NAME:	
Date:	

Unit 1702

Workbook 3

AS/NZS 3000

Introduction

And

Questions

TABLE OF CONTENTS

1 – INTRODUCTION

AS/NZS 3000: is the joint Australian and New Zealand Standard for Electrical Installations and is also known as the "Wiring Rules".

These Wiring Rules are cited in the Electricity Regulations as the means of compliance in the following areas:

ER 63

Testing prescribed electrical work on low and extra-low voltage installations

(1) All prescribed electrical work done on a low or extra-low voltage installation or part installation must be tested—

(a)for operational safety; and

(b) to ensure that the installation or part installation is not electrically unsafe; and

(c) as required by regulation 59 or 60, as the case requires; and

(d) in the case of an installation or part installation that does not comply with Part 2 of AS/NZS 3000, in accordance with the verification or testing process set out in the certified design for the installation or part installation

ERC 59

59 Low and extra-low voltage installations to comply with AS/NZS 3000

(1)Every low or extra-low voltage domestic installation, or part of a domestic installation, must be installed, tested, inspected, and connected so as to comply with Part 2 of AS/NZS 3000 if it has a maximum demand at or below—

(a) 80 amperes per phase if single-phase; or

(b) 50 amperes per phase if multi-phase.

(2) Every other low or extra-low voltage installation or part installation must be installed, tested, inspected, or connected so as to comply with either—

(a) Part 2 of AS/NZS 3000; or

(b) a certified design prepared in accordance with Part 1 of AS/NZS 3000.

(3) A low voltage or extra-low voltage installation or part installation may be maintained or replaced in all or any of the following ways:

(a) in such a way that the installation or part installation complies with Part 1 or Part 2 of AS/NZS 3000:

(b) in such a way that the installation or part installation is restored to, or maintained in, its original condition:

(c) by complying with all manufacturer's instructions relating to the fittings used in, or affected by, the maintenance or replacement.

2 –Getting to know AS/NZS 3000

Section	Title	Important sub-sections
Section 1		
Section 2		
Section 3		
Section 4		
Section 5		
Section 6		
Section 7		
Section 8		
App A		
App B		
App C		
App D		

3 –QUESTIONS on AS/NZS 3000 Section 1

Question 1
Refer to section1 of AS/NZS 3000 and state TWO of the methods of providing protection against indirect contact.

(1)_____
_____
(2) _____
__
_____

Ref: ……

Question 2
Refer to section1 of AS/NZS 3000 and state the TWO basic requirements for the arrangements of circuits in the design of an electrical installation.

_____
_____
_____
_____
_____
_____

Ref: ……

Question 3
Automatic disconnection of the supply is one method of preventing danger to persons where exposed conductive parts become live under fault conditions (indirect contact). Refer to AS/NZS 3000 and state the TWO general methods of achieving automatic disconnection.
(1)_____
_____
_____

(2)_____
_____
_____

Ref: ……

Question 4
Refer to AS/NZS 3000 and list TWO acceptable methods of limiting the maximum demand in mains and sub-mains.

(1) _____
(2) _____

Ref: ……

Question 5
A fundamental principal of AS/NZS 3000 is that persons and livestock shall be protected against dangers that may arise from contact with parts which are live in normal service (direct contact) or exposed conductive parts which may become live under fault conditions (indirect contact).
Refer to AS/NZS 3000 and answer the following:
(a) State the FOUR permitted methods of protection against direct contact.

(1) _____
(2) _____
(3) _____
(4) _____

Ref: ……..
(b) State the TWO minimum degrees of protection permitted when providing protection against direct contact by barriers or enclosures.
(1) _____

---

(2) _____
_____

Ref: ……..

(c) Barriers or enclosures are required to be constructed so that they cannot be opened or removed unless certain conditions apply. State THREE alternative conditions that can be used regarding the opening or removal of barriers or enclosures.

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

Ref: ……..

4 –QUESTIONS on AS/NZS 3000 Section 2

Question 1
Refer to AS/NZS 3000 and state the requirement for a motor isolator that is located remotely from the motor.

_____
_____
_____

Ref: ……..

Question 2
Refer to AS/NZS 3000 and state the safety requirement for the prevention of injury to persons or damage to property that must be met in the event of complete power failure to an electric motor.

_____
_____
_____
_____
_____
_____

Ref: ……

Question 3
(a) Refer to AS/NZS 3000 and state TWO situations where the protection disconnection time for a final subcircuit must not exceed 0.4 seconds.
(1) _____
(2) _____

Question 4
With regard to switchboards, refer to AS/NZS 3000 and state:
(a) The requirement for accessibility.

_____
_____

(b) FOUR situations where it is not permitted to install a switchboard.

(1) _____
_____
_____
(2) _____
_____
_____
(3) _____
_____
_____
(4) _____
_____
_____

Question 5
RCD protection is required to be installed:

On socket outlet and lighting final subcircuits in domestic installations.
On socket outlet final subcircuits in other residential installations.

(a) You are required to wire a new domestic residence. Two RCDs will be installed in the switchboard. One RCD will protect half of the socket outlets and half of the lights. The second RCD will protect the other socket outlets and lights.

(i) The RCDs to be installed have no facility for terminating the neutral conductors. How many neutral busbars will be required in the switchboard?

_____

(ii) What other electrical protection is required on the circuits protected by the RCDs

_____

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

(i) TWO situations where RCDs do not need to be installed after alterations, additions or repairs have been carried out.

(1) _____
_____

(2) _____
_____

Ref: ……

(ii) The ONE situation where an RCD does not need to be installed on a socket outlet final subcircuit in a new installation.

_____

(iii) The maximum rated residual current of an RCD installed to protect socket outlet and lighting final subcircuits in domestic installations.

