Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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TOTAL	

AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2015

Physics (B): Physics in Context PHYB2

Unit 2 Physics Keeps Us Going

Module 1 Moving People, People Moving
Module 2 Energy and the Environment

Thursday 4 June 2015 1.30 pm to 2.45 pm

For this paper you must have:
- a pencil and a ruler
- a calculator
- a Data and Formulae Booklet (enclosed)
- a protractor.

Time allowed
- 1 hour 15 minutes

Instructions
- Use black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific vocabulary where appropriate.

Advice
- You are advised to spend about 20 minutes on **Section A** and about 55 minutes on **Section B**.

Section A

Answer **all** questions in this section.

There are **21** marks in this section.

1 (a) State the difference between a vector quantity and a scalar quantity.

[1 mark]

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1 (b) State **one** vector quantity other than velocity or force.

[1 mark]

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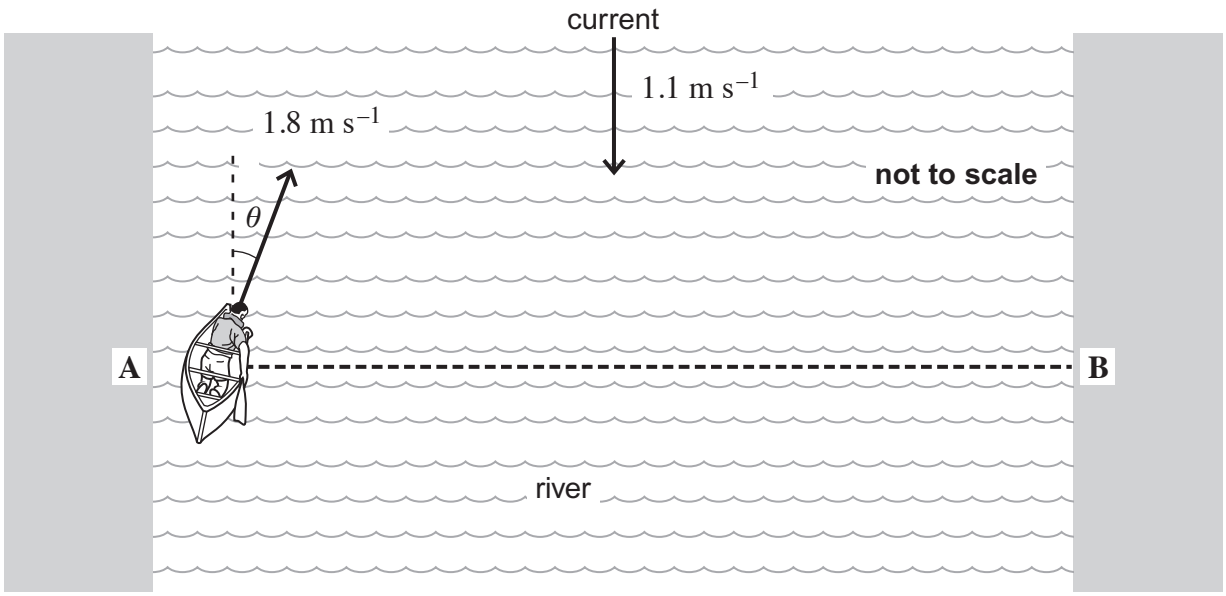
2 A canoeist wishes to cross a river in a straight line between two points labelled **A** and **B** as shown in **Figure 1**.
The canoeist can paddle the canoe at a speed of $1.8\ \text{m s}^{-1}$ in still water.
The current in the river has a speed of $1.1\ \text{m s}^{-1}$.

Figure 1



To cross from **A** to **B** the canoeist has to paddle at an angle θ to the direction of the current, as shown in **Figure 1**.

Determine θ using a scale drawing.

[3 marks]

angle θ ..... degrees

3 (a) Complete **Table 1** by stating the type(s) of charge carriers in each conductor.
The first row has been completed for you.

[2 marks]

Table 1

Conductor	**Charge carriers**
copper wire	free electrons
copper sulfate solution	
helium gas discharge tube	

3 (b) A potential difference is applied across a copper wire.

Explain how electrical energy is transferred to thermal energy in the wire.

[3 marks]

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3 (c) A $1.7\ \text{m}$ length of copper wire has a cross-sectional area of $1.5\ \text{mm}^2$ and a resistance of $1.9 \times 10^{-2}\ \Omega$ at $21\ ^{\circ}\text{C}$.

