VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2014

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER | | | | | | | | | | Letter |

VCE VET INTEGRATED TECHNOLOGIES

Written examination

Monday 10 November 2014

Reading time: 9.00 am to 9.15 am (15 minutes)
Writing time: 9.15 am to 10.45 am (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	10	10	80
			Total 100

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied
- Question and answer book of 21 pages, including a formula sheet on page 21.
- Answer sheet for multiple-choice questions.

Instructions
- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- All written responses must be in English.

At the end of the examination
- Place the answer sheet for multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.

Question 1

The Waubra wind farm, near Ballarat, is the fourth-largest wind farm in Australia.
The electricity generated by its wind turbines is produced from

A. air.
B. heat.
C. the speed of the blades.
D. electromagnetic induction.

Question 2

What does RCD stand for?

A. Residual Current Device
B. Reduced Current Detection
C. Residential Current Device
D. Residential Current Detector

Question 3

Household electrical installations are designed to protect people from electrocution.
Which form of protection is the most appropriate for home safety?

A. a fuse
B. an RCD
C. an earth wire
D. a main switch

Question 4

In electrical testing, the jaws of a modern clamp meter are used by electricians to measure

A. high levels of current.
B. 240 V_{AC} mains voltage.
C. the resistance of an earth stake.
D. low-level earth leakage current.

Question 5

A garden solar light system consisting of a solar cell, a control circuit and a lamp

A. requires its carbon battery to be replaced every 12 months.

B. does not require a battery as it is 'charged' by energy from the sun.

C. contains a primary battery to supply power to the lamp in darkness.

D. contains a secondary battery to supply power to the lamp in darkness.

Question 6

When soldering a component onto a Printed Circuit Board, one must always wear

A. latex gloves.

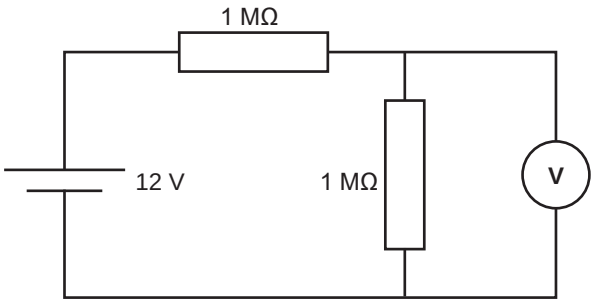
B. a respirator.

C. a dust mask.

D. safety glasses.

Question 7

Refer to the circuit diagram below. The reading on the voltmeter (V) is 4 V.



This reading indicates that the

A. voltmeter is faulty.

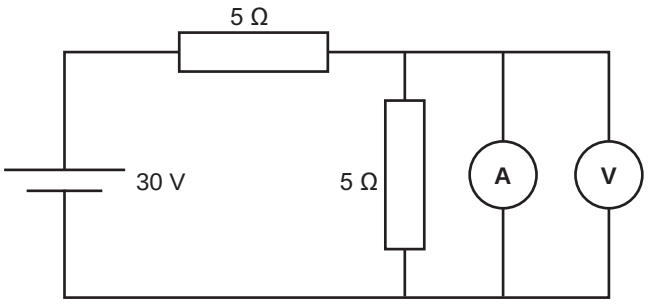
B. voltmeter has zero internal resistance.

C. voltmeter has infinite internal resistance.

D. internal resistance of the voltmeter is 1 MΩ.

Question 8

Refer to the circuit diagram below.



The readings on the ammeter and voltmeter are respectively

A. 0 A, 30 V

B. 3 A, 15 V

C. 6 A, 0 V

D. 6 A, 30 V

Question 9

One function of a transformer in a power distribution system is to

A. supply all electronic devices with the required voltage.

B. reduce the high voltage produced by the generator to the low voltage required by all domestic appliances.

C. increase the low voltage produced by the generator to the voltage required by all appliances and electrical devices.

D. protect all appliances and electrical devices while keeping the voltage produced by the generator constant within the system.

Question 10

The best material to provide a path for current is

A. a conductor.

B. an insulator.

C. a semi-insulator.

D. a semiconductor.

Question 11

What is the name of the electrical device represented by the symbol above?

A. a triac

B. a diac

C. an SCR

D. a diode

Question 12

The colour coding for a 1 MΩ 5% resistor is

A. brown red yellow gold.

B. brown black blue gold.

C. brown black green gold.

D. brown brown green gold.

Question 13

AC power is to be supplied from a farmhouse over a distance of 3 km to a shed containing a 15 kW load. There is a choice of using a 240 V supply or stepping the voltage up to 1200 V, transmitting it along a copper wire to the shed and then stepping the voltage back down to 240 V.

