E104

UEECD0044 Solve problems in multiple path circuits+UEECD0046 Solve problems in single path circuits

Equation Sheet

$$v = \frac{s}{t}$$

$$I = \frac{V}{R}$$

$$P = VI$$

$$P = I^2R$$

$$P = \frac{V^2}{R}$$

$$W = Pt$$

$$\text{h } \% = \frac{P_{out}}{P_{in}} \times \frac{100}{1}$$

$$P_{loss} = P_{in} - P_{out}$$

$$\frac{R_1}{R_2} = \frac{l_1}{l_2}$$

$$\frac{R_1}{R_2} = \frac{A_2}{A_1}$$

$$R = \frac{\rho l}{A}$$

$$R_2 = R_1(1 + \propto (t_2 - t_1))$$

$$R_2 = \frac{R_1 A_1 l_2}{A_2 l_1}$$

$$I_T = I_1 = I_2 = I_3$$

$$V_T = V_1 + V_2 + V_3$$

$$R_T = R_1 + R_2 + R_3$$

$$P_T = P_1 + P_2 + P_3$$

$$V_2 = \frac{R_2}{R_T} \times V_T$$

$$V_T = V_1 = V_2 = V_3$$

$$I_T = I_1 + I_2 + I_3$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2}$$

$$R_T = \frac{R}{n}$$

$$P_T = P_1 + P_2 + P_3$$

$$I_1 = \frac{R_T}{R_1} \times I_T$$

$$Q = It$$

$$Q = CV$$

$$W = 0.5CV^2$$

$$\mathbf{t} = RC$$

$$C_T = C_1 + C_2 + C_3$$

$$V_T = V_1 = V_2 = V_3$$

$$Q_T = Q_1 + Q_2 + Q_3$$

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$V_T = V_1 + V_2 + V_3$$

$$Q_T = Q_1 = Q_2 = Q_3$$

Resistor colour code

Black.....0
Brown.....1
Red 2
Orange 3
Yellow.....4
Green 5
Blue 6
Violet.....7
Grey.....8
White 9

Brown.....1%
Red 2%
Gold.....5%
Silver 10%

Part 1: Basic Electrical Concepts

(Which of the following trades is NOT part of the Electrotechnology industry?

Table 1 Multiple choice

Answer choices	Put X next to your answer
a) Electrician	
b) Linesman	
c) Boilermaker	X
d) Cable Jointer	
e) Telecommunications cabler	

1. 1 The electric charge created by rubbing two surfaces together is called:

Table 2 Multiple choice

Answer choices	Put X next to your answer
a) current electricity	
b) dynamic electricity	
c) motive electricity	
d) static electricity	X

1. 2 Current flow in a circuit is a direct result of applying:

Table 3 Multiple choice

Answer choices	Put X next to your answer
a) an emf to the circuit	X
b) Ohm's Law to the circuit	
c) an ammeter to the circuit	
d) resistance to the circuit	

1. 3 The table below lists examples of electricity production using different sources of energy. Indicate for each process whether the energy source is **renewable** or **non-renewable** by placing an "X" in the relevant box.

Table 4 Multiple response

Electricity Production Process	Renewable	Non-Renewable
Coal fired boiler that converts water into steam which spins a turbine which in turn spins a generator to produce electricity.		X
Wind powered turbine which spins a generator via a gear box to produce electricity.	X	
Water from a dam is gravity fed to a turbine which spins a generator to produce electricity.	X	
Nuclear powered boiler converts water to steam which spins a turbine which in turn spins a generator to produce electricity.		X
Solar radiation falls on photovoltaic panels to produce electricity.	X	

1. 4 Which section of power delivery system is used to deliver power to domestic residences?

Table 5 Multiple choice

Answer choices	Put X next to your answer
a) Transmission	
b) Generation	
c) Distribution	X
d) Communication	

1. 5 Complete the table below to indicate how electricity is utilised by the listed appliances.

The listed appliance converts electricity into:

A – Light **B** – Heat **C** – Radio Waves **D** – Motion or rotation

E– Magnetic Force

Table 6 Short Answer

Appliance	Uses electricity to produce
Electric motor	**D**
Electric hot water tank	**B**
LED lamp	**A**

1. 6 Kilo is the prefix used when a unit is multiplied by:

Table 7 Multiple choice

Answer choices	Put X next to your answer
a) 10^{6}	
b) 10^{3}	X
c) 10^{-3}	
d) 10^{-6}	

1. 7 Milli is the prefix used when a unit is multiplied by:

Table 8 Multiple choice

Answer choices	Put X next to your answer
a) 10^{6}	
b) 10^{3}	
c) 10^{-3}	X
d) 10^{-6}	

1. 8 The terms ‘work’ and ‘energy’ are directly related to:

Table 9 Multiple choice

Answer choices	Put X next to your answer
a) the speed of an object	
b) the power required to move an object	
c) the rate at which energy is spent	
d) the distance a force moves a body	X

1. 9 Power may be defined as:

Table 10 Multiple choice

Answer choices	Put X next to your answer
a) the total amount of work done	
b) the time spent doing work	
c) the energy required to do work	
d) the rate at which work is done	X

1. 10 If an electric welding machine takes a current of 45 amperes for 30 seconds, what quantity of electric charge is transported to the welder?

$Q = It = 45 \times 30 = 1350$ Coulombs

Q= 1350C

1. 11 Velocity of wind is used to generate electricity with Wind Generators. What is the equivalent speed in m/s for a wind velocity of 60 km/h in a northerly direction?

