GCE AS/A Level

1321/01 – LEGACY

PHYSICS – PH1

MOTION, ENERGY AND CHARGE

A.M. TUESDAY, 24 May 2016

1 hour 30 minutes plus your additional time allowance

Surname _____

Other Names _____

Centre Number _____

Candidate Number 2 _____

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	9	
2.	11	
3.	12	
4.	15	
5.	11	
6.	11	
7.	11	
Total	80	

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator and a DATA BOOKLET.

INSTRUCTIONS TO CANDIDATES

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces provided on the front cover.

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The total number of marks available for this paper is 80.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

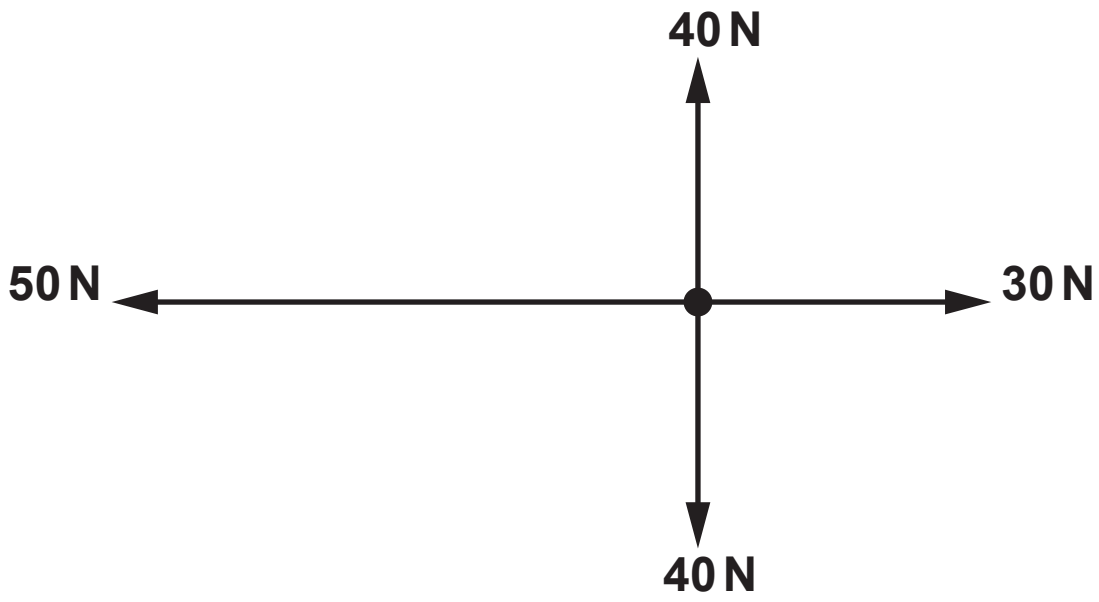
You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

Answer ALL questions.

1(a) **Newton's second law of motion can be expressed by the equation:**

$$\sum F = ma$$

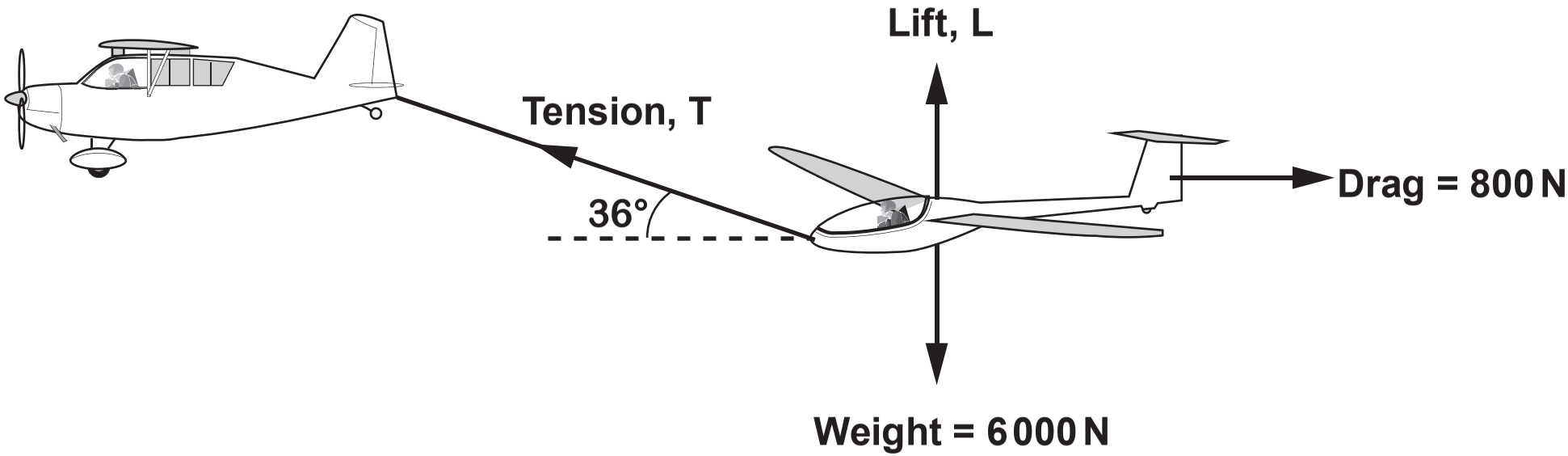
Showing your reasoning, determine $\sum F$ in the free body diagram below. [2]



