Centre Number

71	

Candidate Number

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2013

Physics

Assessment Unit AS 1

assessing

Module 1: Forces, Energy and Electricity

[AY111]

AY111

FRIDAY 11 JANUARY, AFTERNOON

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.
Quality of written communication will be assessed in question **5(i) and (ii)**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question.
Your attention is drawn to the Data and Formulae Sheet which is inside this question paper.
You may use an electronic calculator.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total Marks	

1 **(a)** All physical quantities consist of a magnitude and a unit. Express each of the physical quantities given in **Table 1.1** using the alternative unit indicated. The first has been completed as an example.

Examiner Only	
Marks	Remark

Table 1.1

	Quantity	**Magnitude**	**Alternative Unit**
e.g.	2.42 m	*242 or* 2.42×10^2	cm
(i)	863 μF		F
(ii)	7.34×10^5 V		kV
(iii)	4.82×10^{-7} MJ		mJ

[3]

(b) Complete **Table 1.2** by adding the **name** of the base quantity or the **name** of the base unit as appropriate.

Table 1.2

	Base Quantity	**Base Unit**
(i)	Temperature	
(ii)		mole
(iii)	Electric current	

[3]

(c) A helical spring has a mass m attached to one end. This produces a force F in the spring. The mass is then displaced and released causing it to oscillate. **Equation 1.1** represents the relationship for the periodic time T of a mass–spring system.

$$T = 2\pi\sqrt{\frac{mx}{F}} \qquad \textbf{Equation 1.1}$$

Determine the base units of the term x.

Base units of x = _______________ [2]

Examiner Only	
Marks	Remark

2 A ball bearing is propelled up a 3.00 m long frictionless ramp. It is released with an initial velocity of 3.60 m s^{-1} at a point 1.40 m from the foot of the ramp (0.00 m) and reaches a maximum distance of 2.60 m from the foot of the ramp, as shown in **Fig. 2.1**.

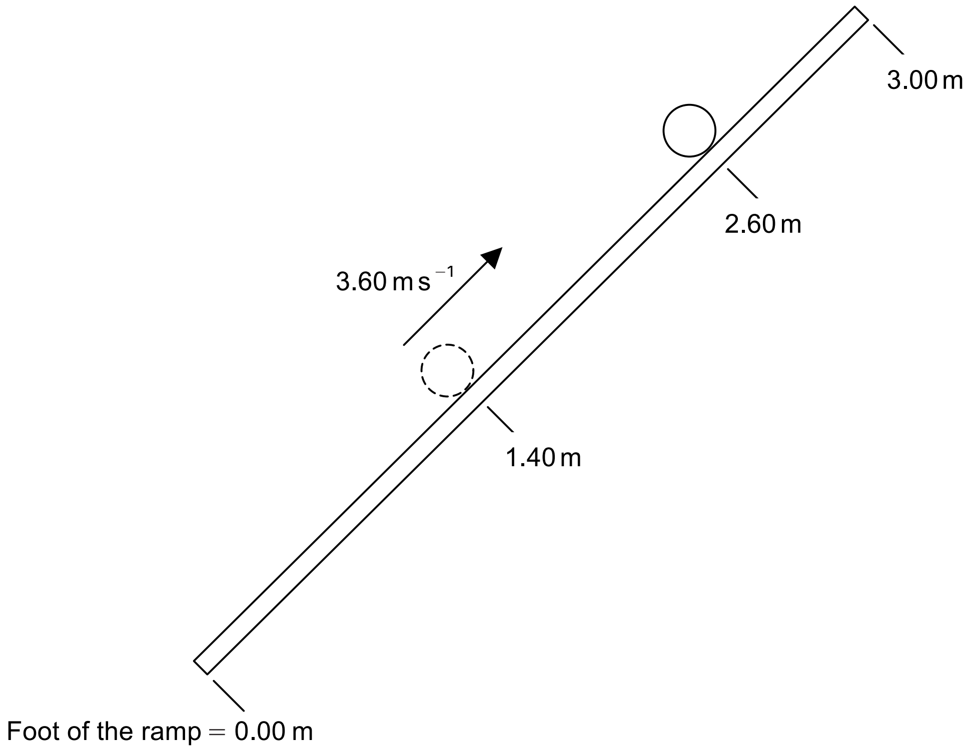

Fig. 2.1

(a) (i) Show that the deceleration of the ball bearing is 5.40 m s^{-2}.

