



IT 19

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
21 November 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; 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 Act and state **TWO** classes of **registered** persons who can be classed as a supervisor of electrical work.

(1 mark)

(1) _____

(2) _____

Ref:

- (b) State **ONE** safety precaution specified in the Electricity Regulations which can be used in a low voltage installation to safeguard against unintentional re-livening after isolation.

(1 mark)

Ref:

- (c) The Electricity Regulations requires certain prescribed electrical work to be certified on a certificate of compliance before connection to a power supply. Refer to the Regulations and state **ONE** type of prescribed electrical work that are not required to be certified.

(1 mark)

Ref:

(turn over)

Question 1 continued

- (d) An electrical inspector has installed new mains and a main switchboard in an electrical installation. Refer to the Electricity Regulations and state whether or not the inspector can inspect that work. State a reference to support your answer.

(1 mark)

Ref:

- (e) You are inspecting an electrical installation and discover a hazard that you consider to be an immediate danger to life. Refer to the Electricity Regulations and state who you must notify.

(1 mark)

Ref:

- (f) Refer to the Electricity Regulations and state the maximum fine that can be imposed on a registered person for failing to test prescribed electrical work

(1 mark)

Ref:

- (g) Refer to the Electricity Regulations and state the category of electrical appliances and fittings that require the Secretary's approval before being offered for sale.

(1 mark)

Ref:

(turn over)

Question 1 continued

- (h) Refer to AS/NZS 3000 state the maximum permitted time permitted for an MCB to function when a phase to earth fault occurs on a final subcircuit supplying a 10A socket outlet.

(1 mark)

Ref:

- (i) The removal of barriers that provide basic protection against direct contact is not permitted unless one of three conditions apply. Refer to AS/NZS 3000 and state **ONE** of those conditions.

(1 mark)

Ref:

- (j) Refer to AS/NZS 3000 and state **TWO** reasons for determining by assessment the maximum demand of an electrical installation.

(1 mark)

(1) _____

(2) _____

Ref:

(turn over)

Question 1 continued

(k) 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:

(l) 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:

(m) Refer to AS/NZS 3000 and state the minimum height above floor level that a socket outlet may be installed in a bathroom.

(1 mark)

Ref:

(n) Refer to AS/NZS 3000 and state **ONE** method of protection against electric shock that are prohibited in refrigeration rooms.

(1 mark)

Ref:

(turn over)

Question 1 continued

(o) Refer to AS/NZS 3000 and state **ONE** requirement for the installation of a wiring system in the classified zone of a hosing down area.

(1 mark)

Ref:

(p) Refer to the AS/NZS 3000 and state **ONE** situation where the voltage drop in an extra-low voltage electrical installation can exceed 10%.

(1 mark)

Ref:

(q) 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:

(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) For what practical reason is it necessary to test all three-phase socket outlets in a new electrical installation with a phase sequence indicator? (1 mark)

- (t) Explain why a single-core steel wired armoured cable should not be used in alternating current systems. (1 mark)

(turn over)

Question 2

An engineering shop is being constructed and will be connected to a 230V/400V standard low voltage supply.

You have been requested to determine the maximum demand of the heaviest loaded phase in the installation. The load will be spread evenly across the three phases (as much as is possible) and the power factor is unity.

Refer to AS/NZS 3000 and determine the maximum demand in amps of the **heaviest loaded phase**. Use the table on the next page for your calculations and answers.

The engineering shop will comprise:

Single phase

<i>Number</i>	<i>Equipment</i>
75	250W Metal Halide lamps – spread over three phases
6	0.75 kW drill presses (motors – nameplate rating; 3.1 amps) – spread over three phases
12	15A socket outlets – on line 1
12	10A socket outlets – on line 2
1	3 kW water heater – on line 3

Three phase

<i>Number</i>	<i>Equipment</i>
6	5 kW lathes (motors – nameplate rating; 10.89 amps/phase)

(10 marks)

(turn over)

Question 3

(a) A two core neutral screen aerial cable supplies a duplex unit comprising two flats.