1(b) **A glider is being towed HORIZONTALLY through the air AT CONSTANT VELOCITY. The diagram opposite shows the forces acting on the glider.**

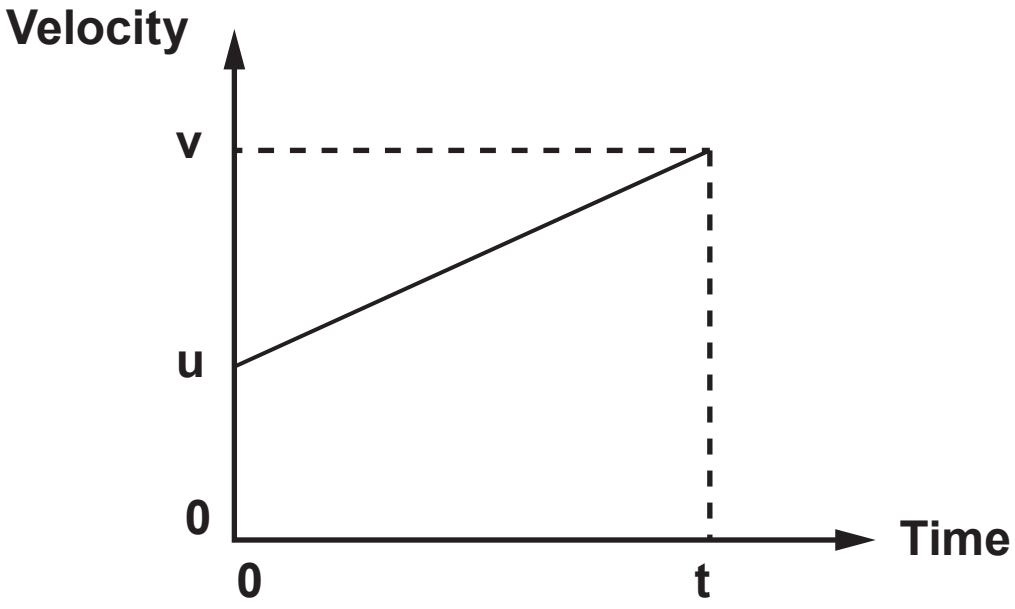
(i) **Calculate the tension, *T*, in the tow line. [2]**

(ii) **Calculate the lift force, *L*, on the glider. [3]**


Lift, L
Tension, T
36°
Drag = 800 N
Weight = 6000 N

1(c) The power used to tow the glider is 40 kW. Determine the horizontal velocity of the towing aircraft. [2]

