ER34

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

ELECTRICIAN'S REGULATIONS EXAMINATION

22 November 2008

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 and nominate the version of AS/NZS 3000 you will use in the boxes 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 5 September 2005.
- AS 60529 or AS 1939 supplement 1 – 1990; AS/NZS 3000:2000 (including amendments 1, 2, 3 and A) or AS/NZS 3000:2007; 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

(a) A single-phase electrical installation operates at standard low voltage. Refer to the Electricity Regulations and state:

(i) The maximum fluctuation permitted <u>above</u> standard low voltage at the point of supply of the electrical installation.

(1 mark)

_____

(ii) The maximum fluctuation permitted <u>below</u> standard low voltage when measured at a socket outlet in the electrical installation.

(1 mark)

_____

Ref: ……..……

(b) Refer to the Electricity Regulations and state the requirements for protective fittings installed by a network operator that are used to protect an electrical installation against overcurrent, short circuiting, earth fault current, overvoltage or undervoltage.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(turn over)

Question 1 continued

(c) Refer to the Electricity Regulations and list **FOUR** types of fittings that must form part of the main earthing system of an MEN system operating at standard low voltage.

(2 marks)

(1) _____

_____

(2) _____

_____

(3) _____

_____

(4) _____

_____

Ref: ……..……

(d) Refer to AS/NZS 3000 and state the circumstances where the protection disconnection time for a circuit can be greater than 0.4s but must not exceed 5 seconds.

(2 marks)

_____

_____

_____

_____

_____

_____

Ref: ……..……

(turn over)

Question 1 continued

(e) AS/NZS 3000 sets **TWO** basic requirements for an electrical installation circuit arrangement. Refer to AS/NZS 3000 and state those requirements.

(2 marks)

(1) _____

_____

(2) _____

_____

Ref: ……..……

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

(i) Near a swimming pool.

(1 mark)

_____

_____

(ii) Near an automatic fire sprinkler.

(1 mark)

_____

_____

Ref: ……..……

(g) Refer to AS/NZS 3000 and state **TWO** circumstances in which low voltage cables can be installed in the same wiring system as extra-low voltage cables.

(2 marks)

(1) _____

_____

(2) _____

_____

Ref: ……..……

(turn over)

Question 1 continued

(h) Refer to AS/NZS 3000 and state the circumstances where structural metalwork must be earthed.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(i) Refer to NZECP 34 and state the minimum vertical distance from the ground of a 230 volt overhead service line:

(i) That crosses a footpath used only by pedestrians

(1 mark)

_____

(ii) That crosses a driveway

(1 mark)

_____

Ref: ……..……

(j) A low voltage MEN electrical installation must have a main earthing lead. State where the ends of the main earthing lead must be connected.

(2 marks)

_____

_____

Ref: ……..……

(turn over)

Question 2

The picture on the next page represents the main switchboard in a low voltage electrical installation.