- State **FOUR** hazards that may occur if the screen of the neutral screen aerial cable becomes open-circuited due to corrosion.
- For each hazard state **ONE** danger that may arise.

(4 marks)

(1) Hazard

Danger

(2) Hazard

Danger

(3) Hazard

Danger

(4) Hazard

Danger

(turn over)

Question 3 continued

- (b) Refer to the Electricity Regulations and state the **TWO** situations where metal must be connected to earth. (2 marks)

(1) _____

(2) _____

Ref:

- (c) With the aid of a labelled circuit diagram, show all the paths for the fault current from one phase of a power transformer, an installation and right through to a phase to frame fault on a Class I appliance supplied by a subcircuit from the MEN main switchboard connected to a standard low voltage supply. (4 marks)

(turn over)

Question 4

(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 4 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 4 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) _____

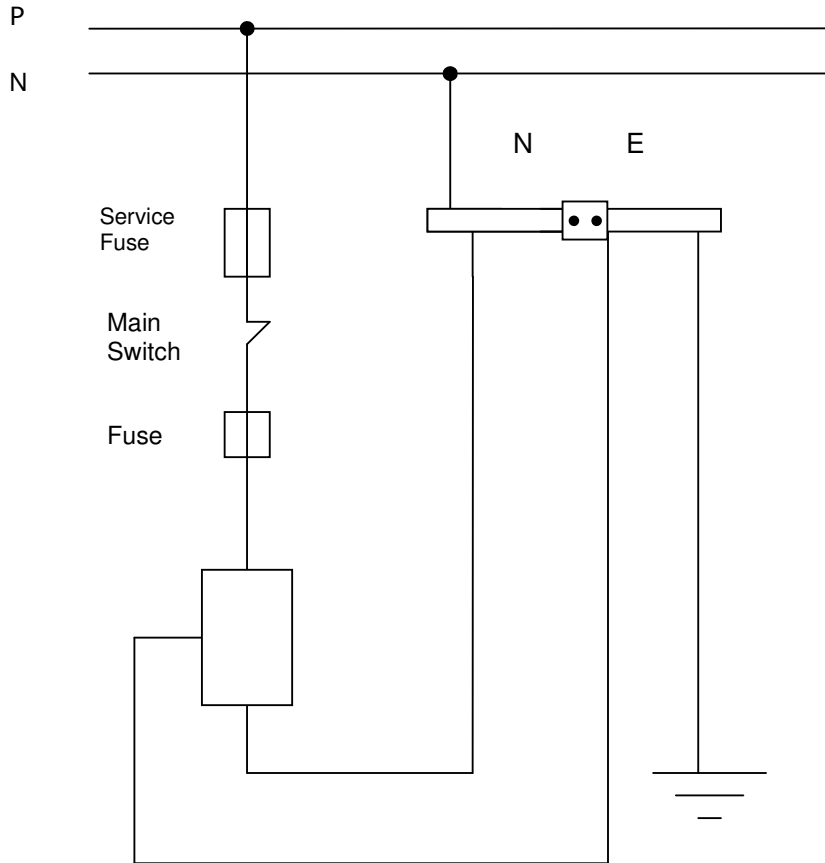
(2) _____

Ref:

(turn over)

Question 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)