_____

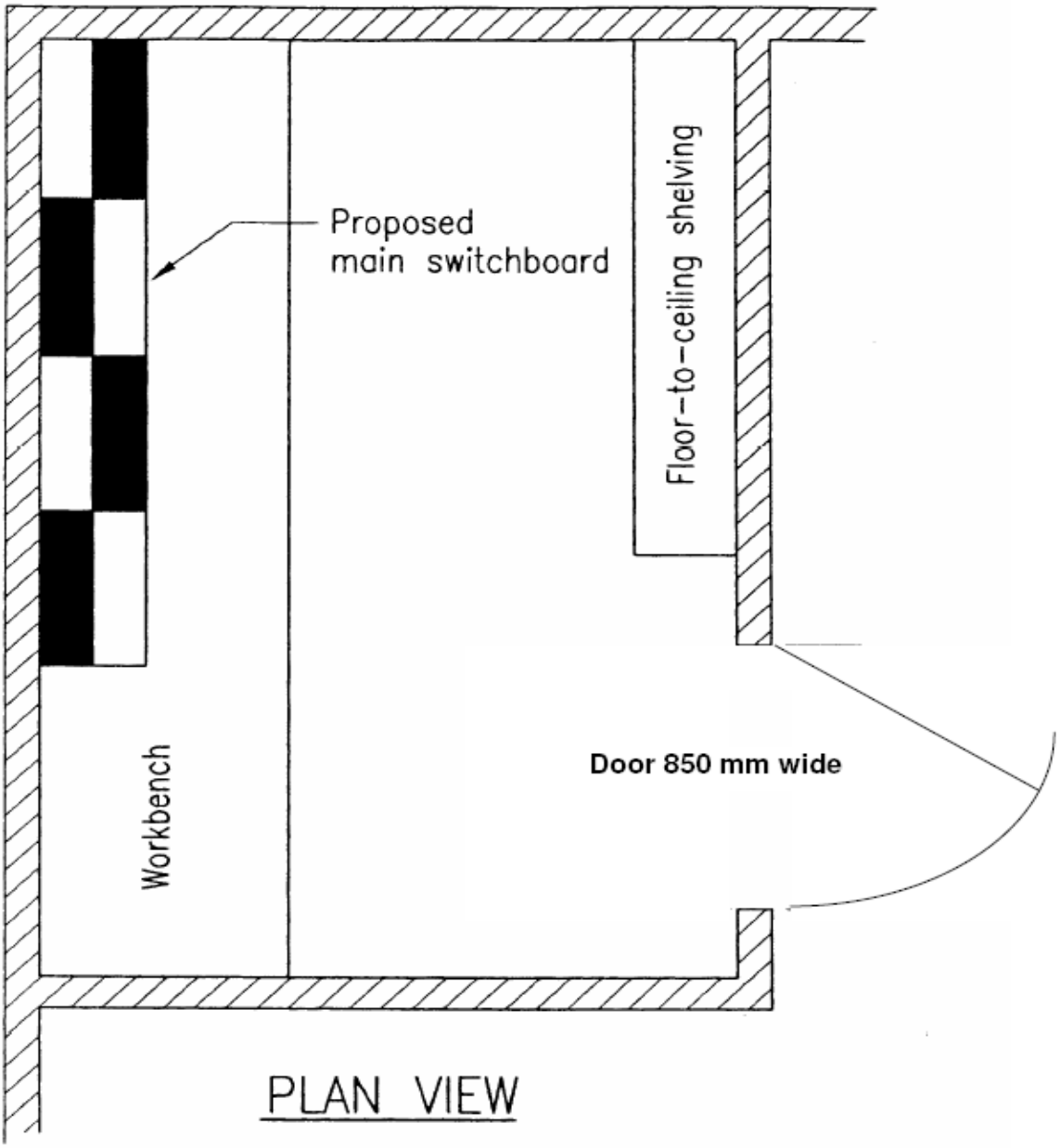
Ref: ……

Question 6
Refer to AS/NZS 3000 and state where fuses or circuit-breakers shall be connected for overcurrent protection in an extra-low voltage system that is earthed at the point of supply.

_____
_____

Ref: ……..

Question 7
A small storage cupboard in a commercial complex is to house a new main switchboard. The cupboard is located in the centre of the complex and the existing workbench and lockable door is to be retained. Below is the floor plan of the storage cupboard.



Question 7 continued
Refer to AS/NZS 3000 and answer the following:
(a) State the TWO requirements for installing a switchboard in a storage cupboard.

(1) _____
_____

(2) _____
_____

Ref: ……..

(b) The switchboard incorporates exposed live parts. State the TWO alternative requirements relating to exposed live parts.

(1) _____

---

(2) _____
_____

Ref: ……..

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

Ref: ……..

(d) State the permitted minimum dimensions of the doorway.
_____
_____
_____

Ref: ……..

Question 8
A three-phase motor is installed to operate a large saw-blade in a timber mill. The motor is manually controlled. Refer to AS/NZS 3000 and answer the following:
(a) State the FOUR requirements relating to devices for the isolation and switching of rotating machines (motors).

(1) _____
_____
_____

(2) _____
_____
_____

(3) _____
_____
_____

(4) _____
_____
_____

Ref: ……..

(b) Most motors require protection against overload. State the minimum motor rating where protection against overload must be provided.
_____
_____

Ref: ……..

(c) State ONE situation where over temperature protection must not be provided for a motor
_____
_____
_____

Ref: ……..

Question 9
Refer to AS/NZS 3000 and state the TWO situations where RCD protection is required in a domestic electrical installation
(1) _____
(2) _____

Ref: ……

Question 10
An electrician is installing the electrical installation in a high–rise apartment block. The installation consists of a main MEN switchboard and a switchboard in each apartment. Refer to AS/NZS 3000 and answer the following:
(a) State the TWO general requirements for the location of the main switchboard.
(1) _____
_____
(2) _____
_____

Ref: ……

(b) The main switchboard is to be located in a storage cupboard. State THREE requirements for locating the switchboard in such an area.
(1) _____
_____
(2) _____
_____
(3) _____
_____

Ref: ……

(c) State the minimum dimensions of the storage cupboard doorway that permits access to the switchboard.

_____
_____

Ref: ……

Question 11
(a) Refer to AS/NZS 3000 and state:
(i) TWO types of electrical installations in which some final subcircuits are required to be protected by an RCD.

(1) _____
(2) _____

Ref: ……

(ii) The TWO types of final subcircuits which are required to be protected by an RCD.

(1) _____
(2) _____

Ref: ……

(b) Briefly explain how a Residual Current Device (RCD) disconnects the supply from an electrical appliance when an earth fault occurs.

_____
_____
_____
_____
_____
_____
_____
_____
_____

Ref: ……

Question 12
Switchboards in an electrical installation shall —

- Be safe to use when properly assembled, installed and connected to supply;
- and Not cause a danger from electric shock, fire, high temperature or physical injury in the event of reasonably expected conditions of overload, abnormal operation, fault or external influences.

Refer to AS/NZS 3000 and answer the following:
(a) State the TWO types of switchboards that shall not be installed in the vicinity of an automatic fire sprinkler system.

(1) _____
_____
(2) _____
_____

Ref: ……

(b) State THREE requirements for the neutral bar or link in a switchboard.
(1) _____
_____
_____
(2) _____
_____
_____
(3) _____
_____
_____

Ref: ……

(c) A switchboard in an industrial electrical installation has exposed live parts. State the access requirements for this switchboard.
_____
_____
_____
_____

Ref: ……

5 –QUESTIONS on AS/NZS 3000 Section 3

Question 1
Refer to clause 3.9.7 of AS/NZS 3000 and state TWO situations where MIMS cables are to be protected by a suitable serving.
(1) _____
_____
(2) _____
_____

Ref: ……

Question 2
A 4 mm2 two core neutral-screened cable is to be installed between two buildings. The cable is to be buried direct (unenclosed) in the ground in an unpaved area. Refer to clause 3.11 of AS/NZS 3000 and state:
(a) The TWO requirements for indicating the position of the buried cable.
(1) _____
_____
(2) _____
_____

Ref: ……

(b) The minimum depth to which the cable must be buried.
_____

Ref: ……

(c) The requirements for bedding the cable in the ground.
_____
_____

Ref: ……

(d) ONE type of cable that, when buried, requires no additional protection.
_____

Ref: ……

Question 3
Refer to AS/NZS 3000 and answer the following:
(a) When using colour for the identification of fixed wiring conductors, what colours may be used to identify the phase conductor of a single-phase circuit?
_____

Ref: ……..

(b) What colours identify equipotential bonding conductors?
_____

Ref: ……..

(c) State FOUR aspects that need to be taken into account when making connections between conductors or between conductors and equipment

(1) _____
_____
(2) _____
_____

(3) _____
_____
(4) _____
_____

Ref: ……..

Question 4
(a) A 10 mm2 twin and earth PVC insulated cable is to be buried direct in the ground in a Category A system. Refer to AS/NZS 3000 and state the minimum depth it can be buried if:

(i) It has no further protection
_____

(ii) It is below 75 mm of continuous concrete
_____

Ref: ……..

Question 5
Refer to AS/NZS 3000 and answer the following:
(a) State the TWO requirements for terminating MIMS (mineral insulated metal sheathed) cables that are subject to vibration.
(1) _____
_____
(2) _____
_____

Ref: ……

(b) For Earth Sheath Return Systems (ESR) state:
(i) The minimum size conductor permitted.
_____

Ref: ……..

(ii) The situation where such a system cannot be used.
_____
_____

Ref: ……..

(iii) The system of earthing of the electrical installation where an ESR system is to be installed.

_____
_____

Ref: ……..

(iv) Where in an electrical installation must an ESR system commence.

_____
_____

Ref: ……..

