TH WALES
RTMENT
DUCATION
TRAINING

TAFE NSW

Family Name .....

Given Name .....

Student Number .....

Centre .....

Signature .....

with Answers.

4 December 2008

6077AC Electrical Systems Safety - Capstone Assessment

Time allowed – Three hours plus Ten minutes reading time

23 Pages in this Question Booklet

TOTAL MARKS AVAILABLE = 100

Aids to be supplied by college:

- None.

Aids to be supplied by student:

- Australian/New Zealand Wiring Rules AS/NZS 3000:2007.
- Australian/New Zealand Electrical Installations – Selection of Cables AS/NZS 3008.1.1:1998.
- NSW Service and Installation Rules.
- Students own marginal notes, indexing and formal amendments may be included in the above regulation books.
- Pen, pencil, eraser, rule, calculator.

Section	Possible Mark	Actual Mark
A	15	
B	20	
C	46	
D	19	
TOTAL	100	

Instructions to student:

- **Mobile phones are to be turned off and removed from your person.** You cannot access a mobile phone during this test.
- All questions to be answered in the space provided on this **Examination Paper.** Answers to Section A – Multi-choice Questions, are to be recorded on the Answer Sheet on Page 23 of this **Question Booklet.**
- You are not to use any other reference book in this examination.
- The whole of this paper is to be handed to the Supervisor upon completion.
- All Questions to be attempted.

Aids permitted where indicated:

Standard Dictionaries	Bilingual Dictionaries	Technical Dictionaries	Programmable Calculators	Non-programmable Calculators	Electronic Devices
No	No	No	No	Yes	No

SECTION A. (15 Marks)

INSTRUCTIONS: Select the best answer for the following statements and place an 'X' in the appropriate box on the Answer Sheet attached to this Examination Paper.

QUESTION 1. (1 Mark)

The term used in AS3000 to describe the current carrying capacity of a cable is:

(a) IN
(b) IZ
(c) ISC
(d) IB

QUESTION 2. (1 Mark)

In a domestic installation, the maximum number of final sub circuits that can be supplied from a single RCD is:

(a) 1
(b) 2
(c) 3
(d) Unlimited

QUESTION 3. (1 Mark)

The maximum permissible voltage drop between the point of supply and any point in a 400 V electrical installation is:

(a) 5 % of Uo
(b) 11.5 Volts
(c) 5 % of the voltage measured at the MSB
(d) 10 % of the nominal supply voltage

QUESTION 4. (1 Mark)

Under short circuit conditions, what is the maximum permissible sheath temperature for a 25 mm^2 XLPE (X 90) Cu single core cable?

(a) 90 °C
(b) 160 °C
(c) 75 °C
(d) 250 °C

QUESTION 5. (1 Mark)

What is the minimum clearance for bare live aerial conductors above a swimming pool?

(a) 3 m
(b) 4.5 m
(c) 5.5 m
(d) Not permitted

QUESTION 6. (1 Mark)

A cable / wiring system suitable for installation in a high temperature environment would be:

(a) Unenclosed TPS cable
(b) TPS cable enclosed in non-metallic conduit
(c) Unenclosed bare MIMS cable
(d) Unenclosed TPI cable

QUESTION 7. (1 Mark)

What is an acceptable level of leakage current for a 230 V class I appliance?

(a) 30 mA
(b) 10 mA
(c) 0.5 mA
(d) 0.22 mA

QUESTION 8. (1 Mark)

The main neutral installed in a 400 / 230 V MEN installation consisting of predominately balanced three phase loads:

(a) Can be reduced to 33.3 % of the main active conductors CSA
(b) Must have the same CSA as the main active conductors
(c) Must not be less than 50 % of the main active conductors CSA
(d) Must have a minimum current carrying capacity of 100 A

QUESTION 9. (1 Mark)

Underwater pool lighting must be supplied with a / an:

(a) Earthing conductor connected to the light
(b) PELV system installed close to the light
(c) PELV or SELV system supply of 12 V AC or less
(d) SELV system not exceeding 30 V AC

QUESTION 10. (1 Mark)

What is the maximum allowable resistance of an equipotential bonding conductor?

(a) Not specified
(b) 0.5 Ω
(c) 1 Ω
(d) 2 Ω

QUESTION 11. (1 Mark)

With which standard must equipment installed in a hazardous area comply?

(a) AS2381
(b) AS2209
(c) AS3017
(d) All of the above

QUESTION 12. (1 Mark)

The maximum number of lighting points that can be connected to a circuit wired in 1.0 mm^2 TPS cable and protected by a 6 A type C CB is:

(a) 12
(b) 15
(c) 20
(d) Not specified

QUESTION 13. (1 Mark)

A Certificate of Compliance should be finalised when an electrical installation is tested and should be completed by the:

(a) Consumer
(b) Licensed installing electrician
(c) Licensed electrician who completed the test
(d) Installation inspecter

QUESTION 14. (1 Mark)

The maximum disconnection time specified for protection against indirect contact for a Sub Main is:

(a) Unspecified
(b) 100 ms
(c) 400 ms
(d) 5 s

QUESTION 15. (1 Mark)

Every conductor shall have a current-carrying capacity that must:

(a) Be lower than the current for which the circuit is designed (IB)
(b) Be equal to or greater than the circuit breaker nominal rating (IN)
(c) Be greater than the current to be carried by the conductor
(d) Be based on an ambient air temperature of 45 °C

Marks

SECTION B. (20 Marks)

INSTRUCTIONS: In this part of the assessment, you are required to answer a range of questions by using AS/NZS 3000.2007. For each question, you are required to supply an answer to the question, and the clause from AS/NZS 3000.2007 that relates to the answer. This section contains ten questions for a total of twenty marks.

QUESTION 1. (2 Marks)

1 What is the maximum disconnection time for a final sub circuit supplying portable equipment intended to be moved during use?

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1 AS/NZS 3000 Reference (Clause number .....)

QUESTION 2. (2 Marks)

1 Is it necessary to provide an equipotential bond to a conductive water pipe that is not accessible from within a building?

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1 AS/NZS 3000 Reference (Clause number .....)

QUESTION 3. (2 Marks)

1 What are the requirements for earthing a switchboard surround that is supplied by unprotected consumers' mains?

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1 AS/NZS 3000 Reference (Clause number .....)

QUESTION 4. (2 Marks)

1 List three acceptable sources for an isolated (separated) supply.

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.....

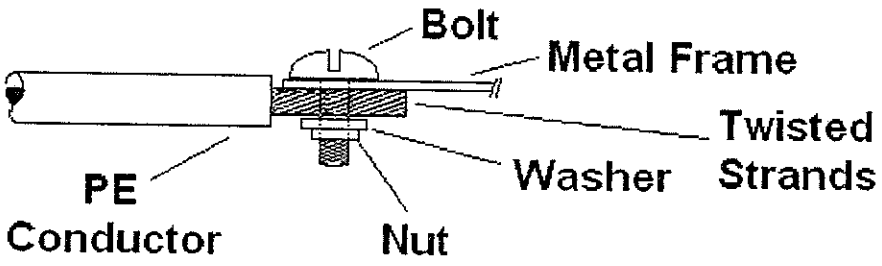
.....

1 AS/NZS 3000 Reference (Clause number .....)

Marks

QUESTION 5. (2 Marks)

1 When terminating a stranded conductor, is it acceptable to twist and place the conductors under a washer as depicted below? List AS3000 requirements.



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1 AS/NZS 3000 Reference (Clause number .....)

QUESTION 6. (2 Marks)

1 A sink has a capacity < 45 litres. List the minimum required IP rating for a luminaire installed within Zone 2.

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1 AS/NZS 3000 Reference (Clause number .....)

QUESTION 7. (2 Marks)

1 Identify an acceptable method used to determine maximum demand of a final sub circuit consisting of 10 A socket outlets.

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1 AS/NZS 3000 Reference (Clause number .....)

Marks

QUESTION 8. (2 Marks)

1 Is it permissible to complete an addition to an existing final sub circuit consisting of unprotected 10 A socket outlets, without installing RCD protection?

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1 AS/NZS 3000 Reference (Clause number .....)

QUESTION 9. (2 Marks)

1 List five criteria that need to be addressed when designing an electrical installation.

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1 AS/NZS 3000 Reference (Clause number .....)

QUESTION 10. (2 Marks)

1 What are the requirements when installing a common neutral?

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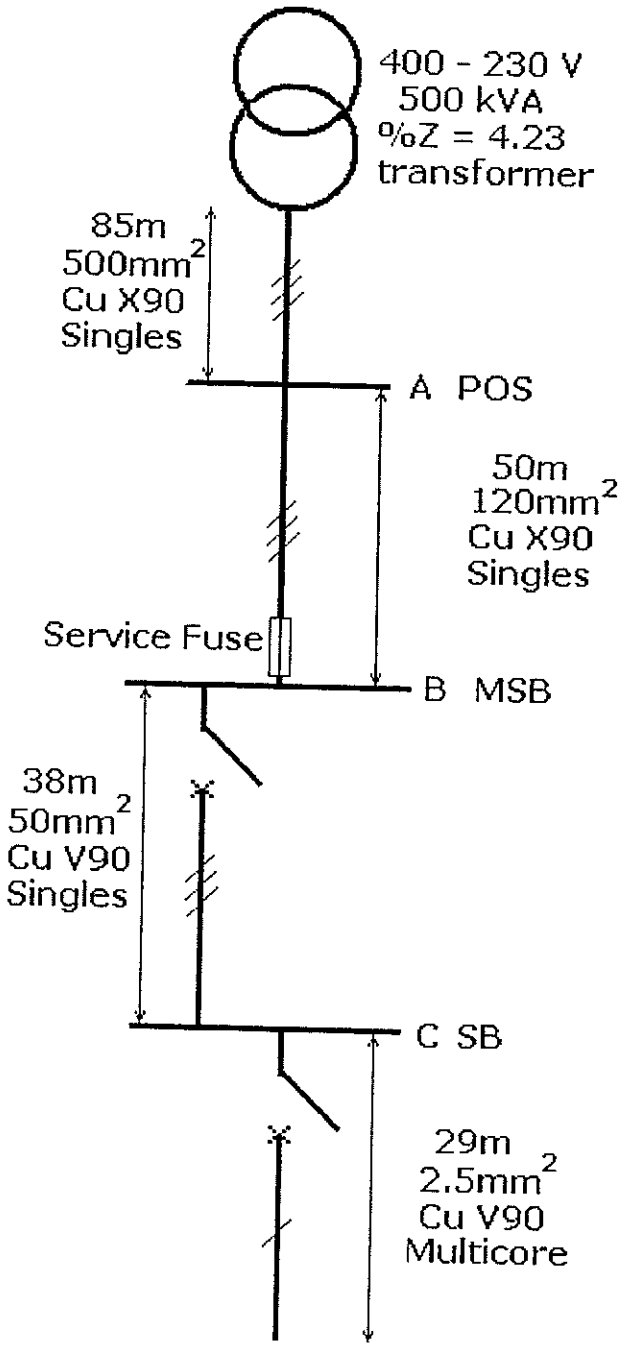
1 AS/NZS 3000 Reference (Clause number .....)

SECTION C. (46 Marks)

INSTRUCTIONS: This section involves calculations. Show all necessary working in the space provided, marks will be awarded accordingly. Answers are to be highlighted or underlined.

QUESTION 1. (4 Marks)



(Continued on the next page.)

Marks

QUESTION 1. (Cont'd)

1 (a) Determine the phase impedance of the transformer.

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1 (b) Assuming the transformer has a phase impedance of 7 mΩ, determine the maximum 3 ϕ prospective short circuit current at the POS (point A), (AS3008 has appropriate tables to determine conductor resistance – ignore conductor reactance).

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1 (c) Determine the system impedance, for a 3 ϕ prospective fault current of 12 kA at point 'C' the Sub Board.

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1 (d) If the Active Earth fault current is 4.5 kA at the SB (point C), determine the maximum earth fault current at the end of the final sub circuit (assume all fault current flows back through MEN at MSB and SB has no MEN connection).