[2]

(ii) Calculate the distance of the ball bearing **from the foot of the ramp** after 1.60 s.

Distance = _______________ m [4]

Examiner Only	
Marks	Remark

(b) On the axes of **Fig. 2.2**, sketch the velocity–time graph for the motion of the ball bearing during the 1.60 s described in part **(a)**.

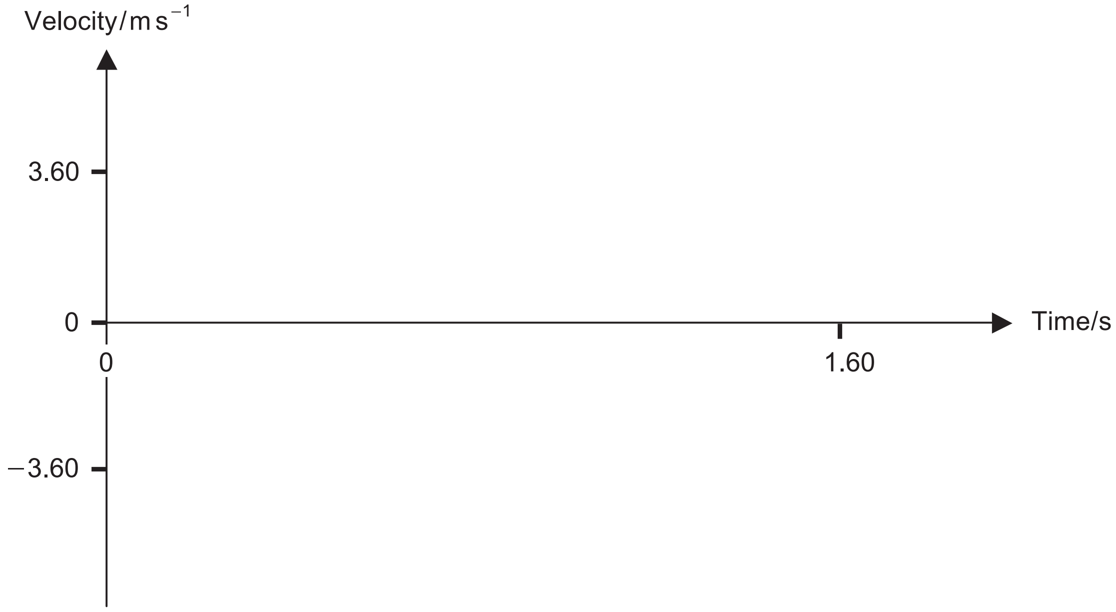

Fig. 2.2

[2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

3 A block of wood of mass 0.450 kg sits on a table. It experiences a force of 4.00 N acting horizontally in one direction and another of 6.00 N also acting horizontally, but in a perpendicular direction to the 4.00 N force as shown in **Fig. 3.1**.