Question 6

A PVC cable wiring system is to be installed in a concrete floor at a depth of 25 mm from the surface of the concrete. Refer to AS/NZS 3000 and state TWO acceptable protection methods that can be used for the cable.

(1)

_____
_____
_____

2)

_____
_____
_____

Ref: ……..

Question 7

Refer to AS/NZS 3000 and state TWO locations in which wiring systems are installed and where those wiring systems are deemed likely to be disturbed.

(1) _____
_____
_____

(2) _____
_____

Ref: ……..

Question 8

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

(1) _____
_____
_____

(2) _____
_____
_____

Ref: ……..

Question 9
You are wiring a new domestic residence.
Refer to AS/NZS 3000 and answer the following.
(a) Table 3.3 details the recommended minimum cable size for certain final sub-circuits. State the THREE factors that need to be taken into account if you want to reduce the size of a cable stated in that table.

(1) _____

(2) _____

(3) _____

Ref: ……..
(b) State the requirements for the minimum size of the neutral conductor in single-phase mains cables.
_____
_____
_____
_____

Ref: ……..

(c) State ONE requirement for installing conductors that are connected in parallel.
_____
_____

Ref: ……..
Question 10
It is proposed to install the fixed wiring in a fruit-packing plant. The wiring comprises both cables and flexible cords and will be installed in cable trunking and flexible and metallic steel conduit. Refer to AS/NZS 3000 and answer the following.
(a) State FOUR requirements relating to the installation of the cable trunking.

(1) _____
_____

(2) _____
_____

(3) _____
_____

(4) _____
_____

Ref: …….

(b) State the requirements for the changing of wiring enclosures.
_____
_____
_____

Ref: ……..

(c) State the TWO types of flexible cords that are required to be used as fixed wiring.
(1) _____
_____

(2) _____
_____

Ref: ……..

Question 11
The figure on the following page represents a cross-sectional view of a three-phase submain from a house to an adjacent workshop. The conductors are four separate stranded PVC insulated aluminium cables with a plastic sheath stamped 'underground'. The cables are buried direct in the ground beneath a concrete driveway using a category "B" system.
Refer to AS/NZS 3000 and answer the following:
(a) Sketch on the figure the minimum requirements for such underground wiring including:

- Identification requirements.
- Mechanical protection
- Depth
- Bedding requirements.

Show items with simple representations only, and include a brief description of each, with distances or depths marked.

Ref: ……..

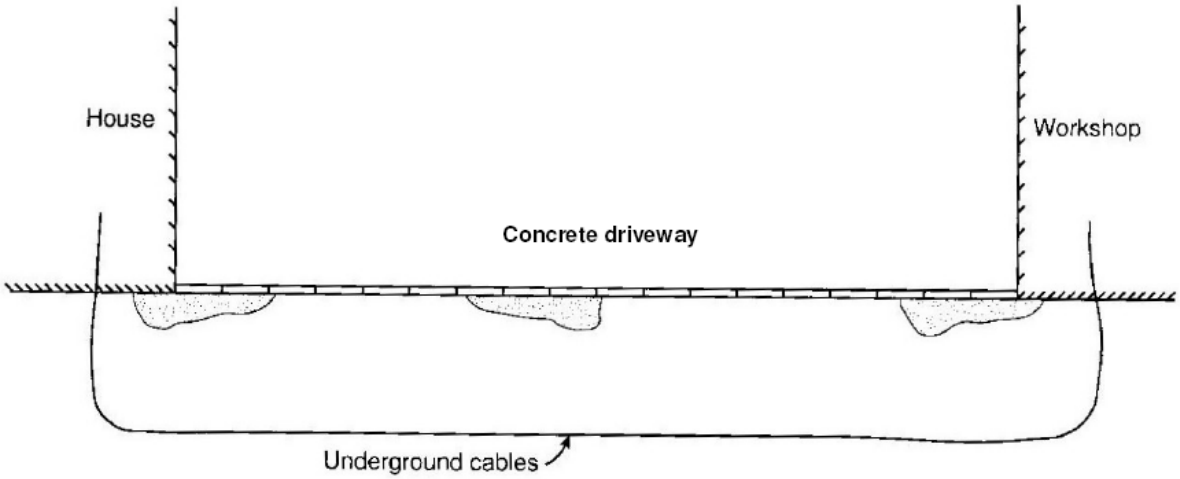
(b) State TWO requirements relating to the spacing between underground wiring systems and other underground wiring systems or services.

(1) _____
_____

(2) _____
_____

Ref: ……..

Question 11 Diagram



Question 12

Refer to AS/NZS 3000 and state TWO protection methods for the mechanical protection of wiring systems.

(1) _____

_____

(2) _____

_____

Ref: ……

Question 13

Refer to AS/NZS 3000 and state TWO situations where MIMS cables are to be protected by a suitable serving.

(1) _____

_____

(2) _____

_____

Ref: ……

Question14

Refer to AS/NZS 3000 and state the TWO types of cable that may be buried direct without requiring the additional mechanical protection of a category B system.

(1) _____

(2) _____

Ref: ……

6 –QUESTIONS on AS/NZS 3000 Section 5

Question 1
Refer to clause 5.3 of AS/NZS 3000 and state the minimum size of protective earthing conductor that would generally be required for a twin and earth 4 mm2 copper TPS cable

_____
_____
_____

Ref: ……

Question 2
Refer to clause 5.3 of AS/NZS 3000 and state the restriction placed on the use of the screen of a neutral screened cable.

_____
_____
_____
_____

Ref: ……

Question 3
Refer to AS/NZS 3000 and state the minimum permissible size for the following in a low voltage electrical installation.

(a) Main earthing conductor

_____
_____

Ref: ……..

(b) An equipotential bonding conductor for metal water pipes

_____
_____

Ref: ……..

Question 4
One end of a main earthing conductor must be connected to the main earthing terminal in the main switchboard. Refer to AS/NZS 3000 and state ONE point where the other end of the main earthing conductor can be connected.

_____
_____
_____
_____

Ref: ……..

Question 5
Refer to AS/NZS 3000 and state the situation where metallic piping systems (e.g., gas or hot water pipes) need to be connected to an equipotential bonding conductor.

_____
_____

Ref: ……..

Question 6
AS/NZS 3000 requires that the selection and installation of the general earthing requirements shall ensure THREE operational results. State these operational results.
(1) _____
_____
_____
_____
_____
_____
(2) _____
_____
_____
_____
_____
_____
(3) _____
_____
_____
_____
_____
_____

Ref: ……

Question 7
Refer to AS/NZS 3000 and state the minimum size of protective earthing conductor that would generally be required for a twin and earth 4 mm2 copper TPS cable

_____
_____

Ref: ……..

Question 8
Refer to AS/NZS 3000 and state TWO types of metallic non-electrical service pipes that shall not be used as a protective earthing conductor.
(1) _____ _
_____

(2) _____
_____

Ref: ……..

Question 9
Refer to AS/NZS 3000 and state TWO types of earthing conductor that are not required to be insulated.

(1) _____
_____

(2) _____
_____

Ref: ……

Question 10
Refer to AS/NZS 3000 and answer the following:
(a) State TWO types of equipment which are required to be equipotentially bonded in a pool area.

(1) _____
_____
_____
_____

(2) _____
_____
_____
_____

Ref: ……

(b) What are the earthing requirements for an underwater luminaire in a pool?
_____
_____
_____

Ref: ……

(c) State the minimum degree of protection required for electrical equipment installed in Zone 0, Zone 1 and Zone 2 of a pool.
Zone 0 _____
Zone 1 _____
Zone 2 _____

Ref: ……

7 –QUESTIONS on AS/NZS 3000 Section 6

Question 1
Refer to AS/NZS 3000 and answer the following:
(a) State TWO types of equipment which are required to be equipotentially bonded in a pool area.
(1) _____
_____
_____
(2) _____
_____
_____
Ref: ……
(b) What are the earthing requirements for an underwater luminaire in a pool?
_____
_____

Ref: ……

(c) State the minimum degree of protection required for electrical equipment installed in Zone 0, Zone 1 and Zone 2 of a pool.