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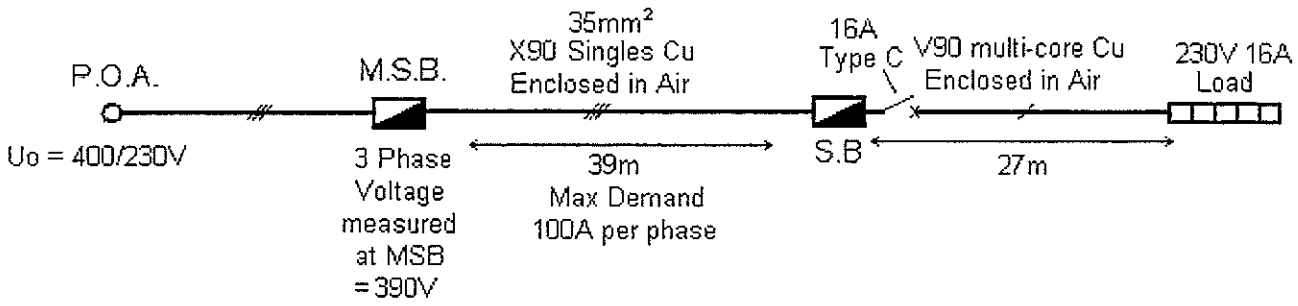
QUESTION 2. (4 Marks)

Determine the minimum size cable for the SINGLE PHASE final sub circuit, based on Voltage Drop.



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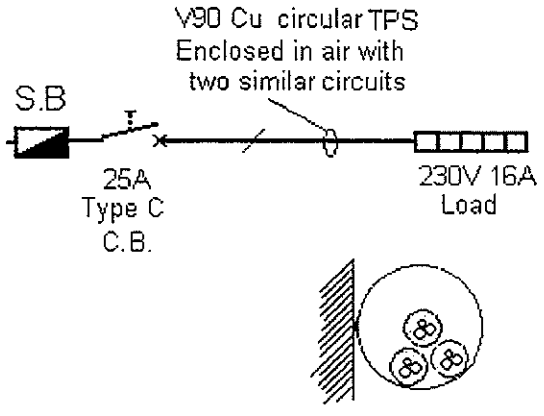
QUESTION 3. (4 Marks)

Determine the minimum size cable for the SINGLE PHASE final sub circuit, based on Current Carrying Capacity.



Cable installation method

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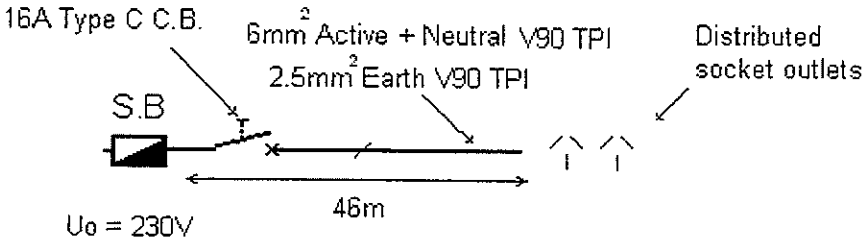
QUESTION 4. (4 Marks)

Determine if the final sub circuit satisfies the requirements for fault loop impedance – show all references and workings.



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QUESTION 5. (4 Marks)

Determine the maximum demand for the following 230 V SINGLE Domestic Installation:

- 34 x 50 W down lights
- 17 x double 10 A socket outlets
- 5 x single 10 A socket outlets
- 1 x 5 kW 230 V cooktop
- 1 x 4 kW 230 V oven
- 1 x 15 A socket outlet (general purpose)
- 1 x 20 A socket outlet for 230 V 16 A air conditioner
- 4 x permanently connected 120 W ceiling fans
- 2 x 10 A socket outlets installed > 2.4 m for 75 W exhaust fans

(Continued on the next page.)

QUESTION 5. (Cont'd)

Load Group	No of Points / Load	Calculation	Maximum Demand
Ai			
Aii			
Bi			
Bii			
Biii			
C			
D			
E			
F			
G			
Maximum Demand			

QUESTION 6. (7 Marks)

Determine the maximum demand for the following 400 / 230 V three-phase MULTIPLE domestic installation, consisting of thirty individual living units.

Electrical equipment associated with each individual (1) unit:

- 18 x 50 W down lights
- 10 x double 10 A socket outlets
- 3 x single 10 A socket outlets
- 1 x 10 A socket outlet for 230 V air conditioner
- 2 x permanently connected 120 W ceiling fans

In addition to the load above, six of the units have the following electrical loads:

- 1 x 5 kW 230 V cooktop
- 1 x 4 kW 230 V oven
- 1 x 4.8 kW electric storage hot water system

The following communal load is also installed:

- 30 x 230 V 100 W bollards (balanced equally across each phase)
- 9 x 230 V 250 W 4 A Metal Halide outdoor lighting (three circuits)
- 8 x double 10 A single phase socket outlets (two circuits)

(Continued on the next page.)

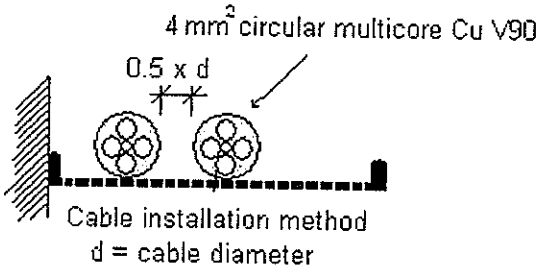
QUESTION 6. (Cont'd)

Use only the required load groups in the table below.

Load Group	No of Points / Load	Calculation	Red	White	Blue
Ai					
Aii					
Bi					
Bii					
Biii					
C					
D					
E					
F					
G					
H					
I					
Ji					
Jii					
Jiii					
K					
L					
M					
Maximum Demand					

QUESTION 7. (3 Marks)

Using the diagram above, determine the current carrying capacity of the THREE phase 4 mm^2 multi-core Cu V 90 cable, which is installed flat on a perforated cable tray spaced from one other similar circuit.



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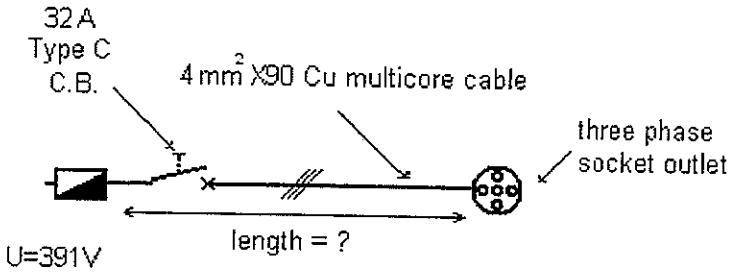
QUESTION 8. (4 Marks)

A 400 V three phase final sub circuit supplying a socket outlet is to be wired with 4 mm^2 X 90 four-core and earth cable. The circuit is protected by a 32 A, type C circuit breaker. The voltage measured at the Sub Board is 391 V. In order to comply with AS/NZS 3000 regarding voltage drop, what is the maximum allowable route length of the circuit?



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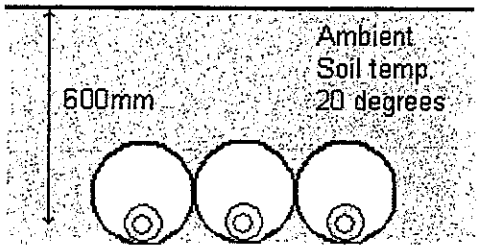
QUESTION 9. (5 Marks)

A 400 V THREE phase consumer main is to be enclosed in three single HD PVC conduits that will be installed touching underground at a depth of 600 mm. The ambient soil temperature is 20 ^{0}C. The circuit will be wired with 4 x single core X 90 Cu cables.

A three pole 100 A type 'C' circuit breaker will protect the circuit.



(a) List all applicable de-rating tables and resulting factors for the circuit.

Derating table No: ..... Derating factor: .....
Derating table No: ..... Derating factor: .....
Derating table No: ..... Derating factor: .....

(b) Determine the minimum required current capacity for each cable.

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(c) Determine the minimum cable size.

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QUESTION 10. (7 Marks)

Determine the maximum demand for the following 400 V FACTORY Installation:

- 10 x double 10 A socket outlets
- 6 x hi bay metal halide lamps @ 3.5 A each
- 30 x fluorescent lamps @ 0.4 A each
- 3 x 20 A three phase socket outlets
- 3 x 15 A three phase socket outlets
- 2 x 400 V single phase welders @ 20 A each
- 2 x 25 A single phase motors

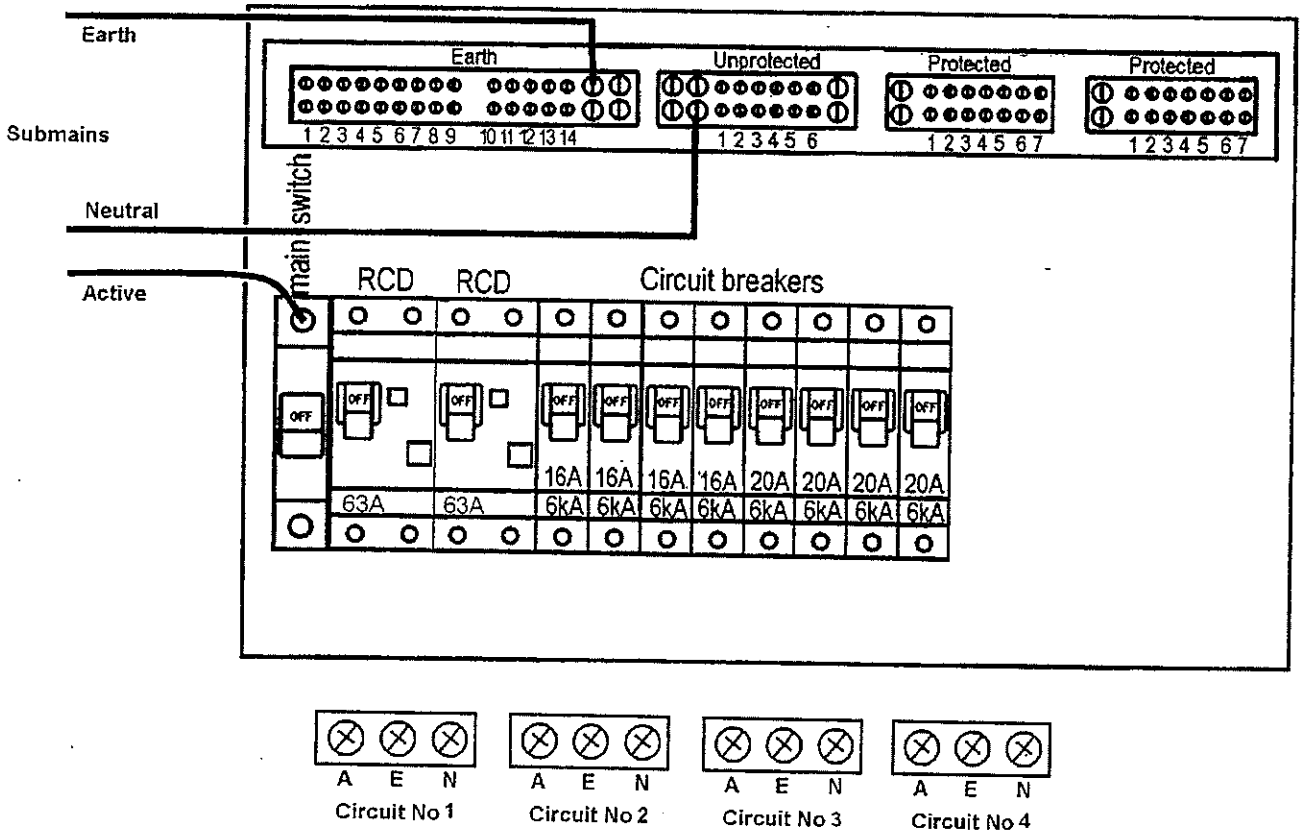
Load Group	Points / Load	Calculation	Red	White	Blue
A					
Bi					
Bii					
Biii					
C					
D					
E					
F					
G					
H					
Maximum Demand					

SECTION D – (19 Marks)

INSTRUCTIONS: The questions in this section require some simple drawing. Ensure that the drawing is neat and legible. The use of pencil on the drawing is acceptable in this section only.