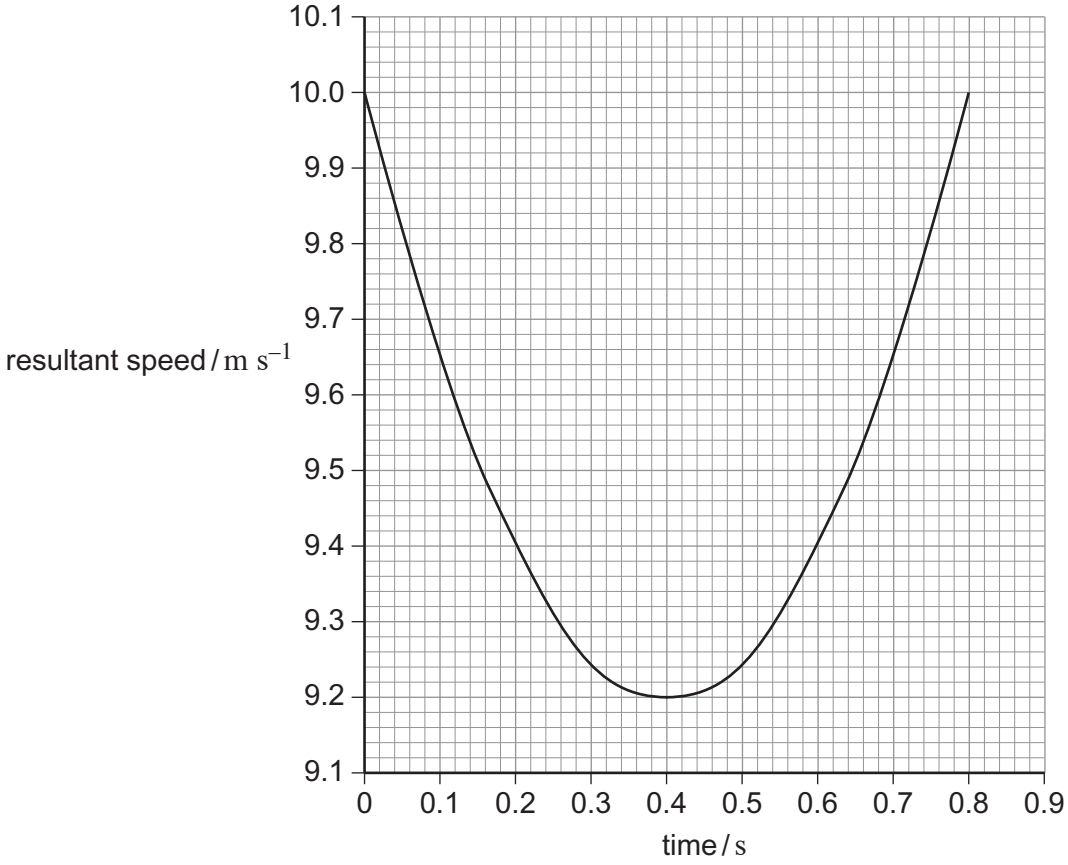
Calculate the resistivity of copper at this temperature.
Give your answer to an appropriate number of significant figures.

[4 marks]

resistivity of copper ..... $\Omega\ \text{m}$

4 **Figure 2** shows how the speed of a long jumper varies with time from the instant she takes off until she lands.

Figure 2



4 (a) Use the graph to estimate the horizontal distance travelled by the long jumper.
Consider the long jumper to be a point mass moving freely under gravity while in the air.
[2 marks]

horizontal distance ..... m

Question 4 continues on the next page

4 (b) **Figure 3** shows the technique used by the long jumper as she prepares to land.

Figure 3

Explain how this technique increases the distance she travels before landing.

[2 marks]

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5 (a) The list shows six energy resources that can be used to generate electricity.

Circle the one that has generated the least energy in the UK in the last 20 years.

[1 mark]

oil coal natural gas nuclear wind geothermal

5 (b) The government has set a target of producing 15% of the UK's electricity from renewable energy resources by 2020.

State **one** possible renewable energy resource and outline why it is unlikely to become a **major** energy resource for electricity in the UK.

[2 marks]

energy resource .....

outline .....

.....

.....