Which one of the following statements could assist in deciding whether to use 240 V or 1200 V to transmit the power?

A. The power loss would be the same because the same amount of electrical power is being transmitted.

B. The power loss would be five times greater when using a 1200 V power source because of the high voltage.

C. The power loss would be 25 times greater when using a 240 V power source because of the low voltage.

D. The power loss would be 25 times greater when using a 1200 V power source because of the high voltage.

Question 14

A transducer is a 'sensor' device that converts a signal from one form of energy to another.

A thermistor is a

A. heat sensor.

B. light sensor.

C. motion sensor.

D. pressure sensor.

Question 15

A smart meter is installed in a home power box to measure the daily usage of electric energy.

If a refrigerator consumes an average of 800 W for four hours per day and the energy tariff is 30 cents per kilowatt hour, what is the daily running cost of the refrigerator?

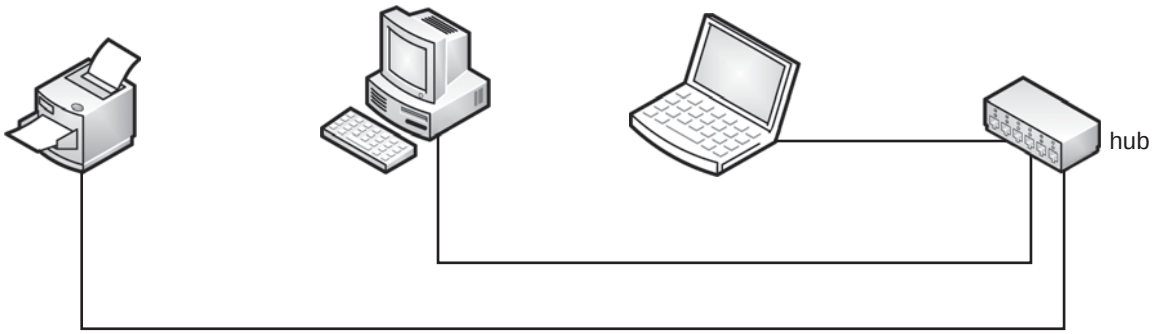
A. $0.30

B. $2.40

C. $0.96

D. $9.60

Question 16



A home computer network is wired as shown above.
What is the network topology of this network?

A. star topology
B. bus topology
C. ring topology
D. home office topology

Question 17

The symbol for a rectifier diode is an 'arrowhead', as shown above.
What does the arrowhead indicate?

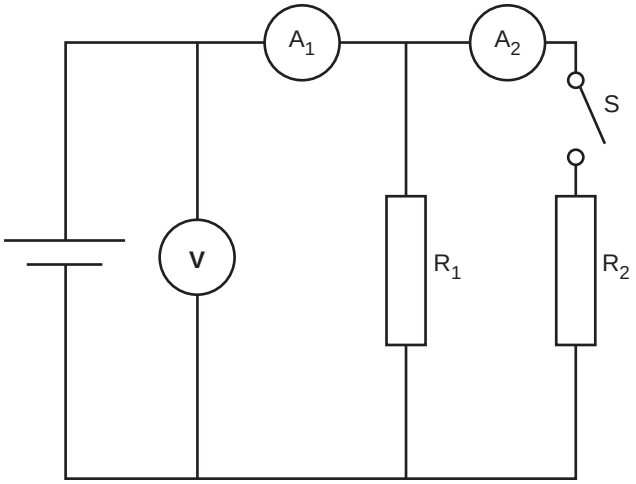
A. it points to the anode of the diode
B. the direction of the flow of electrons
C. the direction of conventional current
D. it shows that the diode is emitting light

Question 18

What kind of energy transfer occurs in a relay or solenoid?

A. heat to electrical
B. electrical to optical
C. mechanical to electrical
D. electrical to mechanical

Question 19



The circuit diagram above has two resistors of different values.

When switch S is closed

A. the reading on the voltmeter will increase.

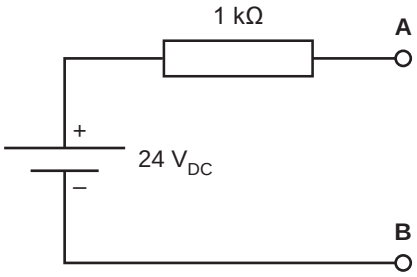
B. the reading on the voltmeter remains unchanged.