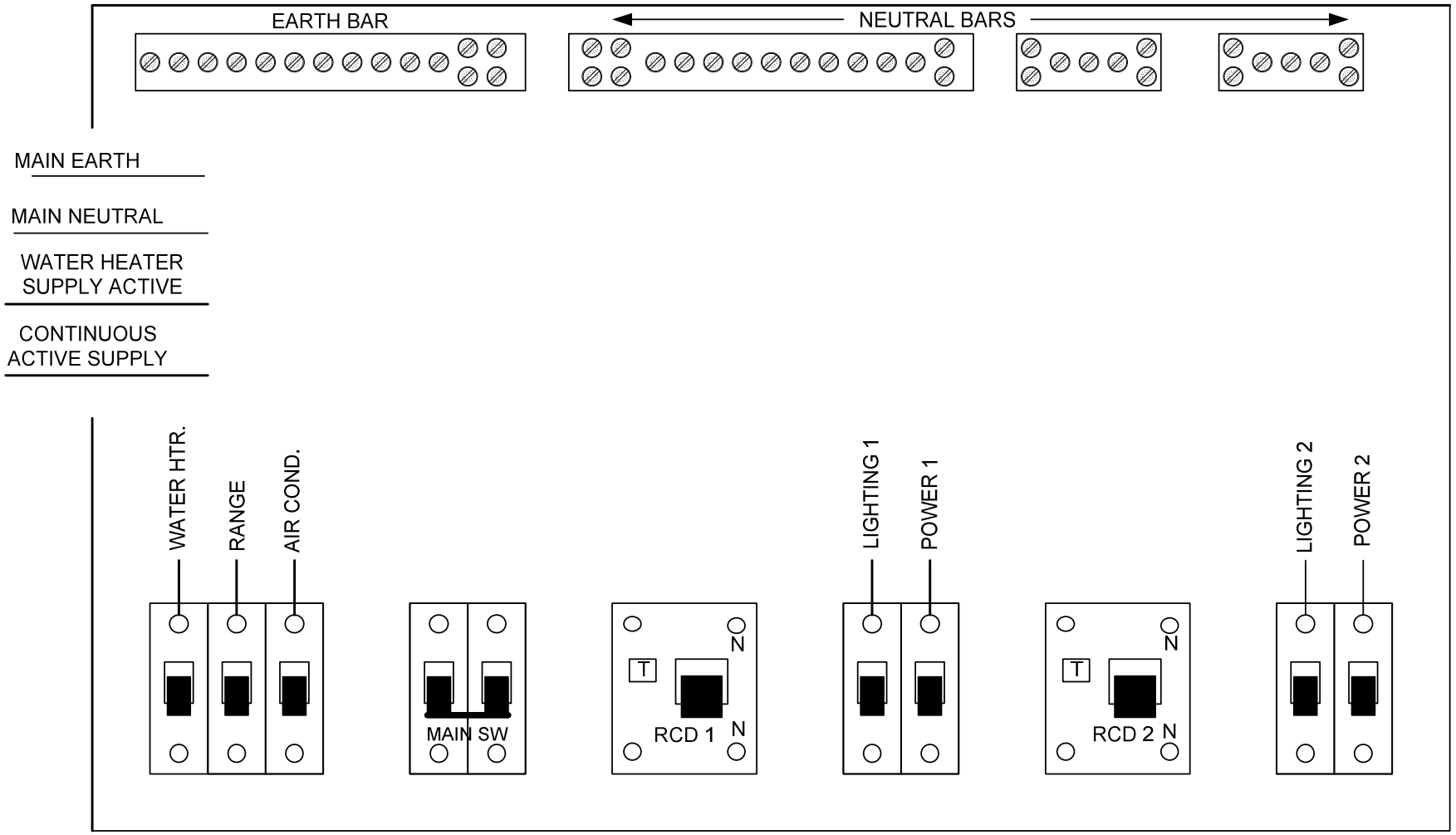
- The installation is controlled by a two-pole main switch.
- RCD 1 protects lighting circuit 1 and power circuit 1
- RCD 2 protects lighting circuit 2 and power circuit 2
- The water heater, range and air conditioning are not RCD protected.

On the picture on the next page clearly show the following:

- How the main earth conductor is connected. (½ mark)
- How the main neutral conductor is connected. (½ mark)
- How the MEN link is connected. (½ mark)
- How the water heater supply active (pilot) is connected. (½ mark)
- How the continuous active supply (the phase) is connected. (½ mark)
- How the supplies to the water heater, range and air conditioning MCBs are connected. (1 mark)
- How actives and neutrals for the RCDs are connected (2 marks)
- How the supply to lighting 1 and power 1 MCBs is connected (½ mark)
- How the supply to lighting 2 and power 2 MCBs is connected (½ mark)
- Where the neutrals for the lighting 1 and power 1 final subcircuits are connected. (1 mark)
- Where the neutrals for the lighting 2 and power 2 final subcircuits are connected. (1 mark)
- Where the neutrals for the water heater, range and air conditioning final subcircuits are connected. (1½ marks)

(turn over)

Question 2 continued



(turn over)

Question 3

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.

(a) A main switch or switches is required to be installed on a main switchboard for the control of an electrical installation. Refer to AS/NZS 3000 and state **THREE** types of fittings that need not be controlled by a main switch.

(3 marks)

(1) _____

_____

_____

(2) _____

_____

_____

(3) _____

_____

_____

Ref: ……..……

(b) There are two points of supply to a building. Each point of supply is controlled by a main switch. Refer to AS/NZS 3000 and state the identification requirements for the main switches.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(turn over)

Question 3 continued

(c) Refer to AS/NZS 3000 and state the circumstances where functional switching is permissible.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(d) Refer to AS/NZS 3000 and state **TWO** circumstances where the switching of a neutral conductor is prohibited.

(2 marks)

(1) _____

_____

(2) _____

_____

Ref: ……..……

(e) Refer to AS/NZS 3000 and state the requirement for a main switch that is able to be controlled remotely.

(1 mark)

_____

_____

_____

Ref: ……

(turn over)

Question 4

It is proposed to install a four-core copper neutral-screened cable to supply a low voltage three-phase 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 buried direct.
- The line current is 85 amps balanced.
- The distance between the property boundary and the main switchboard is 17 metres.
- The ambient soil temperature is 20^{o} C.
- The maximum permitted voltage drop is 1.5%
- The conductor temperature is 75^{o} C
- Allowance needs to be made for a 15% load increase.