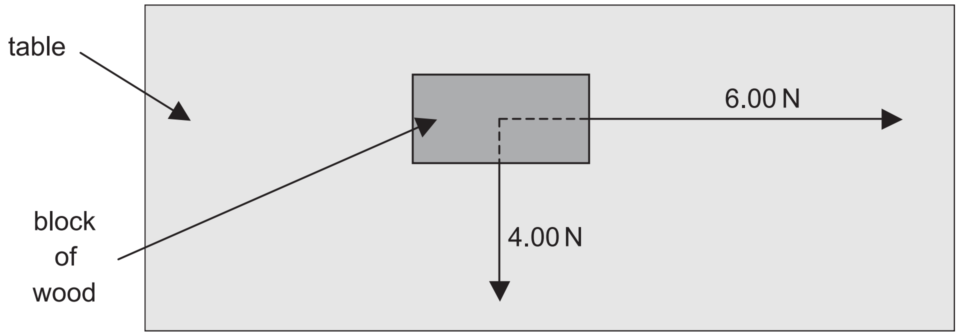

Fig. 3.1

(a) (i) Determine the magnitude of the resultant of the two forces acting on the wooden block.

Resultant = _________________ N [2]

(ii) Hence, determine the expected acceleration of the wooden block.

Acceleration = _________________ $m\,s^{-2}$ [2]

(b) The movement of the wooden block is investigated using a motion data logger. The velocity–time graph obtained from the data is shown in **Fig. 3.2**.

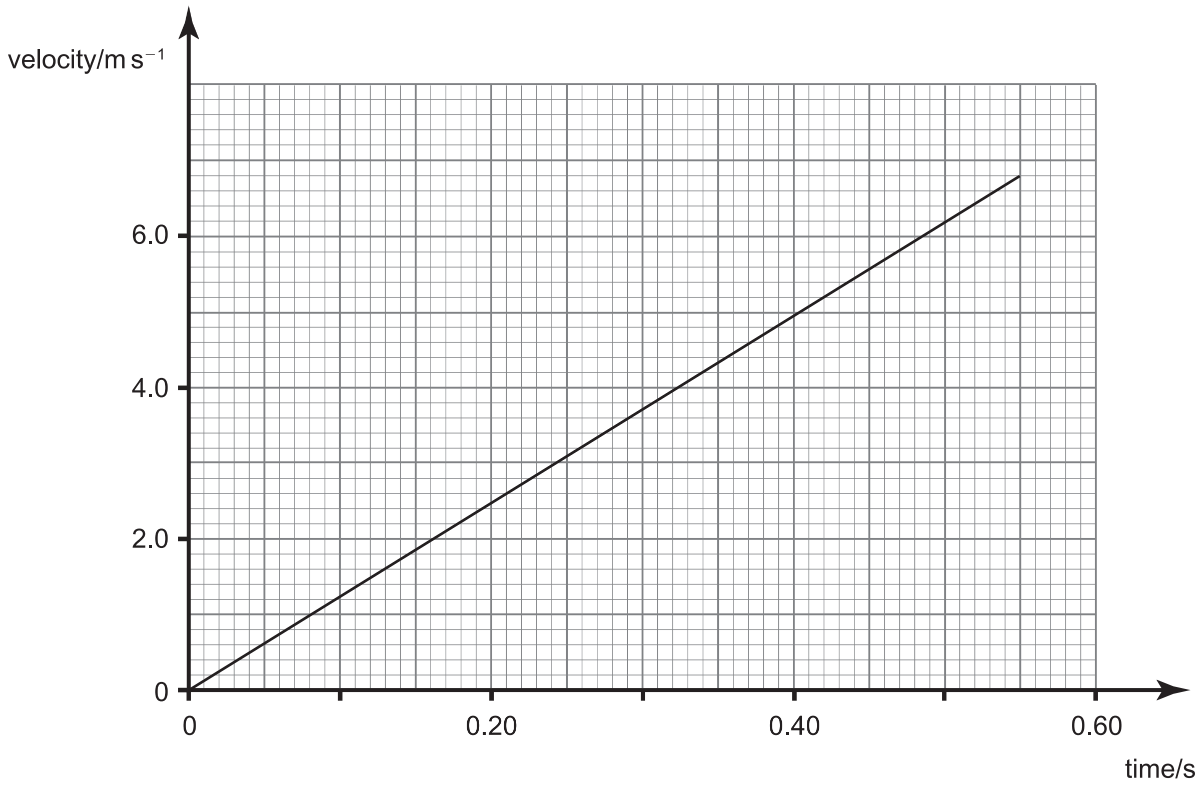

Fig. 3.2

(i) Determine the actual acceleration of the wooden block from the velocity–time graph in **Fig. 3.2**.