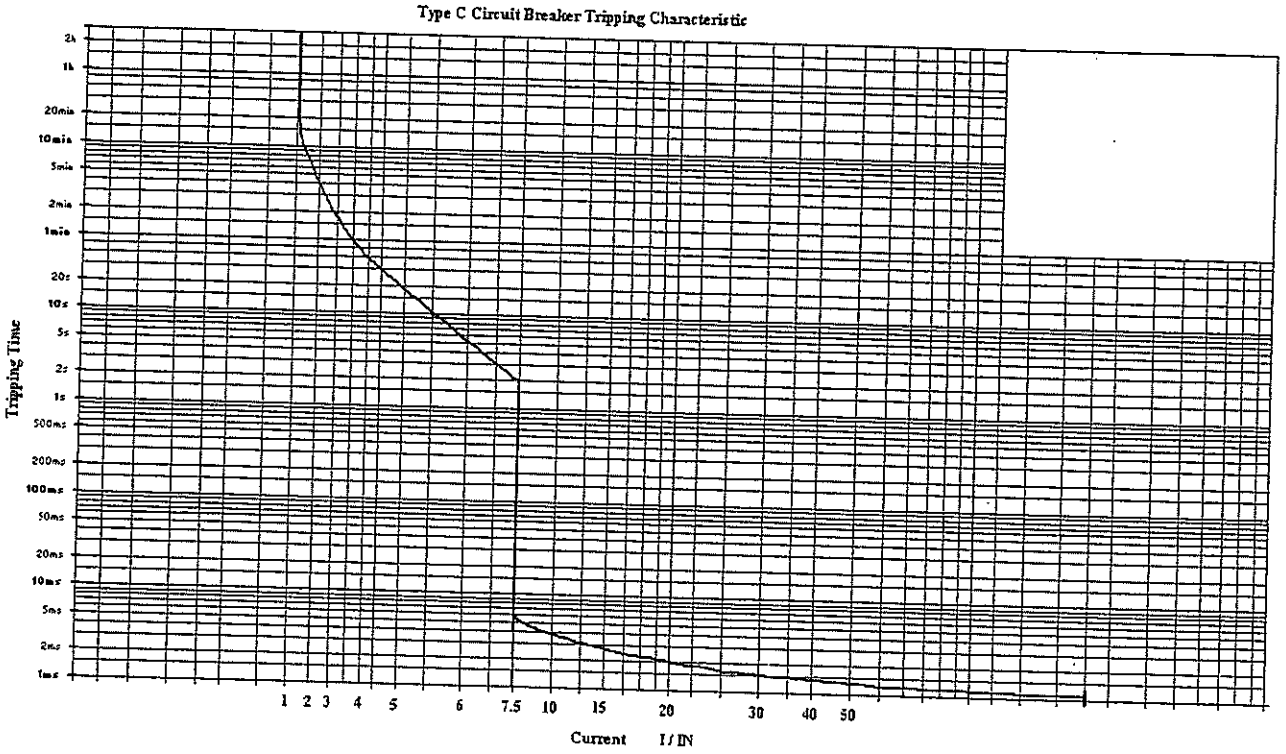
QUESTION 1. (5 Marks)

The following diagram shows a main switch board in a domestic installation. The consumer mains include an active, neutral and main earth from the earth electrode. The installation condition of all final sub circuits is fully surrounded by thermal insulation. There are four final sub circuits supplying socket outlets, wired with 2.5 mm^2, multi-core, V 90, Cu cables. It has been determined to use separate RCD's to provide the required earth leakage protection for the circuits. Complete all necessary active, neutral and earth connections for these four final sub circuits on the wiring diagram below, ensuring the completed wiring complies with AS/NZS 3000.2007 and AS/NZS 3008.1.1:1998.



QUESTION 2. (4 Marks)

A 20 A type C circuit breaker with the following tripping characteristic is protecting a 230 V circuit wired with 2.5 mm ^{2}, multi-core, V 90, Cu cable. The circuit is supplying socket outlets. The fault loop impedance was measured at the extreme point on the circuit using a fault loop impedance instrument. The result was 1.6 Ω at ambient conditions (i.e. 40° C). Answer the questions below. Show all working, and support your answer/s by marking the characteristic curve below.



(a) Calculate the fault current for an active to earth fault at the extreme point.

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.....

(b) Determine the circuit breaker trip time using the fault condition indicated above.

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(c) Does the circuit meet AS/NZS 3000 requirements for fault loop impedance? Why?

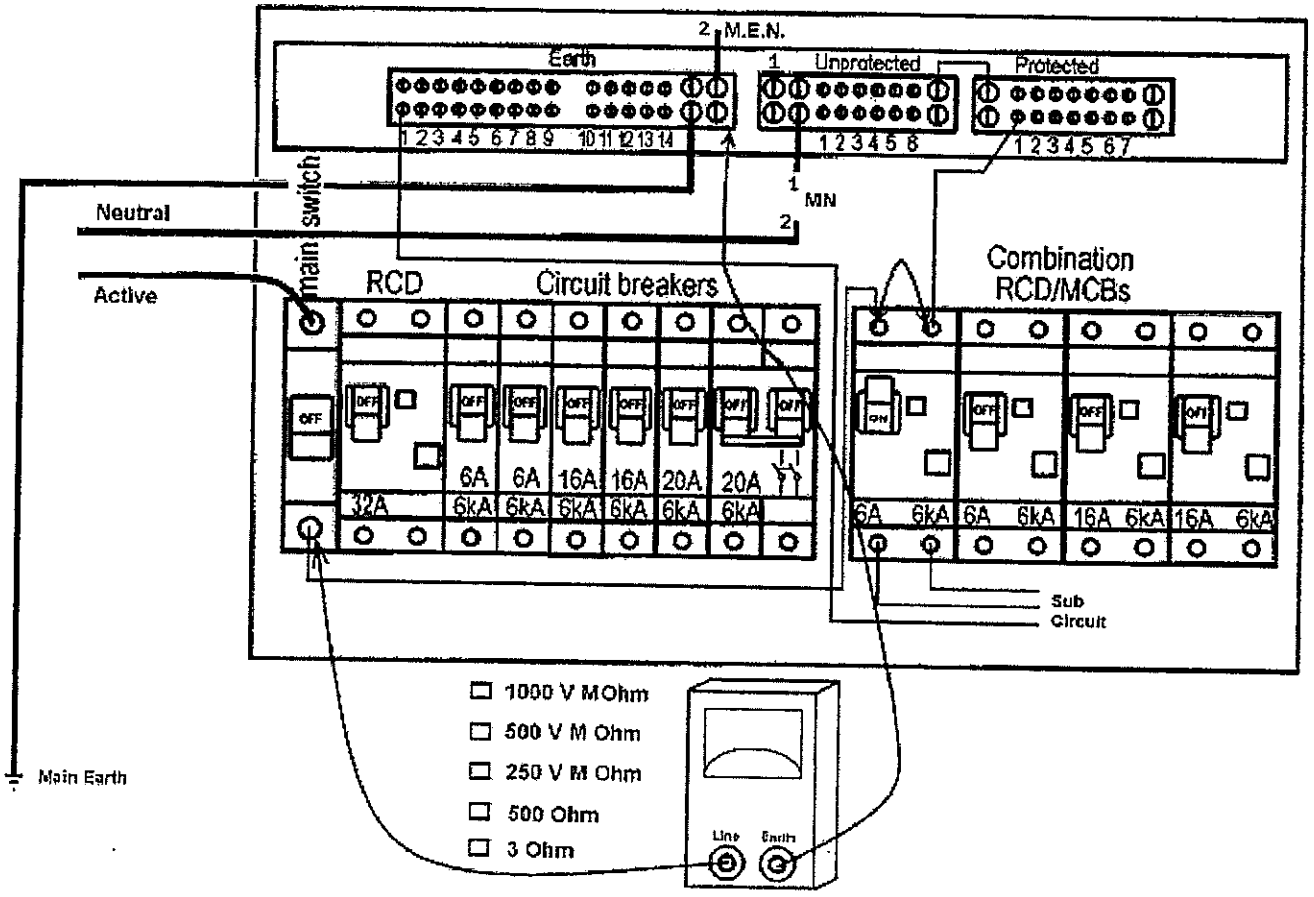
YES / NO.....

(e) Determine the maximum allowable resistance of the protective earth conductor.

.....

QUESTION 3. (4 Marks)

The following diagram shows how the switchboard has been prepared, ready for testing the insulation resistance between active and earth of a single-phase lighting circuit. The circuit is protected by a 6 A combined RCD / MCB. The lighting circuit has loads with dimmer control. Identify the correct setting for the insulation resistance tester by placing an 'X' in the appropriate box and answer the four questions. The board is electrically isolated.



Circle the correct answer:

The MEN link should be:

(a) Connected to position 1

(b) Disconnected as shown in position 2

The main neutral should be:

(a) Connected to Position 1

(b) Disconnected as shown in position 2

A reading of 0.9 MΩ would indicate:

(a) A fault

(b) No fault

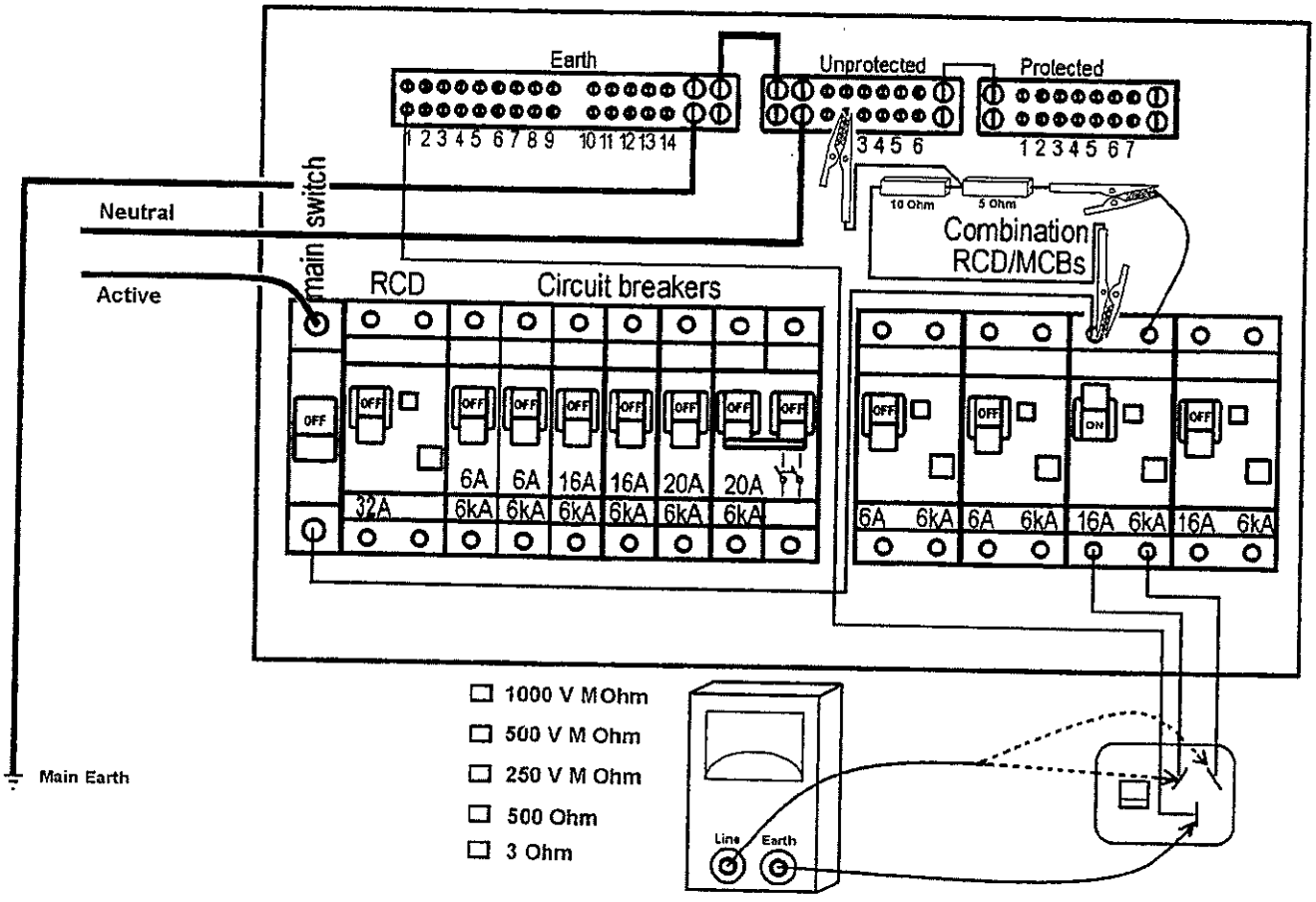
The leads of the testing device are:

(a) Correctly connected

(b) Incorrectly connected

QUESTION 4. (4 Marks)

Answer the question and complete the following table using the diagram below. A correct circuit connection test is being performed. Identify the correct setting for the test equipment by placing an 'X' in the appropriate box. The board is electrically isolated.