21

Turn over for the next question

Section B

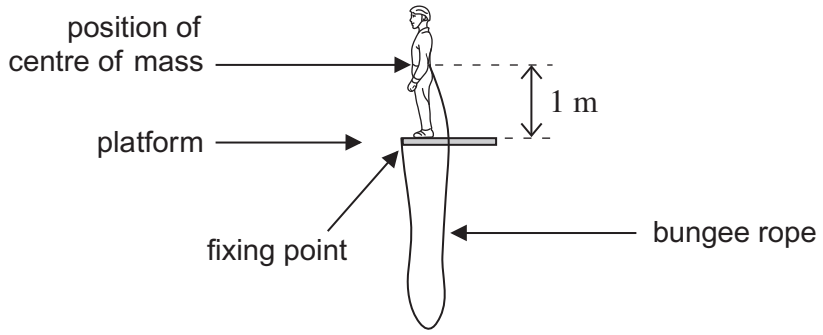
Answer **all** questions in this section.

There are **49** marks in this section.

6 **Figure 4** shows a bungee jumper of mass $75\ \text{kg}$ about to step off a raised platform.
The jumper comes to a halt for the first time when his centre of mass has fallen through a distance of $31\ \text{m}$.
The bungee rope has an unextended length of $19\ \text{m}$ and a stiffness of $380\ \text{N m}^{-1}$.

Ignore the effects of air resistance and the mass of the rope in this question.
Treat the jumper as a point mass located at the centre of mass.

Figure 4



6 (a) (i) Calculate the extension of the bungee rope when the centre of mass of the jumper has fallen through $31\ \text{m}$.

[1 mark]

extension ..... m

6 (a) (ii) Calculate the resultant force acting on the jumper when he reaches the lowest point in the jump.

[2 marks]

resultant force ..... N

6 (b) Calculate the extension of the rope when the jumper's acceleration is zero.

[2 marks]

extension ..... m

6 (c) The extension of the bungee rope is 5.0 m when the jumper's centre of mass has fallen through a distance of 25 m.

Use the principle of conservation of energy to calculate the speed of the jumper in this position.

[4 marks]

speed ..... m s^{-1}

6 (d) The bungee jump operator intends to use a bungee rope of the same unextended length but with a much greater stiffness. The rope is to be attached in the same way as before.

Explain, with reference to the kinetic energy of the jumper, any safety concerns that may arise as the jumper is slowed down by the new rope.

[3 marks]

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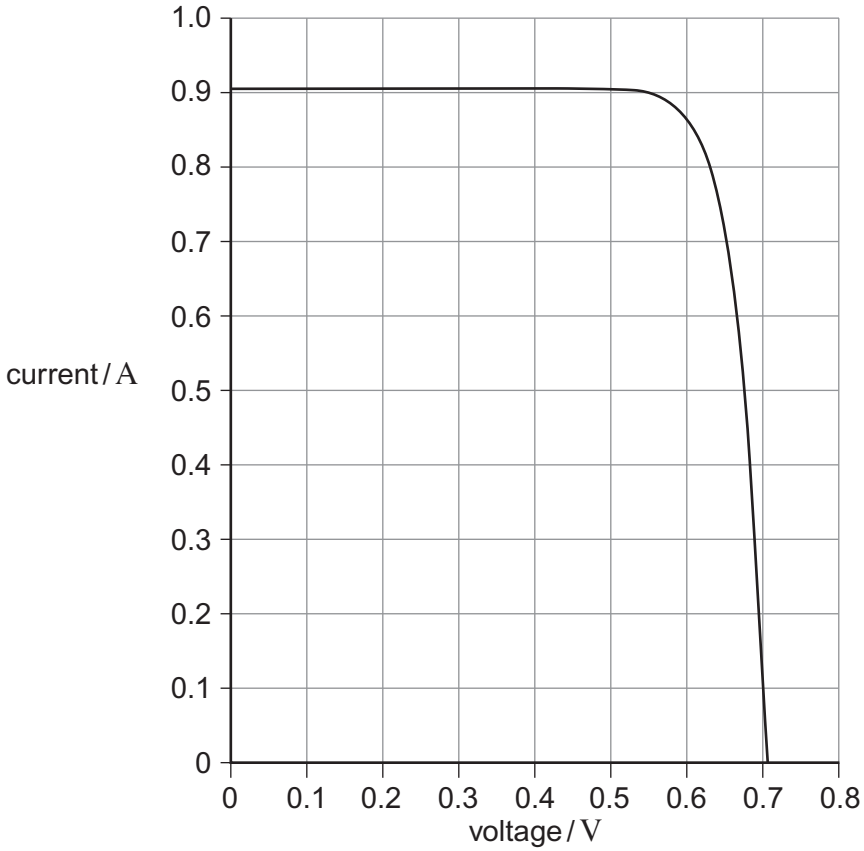
7 **Figure 5** shows the current–voltage characteristic of the output from a solar cell when light of intensity $450\ \text{W m}^{-2}$ is incident on it.