Acceleration = ________________ m s^{-2} [2]

(ii) Calculate the magnitude of the frictional force acting between the wooden block and the table during the movement of the wooden block.

Friction = ________________ N [2]

Examiner Only	
Marks	Remark

4 A town is built on the slopes of a river valley. A cable car connects the Low Town with the High Town. **Fig. 4.1** represents the arrangement of the railway.

Examiner Only	
Marks	Remark

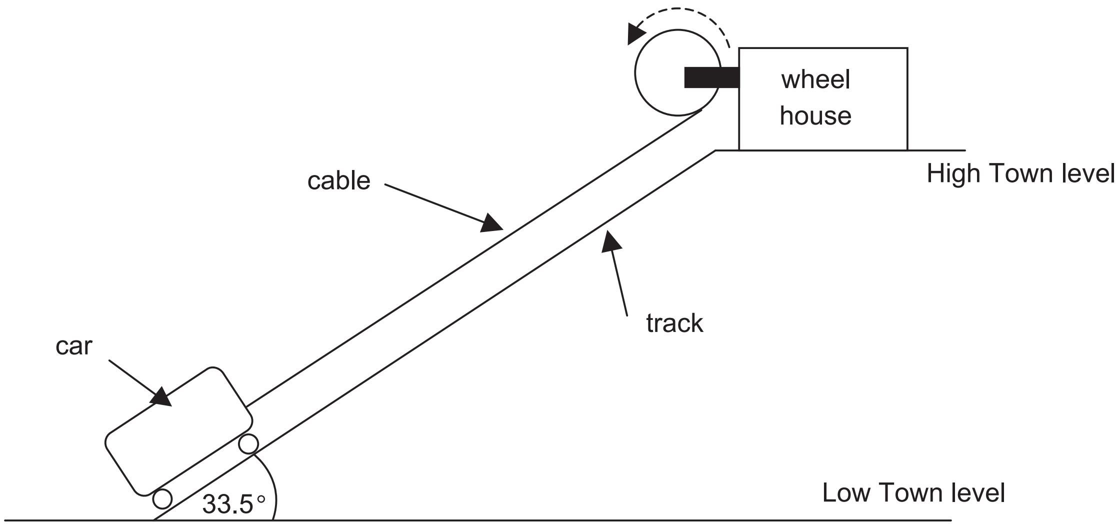

Fig. 4.1

(a) The electric motor, in the wheel house, operates with a power of 15.3 kW to cause the car to move up the track with a steady velocity of 0.44 $m\,s^{-1}$. Calculate the tension in the cable.

Tension = ________________ N [3]

(b) Calculate the additional potential energy the fully laden car has in High Town compared to Low Town. The mass of the fully laden car is 5.50×10^3 kg and the track length is 163 m.

Additional potential energy = ________________ J [3]

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(Questions continue overleaf)

In parts (i) and (ii) of this question you will be tested on the quality of your written communication. Where possible you should answer in continuous prose.

