

Mixed Exam Questions – Set 8

1.

- (a) (i) Define gravitational field strength and state whether it is a scalar or vector quantity. [2 marks]

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- (a) (ii) A mass m is at a height h above the surface of a planet of mass M and radius R . The gravitational field strength at height h is g . By considering the gravitational force acting on mass m , derive an equation from Newton's law of gravitation to express g in terms of M , R , h and the gravitational constant G . [2 marks]

- (b) (i) A satellite of mass 2520 kg is at a height of 1.39×10^7 m above the surface of the Earth. Calculate the gravitational force of the Earth attracting the satellite. Give your answer to an appropriate number of significant figures. [3 marks]

force attracting satellite N

(b) (ii) The satellite in part (b)(i) is in a circular polar orbit. Show that the satellite would travel around the Earth three times every 24 hours.

[5 marks]

(c) State and explain **one** possible use for the satellite travelling in the orbit in part (b)(ii).

[2 marks]

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2.

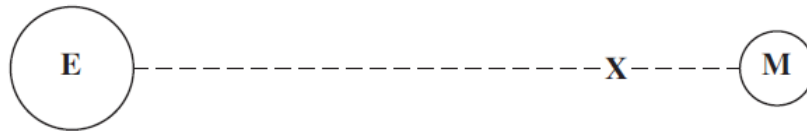
(a) Define the gravitational potential at a point in a gravitational field.

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(2 marks)

(b) **Figure 5**, which is not drawn to scale, shows the region between the Earth (E) and the Moon (M).

Figure 5



(b) (i) The gravitational potential at the Earth's surface is -62.6 MJ kg^{-1} . Point X shown in **Figure 5** is on the line of centres between the Earth and the Moon. At X the resultant gravitational field is zero, and the gravitational potential is -1.3 MJ kg^{-1} .

Calculate the minimum amount of energy that would be required to move a Moon probe of mass $1.2 \times 10^4 \text{ kg}$ from the surface of the Earth to point X. Express your answer to an appropriate number of significant figures.

answer = J
(3 marks)

(b) (ii) Explain why, once the probe is beyond X, no further energy would have to be supplied in order for it to reach the surface of the Moon.

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(1 mark)

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(6 marks)

3.

(a) Name a quantity that has the same unit as potential difference or voltage.
..... [1]

(b) State the electrical unit defined as 'a potential difference of 1 volt per ampere'.
..... [1]

(c) State the SI unit for electrical charge.
..... [1]

(d) State Kirchhoff's first law.
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..... [2]

(e) Fig. 4.1 shows an electrical circuit.

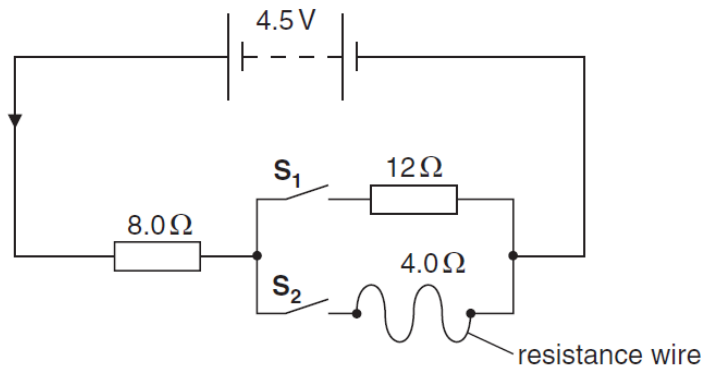


Fig. 4.1

The battery has e.m.f. 4.5V and has negligible internal resistance. The resistance wire has resistance 4.0Ω , length 15cm and cross-sectional area $2.3 \times 10^{-8}\text{m}^2$.

- (i) Suggest how you can arrange switches S_1 and S_2 (e.g. opened or closed) so that the circuit has a total resistance of 12Ω .

.....
..... [1]

(ii) Calculate the resistivity of the material of the resistance wire.

resistivity = unit [4]

(iii) When both switches are **closed**, calculate

1 the **total** resistance of the circuit

resistance = Ω [3]

2 the **total** electrical power delivered by the battery

power = W [3]

3 the ratio

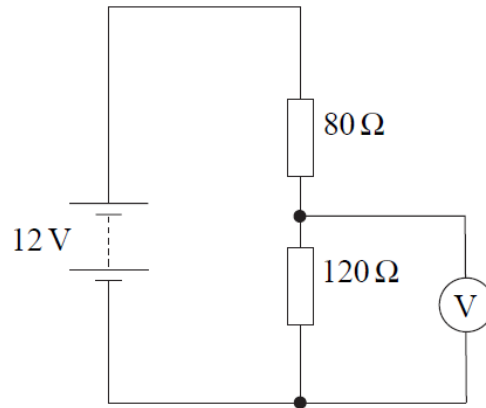
$$\frac{\text{current in the } 12\Omega \text{ resistor}}{\text{current in the resistance wire}}$$

ratio = [1]

4.

- (a) In the potential divider circuit shown in **Figure 2**, the battery has negligible internal resistance.

Figure 2



Calculate the reading on the voltmeter, stating the assumption made.

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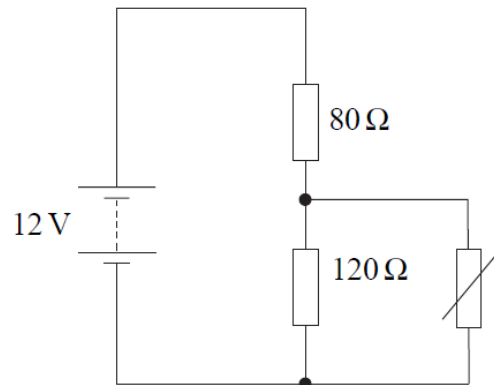
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(3 marks)

- (b) The voltmeter in **Figure 2** is replaced by a thermistor, giving the circuit shown in **Figure 3**.

