



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

ELECTRICAL WORKERS REGISTRATION BOARD

ELECTRICIAN'S REGULATIONS EXAMINATION

24 June 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 and amendments or The Electricity Act 1992 reprint dated 19 August 2005.
- The Electricity Regulations 1997 and the Electricity Amendment Regulations 1999, Electricity Amendment Regulations 2002 and the Electricity Amendment Regulations 2003; or
The Electricity Regulations Compilation 2003 and the Electricity Amendment Regulations 2003; or
The Integrated Electricity Regulations 1997 or
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

Answer all parts of this question. Each part is worth 2 marks.

- (a) The Electricity Act permits any person (other than a registered person or a trainee) to carry out electrical work under supervision. Refer to the Act and state:

- (i) Who is required to carry out the supervision?

(1 mark)

Ref:

- (ii) A condition under which the work must be carried out (apart from being supervised).

(1 mark)

Ref:

- (b) Refer to the Electricity Regulations and state the permitted minimum and maximum voltage at the point of supply for a standard low voltage, single-phase installation.

(2 marks)

Minimum voltage _____

Maximum voltage _____

Ref:

(turn over)

Question 1 continued

- (c) Refer to AS/NZS 3000 and state **TWO** situations in a low voltage domestic installation where RCDs do not need to be installed after alterations, additions or repairs have been carried out.

(2 marks)

(1) _____

(2) _____

Ref:

- (d) Refer to AS/NZS 3000 and state the requirement for a motor isolator that is located remotely from the motor.

(2 marks)

Ref:

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

- (i) The colours permitted to identify the 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) Refer to AS/NZS 3000 and state **TWO** alternative protection methods for the protection of a wiring system installed in a concrete floor at a distance less than 50 mm from the surface of that floor.

(2 marks)

(1) _____

(2) _____

Ref:

(g) Refer to AS/NZS 3000 and specify the conductor type and the minimum permissible conductor size for the following in a low voltage electrical installation.

(i) Main earthing conductor

(1 mark)

Ref:

(ii) An equipotential bonding conductor for metal water pipes

(1 mark)

Ref:

(h) Refer to AS/NZS 3000 and state the **safety** precautions that shall be taken when testing a low voltage electrical installation?

(2 marks)

Ref:

(turn over)

Question 1 continued

- (i) Refer to AS/NZS 3000 and state the **TWO** situations where it would be deemed to be acceptable for the voltage drop on an extra low voltage installation to exceed 10%. (2 marks)

(1) _____

(2) _____

Ref:

- (j) Refer to NZECP 34 and state the closest distance that a 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

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 each of the three phases.
- A Class I electrical appliance plugged into a single-phase final sub circuit via a 10A socket outlet. The appliance has a phase to frame fault on the load side of the appliance switch.

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

(4 marks)

(ii) Indicate on the figure by using arrows or colour, the earth fault path for the faulty appliance circuit.

(1 mark)

Ref:

(turn over)

Question 2 continued

- (b) State the main reason why the overall impedance of an earth fault loop must be low. (1 mark)

Ref:

- (c) The final subcircuit supplying the socket outlet into which the 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:

- (d) If the earth fault loop impedance exceeded the permitted value, state **ONE** method that can be used to reduce the loop impedance to below that permitted value. (1 mark)

Ref:

- (e) Where a fault between a live part and earth occurs and the touch voltages become hazardous, a protective device must automatically disconnect the supply. State the touch voltage limits which, if exceeded, a hazard arises. (1 mark)

Ref:

(turn over)

Question 3

You have been requested to install a **three-phase** mains cable to a large new farm complex comprising 3 large houses, a large milking shed and associated out-buildings. You are to provide the customer the best economical solution that meets the technical requirements. The following are the conditions that must be met:

- The **copper** cable will be run from the road to the milking shed for a distance of 70 metres to a main switchboard/metering point.
 - The cable will be buried direct.
 - The load is 90 amps per phase.
 - The voltage at the switchboard is 400V.
 - The maximum permitted voltage drop is 3%.
 - An allowance of 20% for load growth.
 - The ambient **soil** temperature is 10° C
- Assume the conductor temperature to be 75° C

Use this information and information from the tables below to answer the following.

- (a) Determine by calculation, the minimum size cable that will satisfy the load requirements

(3½ marks)

(turn over)

Question 3 continued

- (b) Determine by calculation whether the cable you have selected in (a) above meets the voltage drop requirements.