C. ammeter 1 and ammeter 2 will have the same reading.

D. the reading on ammeter 1 will be double the reading on ammeter 2.

Question 20

Refer to the circuit diagram below.



If a voltmeter is placed across terminals A and B, and it is set to the correct range, what voltage will be shown on the voltmeter?

A. 0 V_{DC}

B. 6 V_{DC}

C. 12 V_{DC}

D. 24 V_{DC}

END OF SECTION A
TURN OVER

SECTION B

Instructions for Section B

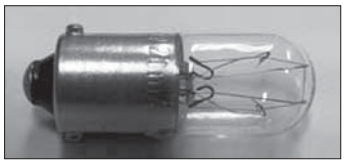
Answer **all** questions in the spaces provided.
Formulas must be relevant to the calculations. Calculations must be shown.
All units must be specified in correct engineering notations in the answers.

Question 1 (8 marks)

In the table below, identify which four components from photos **A.**–**I.** show a relay, a light-dependent resistor (LDR), a capacitor and a transistor, and select the corresponding symbol (**1.**–**12.**) for each component.

Components

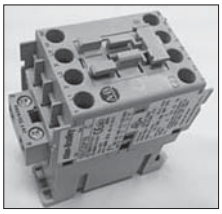
A.



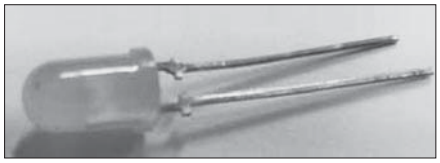
B.

C.

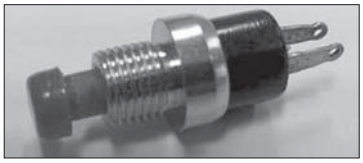
D.



E.

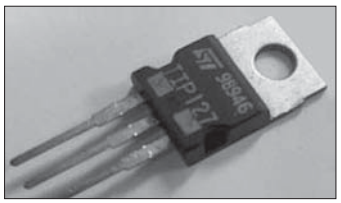


F.



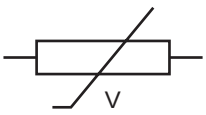
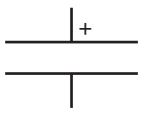
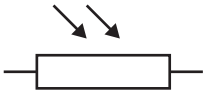
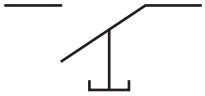
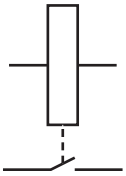
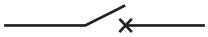
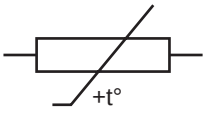
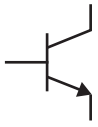
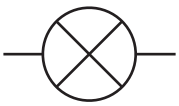
G.

H.



I.

Symbols

1. 	**2.** 	**3.** 	**4.** 
5. 	**6.** 	**7.** 	**8.** 
9. 	**10.** 	**11.** 	**12.** 

	Component	Symbol
relay		
LDR		
capacitor		
transistor		

Question 2 (8 marks)

In engineering, measurements are usually described in engineering notations, such as milliampere (e.g. 33.4 mA) and kilo-ohm (e.g. 2.2 kΩ).

Complete the table below by converting the values given into engineering notations.

Value	Engineering notation	Value	Engineering notation
$8.2 \times 10^5\ \Omega$		33×10^6 pF	
25×10^{-6} A		66 000 V	
0.125 g		0.00357 A	
5700 W		0.56 kΩ	

Question 3 (5 marks)

Figure 1 below shows a schematic circuit diagram for a small electronic circuit. The partially completed Printed Circuit Board (PCB) layout for the circuit is shown in Figure 2.

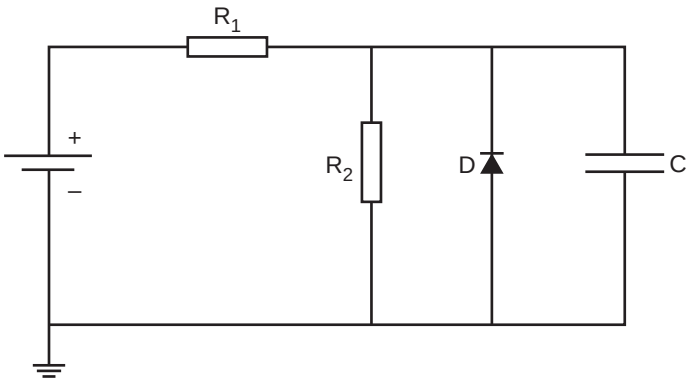


Figure 1

Complete the PCB layout in Figure 2 by drawing the five missing connections. (Note: The outline of the PCB layout and circuit diagram could look different. Make sure the completed PCB works the same as the design of the circuit above.)