60 km/h x 1000 = 60 000 m/h divided by 3600 sec = 16.667 m/s

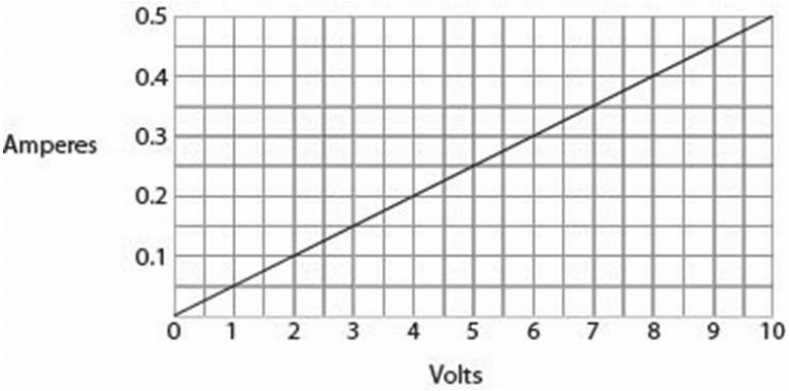
16.667 m/s

1. 12 An electric iron has a power rating of 1100W at 230V. What is the resistance of the element?

$R = \frac{V^2}{P} = \frac{230^2}{1100} = 48\ ohms$

R = 48Ω

1. 13 The graph below shows the current that will flow through a resistive load when different values of voltage are applied.



Determine the current when the applied voltage is 7 volts.

0.35 A

Part 2: Effects of Electric Current, EMF Sources and Energy Conversion (Time Allowed 30 Minutes)

2.1. Which of the following are typical physiological effects of electric current?

Table 11 Multiple choice

Answer choices	Put X next to your answer
a) Luminosity, arcs and burns	
b) Magnetic fields, pressure and radiation	
c) Ventricular fibrillation, asphyxia and muscle spasms	X
d) Electrolysis and corrosion	

2.2. Which of the following are deemed by AS/NZS 3000 to be suitable methods of protection against contact with parts of an electrical installation that are live during normal service?

Table 12 Multiple choice

Answer choices	Put X next to your answer
a) Lightning arrestors	
b) Circuit-breakers and fuses	
c) Earthing of exposed metal	
d) Insulation, barriers, enclosures	X

2.3. Electric current in a solid conductor is a movement of electrons through the conductor. During this process, whenever electrons collide with atoms and ions in the conductor it results in:

Table 13 Multiple choice

Answer choices	Put X next to your answer
a) heating of the conductor	X
b) corrosion of the conductor	
c) magnetisation of the conductor	
d) generation of a voltage in the conductor	

2.4. Electric current flowing in a solid conductor will result in an electromagnetic field around the conductor. If the value of current is increased, the strength of the magnetic field will:

Table 14 Multiple choice

Answer choices	Put X next to your answer
a) fall to zero	
b) reduce	
c) remain the same	
d) increase	X

2.5. An electric current will produce a chemical reaction if two dissimilar metals are placed in:

Table 15 Multiple choice

Answer choices	Put X next to your answer
a) a dielectric	
b) an electrolyte	X
c) an insulator	
d) a conductor	

2.6. The _____ effect of electric current is used in a medical defibrillator.

Table 16 Multiple choice

Answer choices	Put X next to your answer
a) heating	
b) magnetic	
c) chemical	
d) physiological	X

2.7. The _____ effect of electric current is used in an electric toaster.

Table 17 Multiple choice

Answer choices	Put X next to your answer
a) heating	X
b) magnetic	
c) chemical	
d) physiological	

2.8. The _____ effect of electric current is used in electroplating processes.

Table 18 Multiple choice

Answer choices	Put X next to your answer
a) heating	
b) magnetic	
c) chemical	X
d) physiological	

2.9. The _____ effect of electric current is used in the operation of an electric motor.

Table 19 Multiple choice

Answer choices	Put X next to your answer
a) heating	
b) magnetic	X
c) chemical	
d) physiological	

2.10. Where two dissimilar metals are in contact with one another in the presence of an electrolyte:

Table 20 Multiple choice

Answer choices	Put X next to your answer
a) corrosion will occur	X
b) the metals will heat up	
c) a magnetic field will be present	
d) electroplating will occur	

2.11. Which of the following is deemed by AS/NZS 3000 to be a suitable method of protection against the damaging effects of overcurrent?

Table 21 Multiple choice

Answer choices	Put X next to your answer
a) Use of a dry chemical fire extinguisher	
b) Protecting circuits with a suitable fuse or circuit-breaker	X
c) Placing conductors and electrical equipment out of reach	
d) Installation of barriers between equipment and personnel	

2.12. An EMF is produced in a generator by:

Table 22 Multiple choice

Answer choices	Put X next to your answer
a) a magnetic field cutting through the generator windings	X
b) a chemical reaction occurring between the windings	
c) physical pressure being applied to the windings	
d) heat being pumped through the windings	

2.13. An EMF is produced by a thermocouple by:

Table 23 Multiple choice

Answer choices	Put X next to your answer
a) a magnetic field cutting through the thermocouple	
b) a chemical reaction occurring inside the thermocouple	
c) physical pressure being applied to the end of the thermocouple	
d) heat being applied to the end of the thermocouple.	X

2.14. The photovoltaic cell produces an EMF when exposed to:

Table 24 Multiple choice

Answer choices	Put X next to your answer
a) heat	
b) light	X
c) sound	
d) pressure	

2.15. A piezoelectric device produces an EMF when exposed to:

Table 25 Multiple choice

Answer choices	Put X next to your answer
a) heat	
b) light	
c) sound	
d) pressure	X

2.16. An EMF is produced in primary and secondary cells when:

Table 26 Multiple choice

Answer choices	Put X next to your answer
a) heat is applied to the cell plates	
b) a magnetic field cuts through the cell plates	
c) a chemical reaction occurs inside the cell	X
d) physical pressure is applied to the cell plates	

2.17. Fuel cells produce an electrical current when:

Table 27 Multiple choice

Answer choices	Put X next to your answer
a) heat is applied to the cell plates	
b) a magnetic field cuts through the cell plates	
c) a chemical reaction occurs inside the cell	X
d) physical pressure is applied to the cell plates	

2.18. Losses in electrical wiring and machines result in:

Table 28 Multiple choice

Answer choices	Put X next to your answer
a) reduced efficiency	X
b) lower operating noise	
c) increased efficiency	
d) reduced operating temperature	

2.19. The "**Conservation of Energy**" principle states that energy cannot be:

Table 29 Multiple choice

Answer choices	Put X next to your answer
a) changed	
b) converted	
c) destroyed	X
d) transformed	

2.20. The power input to a motor is 20kW and the power output is 17kW. Calculate:

a) the losses

b) the efficiency

$$P_{LOSS} = P_{IN} - P_{OUT} = 20 - 17 = 3kW$$

$$\eta\% = \frac{P_{OUT}}{P_{IN}} \times \frac{100}{1} = \frac{17}{20} \times \frac{100}{1} = 85\%$$

Losses = 3kW

η% = 85%

Part 3: Resistors

(Identify the following fixed resistors by writing the letter for each beside the description in the table below.