Zone 0 _____

Zone 1 _____

Zone 2 _____

Ref: ……

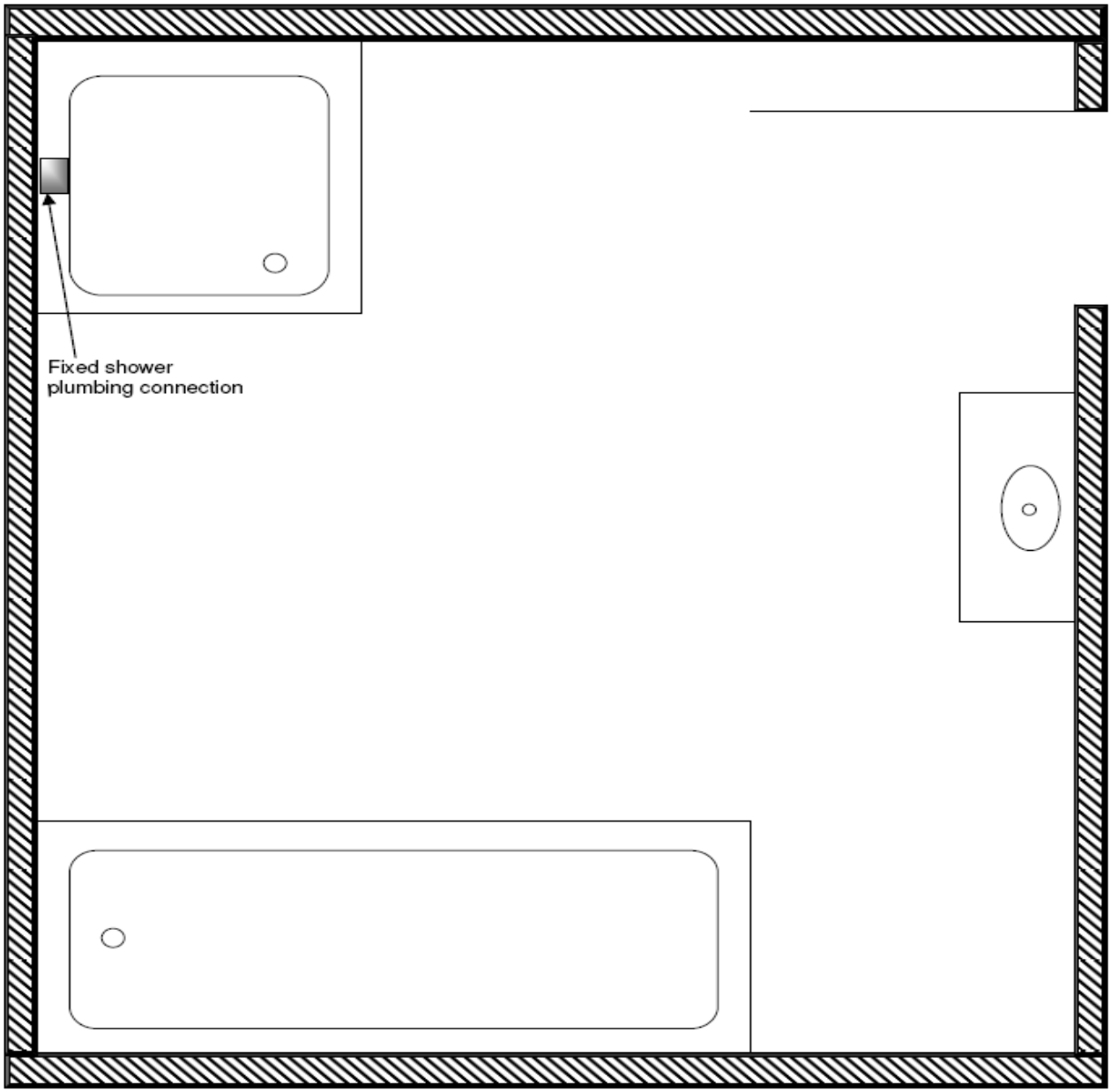
Question 2
The figure on the following page shows a plan bathroom layout that includes a bath, shower (without a fixed partition) and hand basin. Refer to AS/NZS 3000 and:
(a) Draw and label on the figure, the lines and dimensions (where applicable) of Zones 0, 1, 2 and 3 for the shower
Ref: ……..

(b) State the requirements for installing electrical equipment with an IPX7 degree of protection in Zone 0 for the bath.

_____
_____
_____
_____
_____
_____
_____
_____

Ref: ……..

Question 2 continued



Question 3
Refer to AS/NZS 3000 and state the TWO measures against electrical shock that are not permitted to be used in a bathroom
(1) _____
_____

(2) _____
_____

Ref: ……

Question 4
A new rectangular bath has been installed in the corner of a square bathroom. The customer now requires the electrician to install the following:

- 1 x 230 V heated towel rail with adjacent control switch
- 1 x 230 V socket outlet (not incorporated in a shaver unit)
- 1 x Flush wall switch with no IP rating that controls a ceiling light

Refer to clause 6.2 of AS/NZS 3000 and answer the following:
(a) The heated towel rail and adjacent control switch, both with the required degree of protection, can be installed in Zone 2. State:

(i) The minimum IP rating of the heated towel rail.
_____
_____

(i) The minimum IP rating of the control switch.
_____
_____

Ref: ……
(b) State the TWO requirements for installing the socket outlet in Zone 2.

(1) _____
_____
_____
_____

(2) _____
_____
_____
_____

Ref: ……

(c) (i) In which zone is it permissible to install the flush wall switch.
_____
_____
_____

(ii) What is the minimum height from the floor that the switch can be installed?
_____
_____

Ref: ……

Question 5
Refer to AS/NZS 3000 and state TWO requirements for the segregation of fire and smoke control wiring installed in the same enclosure as other wiring.

(1) _____
_____
_____
_____

(2) _____
_____
_____
_____

Ref: ……

Question 6

(b) An electrician is carrying out the installation of a swimming pool that includes:

- A bare overhead low voltage sub-main, passing over the swimming pool, to a shed.
- Luminaires located inside the pool with reference to clause 6.3 of AS/NZS 3000:
-

(i) What restriction is placed on the location of the bare overhead low voltage sub-main?

_____
_____
_____

Ref: ……

(ii) State THREE requirements for the installation of the luminaries.
(1) _____
_____
(2) _____
_____
(3) _____
_____

Ref: ……

8 –QUESTIONS on AS/NZS 3000 Section 7

Question 1
(a) Refer to clause 7.5 of AS/NZS 3000 and state the TWO types of systems permitted for an extra-low voltage installation.

(1) _____
(2) _____

Ref: ……

(b)Refer to clause 7.7 of AS/NZ 3000 and state TWO types of recognised hazardous areas.
(1) _____
_____

(2) _____
_____

Ref: ……

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

Ref: ……..

Question 2
SELV circuits are required to be arranged in a certain manner. State TWO parts of an electrical installation that SELV circuits must not be connected to.
(1) _____
_____
(2) _____
_____

Ref: ……..

Question 3
Refer to AS/NZS 3000 and state TWO requirements for plugs and socket outlets in extra-low voltage electrical installations.

(1) _____
_____

(2) _____
_____

Ref: ……

Question 4
Refer to AS/NZS 3000 and state the requirement for a switch, other than a main switch, in an extra-low voltage system that is not earthed at the point of supply.

_____
_____
_____
_____

Ref: ……..