Examiner Only	
Marks	Remark

5 The arrangement shown in **Fig. 5.1** is used to determine the Young modulus of aluminium.

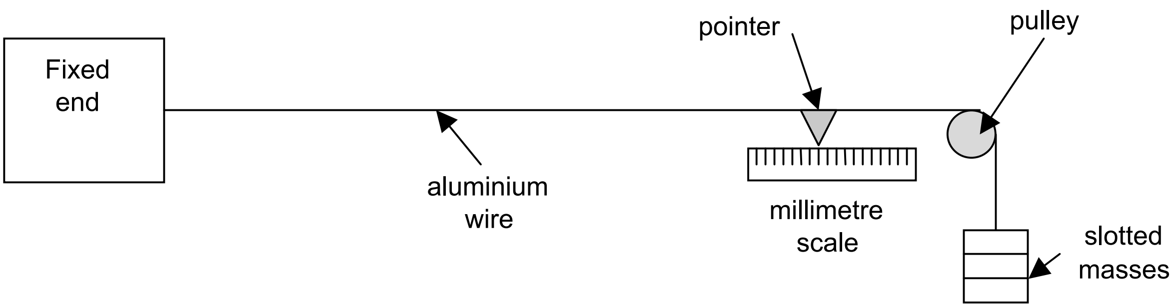


Fig. 5.1

(i) The sample of aluminium used is a wire of uniform cross-sectional area $1.66 \times 10^{-7}\,m^2$. Describe how this area may be determined experimentally.

____

____

____ [3]

(ii) State all other values required in order to determine the Young modulus and describe how, referring to the arrangement in **Fig. 5.1**, those values are obtained.

____

____

____

____

____

____ [3]

Quality of written communication [2]

(iii) A series of values is obtained from the arrangement shown in **Fig. 5.1** and the graph in **Fig. 5.2** is drawn.

Examiner Only	
Marks	Remark

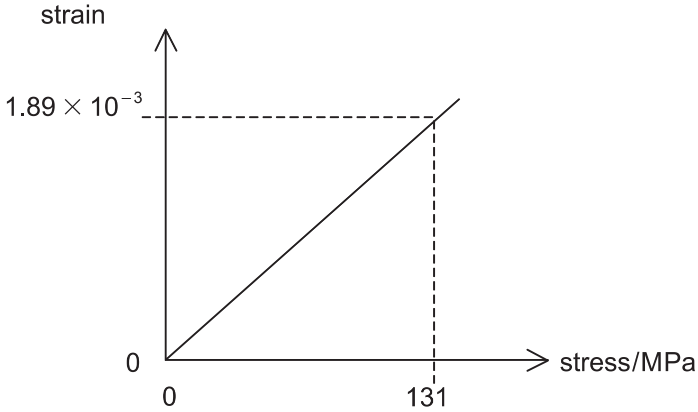


Fig. 5.2

Use data from **Fig. 5.2** to determine the Young modulus of aluminium. Include the unit.

Young modulus = ________________ [2]

Unit = ________________ [1]

6 (a) State Hooke's Law.

____

____

____ [2]

(b) A 3.40 m long wire extends 23.0 mm when a tensile force of 54.0 N is applied.

(i) Assuming the wire obeys Hooke's Law, calculate the stiffness constant (force constant) for the wire and give its unit.

Stiffness constant = ________________ [2]

Unit = ________________ [1]

The 54.0 N force is removed and a new force of 44.0 N is applied.

(ii) Calculate the **total length** of the wire when a tensile force of 44.0 N is applied. Give your answer to 3 significant figures.

Length = ________________ m [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

7 **(a)** Of what are the following definitions:

(i) ***"the amount of energy converted to electrical energy when unit charge passes through."***

is a definition of _______________ [1]

(ii) ***"the rate of flow of charge."***

is a definition of _______________ [1]

(iii) ***"one joule of energy is dissipated per coulomb of charge."***

is a definition of _______________ [1]

(b) An electric drill has a power rating of 1200 W and is connected to a 230 V supply. It is used continuously for 4.0 minutes.

(i) Calculate the size of the current flowing in the electric drill.

Current = _______________ A [3]

(ii) Calculate the charge flowing past a point in the electric circuit of the drill during the 4.0 minutes that it is switched on.

Charge = _______________ C [3]

(iii) Calculate the total amount of electrical energy used by the drill in this time.

Electrical energy = _______________ kJ [3]

8 **(a)** The current–voltage characteristic of a negative temperature coefficient (ntc) thermistor is shown in **Fig. 8.1**.