(3½ marks)

- (c) Determine by calculation the cable size that meets both the load and voltage drop requirements

(3 marks)

(turn over)

Question 3 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
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	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 3 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	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°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 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 °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, °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	-

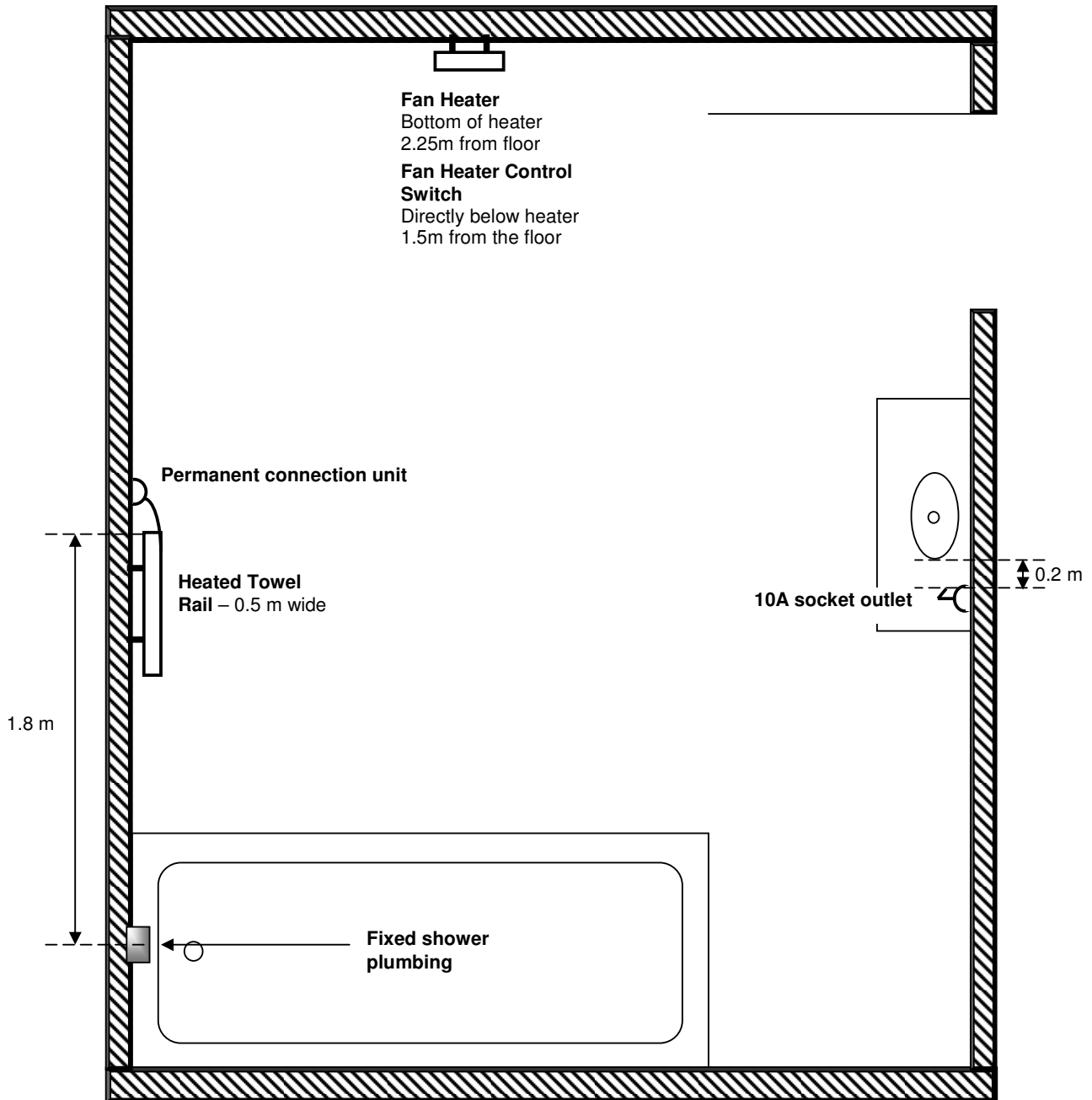
Note: To convert to single-phase values multiply the three-phase value by 1.155

(turn over)

Question 4

The following figure shows a bathroom floor plan (not to scale). Note that:

- The bathroom is 3.0 metres square.
- The basin has a capacity of 30 litres.



(turn over)

Question 4 continued

Using the information given in the figure above, refer to AS/NZS 3000 and answer the following:

(a) Towel rail

- (i) In which Zone is the towel rail situated? (1 mark)

Ref:

- (ii) What is the minimum permitted IP rating for the towel rail? (1 mark)

Ref:

(b) Towel rail permanent connection unit

- (i) In which Zone is the towel rail permanent connection unit situated? (1 mark)

Ref:

- (ii) What is the minimum permitted IP rating for the permanent connection unit? (1 mark)

Ref:

(c) The socket outlet

- (i) In which Zone is the socket outlet situated? (1 mark)

Ref:

- (ii) What is the minimum permitted IP rating for the socket outlet? (1 mark)

Ref:

(turn over)

Question 4 continued

(iii) What type of electrical protection is required for the socket outlet? (1 mark)

Ref:

(d) The fan heater

(i) In which Zone is the fan heater? (1 mark)

Ref:

(ii) What is the minimum permitted IP rating for the fan heater? (1 mark)

Ref:

(e) What is the minimum permitted IP rating for the fan heater control switch? (1 mark)

Ref:

(turn over)

Question 5

You have just finished completely rewiring an existing low voltage electrical installation that has been disconnected from the electricity supply for 9 months. The house is 60 years old and new mains and main earthing system and outside metering have been installed. All final subcircuits and associated fittings have been replaced and the main switchboard has been upgraded.