Figure 5



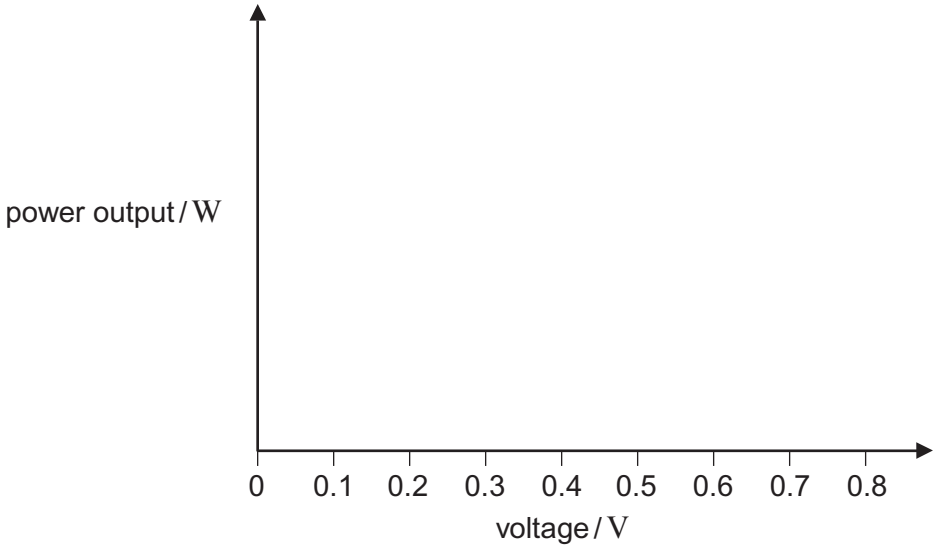
7 (a) (i) Using data from **Figure 5** estimate the **maximum** power output from the solar cell.

[2 marks]

maximum power ..... W

7 (a) (ii) Sketch, on the axes below, a graph to show how the power output varies with voltage for this solar cell for the same incident light intensity.

[2 marks]



7 (a) (iii) When the light intensity is $450\ \text{W m}^{-2}$ the cell has an efficiency of 0.15 at the maximum power.

Calculate the area of the solar cell.

[3 marks]

area ..... m^2

7 (b) A manufacturer has a supply of solar cells that each have an electromotive force (emf) of $0.70\ \text{V}$ and an internal resistance of $0.78\ \Omega$ when delivering maximum power.

7 (b) (i) Explain what is meant by an emf of $0.70\ \text{V}$.

[1 mark]

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7 (b) (ii) The manufacturer uses a number of these solar cells in an array to make a power supply that has an emf of $14\ \text{V}$ and an internal resistance of $3.9\ \Omega$ when delivering maximum power.

Describe and explain the arrangement of cells the manufacturer has to use in this array. Go on to calculate the number of cells the manufacturer needs to make the power supply.

[4 marks]

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number of cells .....

Question 7 continues on the next page

7 (c) Communications satellites use solar cells to generate electrical power.
Discuss why solar cells are appropriate for this task.

Your answer should refer to:
- any additional features that would be needed to ensure that the satellite's electrical systems operate continuously
- whether solar cell arrays are appropriate for space probes that travel to the edge of the solar system.

The quality of your written communication will be assessed in your answer.

[6 marks]

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Turn over for the next question

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8 A student carries out an experiment to investigate the rate of thermal energy transfer through a cylindrical metal bar of length $0.14\ \text{m}$ and diameter $0.050\ \text{m}$.
The ends of the bar **R** and **S** are maintained at $85\ ^{\circ}\text{C}$ and $23\ ^{\circ}\text{C}$ respectively and the bar is well insulated as shown in **Figure 6**.