2(a) **A velocity-time graph is given for a body which is accelerating.**

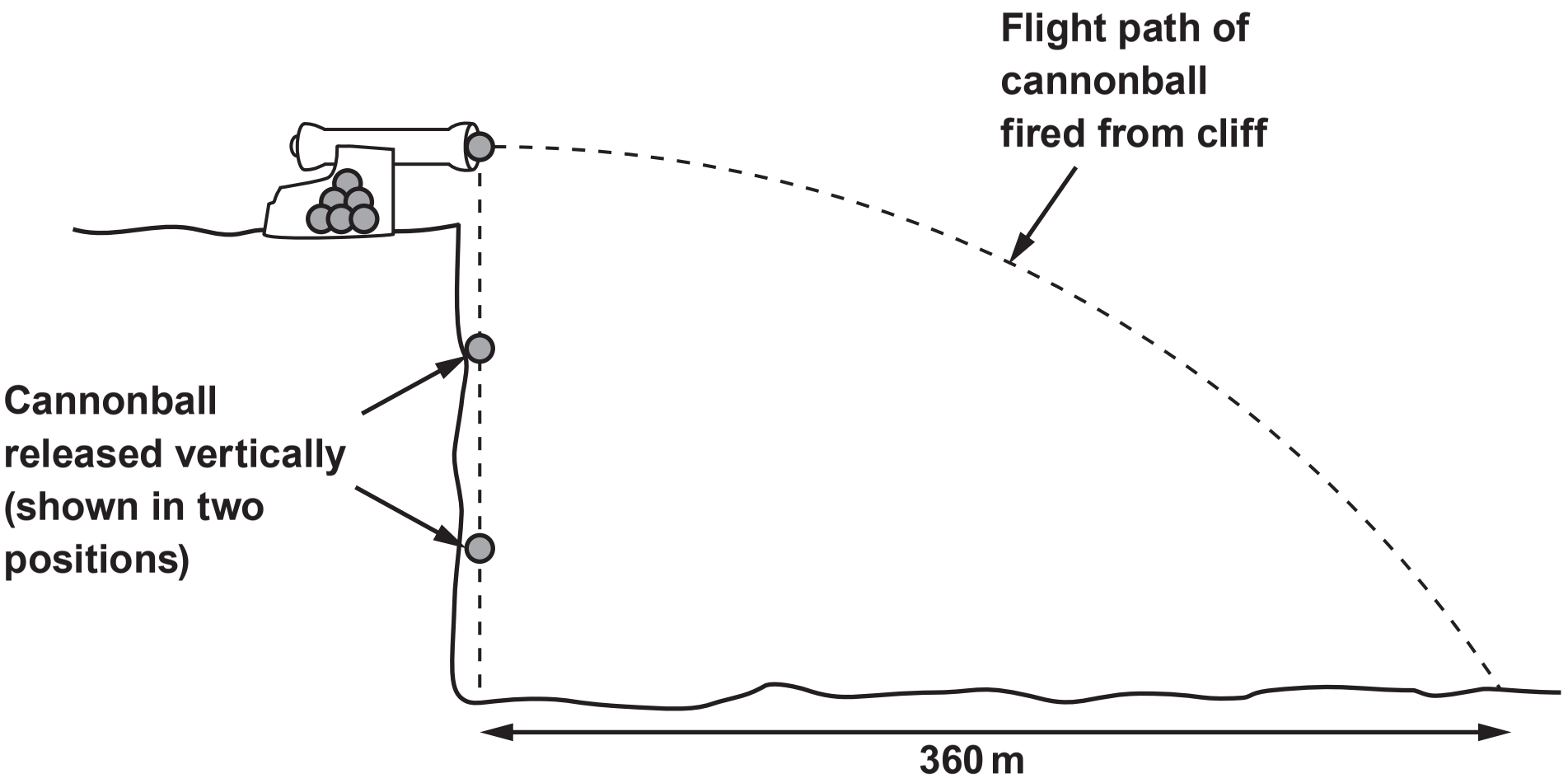


Using the symbols given on the graph, show that:

$v = u + at$ **[2]**

2(b) **The flight path for a cannonball fired horizontally from the top of a cliff is shown opposite. AT THE SAME INSTANT, a second cannonball is released and falls vertically from the same initial height. The second cannonball is shown at two positions during its descent.**

(i) **Draw on the diagram the expected positions of the fired cannonball at the same instants as EACH of the positions indicated by the dropped cannonball. Explain your reasoning. Ignore air resistance. [3]**


Flight path of cannonball fired from cliff
Cannonball released vertically (shown in two positions)
360 m

2(b) (ii) **The cannonball fired from the cannon impacts with the ground 3.20 s after being fired.**

I. Calculate the height from which the cannonball was fired. [2]

2(ii) II. Calculate the velocity with which the FIRED cannonball impacts with the ground. [4]

3. A passenger at an airport pulls a travel case as shown.

(a) When the passenger is stationary, a free body diagram for the travel case is shown opposite. It is held at rest by the passenger's hand at H and its centre of gravity is at G. The mass of the case is 8.5 kg.

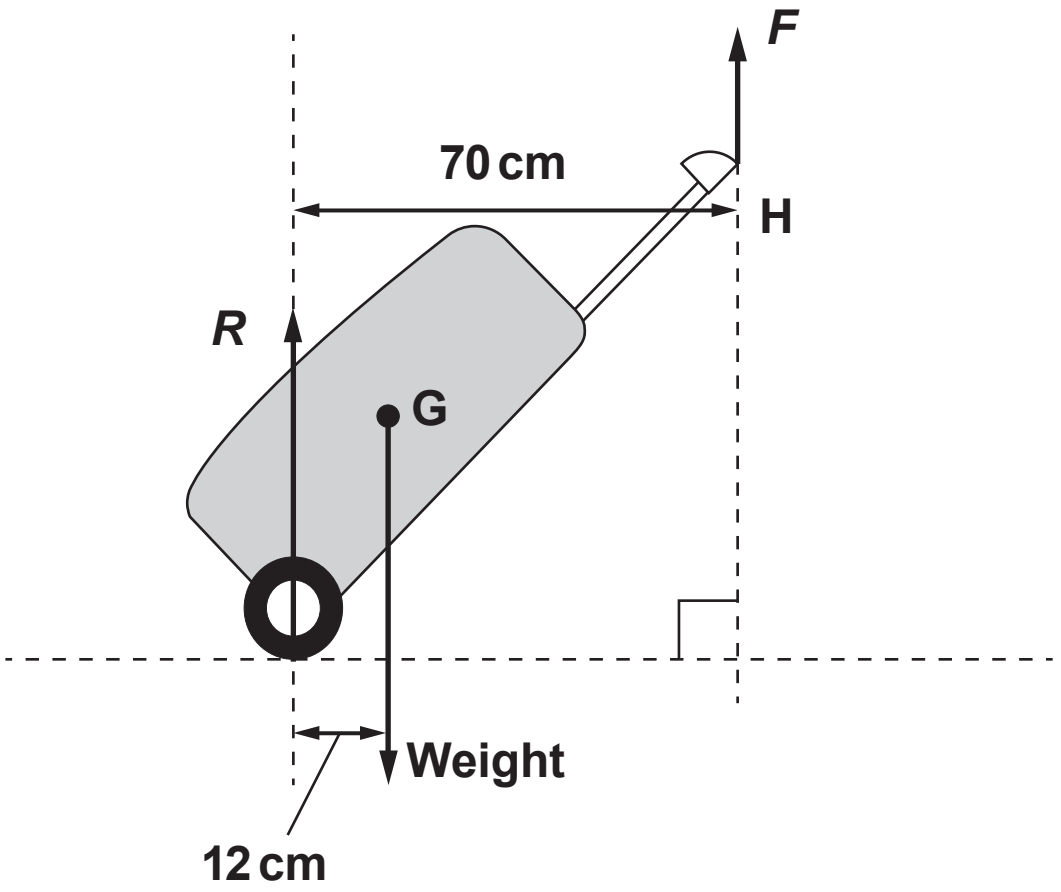
(i) Define the MOMENT OF A FORCE. [1]