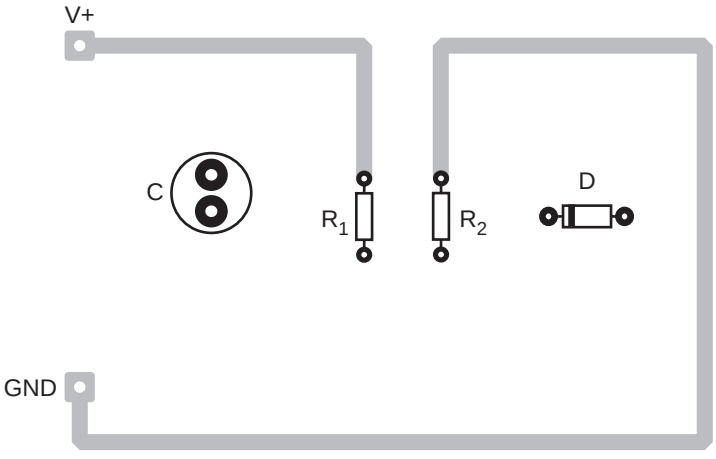


Figure 2

Question 4 (9 marks)
Refer to the circuit diagram in Figure 3.

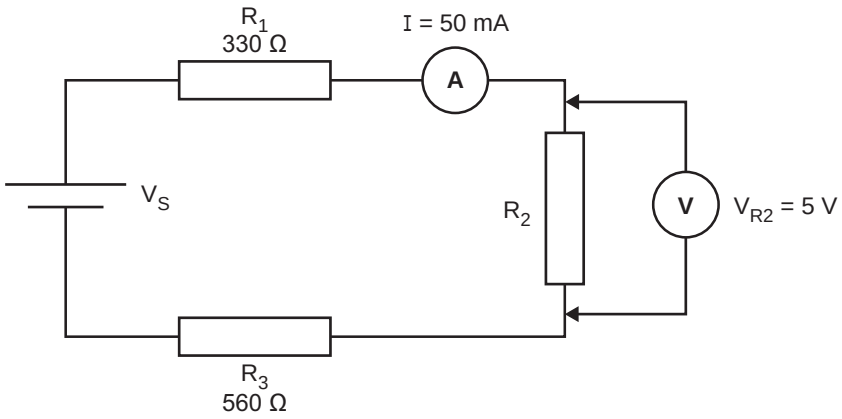


Figure 3

a. What is the power dissipated by R_1? 2 marks

b. What is the voltage drop across R_1? 1 mark

c. What is the supply voltage V_S? 2 marks

d. What is the value of resistor R_2? 1 mark

e. Find the total resistance of the circuit. 2 marks

f. **On Figure 3 above**, show the polarity of the 'analogue' ammeter. 1 mark

Question 5 (8 marks)

$R_1 = 100\ \Omega \quad R_2 = 220\ \Omega \quad R_3 = 47\ \Omega$

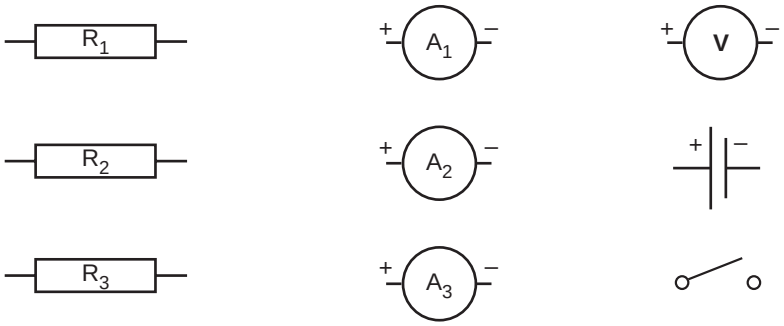


Figure 4

a. Using the components shown in Figure 4, draw a parallel circuit configured as follows:

- R_1, R_2 and R_3 are parallel to each other and the circuit is powered by a 20 V_{DC} power supply.
- Ammeters A_1, A_2 and A_3 measure the current through fixed resistors R_1, R_2 and R_3 respectively.
- The voltmeter measures the voltage drop across R_2.
- When the switch is open, there is no current flowing in the circuit. 6 marks

b. With the circuit connected as described in **part a.** and the switch closed, how much current will be measured on ammeter A_2? 2 marks

_____

_____

Question 6 (8 marks)

Refer to the circuit diagram in Figure 5, where $R_1 = 300\ \Omega$, $R_2 = 300\ \Omega$, $R_3 = 50\ \Omega$ and $R_4 = 250\ \Omega$.