Resistor A
(beige case)

Resistor B
(white ceramic)

Resistor C
(blue case)

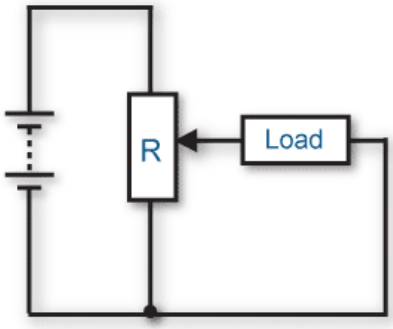
Fixed Resistor Type	Letter
Metal film	C
Carbon film	A
Wire wound	B

3.1. The resistor type typically most suitable for **high power** applications is the:

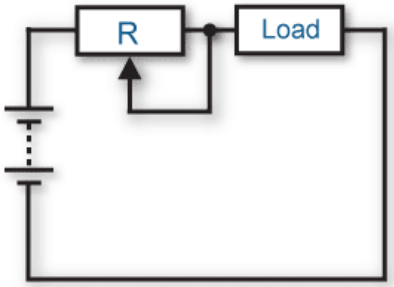
Table 30 Multiple choice

Answer choices	Put X next to your answer
a) metal film resistor	
b) carbon film resistor	
c) wire wound resistor.	X

3.2. Identify the following variable resistors by writing the letter for each beside the description in the table below.



A



B

Variable Resistor Type	Letter
Rheostat	B
Potentiometer	A

3.3. Write the type of resistor next to its application.

Resistors:

VDR	LDR	PTC	NTC

Table 31 Multiple choice

Application	Resistor
Protection for motor windings from overheating	PTC
Surge protection device	VDR
Temperature probe	NTC
Street lights	LDR

3.4. When the voltage applied to a Voltage Dependent Resistor exceeds the **clamping** voltage, the measured resistance of the device:

Table 32 Multiple choice

Answer choices	Put X next to your answer
a) increases	
b) remains the same	
c) decreases	
d) falls dramatically.	X

3.5. When a Light Dependent Resistor is exposed to increasing levels of light, the measured resistance of the device:

Table 33 Multiple choice

Answer choices	Put X next to your answer
a) increases	
b) remains the same	
c) decreases	X
d) falls to zero.	

3.6. When a PTC thermistor is heated, the measured resistance of the device:

Table 34 Multiple choice

Answer choices	Put X next to your answer
a) increases	X
b) remains the same	
c) decreases	
d) falls to zero.	

3.7. When an NTC thermistor is heated, the measured resistance of the device:

Table 35 Multiple choice

Answer choices	Put X next to your answer
a) increases	
b) remains the same	
c) decreases	X
d) falls to zero.	

3.8. Power loss in an electrical cable is primarily due to:

Table 36 Multiple choice

Answer choices	Put X next to your answer
a) insulation failure	
b) stranding of conductors	
c) excessive supply voltages	
d) the resistance of the conductors.	X

3.9. A colour coded resistor with colour bands red, red, orange, gold is measured with an ohmmeter to have a value of 20.95 kΩ. Use the information in the colour chart below to answer these questions:

a) What is the nominal value of the resistor ____22kΩ Tolerance: _____5 %

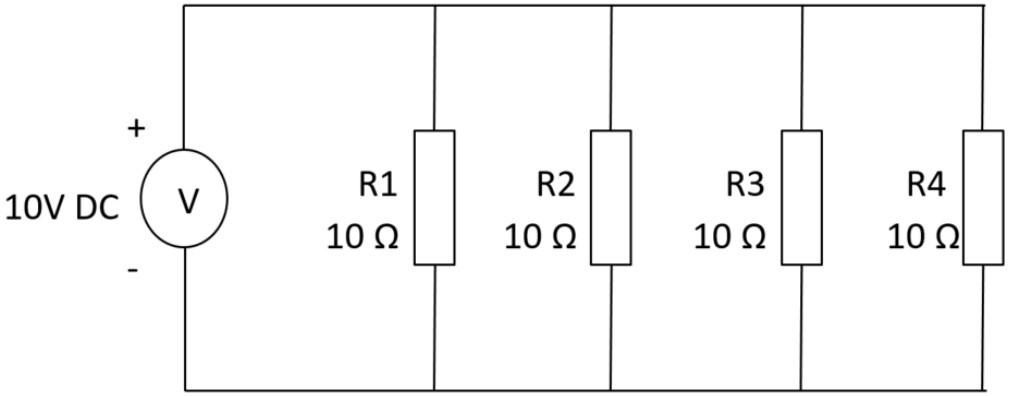
b) What is the resistance range? 20900 Ω to 23100 Ω

c) Does the measured value fall within the specified tolerance? **Yes / No**

Colour	Value	Multiplier	Tolerance
Black	0	1	-
Brown	1	10	1%
Red	2	100	2%
Orange	3	1,000	-
Yellow	4	10,000	-
Green	5	100,000	0.5%
Blue	6	1,000,000	0.25%
Violet	7	-	0.1%
Grey	8	-	-
White	9	-	-
Gold	-	0.1	5%
Silver	-	0.01	10%

Part 4 Factors Affecting Resistance

A



total current of 4 Amperes passed through the following circuit with four equal value resistors with different Power Ratings.

	R1	R2	R3	R4
Power Ratings	1W	2W	5W	10W

a) Which of the four resistors would heat up the most? ___R1_____

b) Which of the four resistors would heat up the least? ___R4_____

c) What would be the result of using a resistor that is below the required power rating in a circuit?