_____

_____

_____

_____


F
70 cm
H
R
G
Weight
12 cm

3(a) (ii) **Calculate the size of the upward pull, *F*, of the hand on the case. [3]**

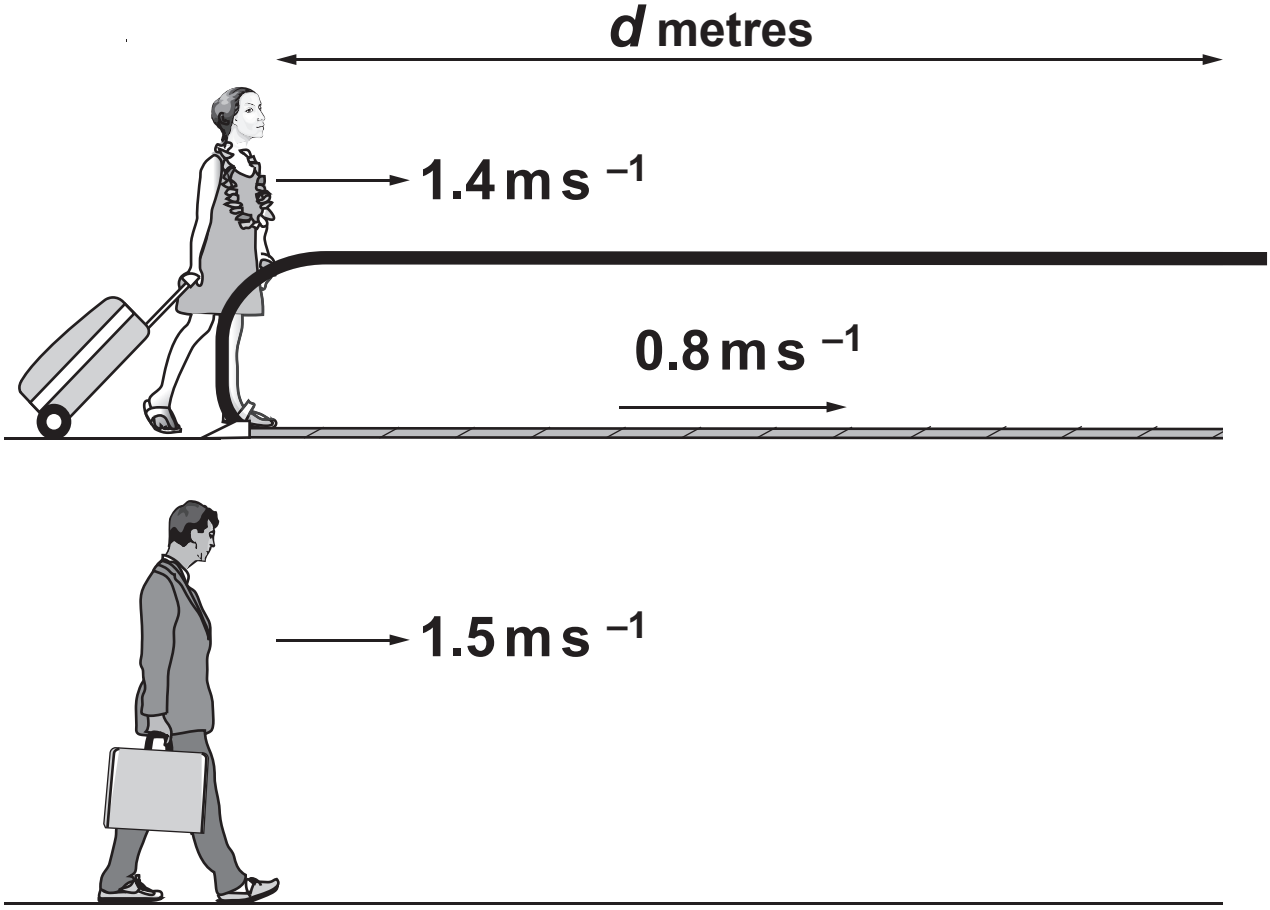
(iii) **Calculate the value of *R*, the force of the ground on the case. [1]**