(a) Assuming the socket outlet is correctly connected, complete the table:

Test Equipment Connection	Reading
Earth to Active with socket outlet switch off	
Earth to Active with socket outlet switch on	
Earth to Neutral with socket outlet switch off	
Earth to Neutral with socket outlet switch on	

(b) Identify any fault indicated by a reading of 5 Ohms between the active and earth socket measured at the socket outlet:

.....

QUESTION 5. (2 Marks)

Using the following table from AS3000.2007 determine the maximum recommended number of lighting points permitted to be added onto an existing final sub circuit consisting of 8 x 10 A double socket outlets. The existing cable is 2.5 mm^2 multi-core Cu cable, protected by a 16 A type C circuit breaker. There are three existing power circuits in the installation.

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TABLE C8

GUIDANCE ON THE LOADING OF POINTS PER FINAL SUBCIRCUIT

Cable cross-sectional area[a] (mm^2)	Rating of circuit-breaker[a] (A)	Contribution of each point (A) (sum must not exceed rating of circuit-breaker)						Maximum connected load for a range[de] (W)
		Lighting points[f]	10 A single or multiphase socket-outlets[cbhi]		15 A single or multi-phase socket-outlets[hi]	20 A single or multi-phase socket-outlets[hi]	Permanently connected fixed or stationary appliances[gj] or water heaters	
			Non-domestic installations without permanent airconditioning	All domestic installations and non-domestic installations with permanent airconditioning				
1	6	0.5	NP	NP	NP	NP	Connected load	NP
1	8	0.5	NP	NP	NP	NP		NP
1	10	0.5	NP	NP	NP	NP		NP
1	13	0.5	NP	NP	NP	NP		NP
1	16	0.5	NP	NP	NP	NP		NP
1.5	8	0.5	NP	NP	NP	NP		NP
1.5	10	0.5	NP	NP	NP	NP		NP
1.5	13	0.5	NP	NP	NP	NP		NP
1.5	16	0.5	NP	NP	NP	NP		5000
1.5	20	0.5	NP	NP	NP	NP		5000
2.5	10	0.5	NP	NP	NP	NP		NP
2.5	13	0.5	2	1	NP	NP		NP
2.5	16	0.5	2	1	15	NP		5000
2.5	20	0.5	2	1	12	20		8000

(continued)

NOTES TO TABLE C8

[a] Cable cross-sectional areas and protective device ratings relate directly to specified installation methods given in Tables C5 and C6, e.g. a 2.5 mm^2 cross-sectional area cable used in conjunction with a 20 A protective device is recommended for use in Table C5 for a single-phase circuit partially surrounded in thermal insulation or from Table C6 for a three-phase circuit unenclosed in air.

[b] Figures for 6 mm^2 and 10 mm^2 conductors are given primarily for dedicated circuits supplying permanently connected fixed or stationary appliances, water heaters and ranges. While this Standard does not prescribe the installation of socket-outlets and lighting points on these circuits, the physical limitations of the terminals of these devices may make their connection impractical.

[c] For the purposes of determining the number of points, a multiple combination of socket-outlets is regarded as the same number of points as the number of integral socket-outlets in the combination.

[d] A hotplate and oven are considered to be one cooking appliance if mounted within one room.

[e] Maximum demand is limited by the circuit-breaker on the final subcircuit which allows for diversity in operation of the range elements and hotplates.

[f] *Lighting points* A luminaire is deemed to comprise one or more lighting points, according to the number of points at which it is connected by flexible cords to the installation wiring, or according to the number of sections in which it is switched or controlled. Connections of festoon lighting and decorative lighting shall not be regarded as lighting points. See Table C1 for track systems and CLV lighting.

A socket-outlet installed more than 2.3 m above a floor for the connection of a luminaire may be included as a lighting point.

An appliance rated at not more than 150 W, which is permanently connected, or connected by means of a socket-outlet installed more than 2.3 m above a floor, may be included as a lighting point.

[g] *Circuits with 10 A socket-outlets connected* Applies where there are two or more circuits in an electrical installation.

[h] *Restricted connections* Table C5 precludes the connection of any socket-outlets or conductors having a cross-sectional area less than 2.5 mm^2, except where they are used for the connection of a lighting point, or appliance rated at not more than 150 W and installed more than 2.3 m above a floor (see *f* above).

[i] The values are intended to be utilized when the final subcircuit is provided for general use. Where it is known that socket-outlets may be used for specific items of electrical equipment, such as dishwashers, room heaters or clothesdryers, the actual load of the equipment should be substituted.

[j] *Fixed and stationary appliances* Fixed and stationary appliances may be connected permanently or through socket-outlets.

NEW SOUTH WALES DEPARTMENT OF EDUCATION AND TRAINING

TAFE NSW

Family Name .....

Given Name .....

Student Number .....

Centre .....

Signature .....

4 December 2008

6077AC Electrical Systems Safety - Capstone Assessment

ANSWER SHEET – Section A. (Multi-choice Questions)

Instructions:

- Enter your personal details on this sheet.
- Place an X in box of your choice. If you make a mistake- circle your answer (X) and choose again.
- For your convenience you can remove this page while you answer Section A. Remember to re-attach it to the paper when you hand it in.

Question	a	b	c	d
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
Totals				
Total Correct Section A				

Total Marks Section A: ..... /15

END OF EXAMINATION

Name:.....

College:.....

ANSWER SHEET – Section A (Multi-choice Questions)

Module - 6077AC **Examination Date: 4th December 2008**

Instructions:

- Enter your name and college on this sheet.
- Place an **X** in box of your choice. If you make a mistake- circle your answer (X) and choose again.
- For your convenience you can remove this page while you answer Section A. **Remember to re-attach it** to the paper when you hand it in.

Question	a	b	c	d
1		X		
2			X	
3	X			
4				X
5				X
6			X	
7				X
8		X		
9			X	
10		X		
11	X			
12	X			X
13			X	
14				X
15		X		
Totals	2	4	4	3
Total Correct Section A				

References AS/NZS 3000
B3.2.1 Equation 2.1
2.6.2.4 (a)
3.6.2
T52 - AS/NZS 3008.1
T3.8
General knowledge

3.5.2
6.3.4.5(a)(iii) A, B, C.
7.4.7.4
Appendix A.
General knowledge
General knowledge
B4.3
B3.2.1 Equation 2.1

Total Marks Section A: ..... **/15**

END OF EXAMINATION

SECTION A – (15 Marks)

INSTRUCTIONS: Select the best answer for the following statements and place an 'X' in the appropriate box on the Answer Sheet attached to this examination paper. Each correct answer is worth ONE (1) mark.

QUESTION 1. (1 Mark)

The term used in AS3000 to describe the current carrying capacity of a cable is:

(a) I_N

(b) Iz

(c) Isc

(d) I_B

QUESTION 2. (1 Mark)

In a domestic installation, the maximum number of final sub circuits that can be supplied from a single RCD is:

(a) 1

(b) 2

(c) 3

(d) unlimited

QUESTION 3. (1 Mark)

The maximum permissible voltage drop between the point of supply and any point in a 400V electrical installation is:

(a) 5% of Uo

(b) 11.5 Volts

(c) 5% of the voltage measured at the MSB

(d) 10% of the nominal supply voltage

SECTION A – (Cont'd)

QUESTION 4. (1 Mark)

Under short circuit conditions, what is the maximum permissible sheath temperature for a 25mm^2 XLPE (X90) Cu single core cable?

(a) 90° C

(b) 160° C

(c) 75° C

(d) 250° C

QUESTION 5. (1 Mark)

What is the minimum clearance for bare live aerial conductors above a swimming pool

(a) 3m

(b) 4.5 m

(c) 5.5 m

(d) not permitted

QUESTION 6. (1 Mark)

A cable/wiring system suitable for installation in a high temperature environment would be

(a) unenclosed TPS cable

(b) TPS cable enclosed in non-metallic conduit

(c) unenclosed bare MIMS cable

(d) unenclosed TPI cable

QUESTION 7. (1 Mark)

What is an acceptable level of leakage current for a 230V class I appliance?

(a) 30 mA

(b) 10 mA

(c) 0.5 mA

(d) 0.22 mA

SECTION A – (Cont'd)

QUESTION 8. (1 Mark)

The main neutral installed in a 400/230V MEN installation consisting of predominately balanced three phase loads:

(a) can be reduced to 33.3% of the main active conductors CSA

(b) must have the same CSA as the main active conductors

(c) must not be less than 50% of the main active conductors CSA

(d) must have a minimum current carrying capacity of 100A

QUESTION 9. (1 Mark)

Underwater pool lighting must be supplied with a/an

(a) earthing conductor connected to the light

(b) PELV system installed close to the light

(c) PELV or SELV system supply of 12V AC or less

(d) SELV system not exceeding 30V AC

QUESTION 10. (1 Mark)

What is the maximum allowable resistance of an equipotential bonding conductor?

(a) not specified

(b) 0.5Ω

(c) 1Ω

(d) 2Ω

QUESTION 11. (1 Mark)

With which standard must equipment installed in a hazardous area comply?

(a) AS2381

(b) AS2209

(c) AS3017

(d) all of the above

SECTION A – (Cont'd)

QUESTION 12. (1 Mark)

The maximum number of lighting points that can be connected to a circuit wired in 1.0 mm^2 TPS cable and protected by a 6A type C CB is

(a) 12

(b) 15

(c) 20

(d) not specified

QUESTION 13. (1 Mark)

A Certificate Of Compliance should be finalised when an electrical installation is tested and should be completed by the

(a) consumer

(b) licensed installing electrician

(c) licensed electrician who completed the test

(d) installation inspector

QUESTION 14. (1 Mark)

The maximum disconnection time specified for protection against indirect contact for a Sub Main is

(a) unspecified

(b) 100 ms

(c) 400 ms

(d) 5s

QUESTION 15. (1 Mark)

Every conductor shall have a current-carrying capacity that must

(a) be lower than the current for which the circuit is designed (I_B)

(b) be equal to or greater than the circuit breaker nominal rating (I_N)

(c) be greater than the current to be carried by the conductor

(d) be based on an ambient air temperature of 45°C

(End of Section A)

SECTION B – (20 Marks)

INSTRUCTIONS: Blank spaces in the following statements represent omissions. Write the appropriate word, words or information in the numbered spaces provided. Each question is worth TWO (2) marks.

- **Use AS/NZS 3000:2007 to best answer each question.**
- **Write clause or table numbers where required.**

QUESTION 1.

What is the maximum d
equipment intended to

0·4S

AS/NZS 3000 Reference

5.7.2 Disconnection times also 1·5·5·3(d)(i)(c)

The maximum disconnection time for a 230 V supply voltage shall not exceed the following:

(a) 0.4 s for final subcircuits that supply—
  (i) socket-outlets having rated currents not exceeding 63 A; or
  (ii) hand-held Class I equipment; or
  (iii) portable equipment intended for manual movement during use.

(b) 5 s for other circuits where it can be shown that people are not exposed to touch voltages that exceed safe values.

NOTES:

1 Maximum disconnection times will vary for other operating voltages or installation conditions, such as wet locations, etc.

2 The fault current must be of sufficient magnitude to cause automatic disconnection within the required times.

QUESTION 2.

Is it necessary to provid
not accessible from wit

NO

AS/NZS 3000 Reference

5.6.2.2 *Conductive water piping*

Conductive water piping that is both—

(a) installed and accessible within the building containing the electrical installation; and

(b) continuously conductive from inside the building to a point of contact with the ground,

shall be bonded to the earthing system of the electrical installation.

Any equipotential bonding of conductive water piping shall be effected by means of an equipotential bonding conductor connected to the main earthing conductor or earth terminal or bar.

The connection of the bonding conductor to the conductive water piping shall be as close as practicable to the entry of the conductive water piping to the building.

QUESTION 3.

What are the requirements for earthing a switchboard surround that is supplied by unprotected consumers mains

Same size as the main neutral conductor

AS/NZS 3000 Reference

5.5.3.5 *Unprotected consumers mains*

Exposed conductive parts associated with consumers mains not provided with short-circuit protection on the supply side shall be earthed by a conductor with a current-carrying capacity not less than that of the main neutral conductor.