Accept any answer that describes damage/ burn etc/

4.1 Which three of the following are examples of a **series circuit**? (Select all three)

Table 37 Multiple response

Answer choices (select ALL of the correct responses)	Put X next to your answer
a) A fuse protecting a load	X
b) Outdoor garden lighting	
c) A switch controlling a single lamp	X
d) A circuit consisting of several socket outlets	
e) A digital voltmeter measuring the voltage across a load	
f) An analogue ammeter measuring the current through a load	X

4.2 Which three of the following are examples of a **parallel circuit?** (select all three)

Table 38 Multiple response

Answer choices (select ALL of the correct responses)	Put X next to your answer
a) A fuse protecting a load	
b) Outdoor garden lighting	X
c) A switch controlling a single lamp	
d) A circuit consisting of several socket outlets	X
e) A digital voltmeter measuring the voltage across a load	X
f) An analogue ammeter measuring the current through a load	

4.3 Which three of the following are examples of a series- parallel circuit? (Select all three)

Table 39 Multiple response

Answer choices (select ALL of the correct responses)	Put X next to your answer
a) A fuse protecting a two parallel connected loads	X
b) Outdoor garden lighting	
c) Two parallel connected switches controlling a single lamp	X
d) A circuit consisting of several socket outlets	
e) A digital voltmeter measuring the voltage across a load	
f) An analogue ammeter measuring the current through number of parallel connected loads	X

4.4 Which **four** of the following factors affect the resistance of a conductor in an electrical cable?

Table 40 Multiple response

Answer choices (select ALL of the correct responses)	Put X next to your answers
a) Ambient temperature	X
b) Cross-sectional area	X
c) Current carrying capacity	
d) Length of cable	X
e) Type of cable insulation	
f) Type of conductor material	X
g) Voltage rating of insulation	

4.5 Two lengths of cable have been cut from the same roll. Which length would have the **least** resistance?

Table 41 Multiple choice

Answer choices	Put X next to your answer
a) 25 metre cable	X
b) 37 metre cable	

4.6 Two cables are identical except for their cross sectional area. Which one will have the **highest** resistance?

Table 42 Multiple choice

Answer choices	Put X next to your answer
a) 1.5mm²	X
b) 2.5mm²	

4.7 For most metals, an increase in temperature will cause the resistance to:

Table 43 Multiple choice

Answer choices	Put X next to your answer
a) decrease	
b) remain the same	
c) increase	X

4.8 The following table lists resistivity values for a range of materials.

Material	*Resistivity ohm-metres*
Silver	1.63×10^{-8}
Copper	1.72×10^{-8}
Lead	2.04×10^{-8}
Gold	2.44×10^{-8}
Aluminium	2.83×10^{-8}
Platinum	10.09×10^{-8}

Based on the values above, which of the following is the best conductor of electricity?

Table 44 Multiple choice

Answer choices	Put X next to your answer
a) Copper	X
b) Aluminium	

4.9 Which of the following cables would have a higher current carrying capacity?

Table 45 Multiple choice

Answer choices	Put X next to your answer
a) 1.5mm²	
b) 2.5mm²	X

4.10 When carrying current, which of the following cables would have a higher voltage drop?

Table 46 Multiple choice

Answer choices	Put X next to your answer
a) A 100m length with cross sectional area of 1.5mm²	X
b) A 100m length with cross sectional area of 2.5mm²	

4.11 Which of the following meters is the most suitable to measure the change in resistance of a conductive material when the material characteristics undergo changes?

Table 47 Multiple choice

Answer choices	Put X next to your answer
a) Ammeter	
b) Multimeter	X
c) Voltmeter	
d) Wattmeter	

4.12 A 100 m length of 1.5mm^2 cable has a resistance of1.65 Ω . What is the resistance of 72m of 2.5mm^2 cable at the same temperature?

Show all working and write your answer in the space provided.

Resistance of 72m cable = $\frac{1.65\ X\ 1.5\ X\ 72}{2.5\ X\ 100}$ = 0.712 Ω

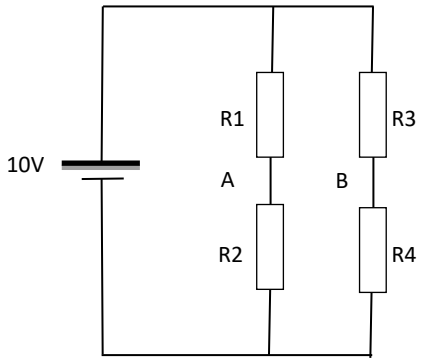
4.13 The tungsten filament of an incandescent lamp has a resistance of 97 ohms at 20°C. When the lamp is switched on, the filament temperature rises to 2000°C. Calculate the resistance of the filament when the lamp is on?
Assume the temperature coefficient of resistance for tungsten to be 0.0045 at 20°C.

Show all working and write your answer in the space provided.

$$R_2 = R_1(1 + \propto (t_2 - t_1)) = 97(1 + 0.0045\ (2000 - 20)) = 961\ ohms$$

R = 961Ω

Consider the circuit below and answer the following four questions (4.15, 4.16, 4.17, 4.18)



R1 = 10Ω

R2 = 20Ω

R3=100Ω

R4=200Ω

4.14 Measured Voltage across R2 is:

Table 48 Multiple choice

Answer choices	Put X next to your answer
10V	
0V	
3.3V	
6.6V	X

4.15 Measured Voltage across R4 is:

Table 50 Multiple choice

Answer choices	Put X next to your answer
10V	
0V	
3.3V	
6.6V	X

4.16 Voltage Difference between A and B:

Table 51 Multiple choice

Answer choices	Put X next to your answer
10V	
0V	X

Answer choices	Put X next to your answer
3.3V	
6.6V	

4.17 What is the current passing through the two resisters R1 and R2?

Table 49 Multiple choice

Answer choices	Put X next to your answer
0.33A	X
0A	
3.3A	
6.6A	

Part 5: Effects of Meters in Circuits

5.1. What is the minimum *Category Rating* for a digital multimeter used to test the supply voltage at the main switch of a domestic installation?