3(a) (iv) **Explain how repacking the case so as to move the centre of gravity further away from the wheel would affect the size of force *F*. [2]**

3(b) **Study the diagram opposite.**
The passenger now walks at $1.4\,\mathrm{m\,s^{-1}}$ onto a walkway of length d metres which is itself moving at $0.8\,\mathrm{m\,s^{-1}}$. At the instant she steps on the walkway, another passenger initially alongside decides not to take the walkway, but instead walks alongside it at a speed of $1.5\,\mathrm{m\,s^{-1}}$. The passenger on the walkway takes a time, t, to reach the end. The passenger walking alongside takes an ADDITIONAL 14 SECONDS before reaching the end of the walkway.

(i) **Write down an expression for the distance, d, travelled by the passenger on the walkway. [1]**

(ii) **Write down an expression for the distance, d, travelled by the passenger walking alongside the walkway. [1]**


d metres
1.4 m s −1
0.8 m s −1
1.5 m s −1

3(b) (iii) **Hence, determine the length, d, of the walkway. [3]**

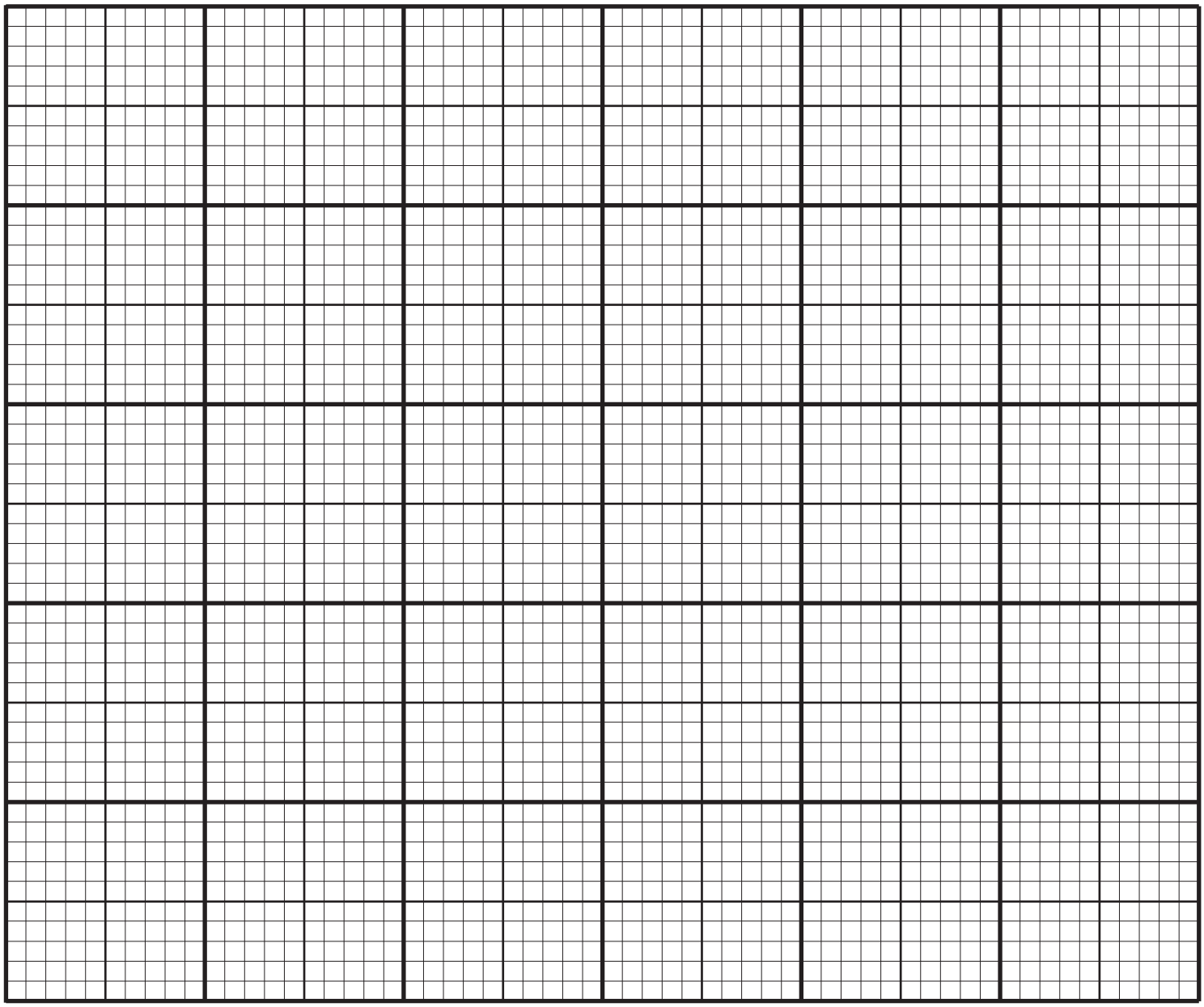
4(a) **A student is asked to carry out an experiment to determine the resistivity of tin in the form of a wire.**

As a first step the student takes readings of the current in the wire against applied potential difference. The results are shown in the table.