Question 5
Refer to AS/NZS 3000 and state:
(a) State TWO methods of identifying main switches controlling fire and smoke control equipment, evacuation equipment and lifts.
(1) _____
_____
_____

(2) _____
_____
_____

Ref: ……..

(b) The TWO items that are deemed to be included within evacuation equipment.

(1) _____
_____

(2) _____
_____

Ref: ……..

(c) The TWO general connection arrangements for main switches supplying fire and smoke control equipment, evacuation equipment and lifts

(1) _____
_____
_____

(2) _____
_____
_____

Ref: ……..

Question 6
An automatically controlled fire pump motor supplies a sprinkler system. Refer to AS/NZS 3000 and state TWO requirements for the isolating switch controlling the motor.

(1) _____
_____

(2) _____
_____

Ref: ……

Question 7
Refer to AS/NZS 3000 and answer the following:
Extra-low voltage electrical installations have particular requirements.
(a) State the TWO types of systems that are permitted in the installation.
(1) _____
(2) _____
Ref: ……

(b) State the TWO situations where it is permissible for the voltage drop of an extra-low voltage installation to exceed 10% of the nominal value.

(1) _____
_____
_____

(2) _____
_____
_____
_____

Ref: ……

(c) State the THREE requirements for plugs and socket outlets used in SELV or PELV systems.
(1) _____
_____
(2) _____
_____
(3) _____
_____

Ref: ……

9 –QUESTIONS on AS/NZS 3000 Section 8

Question 1
Refer to AS/NZS 3000 and state TWO general aspects that must be visually inspected when testing an electrical installation.

(1) _____
_____

(2) _____
_____

Ref: ……

Question 2
Refer to AS/NZS 3000 and state:
_ THREE mandatory checks, using test instruments that are required for the testing of a low voltage electrical installation
_ ONE reason for carrying out each of the tests

Test _____
_____

Reason _____
_____
_____
_____
_____
_____
_____
_____
_____

Ref: ……

Test _____
_____

Reason _____
_____
_____
_____
_____
_____
_____
_____
_____

Ref: ……

Test _____
_____

Reason _____

Ref: ……

Question 3

You have completed installing a new, three-phase, 230/400V food processing plant that includes a 4.5 kW water heating cylinder and two 4 kW ranges. All visual inspections and tests and checking you have carried out comply with the requirements of AS/NZS 3000. You have issued a Certificate of Compliance for the installation that verifies that the installation is electrically safe. The insulation resistance test result you obtained for the whole installation was 600,000Ω.. Describe how you carried out the insulation resistance testing to ensure that the electrical installation met the requirements of AS/NZS 3000.

Ref: ……

Question 4
Refer to AS/NZS 3000 and state the reason why care must be taken when testing the insulation resistance of surge protection devices and electronic equipment.

_____
_____
_____
_____

Ref: ……

Question 5
Refer to AS/NZS 3000 and state:
(a) The minimum acceptable value for an insulation resistance test of a 4 core neutral screened cable operating at 400 volts.

_____
_____

Ref: ……

(b) The specified test voltage when carrying out an insulation resistance test of a 4 core neutral screened cable operating at 400 volts.

_____
_____

Ref: ……

Question 6
Refer to AS/NZS 3000 and state the maximum earth fault loop impedance for a circuit protected by a Type D, 20 amps MCB (in order that a 0.4 second disconnection time will be achieved in the event of a fault in a 230 volt circuit).

_____
_____

Ref: ……

Question 7
A fixed-wired small printing press, driven by a three-phase electric motor is supplied by PVC cables enclosed in a flexible steel conduit. It has been operating safely for some months, but the operator has now reported the MCB protection occasionally tripping. When reset, the MCB functions for a short period. You have been required to find the problem and have safety tagged the circuit and confirmed by testing, that the supply is isolated. You intend to carry out a protective earthing conductor (earth continuity) test and an insulation resistance test.
(a) Refer to ASNZS 3000 and state ONE reason why you will carry out an earthing conductor (earth continuity) test.

_____
_____
_____
_____
_____
_____
_____
_____

Ref: ……

(b) Refer to ASNZS 3000 and state ONE reason why you will carry out an insulation resistance test

_____
_____
_____
_____

Ref: ……

(c) Briefly describe how you will carry out the protective earthing (earth continuity) test. Include the minimum acceptable resistance value for the protective earthing conductor.

_____
_____
_____
_____
_____
_____

10 –Maximum Demand

AS/NZS 3000 2.2.2 Maximum demand:

The maximum demand in consumers mains, submains and final subcircuits, taking account of the physical distribution and intended usage of electrical equipment in the electrical installation and the manner in which the present requirements might vary, shall be determined using one of the methods set out in Items (a) to (d). If the actual measured maximum demand is found to exceed that obtained by calculation or assessment, the measured value shall be deemed to be the maximum demand.

NOTE: Guidance on the determination of maximum demand is provided for basic electrical installations in Appendix C.

(a) Calculation The maximum demand may be calculated in accordance with the guidance given in Appendix C for the appropriate type of electrical installation and electrical equipment supplied. It is recognized that there may be considerable differences in loading from one electrical installation to another. Alternative methods of calculating the maximum demand may be used taking account of all the relevant information available for any particular electrical installation.

(b) Assessment The maximum demand may be assessed where—

(i) the electrical equipment operates under conditions of fluctuating or intermittent loading, or a definite duty cycle; or
(ii) the electrical installation is large and complex; or (iii) special types of occupancy exist.

(c) Measurement The maximum demand may be determined by the highest rate of consumption of electricity recorded or sustained over any 15 min period or periods when demand is at its highest by a maximum demand indicator or recorder.

(d) Limitation The maximum demand may be determined by the current rating of a fixed setting circuit-breaker, or by the load setting of an adjustable circuit-breaker.

The maximum demand of consumers mains and submains may be determined by the sum of the current settings of the circuit-breakers protecting the associated final subcircuit/s and any further submain/s.

Question 1

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

Number	Rating	Equipment
30	100W	Lighting points
10	75W	Outdoor lighting – discharge lamps
1	6kW	Electric range
18	10A	Double socket outlets
10	10A	Single socket outlets
1	3KW	Water storage heater
1	6kW	Sauna

Use the grid on the following page to perform the calculations.

Equipment	Load Group	Calculation	Load in amps

Ref: .....

Question 2
A 230V domestic installation is being supplied from a 230V, single-phase supply. Refer to AS/NZS 3000 and determine the maximum demand in amps of the installation The installation has the following loads:
All lighting is to be assessed on a connected load basis.

Number	Rating	Equipment
14	100W each	Incandescent lights
4	0.3A each	Fluorescent lights
1	6 metres	Lighting track
1	3kW total	Outside lights
20	10A each	Single socket outlets
1	10A	Socket outlet supplying controls for a gas water heater
2	15A each	Socket outlets
1	8kW total	Electric range
1	6kW input	Air conditioner

Use the table on the following page to do the calculations

Equipment	Load Group	Calculation	Load in amps

Ref: .....

Question 3

Refer to AS/NZS 3000 and calculate the maximum demand in amps of a 230V domestic installation with the following loads:
Lighting is to be calculated on a points basis.

Equipment	Load Group	Calculation	Load (Amps)
25 - lighting points			
10 metres of lighting track			
10 – 150W outside lights			
18 - double socket outlets (10 A)			
10 - single socket outlets (10 A)			
1 - 3 kW controlled water heater			
1 - electric range (6 kW)			
2 – 15A space heaters			
1 – 4 kW air conditioner unit			
Total Maximum Demand			

Ref: .....

Question 4
A 400V, three-phase low rise development contains 12, 230v domestic electrical installations. The development has 4 units per phase. Refer to AS/NZS 3000 and determine the maximum demand in amperes of ONE domestic electrical installation.