Figure 6

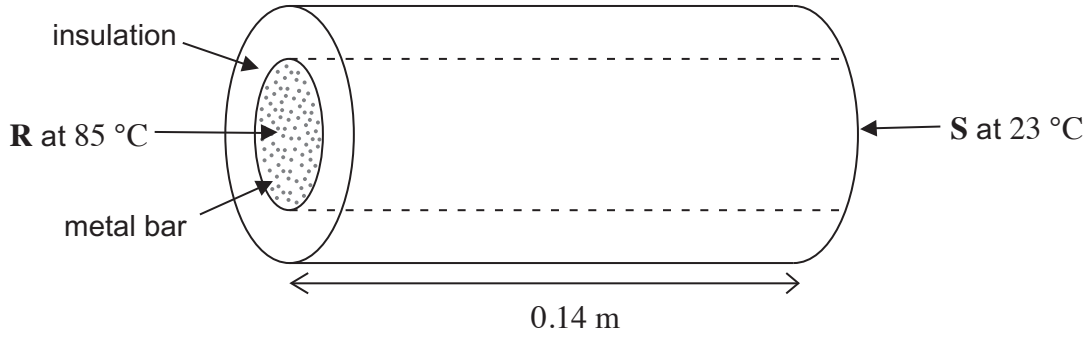
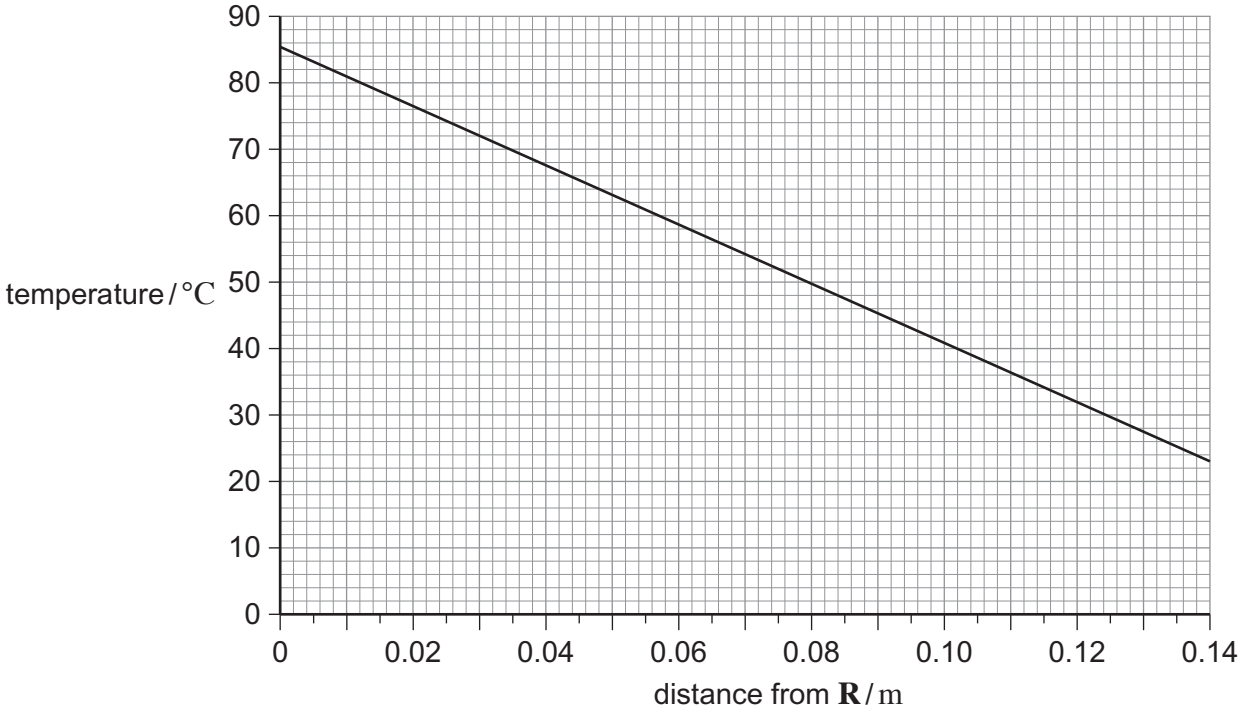


Figure 7 shows how the temperature of the bar varies with distance from **R**. The rate of thermal energy transfer P through the bar is $180\ \text{W}$.

Figure 7



8 (a) (i) Show that the temperature gradient along the bar is approximately $400\ \mathrm{K\ m^{-1}}$.