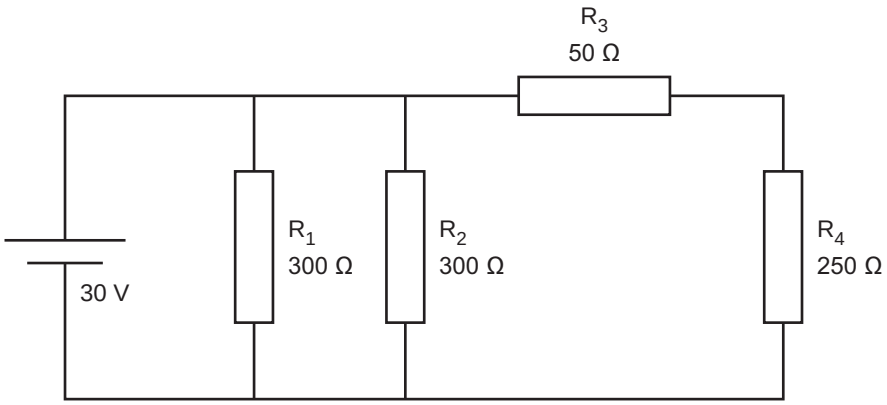


Figure 5

a. Find the total resistance of the circuit. 3 marks

b. Find the current through R_2. 2 marks

c. Find the voltage across R_4. 2 marks

d. Find the current through R_3. 1 mark

Question 7 (11 marks)

a. Figure 6 shows a circuit connected to an oscilloscope.

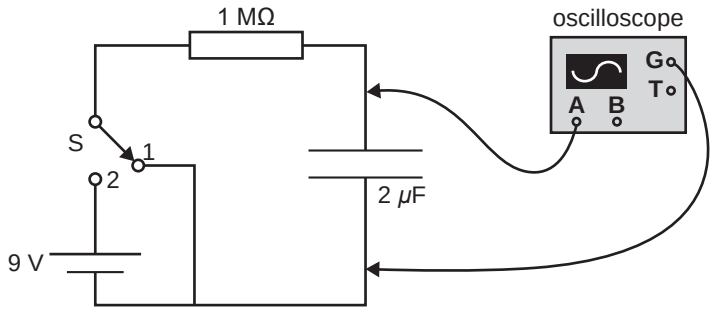


Figure 6

i. Find the time constant of the circuit. 2 marks

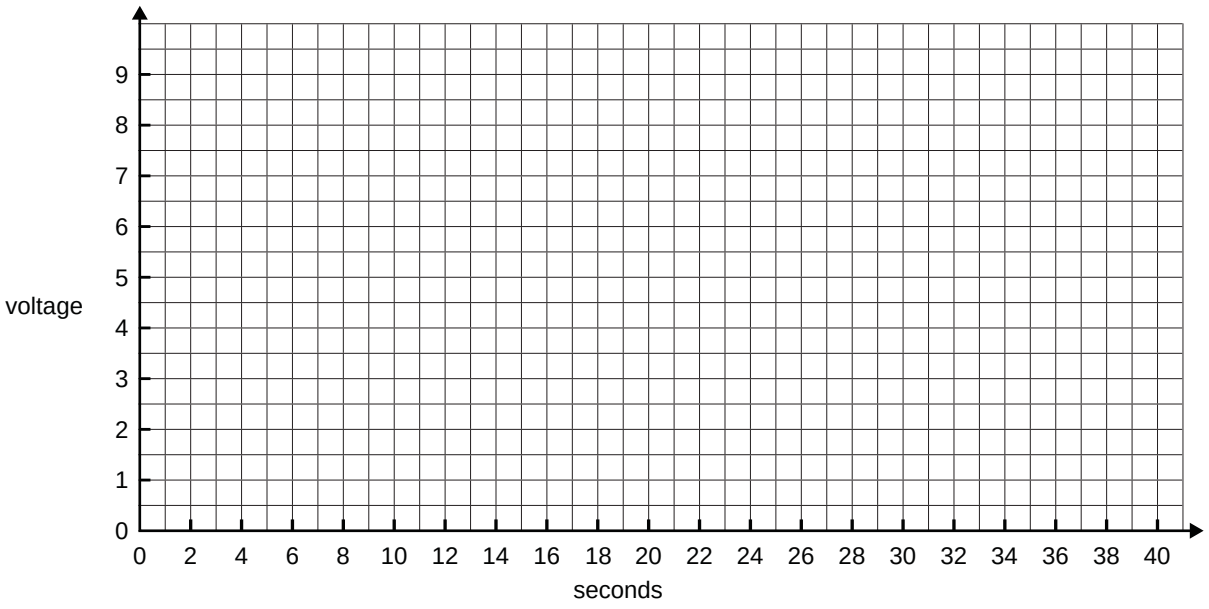
ii. How long does it take the capacitor to fully charge? 1 mark