Applied pd / V	0.10	0.20	0.30	0.40	0.50	0.60
Current / A	0.08	0.16	0.24	0.32	0.40	0.48

(i) **Draw a circuit diagram of the arrangement that could have been used to obtain the readings.** **[2]**

(ii) **Plot a graph on the grid opposite of current (y-axis) against potential difference (x-axis).** **[2]**



4(a) (iii) **The student measures the length of the wire to be 1.45 m and the DIAMETER to be 4.0×10^{-4} m. Show that the resistivity of tin is approximately $1 \times 10^{-7}\ \Omega$ m. [3]**

(iv) **DRAW ON THE SAME GRID (opposite page 17) the current against potential difference graph for a metal wire of the same length and diameter but with DOUBLE the resistivity of tin. [1]**

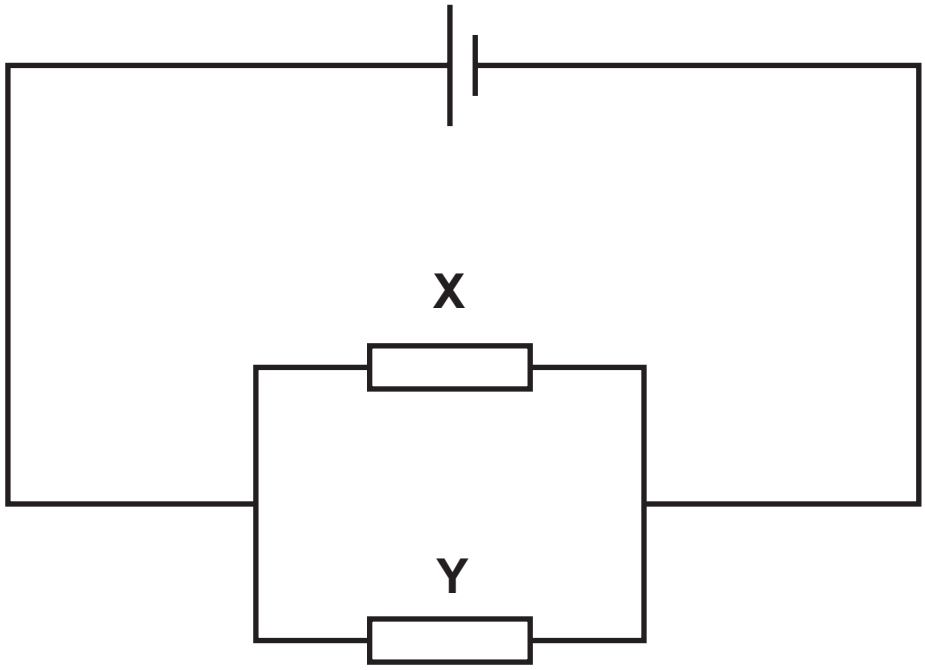
4(b) (i) Calculate the mass of wire used in the experiment given that the density of tin is $7\,310\,\text{kg}\,\text{m}^{-3}$. [2]

(ii) Determine the total number of free electrons in this wire given that an atom of tin has a mass of 1.97×10^{-25} kg and each atom contributes 4 free electrons. [2]

4(b) (iii) **Calculate the mean drift velocity of the electrons in the wire when the current in it is 0.32 A. [3]**

5(a) In the following circuits the resistance of X is GREATER THAN the resistance of Y.

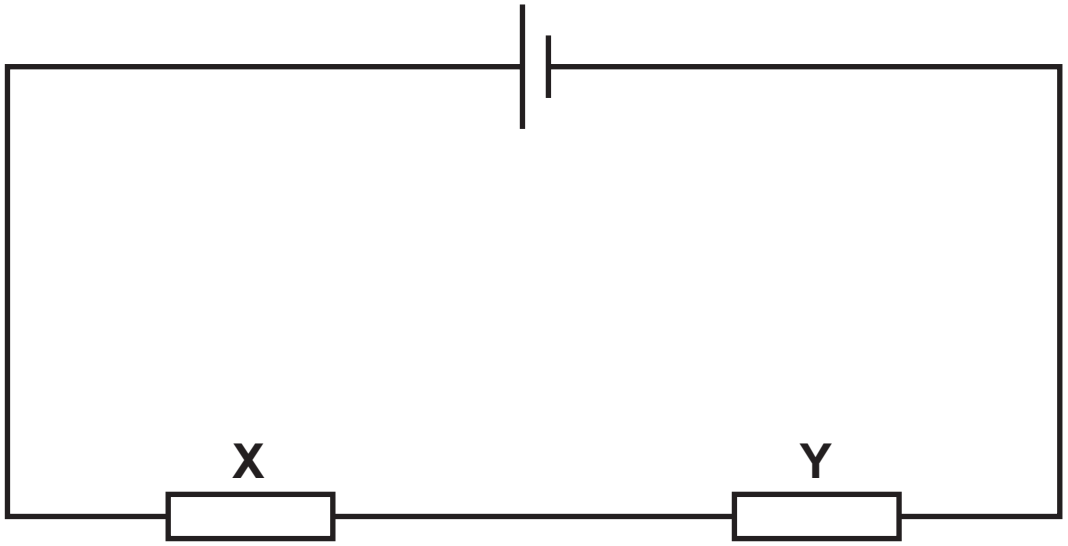
CIRCUIT A



(i) For Circuit A, compare the current through, and the potential difference across X and Y. [1]