Each electrical installation has the following loads:

32	Lighting points	1	Electric oven – 2.5 kW
4	Double socket outlets (10A)	1	Storage water heater – 2kW
10	Single socket outlets (10A)	1	Air-conditioning unit – 4kW Input

Equipment	Load Group	Calculation	Load (Amps)
32 - lighting points			
4 – 10A double socket outlets			
10 – 10A single socket outlets			
1 – 2.5 kW electric oven			
1 – 2 kW storage water heater			
1 – 4 kW air conditioner unit			
Total Maximum Demand			

Ref: .....

Question 5
Refer to AS/NZS 3000 and determine the maximum demand in amps of a 230 volt domestic installation with the following loads:

37	lighting points	1	12 kW electric range

6	Metres of lighting track	1	Gas water heater with controllers supplied from a 10A socket outlet
	3kW outside lighting	15	10A double socket outlets
1	6kW air conditioner	10	10A single socket outlets

Note: All lighting is to be calculated on a points basis

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

U

Ref: .....

Question 6

You are wiring a new three-phase, 400 V, factory and need to determine the load of the highest loaded phase of the installation so the correct size of the mains can be found. Assume all motors, lighting, and loads in the socket outlets to have a unity power factor.

The loads are to be balanced across the three phases wherever possible. Refer to AS/NZS 3000 and calculate the load in amps on each phase (red, white and blue) to determine the highest loaded phase of the installation.
Use the table on the following page for your calculations.

Single-phase

Number	Equipment
12	38W Fluorescent lights
30	75W Fluorescent lights
18	10A socket outlets
9	15A Socket outlets
1	5kW water heater

3- Phase

Number	Equipment
2	9kW motors (15.8A per phase nameplate rating)
2	5kW chiller motors (7.25A per phase nameplate rating)

(a) Calculations

Load Group	Calculation	Load on each phase (amps)		
		R	W	B
Group				
Group				
Group				
Group				
				-
Total				

(b) Load on highest loaded phase =

Ref: .....

11 –Cable Selection

AS/NZS 3000 3.1.2 Selection and installation

Wiring systems shall be selected and installed to perform the following functions associated with the safe design and construction and proper operation of the electrical installation:

(a) Protect against physical contact with live parts by durable insulation materials or by placing live parts out of reach.

(b) Satisfy current-carrying capacity, voltage drop and other minimum size requirements for conductors.

(c) Provide reliability and electrical continuity of connections, joints and terminations.

(d) Provide adequate strength of supports, suspensions and fixings.

(e) Suit intended use, including applications requiring a particular type of wiring system, e.g. fire-resistance, explosion protection, safety services.

(f) Protect against mechanical damage, environmental and other external influences by enclosure or other means.

AS/NZS 3008.1.2 TABLE SET 1

The following are extracts from AS/NZS 3008.1.2.

TABLE 10

CURRENT-CARRYING CAPACITIES

CABLE TYPE: **TWO-CORE SHEATHED**
Cable with or without earth core, armoured or unarmoured, including neutral screened cables

INSULATION TYPE **THERMOSPLASTIC**

MAXIMUN CONDUCTOR TEMPERATURE **75^{0}C**

REFERENCE AMBIENT TEMPERATURE **30^{0}c IN AIR, 15^{0}C IN GROUND**

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current carrying capacity A											
	Unenclosed									Enclosed		
	Spaced			Touching			Exposed to sun			Wiring enclosure in air		
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm^2	Solid/stranded	Flexible		Solid/stranded	Flexible		Solid/stranded	Flexible		Solid/stranded	Flexible	
1	17	18	-	16	17	-	13	14	-	15	15	-
1.5	22	23	-	21	21	-	16	16	-	18	19	-
2.5	31	30	-	30	29	-	23	22	-	26	26	-
4	42	40	-	39	38	-	31	30	-	34	33	-
6	52	51	-	50	48	-	39	36	-	44	43	-
10	73	72	-	68	67	-	52	51	-	59	58	-
16	97	95	75	91	89	71	68	67	54	78	78	59
25	129	125	100	122	119	95	90	88	71	103	99	80
35	158	156	123	149	146	115	111	107	86	128	124	99
50	194	195	150	181	184	141	132	133	103	152	153	117
70	245	245	190	229	230	178	165	165	128	194	193	150
95	302	293	234	283	275	219	200	194	155	233	226	180
120	350	347	272	328	325	255	230	227	179	275	269	213
150	400	397	310	374	372	291	259	257	202	309	304	239
185	459	450	358	430	422	335	294	287	229	357	348	278
240	544	536	425	508	500	398	342	335	268	415	420	325
300	624	612	489	583	572	457	386	377	303	483	473	380
400	719	725	570	671	676	532	438	438	348	549	570	437
500	816	830	656	762	773	611	489	491	393	640	643	514

TABLE 10 CONTINUED

CURRENT-CARRYING CAPACITIES

CABLE TYPE: **TWO-CORE SHEATHED**
Cable with or without earth core, armoured or unarmoured, including neutral screened cables

INSULATION TYPE **THERMOSPLASTIC**

MAXIMUN CONDUCTOR TEMPERATURE **75°C**

REFERENCE AMBIENT TEMPERATURE **30°c IN AIR, 15°C IN GROUND**

14	15	16	17	18	19	20	21	22	23	24	25	26	27
Conductor size	Current carrying capacity A												
	Thermal insulation								Buried direct		Underground wiring enclosure		
	Partially surrounded by thermal insulation, unenclosed		Partially surrounded by thermal insulation, in a wiring enclosure		Completely surrounded by thermal insulation, unenclosed		Completely surrounded by thermal insulation, in a wiring enclosure						
mm^2	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu		Al
											Solid/stranded	Flexible	
1	13	-	11	-	8	-	7	-	19	-	19	20	-
1.5	61	-	15	-	10	-	9	-	23	-	23	24	-
2.5	23	-	22	-	15	-	14	-	33	-	33	32	-
4	31	-	27	-	19	-	17	-	43	-	43	42	-
6	40	-	35	-	25	-	23	-	55	-	55	53	-
10	55	-	48	-	34	-	30	-	73	-	73	72	-
16	73	56	62	48	46	35	39	30	125	97	95	94	73
25	97	75	82	64	60	47	51	40	162	125	123	119	96
35	120	92	103	80	74	58	64	49	196	152	150	146	117
50	145	113	122	95	-	-	-	-	232	179	178	179	139
70	184	143	155	120	-	-	-	-	285	221	222	222	173
95	226	176	186	145	-	-	-	-	342	265	267	260	208
120	262	204	219	171	-	-	-	-	391	304	310	305	242
150	300	233	247	192	-	-	-	-	438	340	349	344	271
185	344	268	285	222	-	-	-	-	494	385	399	388	311
240	407	318	332	260	-	-	-	-	572	447	463	461	362
300	466	366	388	303	-	-	-	-	645	506	531	519	417
400	537	425	440	349	-	-	-	-	729	579	603	616	477
500	609	489	512	410	-	-	-	-	815	655	691	692	554

TABLE 13

CURRENT-CARRYING CAPACITIES

CABLE TYPE: **THREE-CORE AND FOUR-CORE**
Cable with or without earth core, armoured or unarmoured, including neutral screened cables