iii. Initially the switch S is in position 1 and the capacitor is fully discharged. After 5 s, the switch is set to position 2, then after a further 15 s, the switch is reset to position 1. Table 1 below shows this sequence.

Table 1

T (seconds)	0	5	20	30	35
Switch position	1	2	1	1	1

On the graph below, sketch the waveform that will appear on the oscilloscope and show how the capacitor might charge or discharge. 4 marks



b. Find the total capacitance of the circuit in Figure 7. 2 marks

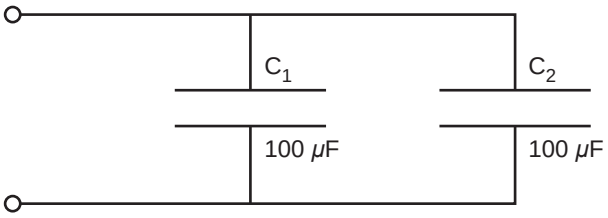


Figure 7

c. Find the total capacitance of the circuit in Figure 8. 2 marks

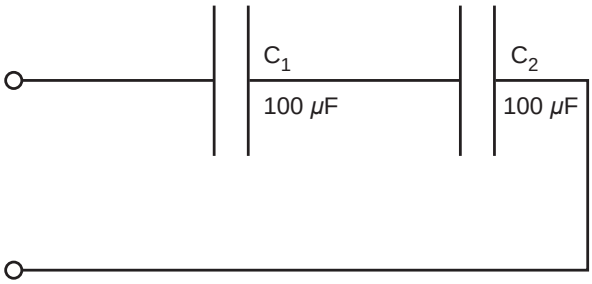


Figure 8

Question 8 (6 marks)

Strain gauges are used to measure stresses on aircraft and to form part of load cells that measure the weight of objects whether in industry or at the supermarket checkout.

A strain gauge is made up of a piece of wire. When stretched, the wire changes its resistance.

A strain gauge forms part of a wheatstone bridge, shown in Figure 9 below, where R_{sg} is the resistance of the strain gauge, R_v is a variable resistor, and R_1 and R_2 are fixed resistors. The output of the bridge feeds a voltage amplifier to detect small changes in the voltage across points A and B.

