____

_____

(turn over)

Question 3

AS/NZS 3000 states:

Persons and livestock shall be protected against dangers that may arise from contact with exposed conductive parts which may become live under fault conditions (indirect contact).

Refer to AS/NZS 3000 and answer the following:

(a) State the **THREE** methods of protection permitted to protect against indirect contact.

(3 marks)

(1) _____

(2) _____

(3) _____

Ref: ……..

(b) (i) Briefly state how the "automatic disconnection of supply" method is achieved.

(2 marks)

_____

_____

_____

_____

Ref: ……

(turn over)

Question 3 continued

(ii) State the **THREE** types of final subcircuits where the electrical protection, under fault conditions, is required to have a disconnection time of not more than 0.4s.

(3 marks)

(1) _____

_____

(2) _____

_____

(3) _____

_____

Ref: .....

(c) Briefly describe how Class II electrical equipment provides protection against electric shock.

(2 marks)

_____

_____

_____

_____

_____

Ref: .....

(turn over)

Question 4

You are wiring a new domestic residence. Items to be installed include:

- A 7000 litre in-ground swimming pool. A block wall will run along one side of and 1.5 metres from the internal rim of the pool.
- A 4000 litre spa pool.

Refer to AS/NZS 3000 and answer the following:

(a) State **ONE** method of protection against electric shock that is prohibited.
(1 mark)

_____

_____

Ref: .....

(b) The customer requires two 230V socket outlets to be installed on the block wall that is 1.5 metres from internal rim of the pool.

- One socket outlet is for the connection of pool equipment.
- One socket outlet is for general use.

Which of these socket outlets is permitted to be installed? State the reason your answer and the reference sources.
(3 marks)

_____

_____

_____

_____

_____

_____

Ref: .....

(turn over)

Question 4 continued

(c) With regard to the socket outlet you have detailed in (b) above state:

(i) The required degree of protection.

(1 mark)

_____

Ref: ……

(ii) The requirement relating to the location of the socket outlet.

(1 mark)

_____

Ref: ……

(iii) The **TWO** requirements relating to the protection and control of the socket outlet.

(2 marks)

(1) _____

_____

_____

(2) _____

_____

_____

Ref: ……

(d) Wiring systems for swimming pool and spa pool areas are to be installed to prevent two situations occurring. State those **TWO** situations.

(2 marks)

(1) _____

_____

(2) _____

_____

Ref: ……

(turn over)

Question 5

You have been engaged to lay a 4-core neutral screened **copper** cable at in a commercial development from an indoor 400 V, three-phase distribution board to an outdoor metering location in an area of the development.

- The cable run length is 30 m.
- The maximum half-hour demand of the new load is 100 kVA.
- The cable will be buried direct.
- The ambient soil temperature is 10 ^{0}C.
- The voltage at the switchboard is 400 V.
- The voltage drop from the switchboard to the metering station must not exceed 7 volts.
- An allowance of 15% must be made for future growth.
- The conductor temperature is assumed to be 75 ^{0}C

Using this information and the relevant information from the following tables determine the size of cable required for this installation. To determine the cable size you must:

- Find by calculation, the size of cable that will carry the intended load.
- Find by calculation, the size of the cable which satisfies the volt drop requirements.
- State the size of cable that will meet the requirements.

(a) The size of cable that will carry the intended load.

(5½ marks)

(turn over)

Question 5 continued

(b) The size of the cable which satisfies the volt drop requirements.

(3½ marks)

(c) The size of cable that will meet the requirements.

(1 mark)

(turn over)

Question 5 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
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**					
mm²	**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 30^0C ambient air temperature and 15^0C ambient soil temperature

(turn over)

Question 5 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															
Conductor size	**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**	**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 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 ^0C	**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, ^0C									
	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

Refer to AS/NZS 3000 and answer the following:

(a) State the recommended sequence of tests for a new low voltage electrical installation.

(4 marks)

(1) _____

_____

(2) _____

_____

(3) _____

_____

(4) _____

_____

(5) _____

_____

(6) _____

_____

(7) _____

_____

(8) _____

_____

Ref: .....

(turn over)

Question 6 continued

(b) State the primary reason for carrying out an earth continuity test on an electrical installation prior to livening.

(2 marks)

_____

_____

_____

_____

_____

_____

Ref: .....