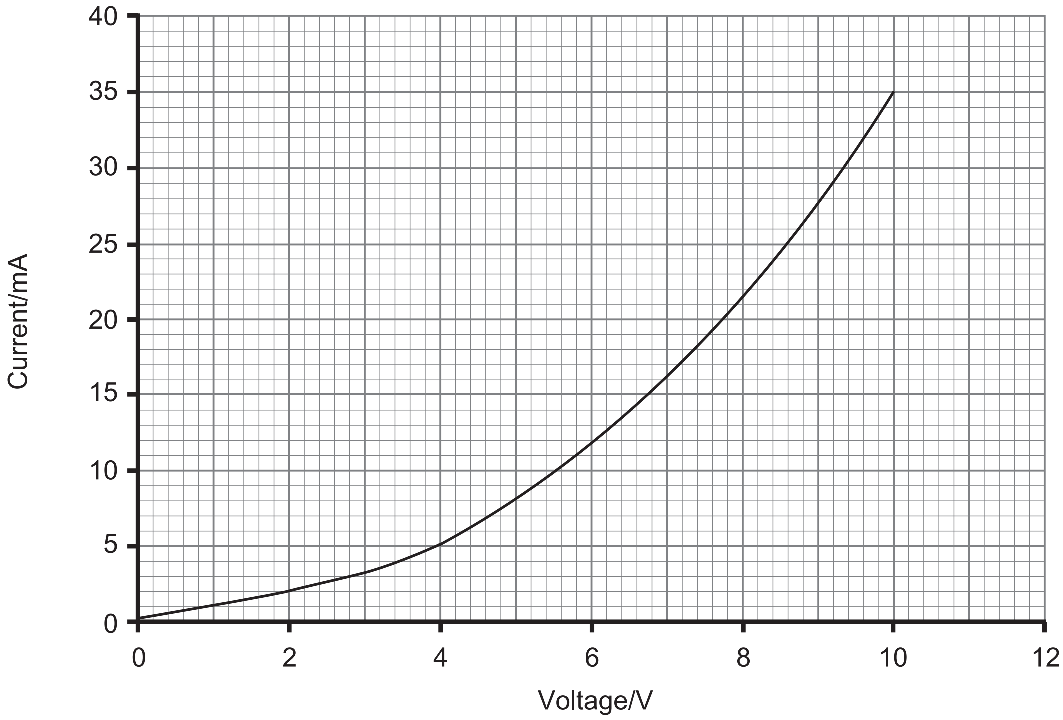
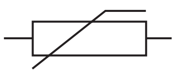


Fig. 8.1

(i) In the space below, draw a circuit diagram that would provide the data from which **Fig. 8.1** could be produced. The symbol for the thermistor has been provided.



[3]

(ii) Explain how **Fig. 8.1** identifies the thermistor as displaying non-ohmic behaviour.

____

____ [1]

Examiner Only	
Marks	Remark

(b) (i) On the axes of **Fig. 8.2**, sketch a graph to show the variation of the resistance of an ntc thermistor with temperature.

Fig. 8.2

[1]

(ii) In terms of molecular theory, explain why the resistance of the ntc thermistor varies with temperature as you have sketched on **Fig. 8.2**.

____

____ [2]

Examiner Only	
Marks	Remark

9 **(a)** **Fig. 9.1** shows a simple d.c. circuit.