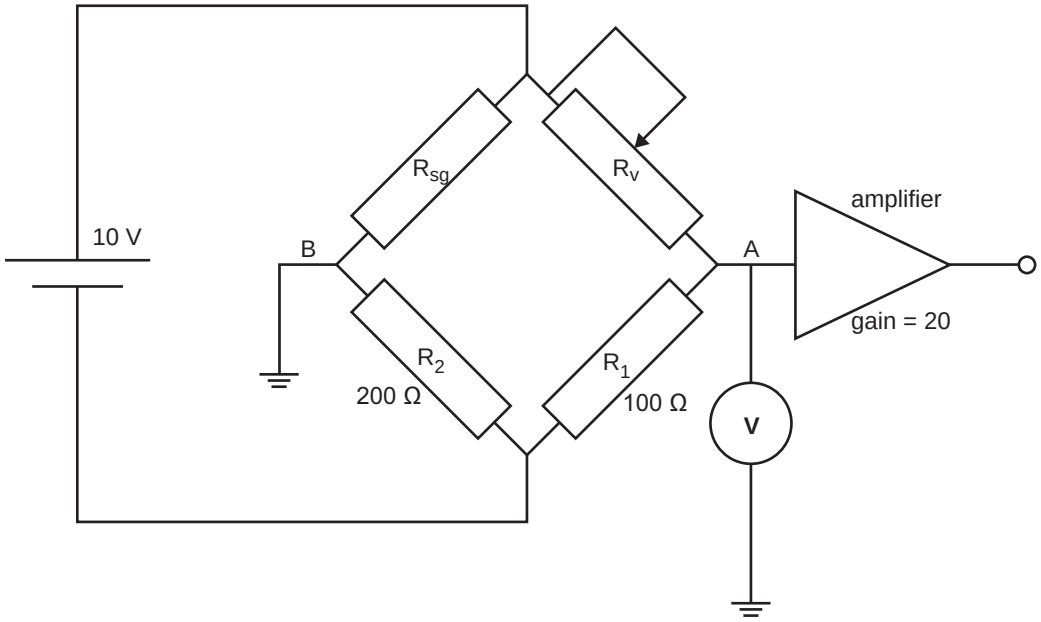


Figure 9

Figure 10 shows the characteristics of the strain gauge resistance wire. It shows the wire's resistance in its non-stretched state and the resistance change as the wire is stretched.

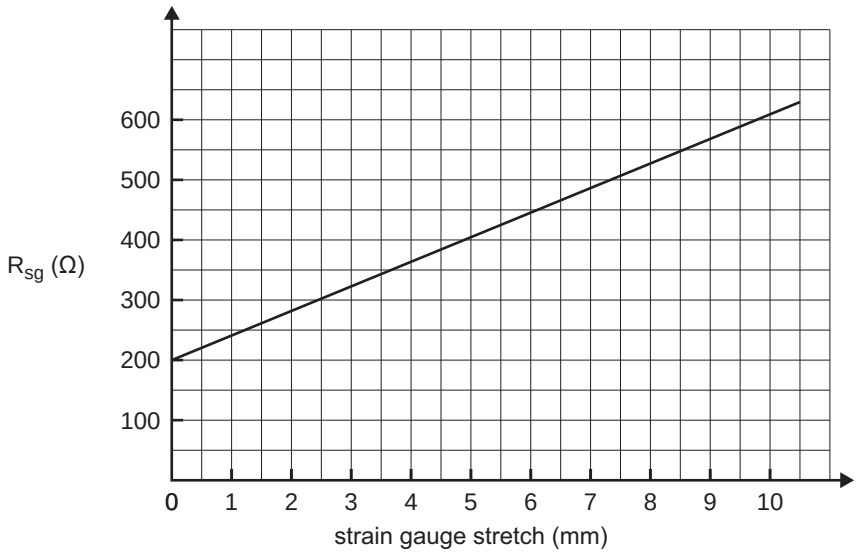


Figure 10

a. The resistance of the strain gauge wire depends on several factors.

What characteristics of the wire will change when the gauge is under stress? 2 marks

b. What effect will temperature have on the wire resistance of the strain gauge? 1 mark

c. In order to measure the stresses on the strain gauge, the system has to be calibrated to produce a reading of 0 V when the strain gauge is at 0 mm (not under any stress). This is done by adjusting resistor R_v.

What will be the value of the resistor R_v when the voltmeter on the output of the bridge reads 0 V? Show your working. 3 marks

Question 9 (9 marks)

Electricity is supplied to the majority of Australian homes at a voltage of 240 V_{AC}. In a particular house, there are a number of electrical devices, including 10 energy-efficient lights, an electric heater, a microwave oven, a portable electric stove, a television, an air conditioner (split system), an electric hot water system, a refrigerator and an electric kettle.

Table 2 shows power usage information for the electrical devices in this house.

Table 2

Device	Power consumption
energy-efficient light globes × 10	14 W each
electric heater	low 1000 W, high 2000 W
microwave oven	max. 1100 W
portable electric stove	max. 2000 W
television	110 W
air conditioner (split system)	max. 4.6 kW
electric hot water system	max. 3.6 kW
refrigerator	max. 550 W
electric kettle	1800 W

There is an extension power board with four power points available. The maximum current of the extension power board is stated as 10 A.

a. If the electric heater is left on high continuously for three days, how much electrical energy will be used (in kWh)? 2 marks

b. Find the current drawn by the kettle when it is switched on. 2 marks

c. Name **one** device that should not be connected using the extension power board. 1 mark

d. Can the microwave oven and portable stove be plugged into the same extension power board? Explain your answer. 2 marks

e. Assume the only load in the house is the electric hot water system.

Of the options below, which one is the appropriate fuse size that will protect the house circuit? Show your working.