Table 50 Multiple choice

Answer choices	Put X next to your answer
a) Category 1	
b) Category 2	
c) Category 3	X
d) Category 4	

5.2. When an analogue meter is being used to measure an unknown voltage, to prevent damage to the needle you should select:

Table 51 Multiple choice

Answer choices	Put X next to your answer
a) lowest range	
b) most common range	
c) highest range.	X

5.3. The best method of accurately measuring a resistance of 0.01 ohm would be using:

Table 52 Multiple choice

Answer choices	Put X next to your answer
a) an Insulation Resistance tester	
b) the volt-ammeter method of testing	
c) a Wheatstone Bridge	X
d) a multimeter set on the ohms range.	

5.4. When using an **IR Tester** to measure insulation resistance of an electrical circuit, the circuit must be:

Table 53 Multiple choice

Answer choices	Put X next to your answer
a) isolated and tested dead	X
b) connected to the supply mains and switched on	
c) completely disconnected and removed from service	
d) connected to an alternative source of supply, such as a photovoltaic array.	

5.5. When performing an electrical isolation procedure, immediately after “testing dead” it is important to:

Table 54 Multiple choice

Answer choices	Put X next to your answer
a) short all live conductors to earth	
b) disconnect the circuit wiring from the equipment	
c) switch the testing device off to conserve battery and store it in a safe place	
d) check that the testing device is functioning correctly by testing on a known live source.	X

5.6. If you are using a digital multimeter to measure 200 volts, select the range from the table below that will give you the most accurate reading.

Table 55 Multiple choice

Answer choices	Put X next to your answer
10 volts	
50 volts	
250 volts	X
500 volts	

5.7. When using an analogue meter care must be taken to avoid “parallax error”. This occurs when:

Table 56 Multiple choice

Answer choices	Put X next to your answer
a) the meter is connected with reverse polarity	
b) the needle is not viewed perpendicular to the face of the meter	X
c) the meter is connected in series instead of in parallel	
d) the reading is affected by a nearby magnetic field	

5.8. **Bench type** voltmeters and ammeters provide a full range of features for laboratory work, however they are usually impractical for field work due to their:

Table 57 Multiple choice

Answer choices	Put X next to your answer
a) low resolution	
b) poor sensitivity	
c) size and weight	X
d) high loading effect	

5.9. Which ammeter would be most suitable to meaure current without modifying the circuit?

Table 58 Multiple choice

Answer choices	Put X next to your answer
Bench	
Clamp/tong	X
Multimeter	
Ohm meter	

5.10. To minimise **loading effect**, the input impedance of a digital multimeter set on the voltage range is typically around:

Table 59 Multiple choice

Answer choices	Put X next to your answer
a) 0.1Ω	
b) 100Ω	
c) 10kΩ	
d) 10MΩ	X

5.11. Voltage indication devices can be classified as being of the **contact** type (probes that make physical contact) or the **non-contact** type (proximity sensing).

When testing dead after isolating a circuit, it is preferable that a **contact** type voltage indication device be used. Which of the following test devices fall into this category?

Select **four (4)** correct answers to score 1 mark.

Table 60 Multiple response

Answer choices (select FOUR correct responses)	Put X next to your answers
a) Digital multimeter on the voltage range	X
b) Neon tester (e.g. Combi-check)	X
c) Volt-stick with LED indication	
d) Series test lamps	X
e) Solenoid tester	X

5.12. Where a circuit has already been correctly isolated and tested dead, which of the following devices could you use to check that a cable in a ceiling space is no longer live prior to being cut?

Table 61 Multiple choice

Answer choices	Put X next to your answer
a) Solenoid tester	
b) Series test lamps	
c) Volt-stick with LED indication	X
d) Digital multimeter on the voltage range	

5.13. The main disadvantage of proximity sensing voltage indicators is the possibility of:

Table 62 Multiple choice

Answer choices	Put X next to your answer
a) static discharge from the device	
b) false readings due to induced voltages	X
c) electric shock if used by untrained personnel	
d) the device being damaged by excess voltage on the circuit	

5.14. Connecting a DC analogue voltmeter with reverse polarity will cause:

Table 63 Multiple choice

Answer choices	Put X next to your answer
a) a reduction in the meter sensitivity	
b) excessive current to flow that will damage the meter	
c) current flow to be restricted causing circuit malfunction	
d) the needle of the meter to move in the reverse direction	X

5.15. The **loading effect** of a meter relates to how much load the meter places on a circuit when a measurement is taken. If an analogue voltmeter has a sensitivity of **750 ohms/volt**, what is the resistance of the meter when used on the 10V range?

Show all working and write your answer in the space provided.

$R_{meter} = \Omega/V \times Range = 750 \times 10 = 7.5\ k\Omega$

R_{meter} = 7.5kΩ

5.16. 12A voltmeter has an accuracy of 1% FSD on the 500V range.

When the meter is indicating 500V, what are the limits of the **actual** voltage?

Show all working.

V_error=1%×500=5 volts

Lower limit=500-5=495V

Upper limit=500+5=505V

Lower limit: 495 volts Upper limit: : 505 volts

Part 6 : Resistance Measurement

(**Ohmmeters** and **IR Testers** have an internal power supply that is applied to the circuit under test. For this reason they must only be used on circuits that are:

Table 64 Multiple choice

Answer choices	Put X next to your answer
a) isolated and tested dead	X
b) connected to the supply mains and switched on	
c) completely disconnected and removed from service	
d) connected to an alternative source of supply, such as a photovoltaic array	

6.1. An **IR Tester** is used to check the integrity of the insulation of cables and equipment. When performing an insulation resistance test on an electrical appliance, which conductors do you need to test between? .

Table 65 Multiple choice

Answer choices (select ALL correct responses)	Put X next to your answer
a) Between active and neutral	
b) Between active and earth	X
c) Between neutral and earth	X

6.2. An **earth continuity** test is performed on a circuit to ensure that the earth resistance is:

Table 66 Multiple choice

Answer choices	Put X next to your answer
a) zero ohms	
b) A value low enough to ensure very good continuity	X
c) a value high enough to reduce the risk of voltage differences occurring	
d) infinity	

6.3. What is the general test voltage specified by AS/NZS 3000 when performing an insulation resistance test on 230/400V electrical circuits?

