



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

ELECTRICIAN'S REGULATIONS EXAMINATION

27 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:

- The Electricity Act 1992 reprint dated 19 August 2005
- The Electricity Regulations 1997 reprint dated 2 September 2005
- AS 60529 **or** AS 1939 Supplement 1-1990; AS/NZS 3000:2000 and Amendments A, 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 54

PLEASE HAND THIS PAPER TO THE SUPERVISOR BEFORE LEAVING THE ROOM

(turn over)

Question 1

- (a) Refer to the Electricity Regulations and state the maximum permitted operating time for a Residual Current Device (RCD) installed for the protection of property.

(2 marks)

Ref:

- (b) Refer to the Electricity Regulations and state **TWO** situations where "fittings" are deemed not to be electrically safe.

(2 marks)

(1) _____

(2) _____

Ref:

- (c) Refer to AS/NZS 3000 and list **TWO** acceptable methods of limiting the maximum demand in mains and sub-mains.

(2 marks)

(1) _____

(2) _____

Ref:

- (d) Refer to AS/NZS 3000 and state the **TWO** situations where RCD protection is required in a new domestic electrical installation

(2 marks)

(1) _____

(2) _____

Ref:

(turn over)

Question 1 continued

(e) A 4mm² two core neutral-screen submain cable is to be run between two buildings. It is to be buried direct (unenclosed) in the ground in an unpaved area. Refer to AS/NZS 3000 and state **TWO** requirements for indicating the position of the buried cable.

(2 marks)

(1) _____

(2) _____

Ref:

(f) Refer to AS/NZS 3000 and state the safety requirement for the prevention of injury to persons or damage to property that must be met in the event of complete power failure to an electric motor.

(2 marks)

Ref:

(g) A step-up transformer is used in an industrial installation to supply equipment that operates at a voltage higher than that at the point of supply. Refer to AS/NZS 3000 and state the requirement for this arrangement.

(2 marks)

Ref:

(turn over)

Question 1 continued

(h) Refer to AS/NZS 3000 and state the circumstances where metallic (conductive) water piping associated with a building is **not** required to be equipotentially bonded.

(2 marks)

Ref:

(i) Refer to AS/NZS 3000 and state where fuses or circuit-breakers shall be connected for overcurrent protection in an extra-low voltage system that is earthed at the point of supply.

(2 marks)

Ref:

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

(2 marks)

Ref:

(turn over)

Question 2

AS/NZS 3000 details the safety outcomes required for an electrical installation, so that installation is “electrically safe” under the Electricity Regulations.

In relation to protection against indirect contact:

AS/NZS 3000:2000: 1.7.4.1 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)”.

AS/NZS 3000:2007: 1.5.5.1 states:

“Protection shall be provided against dangers that may arise from contact with exposed conductive parts that may become live under fault conditions.”

- (a) Refer to AS/NZS 3000 and state **THREE** methods of protection that can be used to provide protection against indirect contact in and electrical installation.

(1½ marks)

(1) _____

(2) _____

(3) _____

Ref:

(turn over)

Question 2 continued

- (b) For **TWO** of the methods of protection you have stated in (a) above, briefly state how the method achieves the safety outcome required.

(4 marks)

(1) _____

(2) _____

- (c) For **TWO** of the methods of protection you have stated in (b) above, briefly state how you would verify that the method is operating correctly to provide the required protection.

(4 marks)

(1) _____

(2) _____

- (d) Refer to AS/NZS 3000 and state the maximum disconnection time for a protective device protecting a Class I, 230V, handheld tool.

(½ mark)

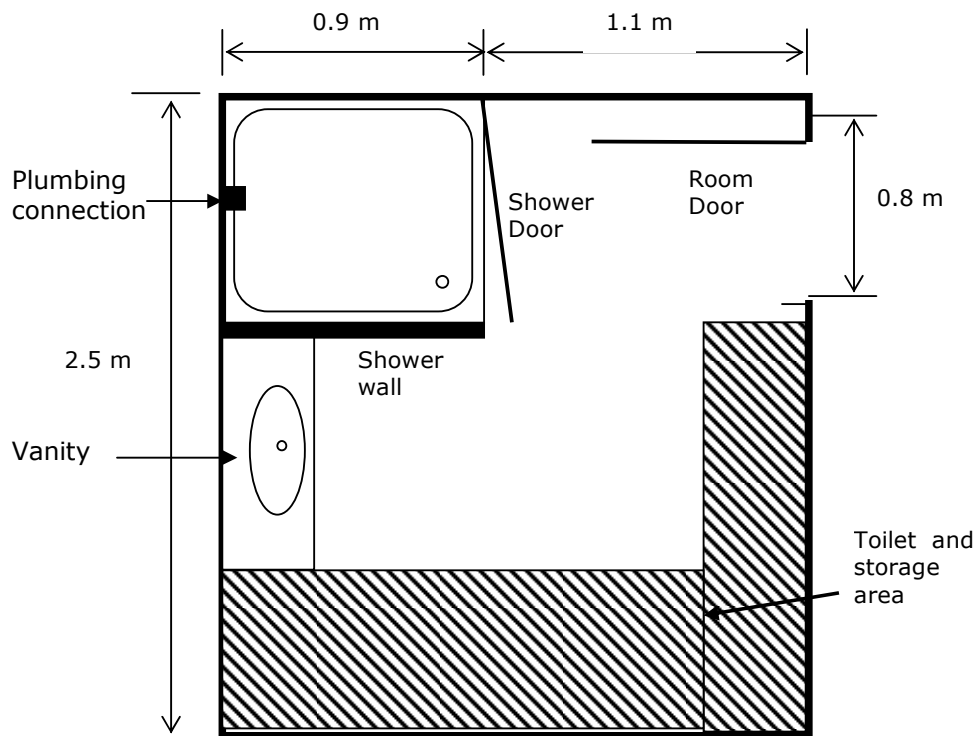
Ref:

(turn over)

Question 3

The figure below represents an en-suite – it is not to scale and:

- The hand basin is of 30 Litre capacity.
- Nothing can be installed in or above the toilet and storage area.
- The shower is enclosed with the door facing the room door
- All fittings operate at 230V



For the en-suite the customer wants to install:

- A light switch
- A heated towel rail and associated permanent connection
- A room heater and associated wall switch
- A socket outlet

(turn over)

Question 3 continued

(a) The light switch is required to be accessible when entering the ensuite.

(i) In which Zones can the light switch be installed? (1 mark)

Ref:

(ii) What is the light switch IP rating for each zone? (1 mark)

Ref:

(iii) What is the minimum mounting height above the floor for the light switch? (½ mark)

Ref:

(b) The towel rail and associated permanent connection unit.

(i) In which Zones can the towel rail and permanent connection unit be installed? (1 mark)

Ref:

(turn over)

Question 3 continued

- (ii) What is the towel rail and permanent connection unit IP rating for each zone?
(1 mark)

Ref:

- (iii) What is the minimum mounting height above the floor for the towel rail and permanent connection unit?
(½ mark)

Ref:

- (c) The wall heater and associated wall switch.

- (i) In which Zones can the wall heater and wall switch be installed?
(1 mark)

Ref:

- (ii) What is the wall heater and wall switch IP rating for each zone?
(1 mark)

Ref:

- (iii) What is the minimum mounting height above the floor for the wall heater and wall switch?
(½ mark)

Ref:

(turn over)

Question 3 continued

(d) The socket outlet must be visible at all times.

(i) In what Zone can the socket outlet be installed?

(½ mark)

Ref:

(ii) What is the socket outlet IP rating for that zone?

(½ mark)

Ref:

(iii) What electrical protection methods can be used for the socket outlet?

(1 mark)

Ref:

(iv) What is the minimum mounting above the floor height for the socket outlet?

(½ mark)

Ref:

(turn over)

Question 4

You have wired and completed a new domestic residence and now must carry out the required tests before livening. The installation includes an oven, a hob and a water heater

(a) You have to carry out an insulation resistance test of entire installation.

(i) Refer to AS/NZS 3000 and state the reason why an insulation resistance test needs to be carried out on the installation. (2 marks)

Ref:

(ii) The testing is required to be carried out on separate parts of the installation. Which parts of the installation would you test separately? (2 marks)

(iii) What type of test instrument would you use to carry out the insulation resistance testing? State the test voltage if applicable. (2 marks)

(turn over)

Question 4 continued

- (iv) Refer to AS/NZS 3000 and state the minimum or maximum permitted test result for each of the parts you have stated in (a)(ii) above. (2 marks)

Ref:

- (b) Refer to AS/NZS 3000 and state the differences between a "polarity test" and a "correct circuit connection test". (2 marks)

Ref:

(turn over)

Question 5

You are wiring a new domestic residence. The modular switchboard comprises:

- A main switch
- An earth bar
- A main neutral bar
- A neutral busbar No.1
- A neutral busbar No.2
- A 32A MCB for an oven
- MCB bank No.1, protected by RCBO No. 1.
- MCB bank No.2, protected by RCBO No. 2.

- (a) (i) Which conductors and fittings are connected to the main neutral bar?
(2 marks)

- (ii) Which conductors are connected to neutral bar No.1?
(1 mark)

- (ii) Which conductors are connected to neutral bar No.2?
(1 mark)

- (b) RCBO No.1

- (i) There is a conductor connected to the in-coming neutral terminal of this RCBO. To where is the other end of this conductor connected?
(1 mark)

- (ii) There is a conductor connected to the out-going neutral terminal of this RCBO. To where is the other end of this conductor connected?
(1 mark)

(turn over)

Question 5 continued

- (iii) There is a conductor connected to the in-coming phase terminal of this RCBO. To where is the other end of this conductor connected?
(1 mark)

- (iv) There is a conductor connected to the out-going phase terminal of this RCBO. To where is the other end of this conductor connected?
(1 mark)