[1 mark]

8 (a) (ii) Theory suggests that the temperature gradient along the bar is related to P by the formula:

$$\text{temperature gradient} = \frac{P}{kA}$$

where k is the thermal conductivity of the metal and A is the cross-sectional area of the bar.

Calculate the thermal conductivity of the metal.
Give an appropriate unit for your answer.

[3 marks]

thermal conductivity ..... unit .....

8 (a) (iii) Suggest **two** ways in which the apparatus could be modified to reduce the rate of thermal energy transfer while maintaining the same temperature at the ends of the bar.

[2 marks]

1 .....

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2 .....

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Question 8 continues on the next page

8 (b) The student uses an ntc thermistor in an experiment to investigate how the temperature changes along the metal bar.
She connects the thermistor into a circuit as shown in **Figure 8**.

Figure 8

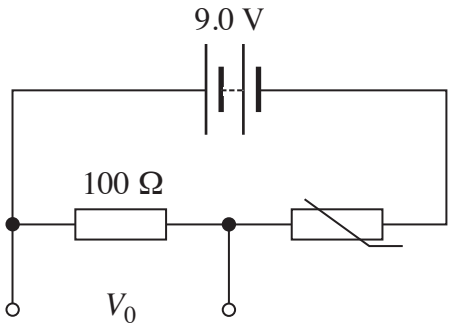
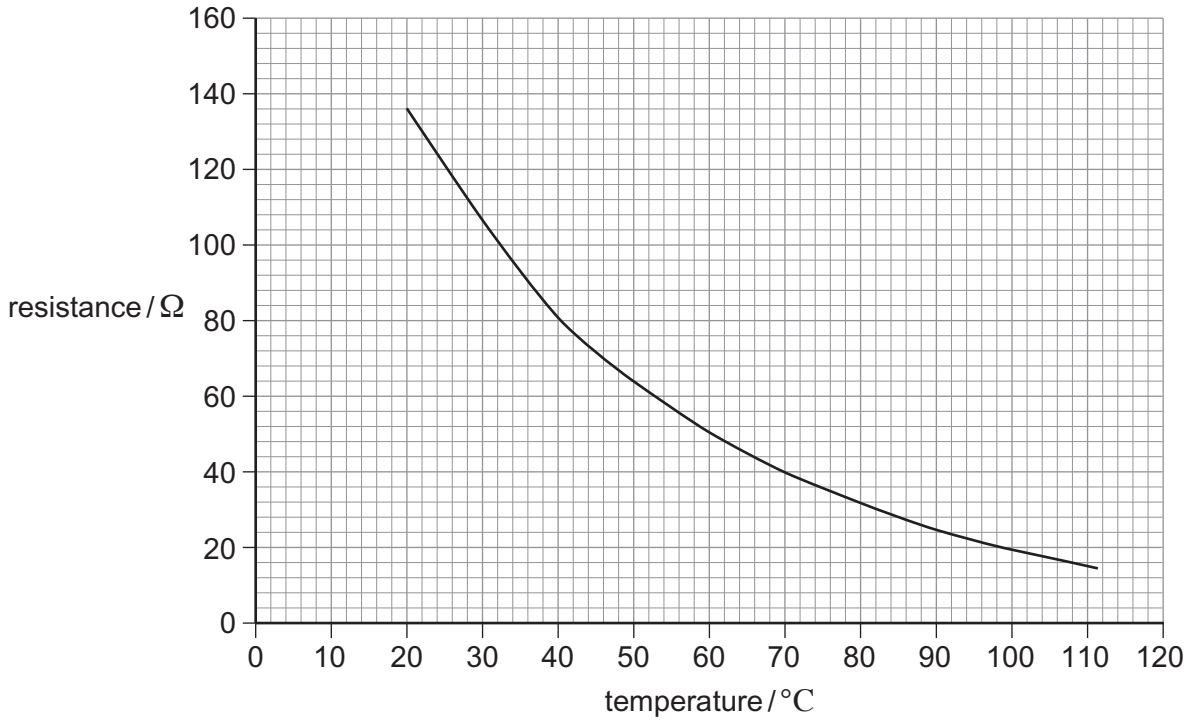


Figure 9 shows the resistance–temperature characteristic of the ntc thermistor that the student uses.

Figure 9



8 (b) (i) The thermistor is placed in thermal contact with the metal bar halfway between **R** and **S** where the temperature is 54 °C.
Show that the output voltage V_0 is approximately 6 V.