Examiner Only	
Marks	Remark

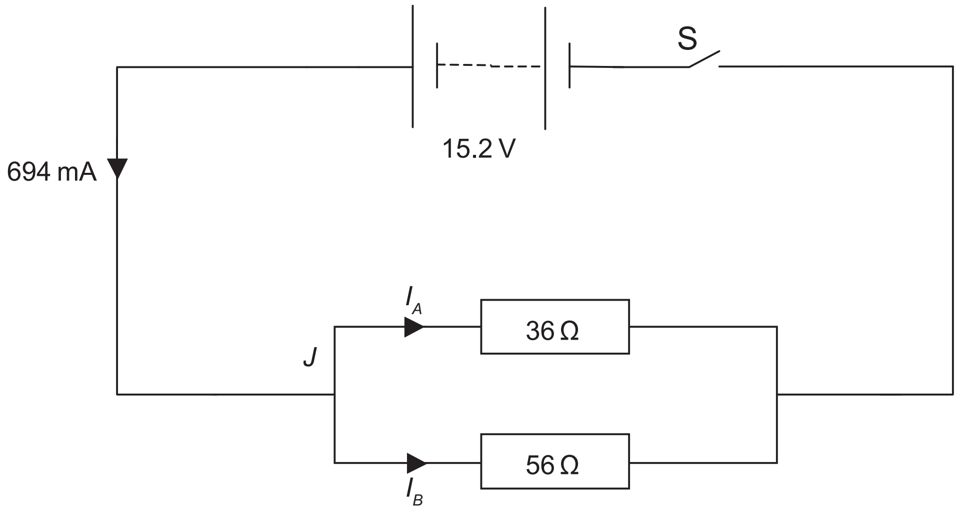


Fig. 9.1

(i) When the switch, S, is closed, deduce the current passing through each of the resistors.

I_A = _______________ mA

I_B = _______________ mA [2]

(ii) Explain how the conservation of charge applies at junction *J* in **Fig. 9.1**.

____

____

____ [2]

(b) A battery of negligible internal resistance and e.m.f. *E* is connected across a circuit containing four equal resistors as shown in **Fig. 9.2**.

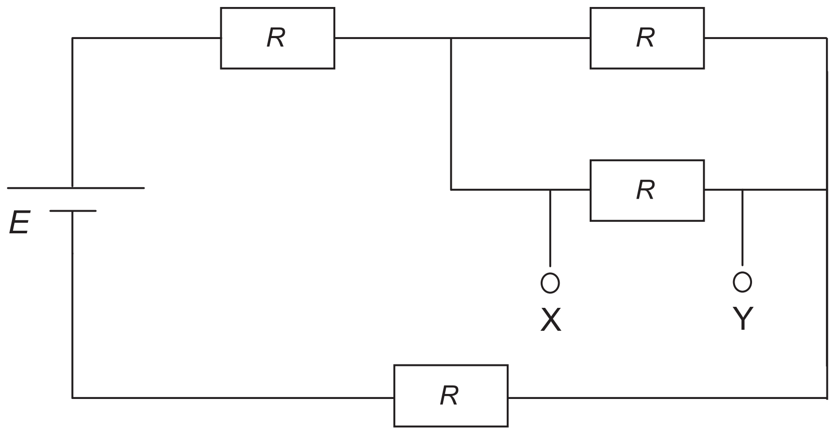


Fig. 9.2

(i) Find the total circuit resistance in terms of *R*.

Circuit resistance = ________________ [2]

(ii) Determine the potential difference between X and Y in terms of the e.m.f. *E*.

Potential difference = ________________ [2]

THIS IS THE END OF THE QUESTION PAPER

113604

GCE (AS) Physics

Data and Formulae Sheet

Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall on the Earth's surface	$g = 9.81$ m s^{-2}
electron volt	1 eV $= 1.60 \times 10^{-19}$ J

Useful formulae

The following equations may be useful in answering some of the questions in the examination:

Mechanics

Conservation of energy $\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs$ for a constant force

Hooke's Law $F = kx$ (spring constant k)

Sound

Sound intensity level/dB $= 10 \lg_{10} \frac{I}{I_0}$

Waves

Two-source interference $\lambda = \frac{ay}{d}$

Light

Lens formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

Magnification $m = \frac{v}{u}$

Electricity

Terminal potential difference $V = E - Ir$ (e.m.f. E; Internal Resistance r)

Potential divider $V_{out} = \frac{R_1 V_{in}}{R_1 + R_2}$

Particles and photons

de Broglie equation $\lambda = \frac{h}{p}$

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