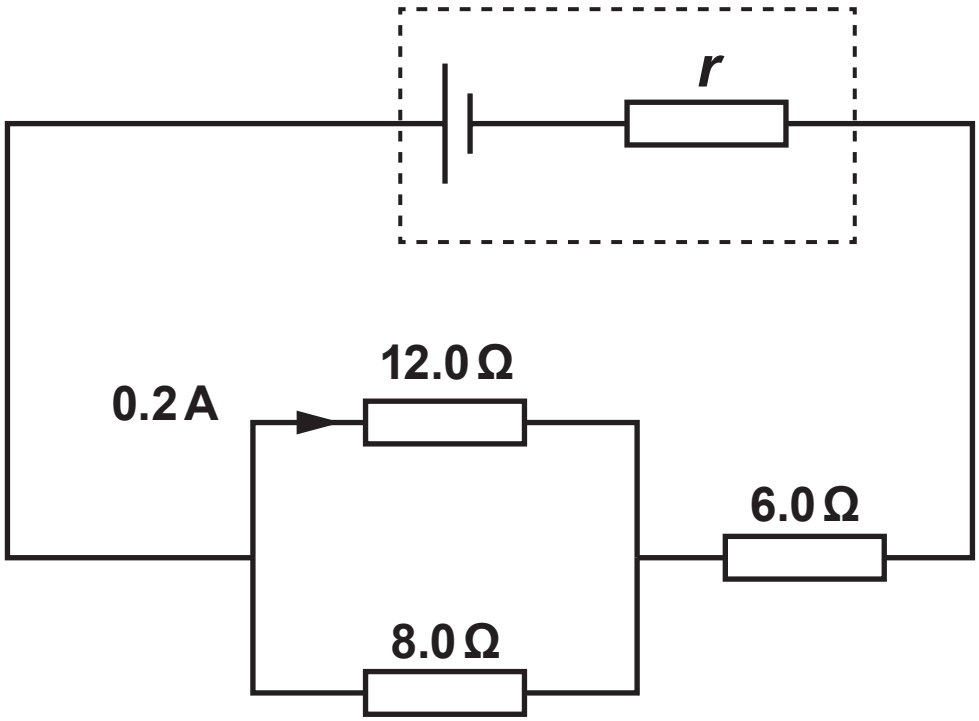
5(a) (ii)

CIRCUIT B



For Circuit B, compare the current through, and the potential difference across X and Y. [1]

5(b) **The diagram below shows three resistors connected together as part of a circuit. The internal resistance, *r*, of the cell is also shown.**



(i) **Show in clear steps that the current in the 8.0 Ω resistor is 0.3 A. [2]**

5(b) (ii) **Show that the potential difference across the combination of three resistors is 5.4 V.** **[3]**

(iii) **Explain why the potential difference across the combination of three resistors is less than the emf of the cell.** **[2]**

5(b) (iv) **Calculate the internal resistance, *r*, of the cell given that its emf is 6.0 V. [2]**

6(a) (i) Compare the movement of free electrons in a metal BEFORE and AFTER a potential difference is applied to the metal. [4]