Test voltage: 500V DC

6.4. What is the test voltage permitted by AS/NZS 3000 when performing an insulation resistance test on 230/400V electrical circuits that contain electronic equipment that might be damaged by the test?

Test voltage: 250V DC

6.5. An IR Tester must be **calibrated** regularly to ensure:

Table 67 Multiple choice

Answer choices	Put X next to your answer
a) accuracy	X
b) battery life	
c) sensitivity	
d) ruggedness	

6.6. Which of the following are important considerations when storing measuring instruments such as multimeters and IR Testers?

*Select **three (3)** correct responses to score 1 mark. If you make an incorrect selection you will score zero.*

Table 68 Multiple response

Answer choices (select THREE correct responses to score 1 mark)	Put X next to your answer
a) Readily accessible in case of emergency	
b) Protected against mechanical damage	X
c) Stored in a dry location	X
d) Switched off	X

6.7. When performing a calibration check on an IR Tester on the 500V setting, with probes connected to a 1MΩ resistor the meter must maintain an output voltage of between:

Table 69 Multiple choice

Answer choices	Put X next to your answer
a) 50V and 230V	
b) 50V and 400V	
c) 230V and 400V	
d) 450V and 600V	X

6.8. Determine the following meter reading based on the ranged selected.

Meter reading: 0.95 Ω

6.9. Determine the following meter reading based on the ranged selected.

Meter reading: 2 MΩ

6.10. When using the volt-ammeter method of measuring resistance, which method is used for very **high** values of resistance?

Table 70 Multiple choice

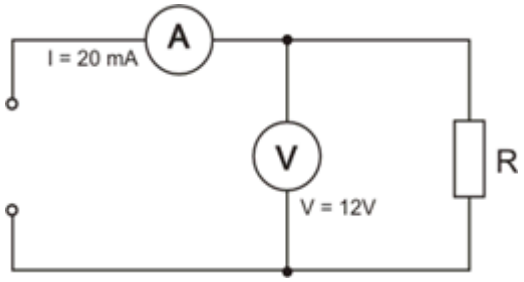
Answer choices	Put X next to your answer
a) Short shunt	
b) Long shunt	X

6.11. When using the volt-ammeter method of measuring resistance, which method is used for very **low** values of resistance?

Table 71 Multiple choice

Answer choices	Put X next to your answer
a) Short shunt	X
b) Long shunt	

6.12. Using the volt-ammeter method for measuring resistance, calculate the Resistance of the resistor in the circuit given below.



$$R_{apparent} = \frac{V}{I} = \frac{12}{20 \times 10^{-3}} = 600\ ohms$$

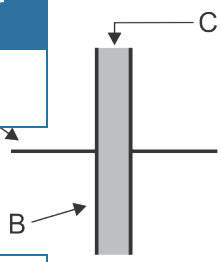
$R_{apparent}$ = 600Ω

Part 7: Capacitors and Capacitance

(Identify the basic parts of a capacitor by writing the appropriate letter for each part in the table below. You must identify ALL parts correctly.

Table 72 Multiple choice

Part	Letter
Connecting lead	A
Dielectric	C
Plate	B



7.1. The table below lists the relative permittivity of a range of dielectric materials and also the equation used to calculate capacitance based on the physical properties of a capacitor.

Dielectric Material	Relative Permittivity
Air	1
Paper	2
Mica	5
Glass	6

$$C = \frac{A\epsilon_0\varepsilon_r}{d}$$

Which of the following materials will result in a capacitor with the **highest** value of capacitance?

Table 73 Multiple choice

Answer choices	Put X next to your answer
a) Air	
b) Paper	
c) Mica	
d) Glass	X

7.2. Identify the following capacitor types by writing the appropriate letter for each in the table below.

Capacitor A

Capacitor B

Capacitor C

Capacitor D

Capacitor E

Capacitor F

Table 74 Multiple choice

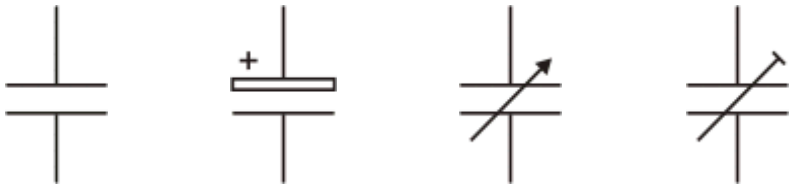
Capacitor Type	Letter
Ceramic	D
Electrolytic	C
Film (rolled or stacked)	A
Tantalum	E
Trimmer	B
Tuning	F

7.3. Which **three** of the following factors determine the capacitance of a capacitor?

Table 75 Multiple response

Answer choices	Put X next to your answer
a) Plate area	X
b) Plate material	
c) Electrolyte material	
d) Dielectric material	X
e) Distance between plates	X

7.4. Identify the following capacitor symbols by writing the appropriate letter for each in the table below.



A **B** **C** **D**

Capacitor Type	Letter
Polarised	B
Standard	A
Trimmer	D
Variable	C

7.5. The **quantity of electricity** stored in a capacitor is known as:

Table 76 Multiple choice

Answer choices	Put X next to your answer
a) capacitance	
b) electric charge	X
c) electrical energy	
d) electromotive force	

7.6. **Capacitance** can be defined as:

Table 77 Multiple choice

Answer choices	Put X next to your answer
a) the ability to do work	
b) the ability of a system to store an electric charge	X
c) the property of matter that causes power to be consumed	
d) the force developed when an object is placed in an electromagnetic field	

7.7. **Energy** can be defined as:

Table 78 Multiple choice

Answer choices	Put X next to your answer
a) the ability to do work	X
b) the ability of a system to store an electric charge	
c) the property of matter that causes power to be consumed	
d) the force developed when an object is placed in an electromagnetic field	