This conductor shall be connected to—

(a) the main neutral conductor or bar; or

(b) the main earthing terminal/connection or bar, in which case, in accordance with Clause 5.3.5.2, the cross-sectional area of the MEN connection shall be not less than that of the main neutral conductor.

SECTION B – (Cont'd)

QUESTION 4.

List three acceptable sources for an isolated (separated) supply?

7.4.2 Source of supply

The source supplying a separated circuit shall be—

(a) an isolating transformer complying with AS/NZS 61558 so that the output is separated from the input by double insulation or equivalent; or

(b) a generator output, e.g. a motor-generator set that is installed so that the output is separated from the frame of the generator; or

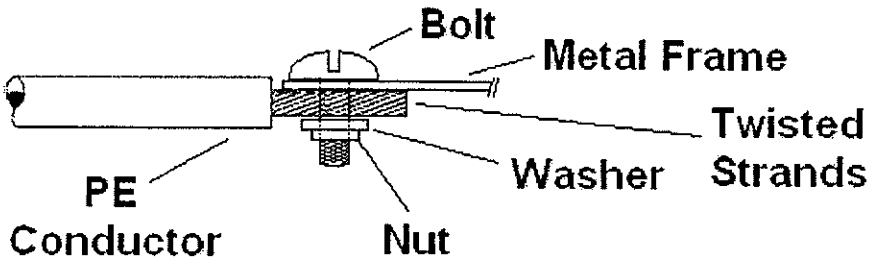
NOTE: The fitting of an RCD, and the connection of an equipotential bonding conductor and an additional conductor to the generator output winding to ensure the correct operation of the RCD, does NOT provide the output separation required by this Clause. See AS/NZS 3010 for details.

(c) an isolated inverter complying with the safety requirements of AS/NZS 4763 (Int).

AS/NZS 3000 Reference (Clau

QUESTION 5.

When terminating a stranded conductor, is it acceptable to twist and place the conductors under a washer as depicted below? List AS3000 requirements.



No

3.7.2.5 *Retention of stranded conductors*

The ends of stranded conductors shall be secured by suitable means, so as to prevent the spreading or escape of individual strands. They shall not be soft-soldered before clamping under a screw or between metal surfaces.

AS/NZS 3000 Reference (Clause number)

QUESTION 6.

A sink has a capacity <45 litres. Lis
luminaire installed within Zone 2

IPX4

AS/NZS 3000 Reference (Clause nu

TABLE 6.1

GUIDANCE ON THE SELECTION AND INSTALLATION OF ELECTRICAL EQUIPMENT FOR BATHS, SHOWERS AND OTHER FIXED WATER CONTAINERS

Equipment	Zone 0	Zone 1	Zone 2	Zone 3
Clause 6.2.4.2 Socket-outlets	Not permitted	Not permitted	(a) a shaver outlet; or (b) RCD-protected and in a cupboard (no specific IP rating).	(a) <0.3 m not permitted (b) ≥0.3 m no IP rating* but shall have— (i) RCD protection; or (ii) separated supply; or (iii) SELV or PELV supply
Clause 6.2.4.3 Switches/ accessories	Not permitted	Same as Zone 2	<0.3 m not permitted ≥0.3 m IPX4*	<0.3 m not permitted ≥0.3 m no IP rating*
Clause 6.2.4.4 Luminaires	IPX7 and specifically for use and SELV or PELV supply	IPX4*	IPX4*; or Class II construction (double or reinforced insulation); or SELV or PELV; or recessed into ceiling	No IP rating*

SECTION B – (Cont'd)

QUESTION 7.

Identify an acceptable method

Assessment

circuit consisting of 10A socke

Limitation

C2.5 Maximum demand in final subcircuits also 2·2·2 a) b) c) d).

C2.5.1 *General*

The maximum demand in final subcircuits is determined—

(a) for single items of equipment, by assessment of the connected load; or

(b) for multiple items of equipment, by limitation of the current rating of a circuit-breaker.

In some applications, the connected equipment may operate in a particular manner that allows for diversity to be applied. This includes welding machines (see Paragraph 2.5.2), domestic cooking appliances (Paragraph C2.5.3) and interlocked equipment (Paragraph C2.5.4)

AS/NZS 3000 Reference (Clause number _____)

QUESTION 8.

Is it permissible to complete an addition to an existing final sub circuit consisting of unprotected 10A socket outlets, without installing RCD protection?

No

1.9.3 Alterations, additions and repairs and 2·6·3·4

Every alteration of, or addition to, an existing electrical installation shall be deemed to be a new electrical installation, and all relevant provisions of this Standard shall apply to every such alteration or addition.

Additions, alterations or repairs to an existing installation constructed to a Part 1 design and installation solution shall not alter the compliance of the existing installation with Part 1.

Alterations or additions to an existing electrical installation shall not cause any portion of the original electrical installation, or electrical equipment connected thereto, to—

(a) carry currents or sustain voltages in excess of those permitted by this Standard; or

(b) be used in any manner that is not in accordance with this Standard.

Repairs to existing electrical installations or parts thereof may be effected using methods that were acceptable when that part of the electrical installation was originally installed, provided that the methods satisfy the fundamental safety principles of Part 1 of this Standard.

AS/NZS 3000 Reference (Clause

QUESTION 9.

List five criteria that need to be addressed when designing an electrical installation.

1.6 DESIGN OF AN ELECTRICAL INSTALLATION

1.6.1 General

An electrical installation shall be designed to—

(a) protect persons, livestock and property from harmful effects;

(b) function correctly as intended;

(c) connect, operate safely and be compatible with the electricity distribution system, or other source of supply, to which the electrical installation is to be connected;

(d) minimize inconvenience in the event of a fault; and

(e) facilitate safe operation, inspection, testing and maintenance.

AS/NZS 3000 Reference (Clause number _____)

SECTION B – (Cont'd)

QUESTION 10.

List the requirements when installing a common neutral?

Also Clause 2.9.5.5

AS/NZS 3000 Reference (Clause

2.2.1.2 *Common neutral*

Each single-phase circuit, and each multiphase circuit that requires a neutral conductor for the operation of connected equipment, shall incorporate a neutral conductor.

A common neutral conductor may be used for two or more circuits subject to the following conditions:

(a) The continuity of the common neutral conductor shall not depend on connections at the terminals of electrical equipment, including control switches.

(b) The circuits shall be controlled and protected by linked circuit-breakers.

(c) The neutral conductor shall be marked at the switchboard to identify the associated active conductors in accordance with Clause 2.9.5.5.

NOTES:

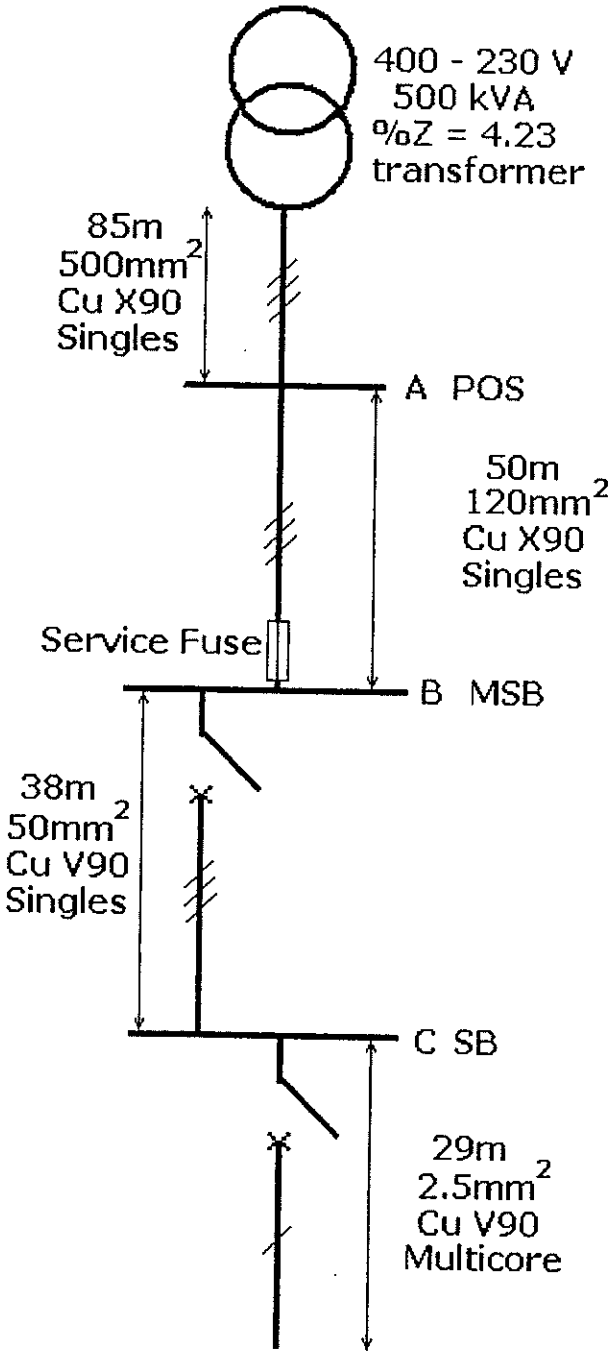
1 Typical applications for common neutrals include groups of single-phase lights arranged across multiphase supply, and separate components of a single-phase appliance, such as a cooking unit

(End of Section B)

SECTION C – (46 Marks)

INSTRUCTIONS: This section involves calculations. Show all necessary working in the space provided, marks will be awarded accordingly. Answers are to be highlighted or underlined.

QUESTION 1. **(4 Marks)**



Alternate solution CM.

400-390

Vdrop = 10V 3ϕ

S.M.

Ref T41 90°C

$Vd = \frac{Vc\,L\,I}{1000}$

$= \frac{1.18 \times 39 \times 100}{1000}$

$= 4.6V$ 3ϕ

fs.c.

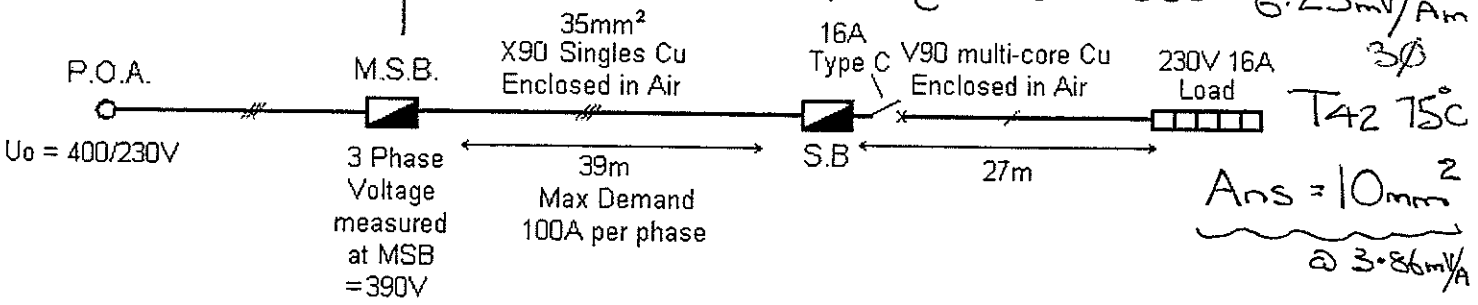
Vd = 20 − 10 − 4.6 =

$V\phi = \frac{5.4}{\sqrt{3}} = 3.12V$ 1ϕ

$Vc = \frac{1000 \times 3.11}{27 \times 16} = 7.2mV/Am$

$Vc = 7.2 \times 0.866 = 6.23mV/Am$ 3ϕ

QUESTION 2.



Ans = 10mm² @ 3.86mV/A

Determine the minimum size cable for the SINGLE PHASE final sub circuit, based on Voltage Drop.