(c) RCBO No.2

- (i) There is a conductor connected to the in-coming neutral terminal of this RCBO. To where is the other end of this conductor connected?
(1 mark)

- (ii) There is a conductor connected to the out-going neutral terminal of this RCBO. To where is the other end of this conductor connected?
(1 mark)

(turn over)

Question 6

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

16	60W lights	1	12 kW electric range
17	100W lights	1	Gas water heater with controls supplied from a 10A socket outlet
6	Metres of lighting track	15	10A double socket outlets
	3kW outside lighting	10	10A single socket outlets
1	6kW input air conditioner		

(10 marks)

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

Note: There are two distinct solutions to this question, you must provide **ONE** solution

(turn over)

Question 7

A new MEN main switchboard is to be installed in a multi-purpose storage room (that is, a cupboard) in a shopping centre. The room is located in the centre of the shopping centre.

Refer to AS/NZS 3000 and answer the following:

- (a) State **TWO** requirements for installing a switchboard in the storage room (cupboard).

(2 marks)

(1) _____

(2) _____

Ref:

- (b) The switchboard incorporates exposed live parts. State the **TWO** requirements either of which can be used to restrict access to the exposed live parts.

(2 marks)

(1) _____

(2) _____

Ref:

- (c) From the outside of the complex it is not obvious where the main switchboard will be located. State the requirement for identifying the location of the main switchboard.

(2 marks)

Ref:

(turn over)

Question 7 continued

(d) State the minimum permitted width of the doorway to the room. State a reference to support your answer.

(1 mark)

Ref:

(e) State the minimum unimpeded space required in front of the switchboard? State a reference to support your answer.

(2 marks)

Ref:

(f) State the reason why a distribution board supplied from the MEN main switchboard would not require a link between the neutral bar and the earth bar.

(1 mark)

Ref:

(turn over)

Question 8

It is proposed to install a four-core **aluminium** neutral-screen cable to supply a low voltage, three-phase switchboard in a building.

(a) Load requirements

Use the following information and information from the tables below and calculate the minimum size cable that will meet the load current requirements.

- The cable will be partly buried direct and partly surface mounted (touching).
- The line current is 60 amps balanced.
- The distance between the property boundary and the main switchboard is 45 metres.
- The ambient soil temperature is 15° C.
- The ambient air temperature is 30° C.
- The maximum permitted voltage drop is 1.5%
- The maximum conductor temperature is 75° C
- Allowance needs to be made for a 20% load increase.

(4 marks)

(turn over)

Question 8 continued

(b) Voltage drop requirements

Use the following information and information from the tables below and calculate the minimum size cable that will meet the voltage drop requirements.

- The cable will be partly buried direct and partly surface mounted (touching).
- The line current is 60 amps balanced.
- The distance between the property boundary and the main switchboard is 45 metres.
- The ambient soil temperature is 15° C.
- The ambient air temperature is 30° C.
- The maximum permitted voltage drop is 1.5%
- The maximum conductor temperature is 75° C
- Allowance needs to be made for a 20% load increase.

(4½ marks)

(c) What is the minimum cable size that will meet both the load current and voltage drop requirements?

(1½ marks)

(turn over)

Question 8 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					
	mm²	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 8 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
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	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

(turn over)

Question 8 continued

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

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

(turn over)

Question 8 continued

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, °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

Table 45

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

Conductor size mm ²	Three-phase voltage drop at 50 Hz, mV/A.m									
	Conductor temperature, °C									
	45		60		75		80		90	
	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.
16	3.64	-	3.84	-	4.04	-	4.11	-	4.24	-
25	2.29	-	2.42	-	2.54	-	2.59	-	2.67	-
35	1.66	-	1.75	-	1.84	-	1.87	-	1.93	-

(turn over)

Question 9

- (a) Refer to AS/NZS 3000 and state **THREE** selection and installation requirements for the earthing arrangements for an electrical installation. (3 marks)

(1) _____

(2) _____

(3) _____

Ref:

- (b) Refer to AS/NZS 3000 and state the minimum size main earthing conductor that must be installed with a three-phase 35mm² aluminium neutral screen mains cable. (1 mark)

(1 mark)

Ref:

(turn over)

Question 9 continued

- (c) A 6mm² twin and earth TPS cable is to be protected by a Type C MCB. Refer to AS/NZS 3000 and state the maximum length of the circuit that can be installed that would still allow the protection to operate under fault conditions.

(1 mark)

Ref:

- (d) A multi-phase electricity supply has active conductors are of different sizes. Refer to AS/NZS 3000 and state how is the minimum size of the earth continuity conductor is determined?

(2 marks)

Ref:

(turn over)

Question 9 continued

(e) A 11kV/400V, 100kVA, three-phase, delta-star transformer has a 5% impedance. When fully loaded a line current of 5.25A flows in its primary windings. Assume there are no internal losses.

(i) Calculate the fault level which would be produced by the transformer.
(1½ marks)

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

(1½ marks)

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		