INSULATION TYPE **THERMOSPLASTIC**

MAXIMUN CONDUCTOR TEMPERATURE **75°C**

REFERENCE AMBIENT TEMPERATURE **30°c IN AIR, 15°C IN GROUND**

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current carrying capacity A											
	Unenclosed									Enclosed		
	Spaced			Touching			Exposed to sun			Wiring enclosure in air		
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm^2	Solid/stranded	Flexible		Solid/stranded	Flexible		Solid/stranded	Flexible		Solid/stranded	Flexible	
1	15	15	-	14	15	-	10	11	-	13	13	-
1.5	18	19	-	17	18	-	14	14	-	16	16	-
2.5	26	25	-	25	24	-	19	18	-	23	22	-
4	35	34	-	33	32	-	26	25	-	29	27	-
6	46	43	-	42	41	-	33	32	-	38	36	-
10	62	62	-	58	58	-	44	43	-	50	49	-
16	82	81	64	78	76	60	58	57	46	66	65	51
25	111	107	86	104	101	81	76	74	59	87	83	67
35	137	133	106	128	125	99	93	91	73	107	105	83
50	166	169	129	156	157	121	113	114	88	128	128	99
70	211	211	163	196	197	153	140	140	109	162	162	127
95	260	253	202	243	236	188	171	165	132	202	196	156
120	302	299	235	282	278	219	196	193	153	230	227	179
150	345	343	268	321	319	250	221	219	172	260	261	202
185	397	390	310	369	363	288	251	245	196	300	293	235
240	470	464	368	437	431	343	292	286	228	360	352	283
300	538	529	424	499	490	393	328	321	259	-	-	-
400	620	626	495	575	579	458	372	372	296	-	-	-
500	702	715	568	651	661	526	414	416	335	-	-	-

TABLE 13 CONTINUED

CURRENT-CARRYING CAPACITIES

CABLE TYPE: **THREE-CORE AND FOUR-CORE**
Cable with or without earth core, armoured or unarmoured, including neutral screened cables

INSULATION TYPE **THERMOSPLASTIC**

MAXIMUN CONDUCTOR TEMPERATURE **75°C**

REFERENCE AMBIENT TEMPERATURE **30°c IN AIR, 15°C IN GROUND**

14	15	16	17	18	19	20	21	22	23	24	25	26	27
Conductor size	Current carrying capacity A												
	Thermal insulation								Buried direct		Underground wiring enclosure		
	Partially surrounded by thermal insulation, unenclosed		Partially surrounded by thermal insulation, in a wiring enclosure		Completely surrounded by thermal insulation, unenclosed		Completely surrounded by thermal insulation, in a wiring enclosure						
mm^2	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu		Al
											Solid/stranded	Flexible	
1	10	-	10	-	7	-	6	-	15	-	15	17	-
1.5	14	-	13	-	9	-	8	-	20	-	20	20	-
2.5	18	-	18	-	13-	-	11	-	28	-	28	26	-
4	26	-	23	-	17	-	15	-	36	-	36	35	-
6	34	-	30	-	22	-	18	-	46	-	46	44	-
10	47	-	40	-	29	-	25	-	61	-	61	59	-
16	62	48	54	41	39	30	33	26	106	83	80	78	62
25	83	65	68	54	52	40	43	33	138	107	103	100	80
35	103	79	86	66	64	49	54	41	165	129	125	123	98
50	124	97	101	79	-	-	-	-	196	152	150	151	116
70	157	122	130	100	-	-	-	-	241	187	187	186	145
95	194	150	162	125	-	-	-	-	289	224	229	221	177
120	226	176	185	144	-	-	-	-	330	256	261	255	202
150	258	200	207	162	-	-	-	-	370	287	293	292	228
185	295	231	241	188	-	-	-	-	417	326	334	326	261
240	350	274	288	226	-	-	-	-	482	378	395	386	309
300	-	-	-	-	-	-	-	-	542	427	444	433	350
400	-	-	-	-	-	-	-	-	613	488	515	514	411
500	-	-	-	-	-	-	-	-	682	551	574	575	464

Table 27(1)

VARIANCE: AIR AND CONCRETE SLAB AMBIENT TEMPERATURES

INSTALLATION CONDITIONS CABLES IN AIR OR HEATED CONCRETE SLAB

1	2	3	4	5	6	7	8	9	10	11
Conductor temperature °C	Rating Factor									
	Air and concrete slab ambient temperature									
	15	20	25	30	35	40	45	50	55	60
150	1.07	1.05	1.03	1.00	0.98	0.96	0.94	0.91	0.89	0.87
110	1.08	1.06	1.03	1.00	0.97	0.93	0.90	0.87	0.83	0.79
90	1.15	1.09	1.05	1.00	0.95	0.91	0.85	0.80	0.74	0.66
80	1.17	1.12	1.06	1.00	0.95	0.89	0.82	0.75	0.68	0.59
75	1.18	1.12	1.06	1.00	0.94	0.88	0.80	0.72	0.63	0.53

Table 27(2)

VARIANCE: SOIL AMBIENT TEMPERATURES

INSTALLATION CONDITIONS CABLES BURIED DIRECT IN GROUND OR IN UNDERGROUND WIRING ENCLOSURES

1	2	3	4	5	6	7	8
Conductor temperature °C	Rating Factor						
	Soil 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 (V_c) at 50 Hz

CABLE TYPE: MULTICORE WITH CIRCULAR COPPER CONDUCTORS

Conductor size mm²	Three-phase voltage drop (V_c) 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	-
50	0.751	-	0.790	-	0.829	-	0.868	-	0.920	-
70	0.530	-	0.556	-	0.583	-	0.609	-	0.645	-
95	0.394	-	0.413	-	0.431	-	0.450	-	0.475	-
120	0.323	-	0.337	-	0.351	-	0.366	-	0.385	-
150	0.274	-	0.285	-	0.296	-	0.307	-	0.322	-
185	0.234	-	0.242	-	0.251	-	0.259	-	0.271	-
240	0.198	0.198	0.204	0.204	0.210	0.210	0.216	0.216	0.224	-
300	0.178	0.175	0.182	0.180	0.186	0.185	0.190	0.189	0.196	0.196
400	0.162	0.157	0.165	0.160	0.168	0.164	0.171	0.167	0.175	0.172
500	0.152	0.143	0.154	0.146	0.156	0.148	0.158	0.151	0.160	0.155

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

Table 45

THREE-PHASE VOLTAGE DROP (V_c) at 50 Hz

CABLE TYPE: MULTICORE WITH CIRCULAR ALUMINIUM CONDUCTORS

Conductor size mm²	Three-phase voltage drop (V_c) 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.
16	3.64	-	3.84	-	4.04	-	4.11	-	4.24	-
25	2.29	-	2.42	-	2.54	-	2.59	-	2.67	-
35	1.66	-	1.75	-	1.84	-	1.87	-	1.93	-
50	1.23	-	1.30	-	1.36	-	1.39	-	1.43	-
70	0.856	-	0.902	-	0.948	-	0.966	-	0.993	-
95	0.626	-	0.659	-	0.691	-	0.706	-	0.723	-
120	0.501	-	0.527	-	0.552	-	0.565	-	0.577	-
150	0.416	-	0.436	-	0.457	-	0.468	-	0.476	-
185	0.341	-	0.357	-	0.373	-	-	-	0.388	-
240	0.274	-	0.285	-	0.297	-	-	-	0.307	-
300	0.233	-	0.242	-	0.251	-	-	-	0.258	-
400	0.200	0.200	0.206	0.206	0.212	-	-	-	0.216	-
500	0.178	0.176	0.182	0.181	0.186	0.185	-	-	0.189	0.189

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

Question 1

Introduction

You have been asked to install a 4-core neutral screened copper cable from a three-phase 400V, three-phase distribution panel to a three-phase, 400V service centre building in a ski-field. The installation requirements are:

The cable route length is 45 m. The service centre building load is 68kW
The allowance for load increase is 10%
The cable will be buried direct.
The ambient soil temperature is 10°C.
The voltage drop between distribution panel and the service centre switchboard must not exceed 2.5%.
The conductor temperature is assumed to be 75°C

Use the information in the introduction to this question and information from **AS/NZS 3008.1.2 Table Set 1** to answer the following.