[3 marks]

V_0 V

8 (b) (ii) The thermistor is moved from the halfway point between **R** and **S**. This movement increases V_0.

State whether the thermistor is moved towards **R** or **S** and explain why this movement increases V_0.

[3 marks]

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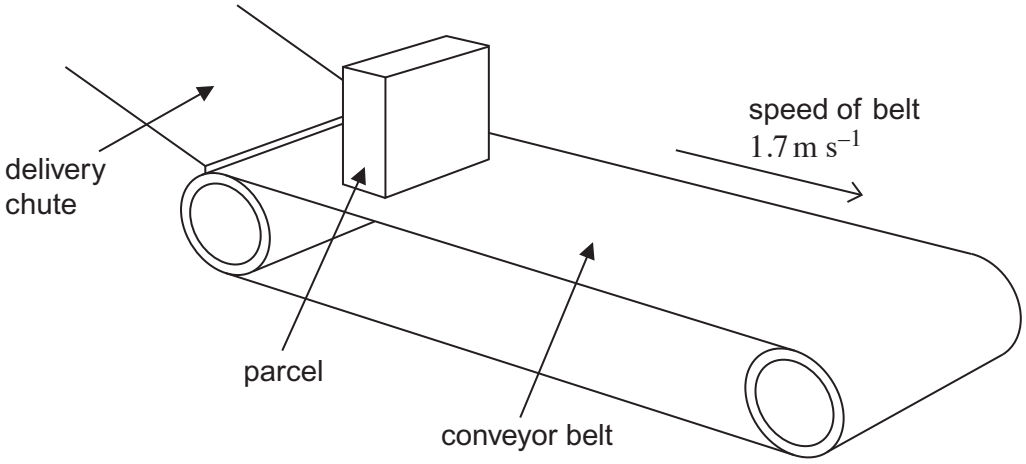
12

Turn over for the next question

9 (a) A parcel of mass $15\ \text{kg}$ drops from a delivery chute onto a conveyor belt as shown in **Figure 10**.
The belt is moving at a steady speed of $1.7\ \text{m s}^{-1}$.
The parcel lands on the moving belt with negligible speed and initially starts to slip. It takes $0.82\ \text{s}$ for the parcel to gain enough speed to stop slipping and move at the same speed as the conveyor belt.

Figure 10



9 (a) (i) Calculate the change in kinetic energy of the parcel during the first $0.82\ \text{s}$.

[2 marks]

change in kinetic energy ..... J

9 (a) (ii) The average horizontal force acting on the parcel during the first $0.82\ \text{s}$ is $31\ \text{N}$.

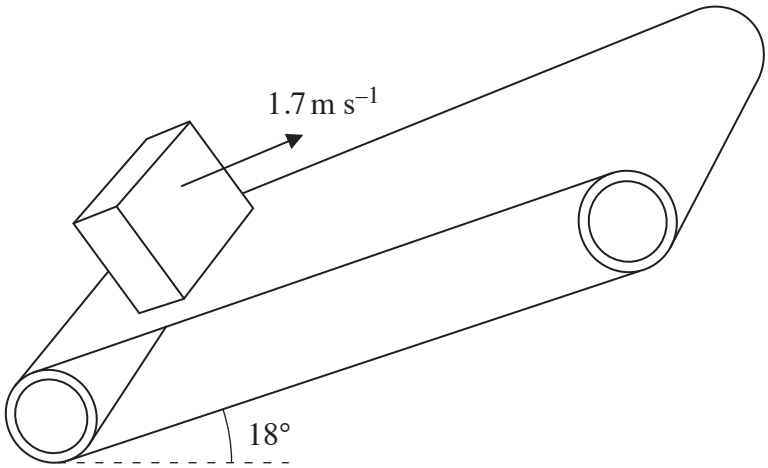
Calculate the horizontal distance between the parcel and the end of the delivery chute $0.82\ \text{s}$ after the parcel lands on the conveyor belt.
Assume that the parcel does not reach the end of the conveyor belt.

[2 marks]

horizontal distance ..... m

9 (b) At a later stage the parcel is being raised by another conveyor belt as shown in **Figure 11**.

Figure 11



This conveyor belt is angled at 18° to the horizontal and the parcel moves at a steady speed of $1.7\ \text{m s}^{-1}$ without slipping.

Calculate the rate at which work is done on the parcel.

[3 marks]

rate at which work is done ..... W

7

END OF QUESTIONS

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