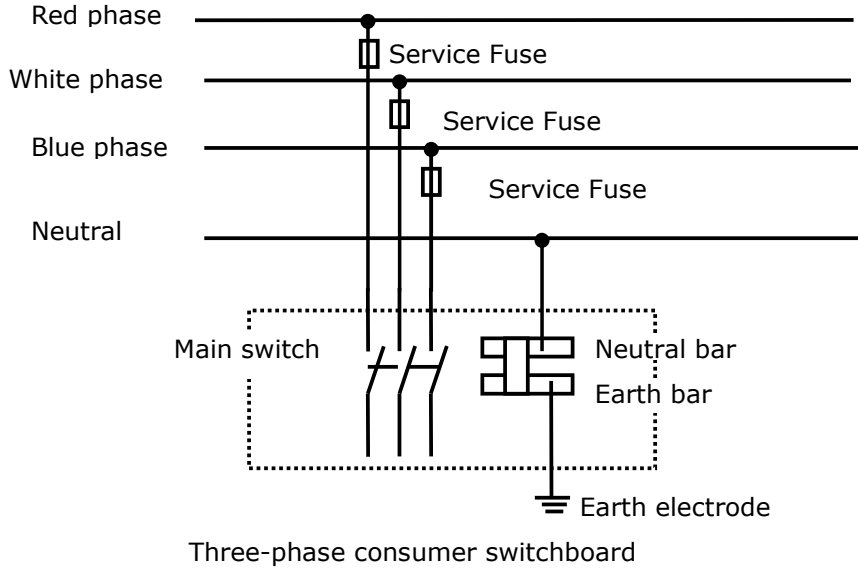
(1) _____

(2) _____

(turn over)

Question 6

The figure below represents a low voltage, three-phase 400V supply to an electrical installation. **The installation is live.**



This figure is relevant to both questions (a) and (b).

- (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.

(3 marks)

- (1) _____

- (2) _____

- (3) _____

(turn over)

Question 7

- (a) Refer to AS/NZS 3000 and state the **FOUR** situations where RCD protection is **not** required to be installed on socket outlet circuits or lighting final subcircuits that are altered or repaired in existing motel units.

(4 marks)

(1) _____

(2) _____

(3) _____

(4) _____

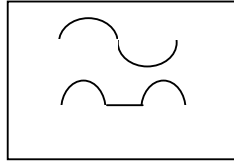
Ref:

(turn over)

Question 7 continued

- (b) RCDs for personal protection must be of a certain type.

An RCD marked with the following symbols is a type permitted to be installed for personal protection:



- (i) What type of RCD is identified by these symbols?

(1 mark)

Ref:

- (ii) Refer to AS/NZS 3000 and describe the operating characteristics of the RCD.

(2 marks)

Ref:

(turn over)

Question 7 continued

- (c) Describe the operation of an RCD when there is an active (phase) to earth fault on the circuit the device protects.

(3 marks)

(turn over)

Question 8

A 230V supply is required for a pottery kiln in a rural area.

You are required to determine the **minimum size** of cable that will meet the load, voltage drop and environmental conditions.

(a) **Calculate the load current required to supply the kiln** using the following information and information from the tables below.

- The cable will be a PVC insulated two-core and earth copper TPS cable clipped direct (touching)
- The kiln operates at 230V
- The load is 11kW
- The ambient air temperature is 30°C but rises to 40°C in the last 10 metres of the cable run.
- The cable run between the switchboard and the kiln is 16.5 metres.
- The maximum conductor temperature permitted is 75 °C.
- The maximum allowable voltage drop is 1.5%

(2 marks)

(turn over)

Question 8 continued

(b) **Calculate the minimum conductor size of the cable that can supply the load** using the following information and information from the tables below.

- The cable will be a PVC insulated two-core and earth copper TPS cable clipped direct (touching)
- The kiln operates at 230V
- The load is 11kW
- The ambient air temperature is 30°C but rises to 40°C in the last 10 metres of the cable run.
- The cable run between the switchboard and the kiln is 16.5 metres.
- The maximum conductor temperature permitted is 75 °C.
- The maximum allowable voltage drop is 1.5%

(2½ marks)

(turn over)

Question 8 continued

(c) **Calculate the minimum conductor size of the cable that can satisfy the voltage drop requirements** using the following information and information from the tables below.

- The cable will be a PVC insulated two-core and earth copper TPS cable clipped direct (touching)
- The kiln operates at 230V
- The load is 11kW
- The ambient air temperature is 30°C but rises to 40°C in the last 10 metres of the cable run.
- The cable run between the switchboard and the kiln is 16.5 metres.
- The maximum conductor temperature permitted is 75 °C.
- The maximum allowable voltage drop is 1.5%

(4½ marks)

(turn over)

Question 8 continued

- (d) (i) From the calculations you have carried out, state the minimum size cable for this installation. that will satisfy the load and voltage drop requirements.