Figure 3



The resistance of the thermistor at 0°C is $120\ \Omega$. As the temperature increases, its resistance decreases. Explain, without calculation, whether the current through the battery increases or decreases as the temperature of the thermistor is increased from 0°C .

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

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(3 marks)

5.

A student wishes to collect data so he can plot the I - V curve for a semiconductor diode.

- (a) (i) Draw a suitable diagram of the circuit that would enable the student to collect this data.

(3 marks)

- (a) (ii) Describe the procedure the student would follow in order to obtain an I - V curve for the semiconductor diode.

The quality of your written communication will be assessed in this question.

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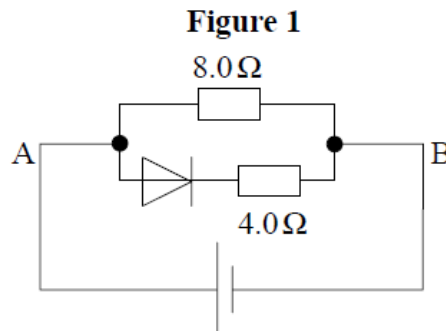
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(6 marks)

(b) **Figure 1** shows an arrangement of a semiconducting diode and two resistors.



A 12.0 V battery is connected with its positive terminal to A and negative terminal to B.

(b) (i) Calculate the current in the 8.0 Ω resistor

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answerA
(2 marks)

(b) (ii) Calculate the current in the 4.0 Ω resistor if the p.d. across the diode, when in forward bias, is 0.65 V expressing your answer to an appropriate number of significant figures.

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answerA
(3 marks)

6.

(a) The I/V characteristic of a particular component is shown in Fig. 1.1.

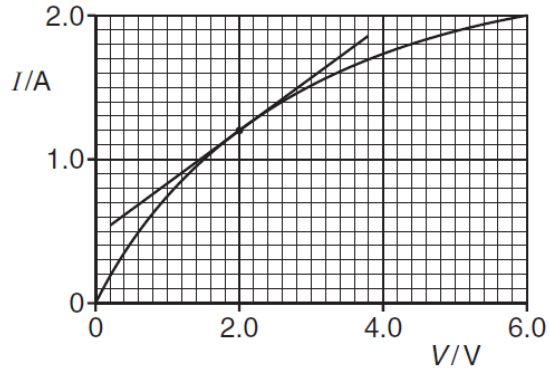


Fig. 1.1

(i) Name the component.

..... [1]

(ii) According to one student, the 'gradient of the graph at 2.0V can be used to determine the resistance of the component at 2.0V'. Explain why the student is wrong.

.....
..... [1]

(iii) Determine the resistance of the component at 2.0V.

resistance = Ω [2]

- (b) Fig. 1.2 shows a sketch graph of the variation of resistance R of a different component with potential difference (voltage) V .

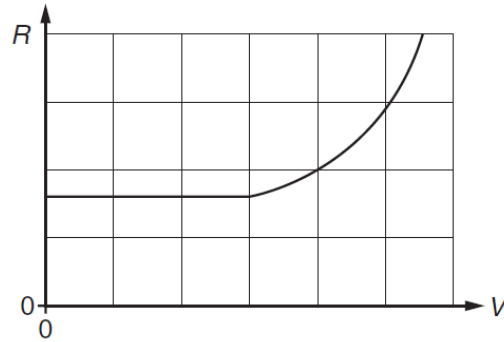


Fig. 1.2

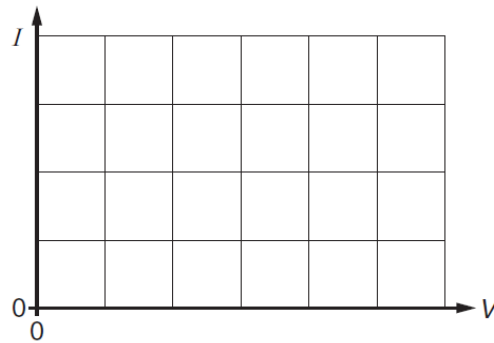


Fig. 1.3

Complete Fig. 1.3 by drawing a sketch graph to show the I/V characteristic of the component. [2]

- (c) Fig. 1.4 shows an electrical circuit containing a semiconductor diode.

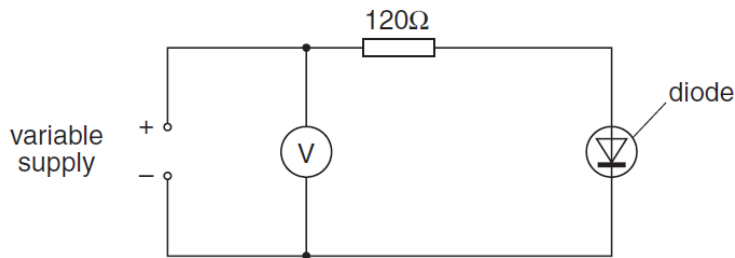


Fig. 1.4

This diode has a very low resistance when it conducts. It has an infinite resistance when the potential difference across it is less than 0.6V. The variable supply is adjusted to give a reading of 0.4V on the voltmeter.

- (i) State the current in the 120Ω resistor.

current = A [1]

(ii) State the potential difference across the diode.

potential difference = V [1]