AS3008 Table 41
35mm² Cu X90
Vc = 1.18 mV/Am

Vd= VcLI / 1000
= 1.18x39x100 / 1000
= 4.6V

1 Mark

Total Vd to MSB
400–390= 10V
Total Vd to SB
= 10 + 4.6
=14.6V
Convert to 1ϕVc
=14.6/√3
=8.43V

1 Mark

5%x230 = 11.5V
11.5–8.43=3.07V
Vc= 1000Vd / LI
= 1000x3.07 / 27x16
= 7.12 mV/Am

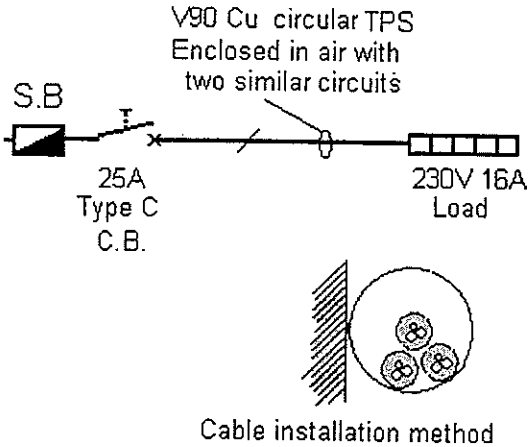
1 Mark

Convert 7.12 to 3ϕVc
7.12x0.866 = 6.17mV/Am
AS3008 Table 42
V90 Cu Multicore
Minimum cable size

10mm (3.86mV/Am)

1 Mark

QUESTION 3. **(4 Marks)**



Cable installation method

Determine the minimum size cable for the SINGLE PHASE final sub circuit, based on Current Carrying Capacity

Derating Table 22 Item 2 Column 6
Derating factor 0.7

Cable minimum CCC = 16 / 0.7 = 22.9A

From AS3008 Table 2.2 Item 7
Table 9 Column 6

Minimum cable size = 4mm (26A)

1 Mark T22 Item 2 Col 6 = 0.7

1 Mark 25 / 0.7 = 35.7A

1 Mark T2(2) Item 7 → T9 Col 6

1 Mark 10mm² @ 47A

SECTION C – (Cont'd)

Corrected page from Sette
24/10/2008

a) Determine the phase impedance of the transformer.

1 Mark

Ifl= S / √3V = 500,000 / 693 = 722 A

Isc=100 Ifl / %z = 72,200 / 4.23 = 17.1 kA

Zph=Uph / Isc = 230 / 17100 = 13.5 mΩ

$Z_{Tx} = 0.01348\Omega$

$S = \sqrt{3} V I \therefore I = \frac{S}{\sqrt{3} V}$

b) Assuming the transformer has a phase impedance of 7mΩ, determine the maximum 3ϕ prospective short circuit current at the P.O.S. (point A). (AS3008 has appropriate tables to determine conductor resistance – ignore conductor reactance)

1 Mark

Isc= Uph / Zfl = 230 / (0.007 + 0.0046) = 19793 A = 19.8 kA

AS3008 Table 34 85m 500mm² X90 Cu = 0.0538 x 85 / 1000 = ~~4.62~~ 4.573 mΩ

Ref T34 500mm² Single Core X90

0.538Ω

$I_{s/c} = 19.8KA$

c) Determine the system impedance, for a 3ϕ prospective fault current of 12kA at point "C" the Sub Board.

1 Mark

Zph=Uph / Isc = 230 / 12000 = 19.2 mΩ

$Z_{system} = 0.0192\Omega$

d) If the Active Earth fault current is 4.5 kA at the SB (point C), determine the maximum earth fault current at the end of the final sub circuit. (Assume all fault current flows back through MEN at MSB and SB has no MEN connection)

1 Mark

Zph=Uph / Isc = 230 / 4500 = 51.1 mΩ

Isc=Uph / Zfl = 230 / (0.051 + 0.52) = 402 A

AS3008 Table 35 29m 2.5mm V90 Cu = 9.01 x 29 / 1000 = 0.26 Ω x 2 (Rph+Rpe) = 0.52 Ω

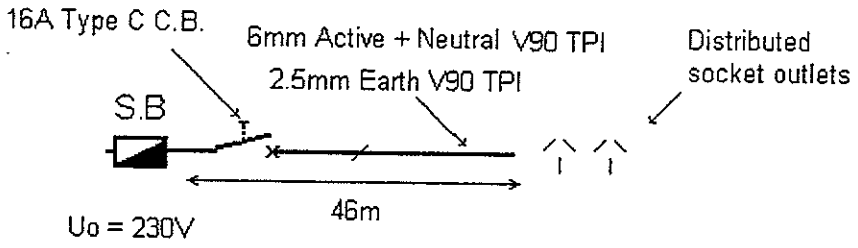
$I_{s/c} = 402A$

FOR MAXIMUM FAULT CURRENT

* NOTE! Answers may vary if the temperature is 45°C *

SECTION C – (Cont'd)

QUESTION 4. **(4 Marks)**



Determine if the final sub circuit satisfies the requirements for fault loop impedance – show all references and working

AS3000.2007 Disconnection time 0.4s Unable to use Table B1	From AS3000.2007 Appendix B5.2.2 ρ=0.0225 Appendix B4.5 Ia=16x7.5 Ia =120	Lmax=0.8UoSphSpe Iaρ(Sph+Spe) Lmax=0.8x230x6x2.5 120x0.0225x8.5 Lmax=2760 22.95 Lmax=120m	Circuit Length = 46m Lmax=120m 46<120 Circuit satisfies the requirements of fault loop impedance.
1 Mark	1 Mark	1 Mark	1 Mark

QUESTION 5. **(4 Marks)**

Determine the maximum demand for the following 230V SINGLE Domestic Installation

34 x 50W down lights (Ai)

17 x double 10A socket outlets (Bi)

5 x single 10A socket outlets (Bi)

1 x 5 kW 230V cooktop (C)

1 x 4 kW 230V oven (C)

1 x 15A socket outlet (general purpose) (Bii)

1 x 20A socket outlet for 230V 16A air conditioner (D)

4 x permanently connected 120W ceiling fans (Ai)

2 x 10A socket outlets installed > 2.4m for 75W exhaust fans (Ai)

SECTION C – (Cont'd)

Deduct 1 mark each incorrect line

TOTAL = 4 marks

Load Group	No of Points / Load	Calculation	Maximum Demand
Ai	34 lights 4 c fans 2 ex fans	40 points 3A (first 20) 2A (next 20 or part thereof)	5A
Aii			
Bi	17 Dbl 10A 17 x 2=34 5 Single 10A	39 points 10A (first 20) 5A (next 20 or part thereof) Note if 10A fan sockets added are here Max Demand = 20A	15A
Bii	1 x 15A socket outlet	1 point 10A	10A
Biii			
C	5kW CT 4kW Oven	9kW Total (50% connected load) I= 9000 / 230 x 0.5 =19.6A	19.6A
D	1 x 20A socket outlet	16A Air Cond. (75% connected load) I=16 x 0.75 =12A	12A
E			
F			
G			
Maximum Demand			61.6A OR 66.57A

SECTION C – (Cont'd)

QUESTION 6. **(7 Marks)**

Determine the maximum demand for the following 400/230V three-phase MULTIPLE domestic installation, consisting of thirty (30) individual living units.

Electrical equipment associated with each individual (1) unit:

18 x 50W down lights (Ai)

10 x double 10A socket outlets (Bi)

3 x single 10A socket outlets (Bi)

1 x 10A socket outlet for 230V air conditioner (Bi)

2 x permanently connected 120W ceiling fans (Ai)

In addition to the load above, six (6) of the units have the following electrical loads.

1 x 5 kW 230V cooktop (C)

1 x 4 kW 230V oven (C)

1 x 4.8 kW electric storage hot water system (F)

The following communal load is also installed:

30 x 230V 100W bollards (balanced equally across each phase) (H)

9 x 230V 250W 4A Metal Halide outdoor lighting (three (3) circuits) (H)

8 x double 10A single phase socket outlets. (two (2) circuits) (I)

Total = 7 marks

30 units / 3 = 10 units/phase

SECTION C – (Cont'd)

Deduct 1 mark each incorrect line

Use only the required load groups in the table below

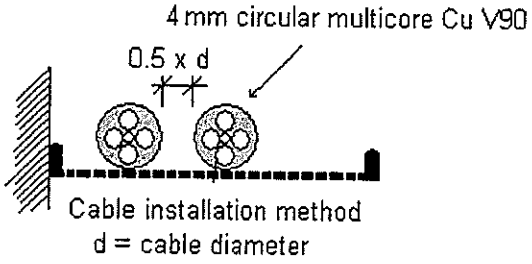
T C1 Col 4 / 3

Load Group	No of Points / Load	Calculation	Red	White	Blue
Ai	lighting	Column 4 10 l/u per ϕ 5A + 0.25A x 10 = 7.5A per ϕ	7.5	7.5	7.5
Aii					
Bi	10A skt outlets	Column 4 10 l/u per ϕ 15A + 3.75A x 10 = 52.5A per ϕ	52.5	52.5	52.5
Bii					
Biii					
C	9kW Cooking	Column 3 2 l/u per ϕ 2 units per phase = only 6 units 15A per ϕ	15	15	15
D		Inc in Bi - footnote i			
E					
F	4.8 kW O.P.H.W.	Column 3 2 l/u per ϕ 2 units per phase 6A per l/u = 6A x 2 = 12A per ϕ	12	12	12
G					
H	30 bollard 9 Halide	10 bollard + 3 Metal Halide per ϕ (10x100)/230 + 3 x 4A = 16.3A per ϕ	16.3	16.3	16.3
I	8 x Dbl 10A S.O.	8 x 2 = 16 points over 2 circuits 8 x 2A= max 15A over two ϕ	15	15	
Ji					
Jii					
Jiii					
K					
L					
M					
Maximum Demand			118.3	118.3	103.3

Other answers are possible

SECTION C – (Cont'd)

QUESTION 7. (3 Marks)



Using the diagram above, determine the current carrying capacity of the THREE phase 4mm^2 multi-core Cu V90 cable, which is installed flat on a perforated cable tray spaced from one other similar circuit.

AS3008
Table 2.1 Item 10
Table 12 Column 2
Derating Table 24

1 Mark

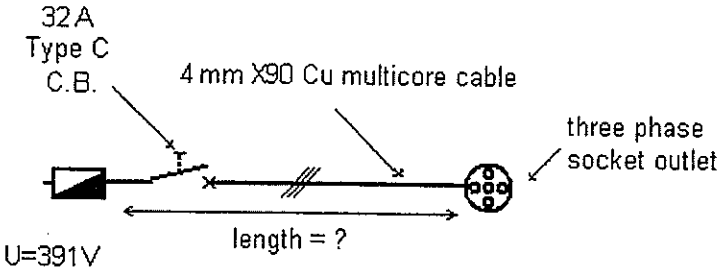
Derating Table 24
Item 7 Column 6
Derating factor 0.88
(not spaced enough to ignore derating)

1 Mark

AS3008
Table 12 Column 2
4mm = 31A x 0.88
C.C.C. = 27.3A

1 Mark

QUESTION 8. (4 Marks)



A 400V three phase final sub circuit supplying a socket outlet is to be wired with 4mm^2 X90 four-core and earth cable. The circuit is protected by a 32A, type C circuit breaker. The voltage measured at the Sub Board is 391V. In order to comply with AS/NZS 3000 regarding voltage drop, what is the maximum allowable route length of the circuit?

Total Vd to MSB
400–391= 9V

1 Mark

5%x400 = 20V
20–9 = 11V
Maximum available voltage drop remaining = 11V

1 Mark

AS3008 Table 42
4mm Cu X90
3ϕVc = 10.2 mV/Am

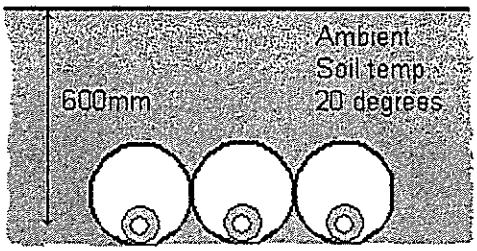
1 Mark

$L = \frac{1000Vd}{VcI}$
$= \frac{1000 \times 11}{10.2 \times 32}$
= 33.7m

1 Mark

SECTION C – (Cont'd)

QUESTION 9. **(5 Marks)**



A 400V THREE phase consumer main is to be enclosed in three single HD PVC conduits that will be installed touching underground at a depth of 600mm. The ambient soil temperature is 20 °C. The circuit will be wired with 4 x single core X90 Cu cables.