(a) Calculate the minimum size cable that will meet the loading requirements.

(b) Calculate the minimum size cable that will meet the voltage drop requirements.

(c) State the minimum size 4-core neutral screened copper cable that will meet the load and voltage drop requirements.

Question 2

Introduction

A 400V, three-phase low rise development contains 12, 230v domestic electrical installations. The development has 4 units per phase and each unit draws the same current. Calculate the size of the cable required based on the following information and the information contained in **AS/NZS 3008.1.2 Table Set 1:**

The rating of ONE unit is 55.04A There are 4 units per phase. The cable will be direct buried. The Load is based on the Max Demand calculation in question 4. The ambient soil temp is 20° C The conductor temp to be 75° C

Note: Voltage drop is not an issue as it is a short length of cable run.

Question 3

Introduction
You have been requested to install a 400V, three-phase stranded copper mains cable to a commercial complex. The best solution that meets the technical requirements must be provided. The stated conditions are:

The cable route length is 70 metres between the point of supply and the main switchboard 40 metres of the cable will be buried direct, the balance will be installed through a building (touching)
The load is 85 amps per phase
The voltage at the switchboard is 400V
The maximum permitted voltage drop is
1.5% An allowance of 20% for load
growth
The ambient soil temperature is
20° C The ambient air temperature
is 35° C
The maximum conductor temperature is 75°C

(a) Use the information in the introduction and information from **AS/NZS 3008.1.2 Table Set 1** and determine by calculation, the minimum size cable that will satisfy the load requirements.

(b) Use the information in the introduction and information from the tables and determine by calculation, the **minimum** size cable that will satisfy the **voltage drop** requirements.

(c) State the minimum size cable that meets both the load and voltage drop requirements.

Question 4

Introduction
A three-phase, 400V, copper, mains cable is being installed to a large new farm complex electrical installation comprising 3 large houses, a large milking shed and associated out-buildings. The customer is to be provided with the best solution that meets the technical requirements.

(a) Calculate and state the minimum size cable that will satisfy the **load requirements** of the installation.
Use the following information and information from **AS/NZS 3008.1.2 Table Set 1** for the calculations.

The route length between the point of supply and the main switchboard is 60 metres The cable will be buried direct
The load is 60kW balanced over the three phases The maximum permitted voltage drop is 1.5%
An allowance of 20% for load growth The ambient **soil** temperature is 10°C The conductor temperature to be 75° C

(b) Calculate and state the minimum size cable that will satisfy the **voltage drop** requirements of the installation

(c) State the minimum size cable that meets **both** the load and voltage drop requirements

Question 5

Introduction
A 230V final subcircuit originating at a factory switchboard supplies two socket outlets.
30 metres of 4mm2 twin and earth TPS cable from the switchboard supplies the first socket outlet.
10 metres of 2.5mm2 twin and earth TPS cable from the first socket outlet supplies the second socket outlet.
Each socket outlet supplies a 1kW load. The TPS cable is clipped touching.
The mV/A.m for the 4mm2 twin and earth TPS cable is 11.2151
The mV/A.m for the 2.5mm2 twin and earth TPS cable is 18.018
The maximum voltage drop permitted is 2.5%.

(a) Calculate maximum current in **each section** of the final sub-circuit

(b) Determine by calculation whether the maximum voltage drop of the final sub-circuit meets the voltage drop requirements.

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															
	Unenclosed				Enclosed								Buried Direct		Underground non-metallic wiring enclosure	
Conductor size	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^{0}C ambient air temperature and 15^{0}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 ^{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

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

Question 6

Introduction
A three-phase 400V oven is to be installed in a restaurant. The electrician has calculated in accordance with Part 2 of AS/NZS 3000, that the minimum size cable that will meet all requirements is a 4mm2, 4 core, TPS copper cable. You have to confirm - or otherwise - using calculations that the 4 mm2, 4 core TPS copper cable is the minimum size cable that meets the load and voltage drop requirements.
(a) Calculate whether the 4mm2, 4 core, TPS copper cable meets the load requirements by using the information below and relevant information from **AS/NZS 3008.1.2 Table Set 2**
The cable route length is 20 metres in length. The load is 25 kW The cable is fixed directly (touching). The ambient air temperature is 20°C. The voltage at the switchboard is 400 V. The permitted voltage drop from the switchboard to the oven must not exceed 1.5% The conductor temperature is assumed to be 75°C

(b) Calculate whether the 4mm2, 4 core, TPS copper cable meets the **voltage drop requirements** by using relevant information from **AS/NZS 3008.1.2 Table Set 2**

(c) Is the 4mm2, 4 core, TPS copper cable the minimum size cable that meets the load and voltage drop requirements? State a reason to support your answer.

Question 7

Introduction
You have been asked to install a 4-core neutral screened copper cable from a three-phase 400V, three-phase distribution panel to a three-phase, 400V service centre building in a ski-field. You need to find, by calculation the minimum size 4-core neutral screened copper cable that will meet the load and voltage drop requirements. (a) Use the following information and information from **AS/NZS 3008.1.2 Table Set 2** and calculate the minimum size cable that will meet the loading requirements.

The cable route length is 15.7 m. The service centre building load is 63 kW. The cable will be buried direct. The ambient soil temperature is 15°C. The voltage drop between distribution panel and the service centre switchboard must not exceed 2.5%. The conductor temperature is assumed to be 75°C

(b) Use **AS/NZS 3008.1.2 Table Set 2** calculate the minimum size cable that will meet the **voltage drop** requirements.

(c) State the minimum size 4-core neutral screened copper cable that will meet the **load** and **voltage drop** requirements.

Question 8

Introduction

It is proposed to install a three-phase, four-core copper cable to supply a low voltage, three-phase, 20kW motor. For this question you do not need to consider the power factor or efficiency of the motor.

(a) Load requirements

Use the following information and information from AS/NZS 3008.1.2 Table Set 2 to calculate the minimum size copper cable that will meet the load current requirements.

The voltage at the switchboard is 400V The cable route between the switchboard and the motor is 60 metres. In the 1st half of the cable route, the cable will be completely surrounded by thermal insulation. In the 2nd second half of the cable route, the cable will be surface clipped (touching). The maximum permitted voltage drop is 1%. The conductor temperature is 75°C. Allowance needs to be made for a 20% load increase (the circuit may supply a motor control panel in the future).

(b) Voltage drop requirements

Use information from AS/NZS 3008.1.2 Table Set 2 to calculate the minimum size copper cable that will meet the voltage drop requirements.

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

12 –ECP 34

1. Metal poles for floodlights are being erected by a crane along a boundary fence of a sports field. There is an 11 kV overhead electric line supported by towers running parallel to and directly above the boundary fence. Refer to NZECP 34 and state the closest distance that the crane, and the crane's load (a metal pole), can be manoeuvred to the conductors of the 11 kV line:

(i) **Without** the consent of the owner of the 11 kV line.

……
…….

REF_____

(ii) **With** the consent of the owner of the 11 kV line.

……
…….

REF_____

2. Refer to NZECP 34 and state the minimum vertical distance from the ground of a 230 volt overhead sub-main:

(i) That crosses a footpath used only by pedestrians

……
……

REF_____

(ii) That crosses a driveway

……
……

REF_____

3. Refer to NZECP 34 and state TWO situations where compliance with the safe approach distances for persons is not required.

……
……

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……
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…….

……
…….

……
…….

REF_____

4. A building is being constructed near an 11 kV overhead pole line with a span of 120 metres.

(i) Refer to NZECP 34 and state how close to the overhead line supports building construction can be carried out without prior written consent.

……
……

REF_____

(ii) Refer to NZECP 34 and state the minimum distance to the side of a conductor of the overhead line from any part of the building once it has been completed.

……
……

REF_____