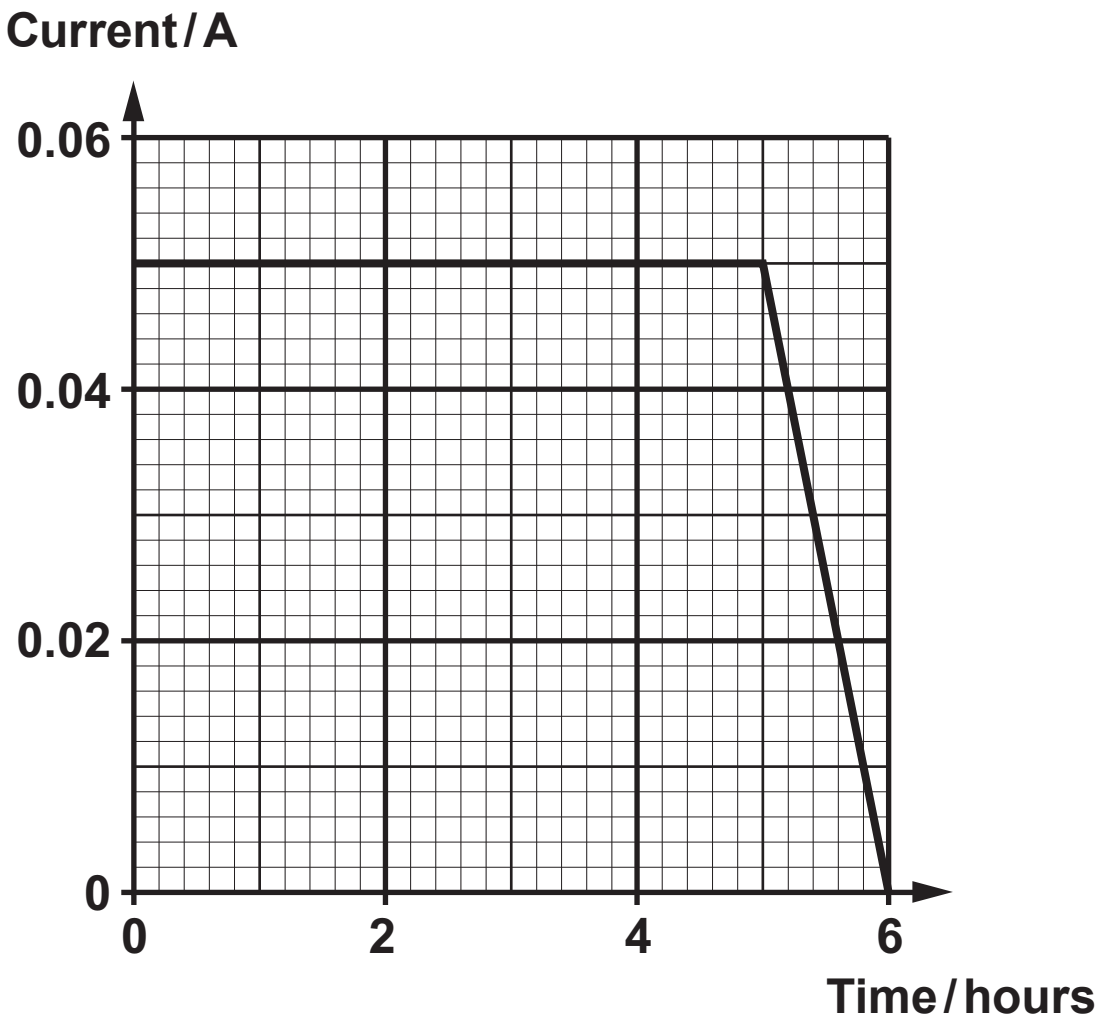
(ii) Hence explain how resistance arises in a metal when a potential difference is applied to it. [1]

6(b) **A resistor is connected for many hours to a cell. The graph opposite shows the variation of current, *I*, through the resistor with time, *t*.**

(i) **Calculate the charge which passes through the resistor:**

I. **during the first 5 hours; [2]**

II. **in the last hour. [1]**


Current / A
0.06
0.04
0.02
0
0
2
4
6
Time / hours

6(b) (ii) **Calculate the energy dissipated by the resistor during the first 5 hours given that the cell has an emf of 3.2 V. [Assume internal resistance = 0 Ω.] [2]**

(iii) **Calculate the rate at which the resistor dissipates energy during the first 5 hours. [1]**

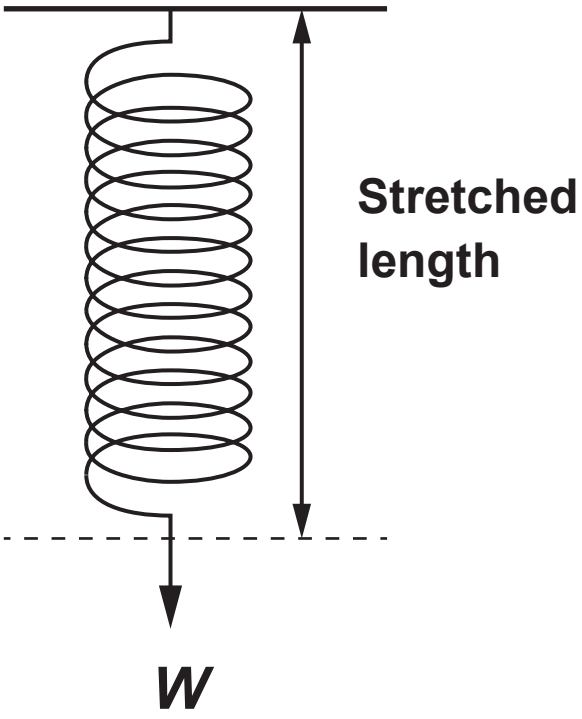
7(a) (i) State what is meant by the spring constant, *k*. [1]

(ii) Show that the unit of *k* may be written as $kg\,s^{-2}$. [2]

7(b) **A brief experiment is carried out in order to determine *k* for a spring. The following results are shown opposite.**

(i) **Determine the value of *k*, stating any assumptions you make. [3]**

(ii) **Determine the unstretched length of the spring. Show your reasoning. [2]**



Weight, *W*, attached to spring / N	Stretched LENGTH of spring / m
1.0	0.25
5.0	0.45

7(b) (iii) **Calculate the elastic potential energy stored in the spring when $W = 5.0$ N. [3]**

END OF PAPER