3 A 5 A 10 A 15 A 20 A 25 A

2 marks

Question 10 (8 marks)

Alex has moved into a small house on a friend's property. The house is 100 m from the main building. When the sound system, lights and air conditioner are turned on simultaneously, the circuit breaker on the mains switchboard drops out or the lights go dim and nothing seems to work correctly. When the air conditioner is not turned on, turning on some appliances causes the lights to go dim.

Upon further investigation, Alex discovers that the power cable to the small house is a **1 mm^2** 'twin and earth' copper cable.

Figure 11 shows the small house as a resistive load of 10 Ω (appliances are 'on').

The resistivity (ρ) of copper is 1.72×10^{-8} Ωm.

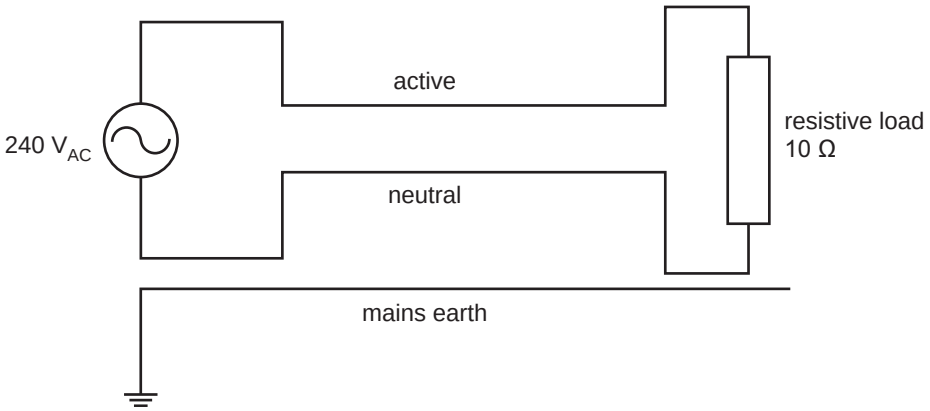


Figure 11

a. Calculate the resistance of the cable. Show your working. 3 marks

b. What will the voltage drop be on the cable? 2 marks

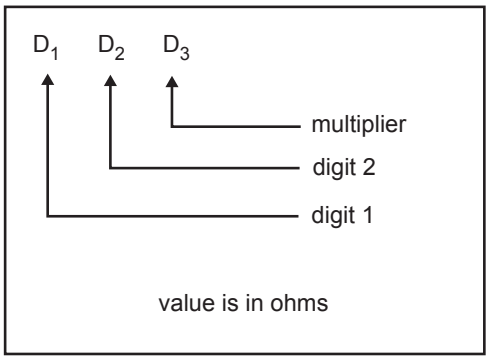
c. How much power is dissipated by the cable? 2 marks

d. How could the voltage drop on the cable be minimised? 1 mark

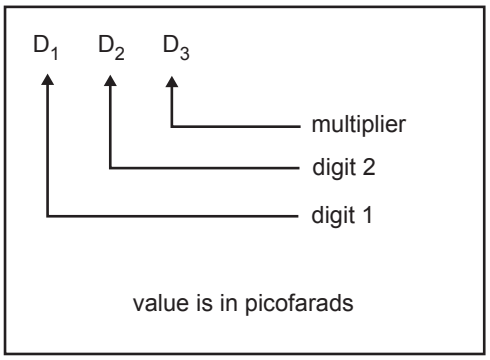
END OF SECTION B

Formula sheet

resistor code



capacitor code



$$R_T = R_1 + R_2 + R_3$$

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

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

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

$$V = I \times R$$

$$P = V \times I$$

$$V_X = V_S\left(\frac{R_X}{R_T}\right)$$

$$V_{PK} = \sqrt{2} \times V_{RMS}$$

$$\text{turns ratio} = \frac{N1}{N2}$$

$$\frac{V_{primary}}{V_{secondary}} = \frac{N_{primary}}{N_{secondary}} = \frac{I_{secondary}}{I_{primary}}$$

$$f = \frac{1}{T}$$

$$V_{STEP} = \frac{V_{max}}{2^n - 1}$$

$$\tau = C \times R$$

$$C = \frac{\varepsilon A}{d}$$

$$C_T = C_1 + C_2 + C_3$$

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

$$Q = V \times C$$

$$W = \frac{1}{2}CV^2$$

$$W = P\,t$$

Resistor colour code

0 black
1 brown
2 red
3 orange
4 yellow
5 green
6 blue
7 violet
8 grey
9 white
gold 5%

$$\text{efficiency } \% = \frac{output}{input} \times 100$$

END OF QUESTION AND ANSWER BOOK