7.8. The unit of **electric charge** is the:

Table 79 Multiple choice

Answer choices	Put X next to your answer

Answer choices	Put X next to your answer
a) coulomb	X
b) farad	
c) joule	
d) watt	

7.9. The unit of **capacitance** is the:

Table 80 Multiple choice

Answer choices	Put X next to your answer
a) coulomb	
b) farad	X
c) joule	
d) watt	

7.10. The unit of **energy** is the:

Table 81 Multiple choice

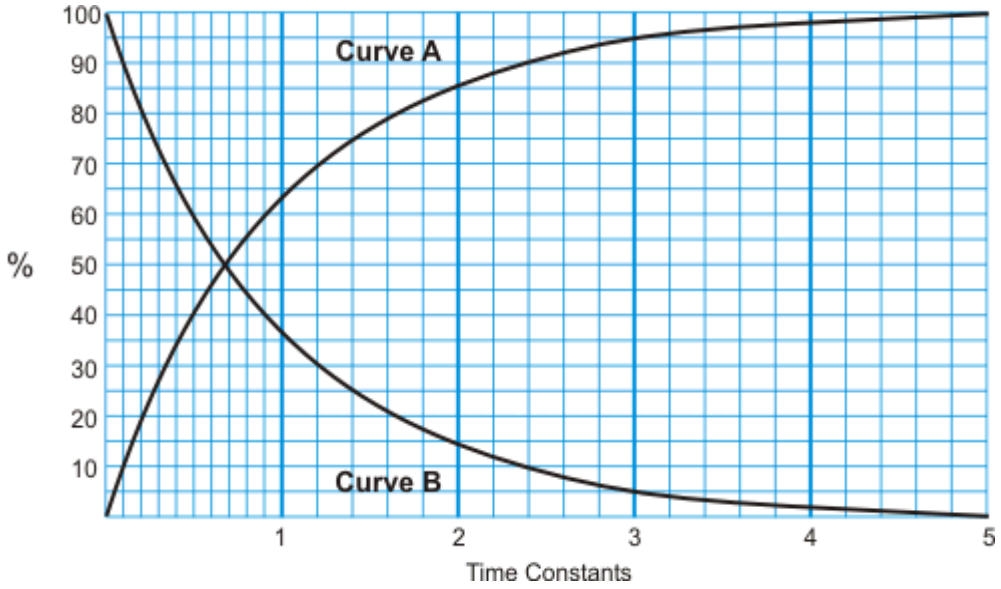
Answer choices	Put X next to your answer
a) coulomb	
b) farad	
c) joule	X
d) watt	

7.11. Fill in the blanks with an appropriate word from the options below. You must select BOTH of the correct responses to score 1 mar.

charge, conductors, dielectric, insulation, plates

All electrical circuits exhibit the property of capacitance to some extent. This is because the metallic wires act as ___**plates**___and the space between the wires acts as the__**dielectric**___**.**

7.12. The Universal Time Curves shown below may be used to determine the instantaneous values of voltage and current in an RC circuit during both the charging and discharging cycle.



Which curve is used for..	Curve
the capacitor **voltage** during **charging**?	A
the capacitor **current** during **charging**?	B
the capacitor **voltage** during **discharging**?	B
the capacitor **current** during **discharging**?	B

7.13. Determine the charge on a 330µF capacitor when connected to a 600V supply.

Show all working and write your answer in the space provided.

$Q = CV = 330x10^{-6} \times 600 = 198\ millicoulombs$

Q = 198 mC

7.14. How much energy is stored by a 22µF capacitor when it is fully charged by a 400V supply?

Show all working and write your answer in the space provided.

$E = 0.5CV^2 = 0.5 \times 22x10^{-6} \times 400^2 = 1.76\ joules$

W = 1.76J

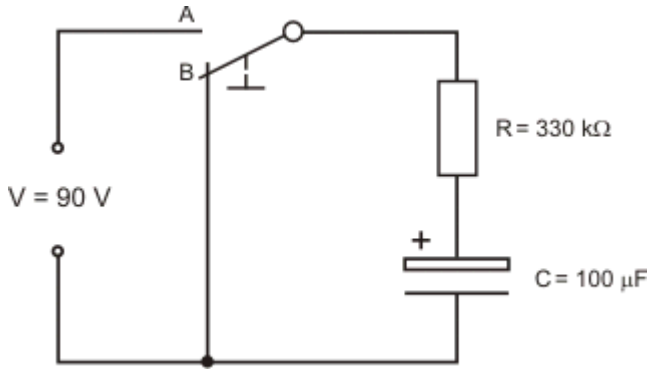
7.15. A 100µF capacitor contains 15mC of electric charge. What is the voltage across its terminals?

Show all working and write your answer in the space provided.

$$V = \frac{Q}{C} = \frac{15x10^{-3}}{100x10^{-6}} = 150\ volts$$

V = 150V

7.16. The RC circuit below is connected to allow the capacitor to be charged and discharged via the switch.



If the switch is moved to position "A", calculate:

- the capacitor voltage after 1 time constant
- the time taken for the capacitor to reach full charge

$$V = 63\% \times V_{supply} = 0.63 \times 90 = 56.7\ volts$$

$$\tau = RC = 330x10^{3} \times 100x10^{-6} = 33\ \text{seconds}$$

$$Full\ charge\ at\ 5\tau = 5 \times 33 = 165\ \text{seconds}$$

Capacitor voltage after 1 time constant: 56.7 volts

Time taken for capacitor to reach full charge: 165 seconds

Part 8: Capacitors in Series and Parallel

(To minimise the risk of electric shock when handling capacitors, care must be taken to ensure that they have been:

Table 82 Multiple choice

Answer choices	Put X next to your answer
a) polarised	
b) discharged	X
c) electrolysed	
d) disconnected	

8.1. Appropriate PPE must be used when handling older capacitors containing PCB oil as contact with the skin could present a risk of developing:

Table 83 Multiple choice

Answer choices	Put X next to your answer
a) radiation sickness	
b) chronic fatigue	
c) acid burns	
d) cancer	X

8.2. AS/NZS 3000 requires capacitors greater than 0.5µF and rated up to and including 650V to be provided with a discharge path that reduces the terminal voltage to not more than 50V within:

Table 84 Multiple choice

Answer choices	Put X next to your answer
a) 10 seconds	
b) 1 minute	X
c) 5 minutes	
d) 10 minutes	

8.3. Some appliances that contain capacitors are fitted with a _____ resistor across the supply terminals to provide a permanent discharge path.