A three pole 100A type 'C' circuit breaker will protect the circuit.

a) List any applicable de-rating table and derating factor for the circuit

Derating table No 27(2) **1/2 Mark** Derating factor: 1.03 **1/2 Mark**

Derating table No 28(2) **1/2 Mark** Derating factor: 0.98 **1/2 Mark**

Derating table No N/A **1/2 Mark** Derating factor: N/A **1/2 Mark**

26(1) Col 2 0.78

b) Determine the minimum required current capacity for each cable

$= \frac{100}{1.03 \times 0.98}$

$= 99.1A$

$\frac{100}{1.03 \times 0.98 \times 0.78}$

$= 127A$

1 Mark

c) Determine the minimum cable size T2(4) Item 6

T7 Col 18

AS3008 Table 2(4) Item 6
Table 7 Column 18
16mm = 105A

use $25mm^2$ @ 135A

1 Mark

SECTION C – (Cont'd)

QUESTION 10. (7 Marks)

Deduct 1 mark each incorrect line

Determine the maximum demand for the following 400V FACTORY Installation

10 x double 10A socket outlets (Bi)

6 x hi bay metal halide lamps @ 3.5A each (A)

30 x fluorescent lamps @ 0.4A each (A)

3 x 20A three phase socket outlets (Biii)

3 x 15A three phase socket outlets (Biii)

2 x 400V single phase welders @ 20A each (H)

2 x 25A single phase motors (D)

Load Group	Points / Load	Calculation	Red	White	Blue
A	Lighting 30 fluro 6 Hi Bay	30/3 = 10 per ϕ 10 x 0.4 = 4A 6/3 = 2 per ϕ 3.5 x 2 = 7A	11	11	11
Bi	10A skts 10x2 = 20 points	1000 + (750 x 7) = 27.2A (8 points) 1000 + (750 x 5) = 20.6A (6 points) 1000 + (750 x 5) = 20.6A (6 points)	27.2	20.6	20.6
Bii					
Biii	3 x 20A 3ϕ 3 x 15A 3ϕ	FLC x 20 = 20A per ϕ + 75% x (20 x 2) = 30A per ϕ + 75% x (15 x 3) = 33.8A per ϕ	83.8	83.8	83.8
C					
D	2 x 25A 1ϕ Motors	FLC Largest = 25A 75% x 25A = 18.8A	43.8		
E					
F					
G					
H	2 x 400V 1ϕ Welders	FLC highest two 20A per welder over 2ϕ		40	40
Maximum Demand			165.8		

End of Section C)

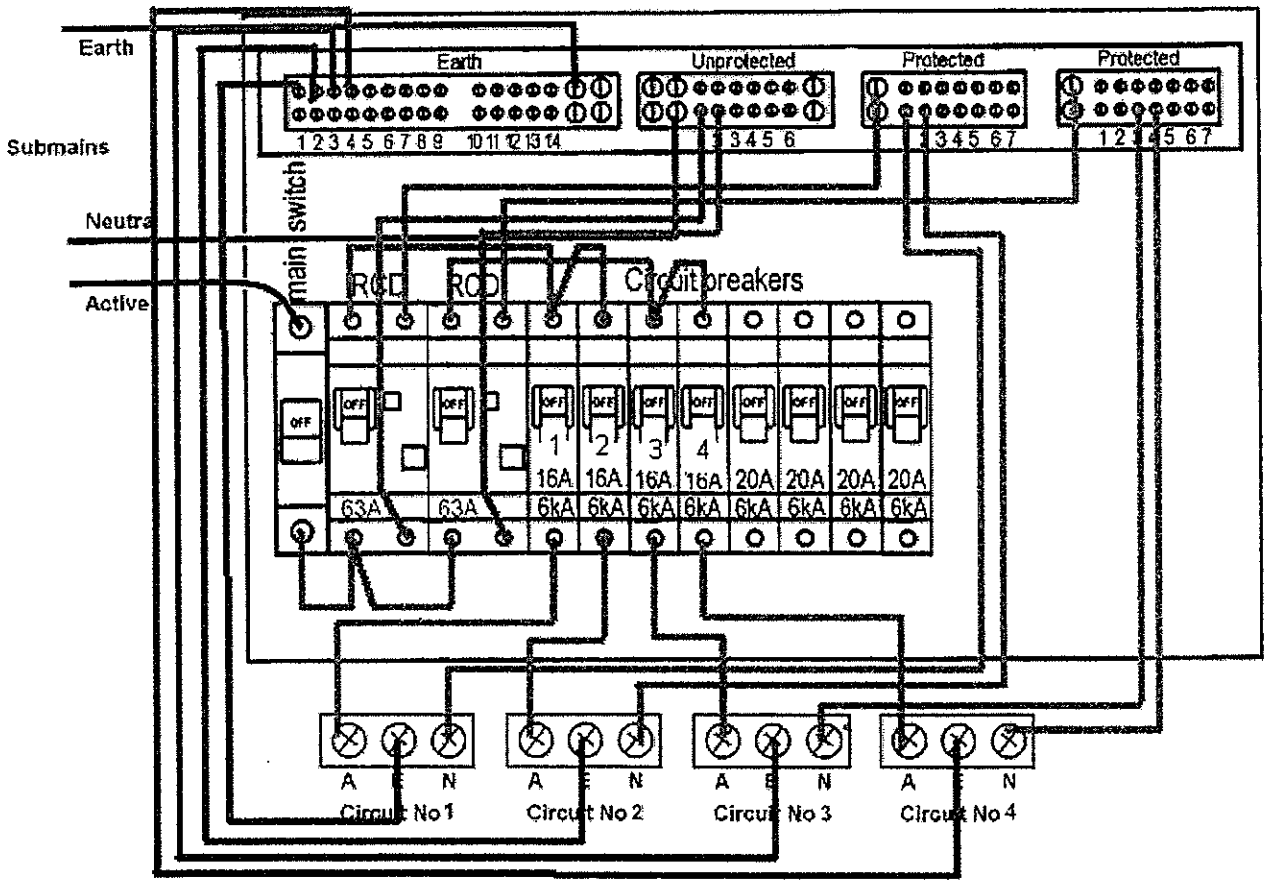
SECTION D – (19 Marks)

INSTRUCTION: The questions in this section require some simple drawing. Ensure that the drawing is neat and legible. The use of pencil on the drawing is acceptable in this section only.

QUESTION 1. (5 Marks)

The following diagram shows a main switch board in a domestic installation. The consumer mains include an active, neutral and main earth from the earth electrode. The installation condition of all final sub circuits is **fully surrounded by thermal insulation**. There are four (4) final sub circuits supplying socket outlets, wired with 2.5 mm^2, multi-core, V90, Cu cables. It has been determined to use separate RCD's to provide the required earth leakage protection for the circuits. Complete all necessary active, neutral and earth connections for these four final sub-circuits on the wiring diagram below, ensuring the completed wiring complies with AS/NZS 3000.2007 and AS/NZS 3008.1.1:1998.

T2(2) Item 11 → Ta Col 12
2.5 mm² @ 13A

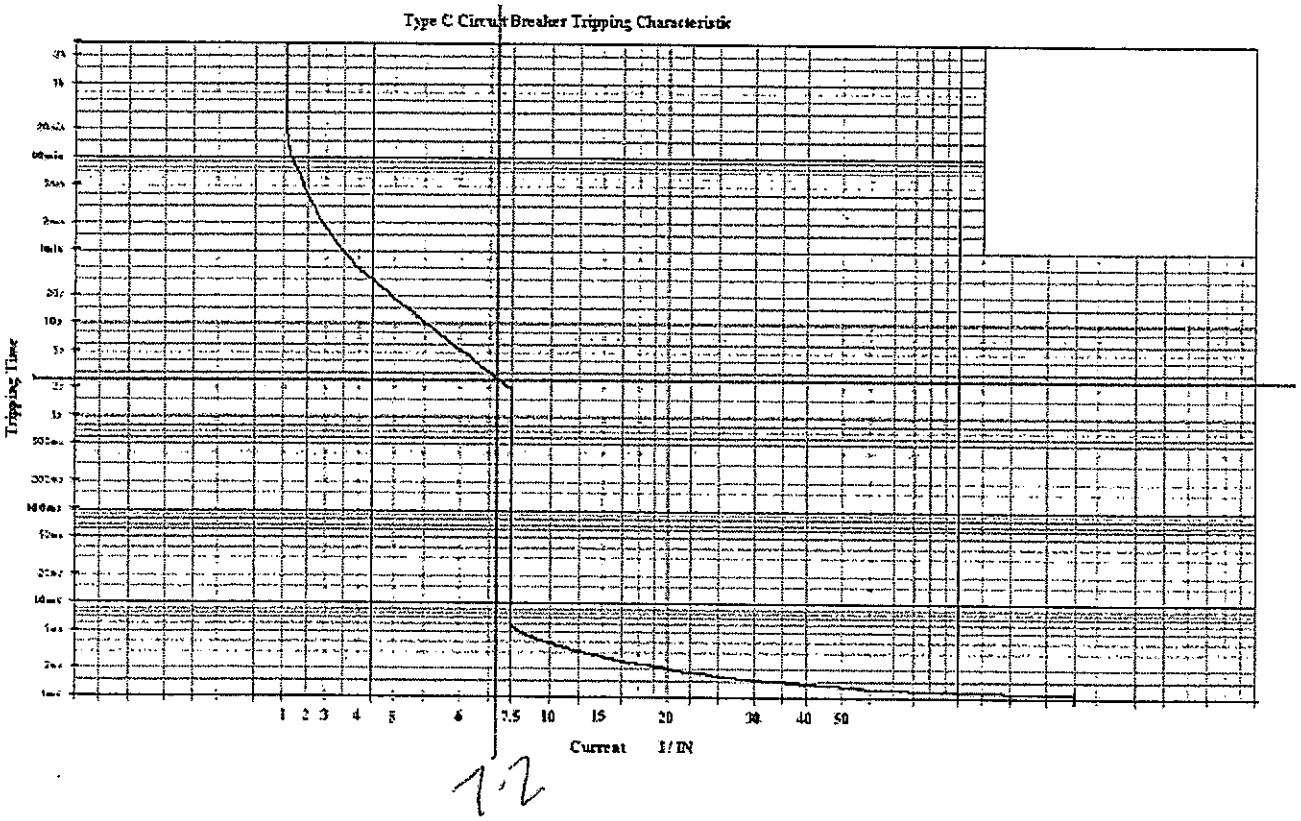


* Must used the 16A C/B's)

SECTION D – (cont)

QUESTION 2. **(4 Marks)**

A 20A type C circuit breaker with the following tripping characteristic is protecting a 230V circuit wired with 2.5 mm ^{2}, multi-core, V90, Cu cable. The circuit is supplying socket outlets. The fault loop impedance was measured at the extreme point on the circuit using a fault loop impedance instrument. The result was 1.6 Ω at ambient conditions (ie 40° C). Answer the questions below. Show all working, and support your answer/s by marking the characteristic curve below.



a) Calculate the fault current for an active to earth fault at the extreme point.

Ia = Uo / Zfl
= 230 / 1.6
= 144A

1 Mark

b) Determ[illegible]ker trip time using the fault condition indicated above.

I / In
= 144 / 20
= 7.2

2.5 s

1 Mark

c) Does the circuit meet AS/NZS 3000 requirements for fault loop impedance? Why?

YES / NO No, disconnection time > 0.4 seconds

1 Mark

e) Determine the maximum allowable resistance of the protective earth conductor.