(4½ marks)

(turn over)

Question 4 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 buried direct.
- The line current is 85 amps balanced.
- The distance between the property boundary and the main switchboard is 17 metres.
- The ambient soil temperature is 20° C.
- The maximum permitted voltage drop is 1.5%
- The conductor temperature is 75° C
- Allowance needs to be made for a 15% load increase.

(4½ marks)

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

(1 mark)

_____

(turn over)

Question 4 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**					
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 30^0C ambient air temperature and 15^0C ambient soil temperature

(turn over)

Question 4 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 4 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 5

Earthing arrangements are an integral part of the New Zealand MEN system.

(a) A three–phase copper mains cable to an industrial installation has active conductor sizes of 16mm^2, 16mm^2 and 25mm^2 respectively. Refer to AS/NZS 3000 and answer the following:

(i) How is the minimum size of the main earthing conductor determined? Include a reference source to support your answer.

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(ii) Determine the size of the main earthing conductor. Include a reference source to support your answer.

(1 mark)

_____

_____

Ref: ……..……

(b) Refer to AS/NZS 3000 and state **SIX** types of earthing conductors that are not required to be insulated.

(3 marks)

(1) _____

(2) _____

(3) _____

(4) _____

(5) _____

(6) _____

Ref: ……..……

(turn over)

Question 5 continued

(c) Refer to AS/NZS 3000 and state whether an RCCB type RCD can be used as the only electrical protection for a final subcircuit. State a reason and the reference to support your answer.

(2 marks)

_____

_____

_____

Ref: ……..……

(d) Refer to AS/NZS 3000 and state the **TWO** restrictions placed on a protective earthing conductor that originates at a distribution switchboard.

(2 marks)

(1) _____

_____

_____

(2) _____

_____

_____

Ref: ……..……

(turn over)

Question 6

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

(i) The main reason for carrying out an insulation resistance test on an electrical installation prior to livening.

(2 marks)

_____

_____

_____

_____

_____

_____

Ref: ……..……

(ii) The minimum insulation resistance between live and earthed parts in an electrical installation.

(1 mark)

_____

Ref: ……..……

(iii) The circumstances in which an electrical installation can be certified on a certificate of compliance when the insulation resistance result is less than that stated in (a)(ii).

(2 marks)

_____

_____

_____

_____

Ref: ……..……

(turn over)

Question 6 continued

(b) You have completely rewired a single-phase domestic residence. The work included all final subcircuits including a 2 kW water heater and a 6 kW range. There was no change to the mains, main earthing system or switchboard. You now need to carry out an insulation resistance test on the installation (but not the mains, main earthing system or switchboard) and the supply has not been reconnected.

Describe how you will carry out the insulation resistance test on the installation after you have disconnected all the water heater and range conductors at the switchboard. Include the permitted minimum test result.

(5 marks)

(turn over)

Question 7

(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) _____

_____

_____

_____

(turn over)

Question 7 continued

(b) Refer to AS/NZS 3000 and state the **TWO** requirements for the switching and connection of a range in a new domestic installation.

(2 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

Ref: ……..……..

(c) AS/NZS 3000 requires that socket outlets be installed so they will not be subjected to undue mechanical stress or damage. Refer to AS/NZS 3000 and state **TWO** installation methods required for the protection of a socket outlet against undue mechanical stress or damage.

(2 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

Ref: ……..……..

(turn over)

Question 7 continued

(d) An air compressor motor circuit is protected by fuses labelled gM at a switchboard. Describe the main characteristics of a fuse labelled gM that distinguishes it from a fuse labelled gG.

(2 marks)

_____

_____

_____

(turn over)

Question 8

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

32	75W indoor lighting points	1	3kw controlled water heater
15	75W outdoor lighting points	1	6kw spa pool
1	10kW electric range		
10	Single 10A socket outlets	10	Double 10A socket outlets
6 metres of lighting track			

(10 marks)

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

Ref: ……..……..

(turn over)

Question 9

(a) Refer to AS/NZS 3000 and state **THREE** reasons why testing the polarity of mains cables is necessary:

(3 marks)

(1) _____

_____

_____

_____

(2) _____

_____

_____

_____

(3) _____

_____

_____

_____

Ref: ……..

(turn over)

Question 9 continued

(b) (i) Describe how you would carry out a test to establish whether a phase/neutral transposition has taken place on the mains in a **live** single-phase low voltage electrical installation. At the commencement of your answer list the equipment you would use.

(5 marks)

(ii) State the expected instrument readings from the test you have carried out in (b)(i) if a transposition has taken place.

(1 mark)

(iii) State the expected instrument readings from the test you have carried out in (b)(i) if no transposition has taken place.

(1 mark)

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		