(c) State the primary reason for carrying out an insulation resistance test on an electrical installation prior to livening.

(2 marks)

_____

_____

_____

_____

_____

_____

Ref: .....

(turn over)

Question 6 continued

(d) An electrician has completed a new domestic installation. All the required tests have been carried out and a Certificate of Compliance has been issued to the owners.

The electrician certified the installation even though the insulation resistance test result was less than 1 Mohm. State the reason why the electrician would have proceeded with certification.

(2 marks)

_____

_____

_____

_____

Ref: .....

(turn over)

Question 7

Clause 1.9.2 of AS/NZS 3000 states that all electrical equipment in an electrical installation shall:

- Be safe to use when properly assembled, installed and connected to supply; and
- Not cause a danger from electric shock, fire, high temperature or physical injury in the event of reasonably expected conditions of overload, abnormal operation, fault or external influences.

Refer to AS/NZS 3000 and answer the following:

(a) State the **THREE** types of protective fittings that can be used for short-circuit or over-current protection.

(3 marks)

(1) _____

(2) _____

(3) _____

Ref: .....

(b) State the **TWO** requirements for an industrial switchboard in which there is access to live parts.

(2 marks)

(1) _____

_____

(2) _____

_____

Ref: .....

(turn over)

Question 7 continued

(c) For a high-rise apartment building state:

(i) The location where the main switchboard must be placed.

(1 mark)

_____

_____

Ref: ……

(ii) The location where the main switchboard cannot be placed.

(1 mark)

_____

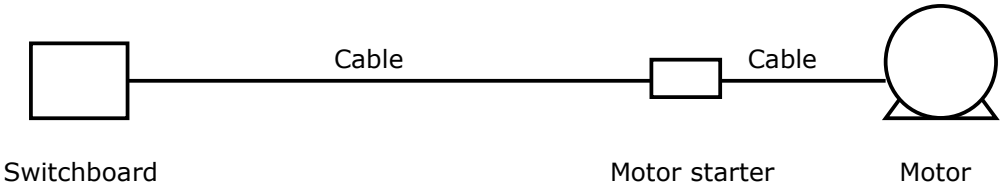
_____

Ref: ……

turn over)

Question 7 continued

(d) The block diagram below represents the supply to a three-phase induction motor.



(i) What type of motor protection would normally be installed at the switchboard?

(1 mark)

_____

(ii) What type of motor protection would normally be installed in the motor starter?

(1 mark)

_____

(iii) What type of fault would operate the protection you have stated in (d)(ii) for the motor starter?

(1 mark)

_____

(turn over)

Question 8

Refer to AS/NZS 3000 and answer the following:

(a) (i) 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 <u>one</u> of the three phases.
- A fixed-wired Class I electrical appliance connected to a single-phase final subcircuit. The appliance has a phase to frame fault on the load side of the appliance switch.

<u>You do not need</u> to show the main switch or metering

(4 marks)

(ii) Clearly indicate on the figure, the earth fault path for the faulty appliance circuit.

(1 mark)

Ref: .....

(turn over)

Question 8 continued

(b) State the main reason why the overall impedance of an earth fault loop must be low.

(2 marks)

_____

_____

_____

_____

Ref: ……

(c) The final subcircuit supplying a 10A socket outlet into which an electrical appliance is plugged is protected by a 20A type C MCB.

(i) State the maximum disconnection time permitted for the MCB.

(1 mark)

_____

Ref: ……

(ii) State the maximum earth fault loop impedance permitted in the final subcircuit if the MCB is to operate within the maximum disconnection time.

(1 mark)

_____

Ref: ……

(iii) The final subcircuit is a 2.5mm^2 twin and earth TPS copper cable. The earth conductor is also 2.5mm^2. State the maximum length of run that can be installed that still ensures that the MCB will within the maximum disconnection time under fault conditions.

(1 mark)

_____

Ref: ……

(turn over)

Question 9

Refer to AS/NZS 3000 and determine the maximum demand of a 230 volt domestic installation with the following loads:

32	indoor lighting points	1	3 kW permanently connected clothes dryer in a laundry
10	10 A double socket outlets		
9	10 A single socket outlets	1	2.4 kW air conditioner
1	10 kW electric range	1	6 kW instantaneous water heater

(10 marks)

Load Group	Calculation	Load (A)
Group		
Group		
Group		
Group		
Group		
Total maximum demand		

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

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