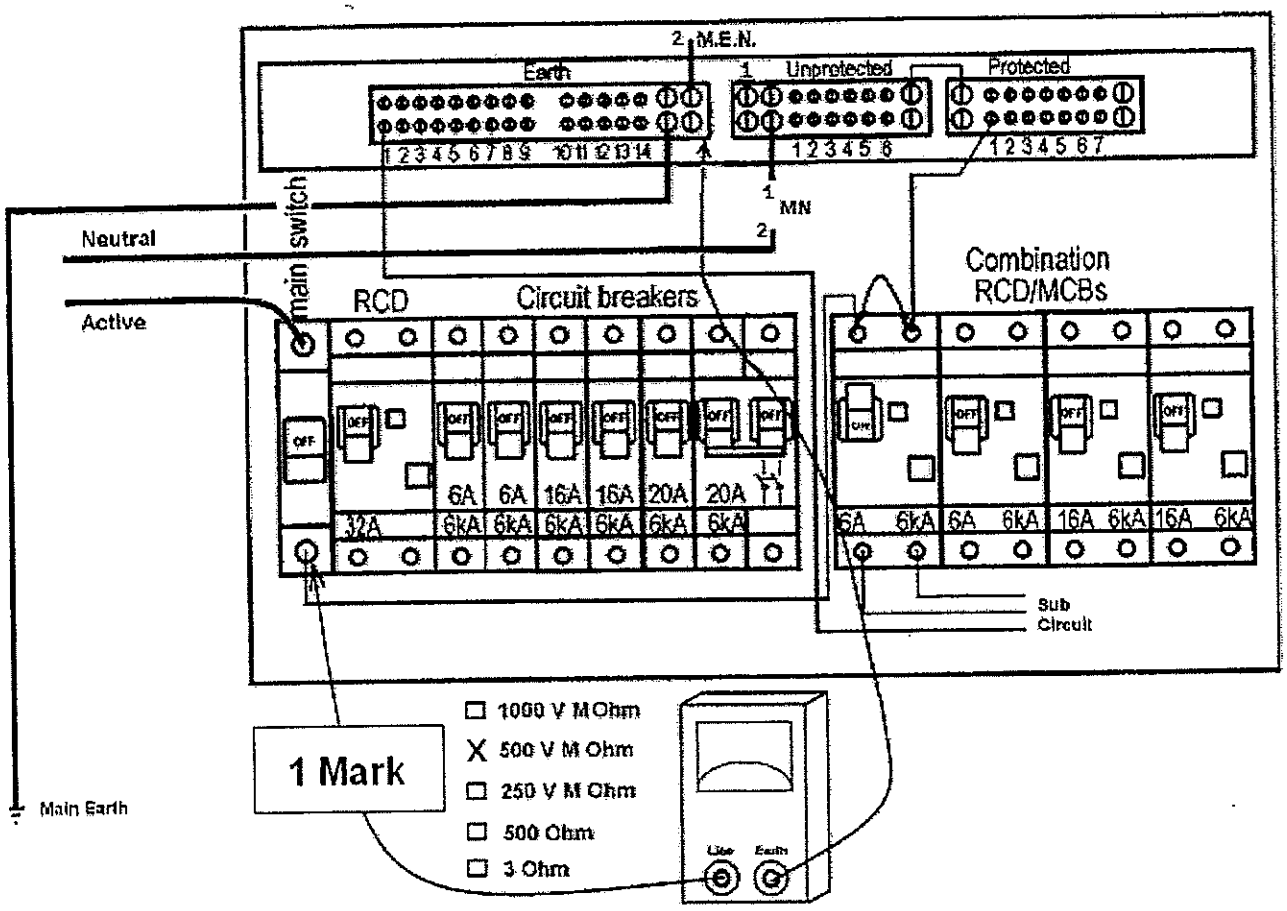
AS3000:2007 Table 8.2 - maximum 0.5 Ohm.

1 Mark

SECTION D – (cont)

QUESTION 3. **(4 Marks)**

The following diagram shows how the switchboard has been prepared, ready for testing the insulation resistance between active and earth of a single-phase lighting circuit. The circuit is protected by a 6A combined RCD/MCB. The lighting circuit has loads with dimmer control. Identify the correct setting for the insulation resistance tester by placing an "X" in the appropriate box and answer the four questions. The board is electrically isolated.



Circle the correct answer

The MEN link should be:

a) Connected to position 1

b) **Disconnected as shown in position 2** ⇐

1/2 Mark

A reading of 0.9MΩ would indicate:

a) **A fault** ⇐

b) No fault

1 Mark

The main neutral should be:

a) Connected to Position 1

b) Disconnected as shown in position 2 ⇐

1/2 Mark

The leads of the testing device are:

a) **correctly connected** ⇐

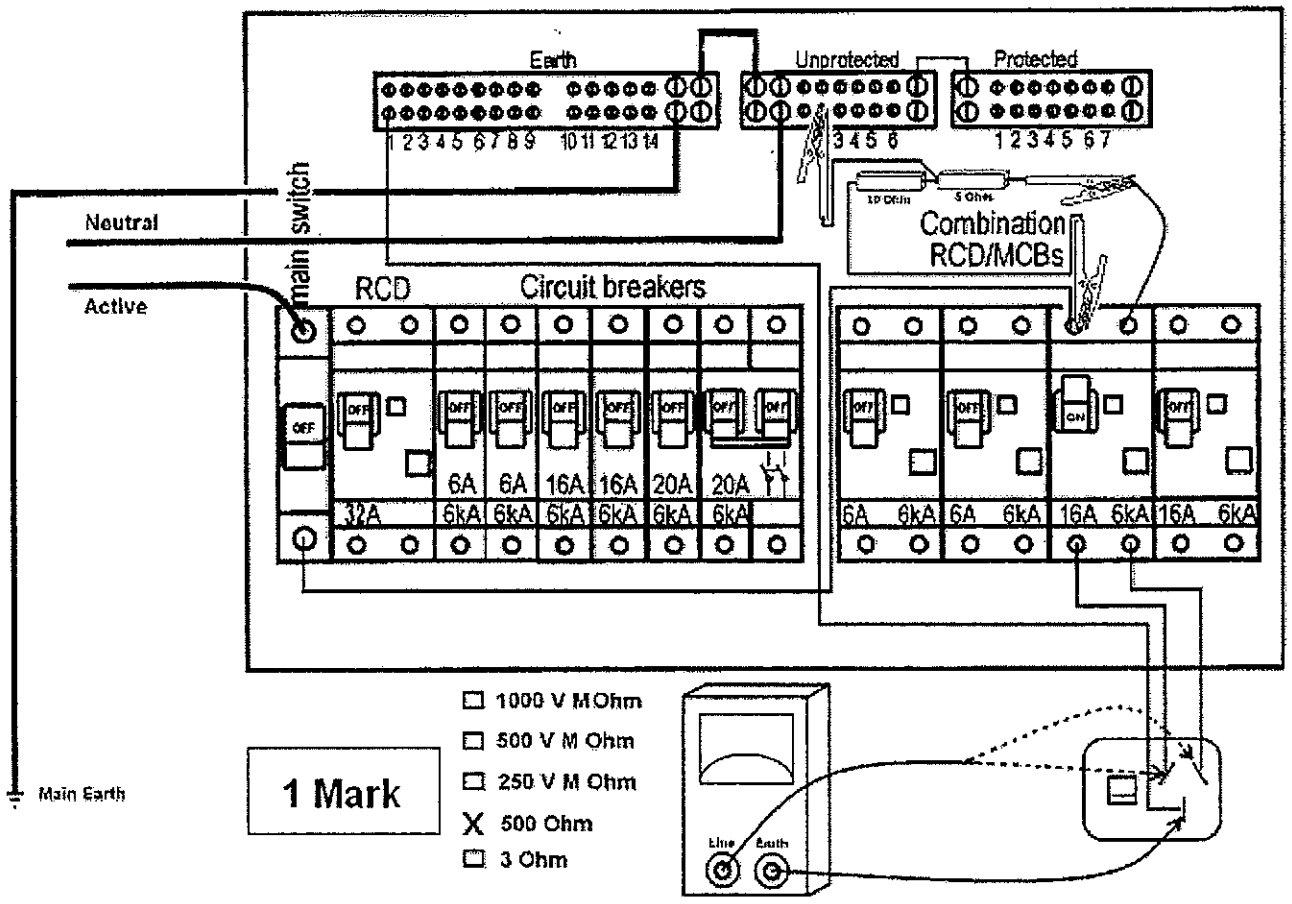
b) incorrectly connected

1 Mark

SECTION D – (cont)

QUESTION 4. **(4 Marks)**

Answer the question and complete the following table using the diagram below. A correct circuit connection test is being performed. Identify the correct setting for the test equipment by placing an "X" in the appropriate box. The board is electrically isolated.



Assuming the socket outlet is correctly connected, complete the table

Test Equipment Connection	Reading	
Earth to Active with socket outlet switch off	∞	1/2 Mark
Earth to Active with socket outlet switch on	$\approx 10\ \Omega$	1/2 Mark
Earth to Neutral with socket outlet switch off	$\approx 5\ \Omega$	1/2 Mark
Earth to Neutral with socket outlet switch on	$\approx 5\ \Omega$	1/2 Mark

Identify any fault indicated by a reading of 5 Ohms between the active and earth socket measured at the socket outlet:

Active - Neutral transposition — **1 Mark**

SECTION D – (cont)

QUESTION 5. (2 Marks)

Using the following table from AS3000.2007 determine the maximum recommended number of lighting points permitted to be added onto an existing final sub circuit consisting of 8 x 10A double socket outlets. The existing cable is 2.5mm^2 multi-core Cu cable, protected by a 16A type C circuit breaker. There are three existing power circuits in the installation.

1 Mark

Maximum current = 16A. Connected load: 10A socket outlets 8 x 2 @ 1A each = 16A.
Therefore no lighting points can be added.

1 Mark

TABLE C8

IDANCE ON THE LOADING OF POINTS PER FINAL SUBCIRCUIT

* No lighting Pts can be added

Cable cross-sectional area[a] (mm^2)	Rating of circuit-breaker[a] (A)	Contribution of each point (A) (sum must not exceed rating of circuit-breaker)						Maximum connected load for a range[de] (W)
		Lighting points[f]	10 A single or multiphase socket-outlets[cghi]		15 A single or multi-phase socket-outlets[hi]	20 A single or multi-phase socket-outlets[hi]	Permanently connected fixed or stationary appliances[g] or water heaters	
			Non-domestic installations without permanent airconditioning	All domestic installations and non-domestic installations with permanent airconditioning				
1	6	0.5	NP	NP	NP	NP	Connected load	NP
1	8	0.5	NP	NP	NP	NP		NP
1	10	0.5	NP	NP	NP	NP		NP
1	13	0.5	NP	NP	NP	NP		NP
1	16	0.5	NP	NP	NP	NP		NP
1.5	8	0.5	NP	NP	NP	NP		NP
1.5	10	0.5	NP	NP	NP	NP		NP
1.5	13	0.5	NP	NP	NP	NP		NP
1.5	16	0.5	NP	NP	NP	NP		5000
1.5	20	0.5	NP	NP	NP	NP		5000
2.5	10	0.5	NP	NP	NP	NP		NP
2.5	13	0.5	2	1	NP	NP		NP
2.5	16	0.5	2	1	15	NP		5000
2.5	20	0.5	2	1	12	20		8000

(continued)

8 double @ 1A each

double

$2 \times 8 \times 1A = 16A$

* circuit has reached its capacity *

NOTES TO TABLE C8

a Cable cross-sectional areas and protective device ratings relate directly to specified installation methods given in Tables C5 and C6, e.g. a 2.5 mm^2 cross-sectional area cable used in conjunction with a 20 A protective device is recommended for use in Table C5 for a single-phase circuit partially surrounded in thermal insulation or from Table C6 for a three-phase circuit unenclosed in air.

b Figures for 6 mm^2 and 10 mm^2 conductors are given primarily for dedicated circuits supplying permanently connected fixed or stationary appliances, water heaters and ranges. While this Standard does not prescribe the installation of socket-outlets and lighting points on these circuits, the physical limitations of the terminals of these devices may make their connection impractical.

c For the purposes of determining the number of points, a multiple combination of socket-outlets is regarded as the same number of points as the number of integral socket-outlets in the combination.

d A hotplate and oven are considered to be one cooking appliance if mounted within one room.

e Maximum demand is limited by the circuit-breaker on the final subcircuit, which allows for diversity in operation of the range elements and hotplates.

f *Lighting points* A luminaire is deemed to comprise one or more lighting points, according to the number of points at which it is connected by flexible cords to the installation wiring, or according to the number of sections in which it is switched or controlled. Connections of festoon lighting and decorative lighting shall not be regarded as lighting points. See Table C1 for track systems and ELV lighting.

A socket-outlet installed more than 2.3 m above a floor for the connection of a luminaire may be included as a lighting point.

An appliance rated at not more than 150 W, which is permanently connected, or connected by means of a socket-outlet installed more than 2.3 m above a floor, may be included as a lighting point.

g *Circuits with 10 A socket-outlets connected* Applies where there are two or more circuits in an electrical installation.

h *Restricted connections* Table C8 precludes the connection of any socket-outlets or conductors having a cross-sectional area less than 2.5 mm^2, except where they are used for the connection of a lighting point, or appliance rated at not more than 150 W and installed more than 2.3 m above a floor (see *f* above).

i The values are intended to be utilized when the final subcircuit is provided for general use. Where it is known that socket-outlets may be used for specific items of electrical equipment, such as dishwashers, room heaters or clothesdryers, the actual load of the equipment should be substituted.

j *Fixed and stationary appliances* Fixed and stationary appliances may be connected permanently or through socket-outlets.

(End of Section D)