Table 85 Multiple choice

Answer choices	Put X next to your answer
a) load	
b) bleed	X
c) series	
d) charge	

8.4. What is the **primary** danger of a charged capacitor?

Table 86 Multiple choice

Answer choices	Put X next to your answer
a) Explosion	
b) Flammability	
c) Electric shock	X
d) Hazardous chemicals	

8.5. If a charged capacitor were to be discharged through a person, what are the possible consequences? *Select **two (2)** correct responses to score 1 mark*.

Table 87 Multiple response

Answer choices	Put X next to your answer
a) Cardiac arrest	X
b) Hypothermia	
c) Electrical burns	X
d) Heartburn	

8.6. When testing a capacitor with an analogue ohmmeter, a **healthy** capacitor will indicate:

Table 88 Multiple choice

Answer choices	Put X next to your answer
a) zero ohms	
b) low ohms initially, then increasing resistance as the capacitor charges	X
c) a high resistance	
d) a high resistance initially, then decreasing resistance as the capacitor charges	

8.7. When testing a capacitor with an analogue ohmmeter, an **open circuit** capacitor will indicate:

Table 89 Multiple choice

Answer choices	Put X next to your answer
a) zero ohms	
b) zero ohms initially, then increasing resistance as the capacitor charges	
c) a high resistance	X
d) a high resistance initially, then decreasing resistance as the capacitor charges	

8.8. When testing a capacitor with an analogue ohmmeter, a **short-circuited** capacitor will indicate:

Table 90 Multiple choice

Answer choices	Put X next to your answer
a) zero ohms	X
b) zero ohms initially, then increasing resistance as the capacitor charges	
c) a high resistance	
d) a high resistance initially, then decreasing resistance as the capacitor charges	

8.9. Before testing a capacitor with an ohmmeter or capacitance meter, the capacitor must be:

Table 91 Multiple choice

Answer choices	Put X next to your answer
a) charged	
b) discharged	X
c) connected to the supply	
d) disconnected from the supply	

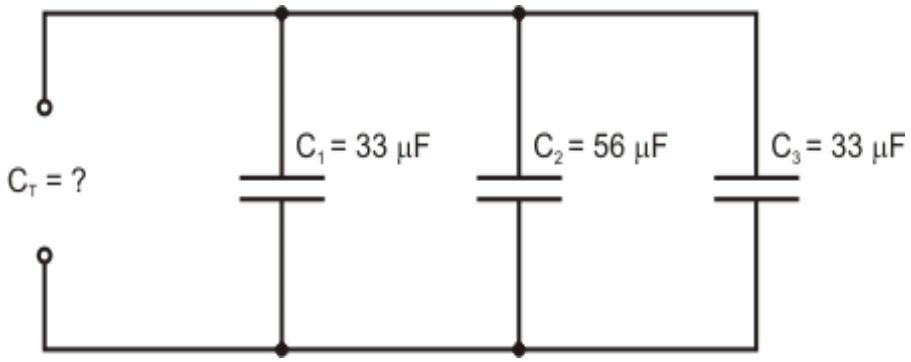
8.10. Which of the following are typical applications for capacitors?

*Select **four (4)** correct responses.*

Table 92 Multiple response

Answer choices (select FOUR correct responses to score 1 mark)	Put X next to your answer
a) Power factor correction	X
b) Increase motor torque	X
c) Voltage regulation	
d) Water heaters	X
e) Fluorescent lighting	X

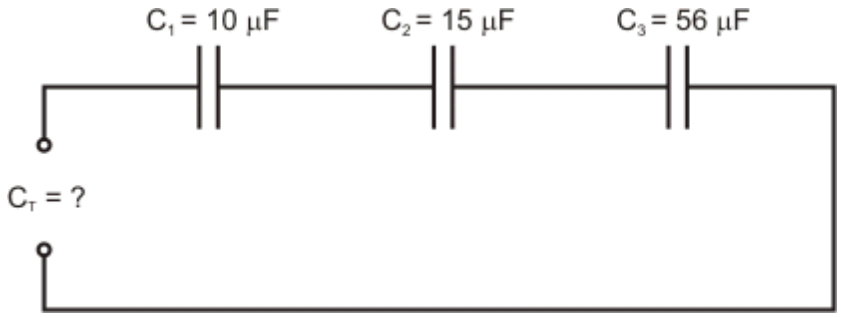
8.11. Determine the total circuit capacitance (C_T) of the circuit below.



$$C_T = C_1 + C_2 + C_3 = 33 + 56 + 33 = 122\ \mu F$$

C_T = 122 uF

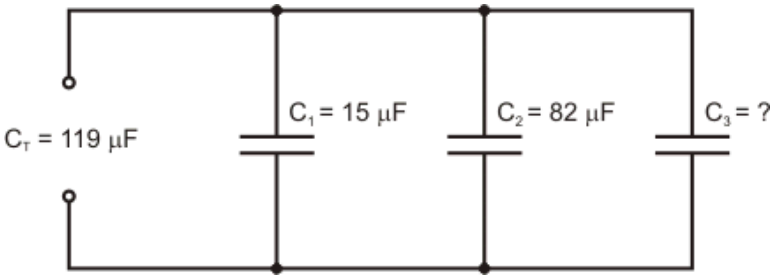
8.12. Determine the total circuit capacitance (CT) of the circuit below.



$$C_T = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}} = \frac{1}{\frac{1}{10}+\frac{1}{15}+\frac{1}{56}} = 5.42\ \mu F$$

C_T = 5.42uF

8.13. Select a suitable value for capacitor C3 below to give the total capacitance as shown.



$$C_3 = C_T - C_1 - C_2 = 119 - 15 - 82 = 22\ \mu F$$

C_T = 22 µF