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

(i) The **FIVE** mandatory tests, using instruments, which are required to be carried out:

(2½ marks)

- (1) _____
- (2) _____
- (3) _____
- (4) _____
- (5) _____

Ref:

(ii) **FIVE** visual checks on the main switchboard that it is recommended be carried out:

(2½ marks)

- (1) _____
- (2) _____
- (3) _____
- (4) _____
- (5) _____

Ref:

(turn over)

Question 5 continued

(b) Refer to the Electricity Regulations and state **FOUR** actions that must be taken by the person connecting the electrical installation to the electricity supply:

(4 marks)

- (1) _____

- (2) _____

- (3) _____

- (4) _____

Ref:

(c) Refer to the Electricity Regulations and state who must ensure that all applicable testing requirements of regulations 37 and 38, all applicable certification requirements of regulation 39, and all applicable inspection requirements of regulation 41, have been carried out.

(1 mark)

Ref:

(turn over)

Question 6

Earthing arrangements for protective purposes shall be comprised of protective earthing conductors used with overcurrent protective devices provided in the active for protection against indirect contact and overcurrent. Refer to AS/NZS 3000 and answer the following:

- (a) The selection and installation of the general earthing requirements shall ensure **THREE** operational results. State these operational results. (3 marks)

(1) _____

(2) _____

(3) _____

Ref:

- (b) In a multi-phase electricity supply where the active conductors are of a different size, how is the minimum size of the earth continuity conductor determined? (2 marks)

Ref:

(turn over)

Question 6 continued

(c) State the **THREE** methods of protecting earthing conductors against mechanical damage.

(3 marks)

(1) _____

(2) _____

(3) _____

Ref:

(d) State the **TWO** restrictions on a protective earthing conductor that originates at a distribution board.

(2 marks)

(1) _____

(2) _____

Ref:

(turn over)

Question 7

Electrical installations shall be provided with devices for isolation and switching to prevent or remove hazards associated with the electrical installation and maintenance of electrical equipment. Refer to AS/NZS 3000 and answer the following:

- (a) State **TWO** situations where switches or circuit breakers are not to be operated in a neutral conductor:

(2 marks)

(1) _____

(2) _____

Ref:

- (b) State **FOUR** features of switching devices installed for mechanical maintenance.

(4 marks)

(1) _____

(2) _____

(3) _____

(4) _____

Ref:

(turn over)

Question 7 continued

(c) State **FOUR** features of switching devices installed for isolation purposes. (4 marks)

(1) _____

(2) _____

(3) _____

(4) _____

Ref:

(turn over)

Question 8

Refer to AS/NZS 3000 answer the following:

- (a) What do you understand to be the meaning of the term "maximum demand"? (2 marks)

Ref:

- (b) Determine by calculation the maximum demand of a 230 V domestic installation with the following loads: (5 marks)

Equipment	Load Group	Calculation	Load (Amps)	
25 - lighting points				(½ mark)
10 metres of lighting track				(½ mark)
10 – 150W outside lights				(½ mark)
18 - double socket outlets (10 A)				(½ mark)
10 - single socket outlets (10 A)				(½ mark)
1 - 3 kW controlled water heater				(½ mark)
1 - electric range (6 kW)				(½ mark)
2 – 10A space heaters				(½ mark)
1 – 4 kW air conditioner unit				(½ mark)
Total Maximum Demand				(½ mark)

Ref:

(turn over)

Question 8 continued

(c) State the **THREE** other methods of determining the maximum demand of an electrical installation

(3 marks)

(1) _____

(2) _____

(3) _____

(turn over)

Question 9

Refer to AS/NZS 3000 and answer the following:

- (a) (i) State the minimum acceptable insulation resistance value for a low voltage electrical installation.

(1 mark)

Ref:

- (ii) State the circumstances in which the minimum acceptable value required in (a)(i) could be less.

(1 mark)

Ref:

- (iii) In the circumstances outlined in (a)(ii), what would be the minimum acceptable value?

(1 mark)

Ref:

- (b) (i) State the reason why it is necessary to carry out an insulation resistance test using test instruments on an electrical installation prior to livening.

(2 marks)

Ref:

(turn over)

Question 9 continued

- (ii) State the **THREE** circumstances an acceptable insulation test result is designed to prevent. (3 marks)

- (1) _____
- (2) _____
- (3) _____

Ref:

- (c) (i) State the specified test voltage for an insulation resistance test of a low voltage electrical installation. (1 mark)

Ref:

- (ii) State the performance criteria for an insulation resistance tester. (1 mark)

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		