(½ mark)

- (ii) The cable is protected by a 50A, Type C, MCB. Refer to AS/NZS 3000 and state whether this cable meets the earth fault loop impedance requirements. State the reference with your answer.

(½ mark)

Ref.

(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					
	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 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
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 8 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	-

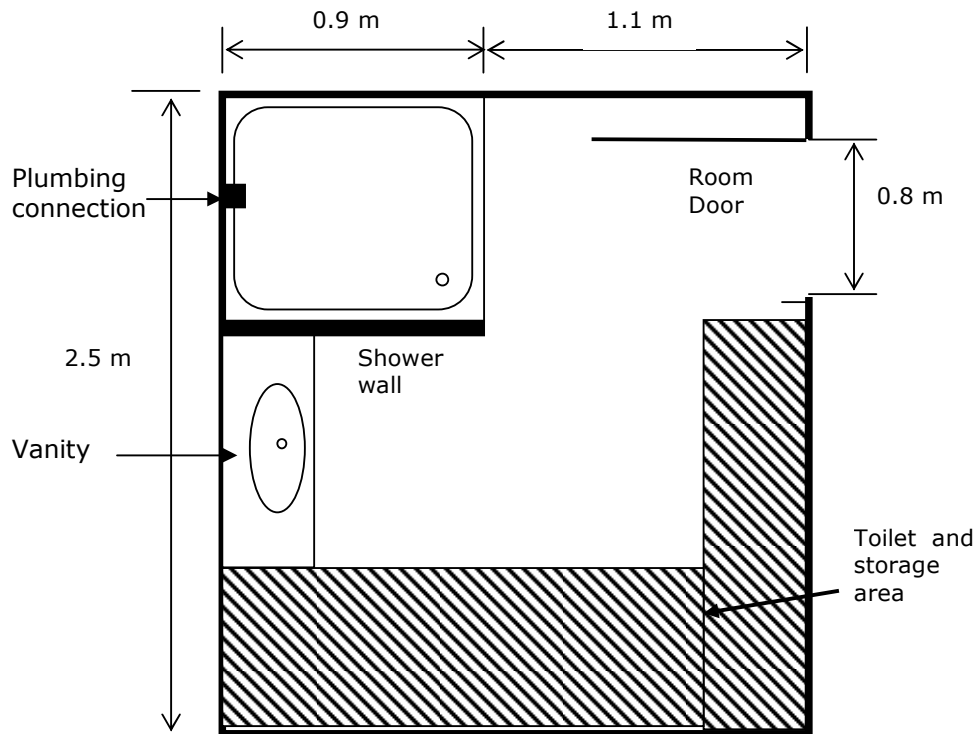
Note: To convert to single-phase values multiply the three-phase value by 1.155

(turn over)

Question 9

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

- The hand basin is of 10 Litre capacity.
- Nothing can be installed in, against or above the toilet and storage area or on the vertical surfaces of that area.
- All fittings operate at 230V



The customer wants to install in the en-suite:

- A light switch
- A heated towel rail and associated permanent connection
- A socket outlet for a hair-dryer

(turn over)

Question 9 continued

- (a) (i) What change is required to the bathroom fittings (not the electrical cables or fittings) to permit the light switch, heated towel rail and permanent connection unit and socket outlet to be installed in the ensuite?

(1 mark)

- (ii) State the reason why you would make the change stated in (a)(i) above.

(1½ marks)

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

- (i) In which Zones **should** 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:

(turn over)

Question 9 continued

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

- (i) In which Zones **should** the towel rail and permanent connection unit be installed?

(1 mark)

Ref:

- (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?

(1/2 mark)

Ref:

(turn over)

Question 9 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:

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		