Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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10	
TOTAL	

AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2014

Physics (B): Physics in Context PHYB2

Unit 2 Physics Keeps Us Going

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

Monday 9 June 2014 9.00 am to 10.15 am

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 specialist vocabulary where appropriate.

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

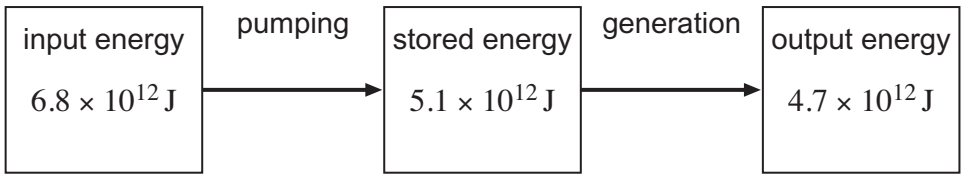
Section A

Answer **all** questions in this section.

There are 21 marks in this section.

1 (a) **Figure 1** is a flow diagram illustrating the energy transfer in one cycle of a pumped storage system.

Figure 1



Calculate the overall efficiency of the pumped storage system.

[2 marks]

efficiency .....

1 (b) Give **one** reason why the energy from a pumped storage system may not be considered to be renewable.

[1 mark]

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1 (c) Give **one** advantage of using pumped storage systems to produce electrical power at times of peak demand.

[1 mark]

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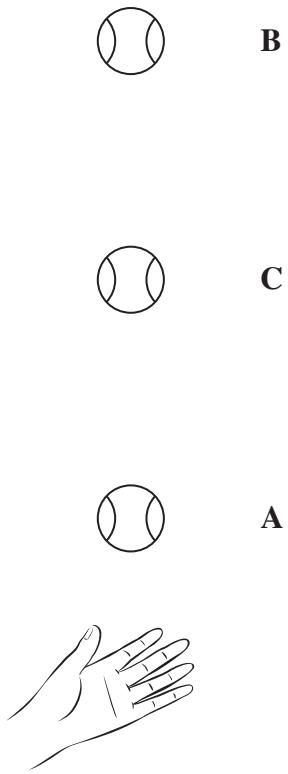
2 A tennis player throws a ball vertically into the air.

Figure 2 shows the ball at stages, **A**, **B** and **C**, during its time in the air. The tennis ball leaves the player's hand at stage **A**, reaches its maximum height at stage **B** and is travelling downwards at stage **C**.

Figure 2



Ignoring air resistance, compare the accelerations of the ball at points **A**, **B** and **C**. Explain your reasoning.

[2 marks]

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Turn over ▶

3 (a) State the principle of flotation.

[1 mark]

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3 (b) **Figure 3** shows a floating oil tanker before it is filled with oil.

Figure 3

State and explain how the distance between the water line and the main deck would be affected by filling the tanker with oil.

[2 marks]

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4 The fuel economy of a petrol car is $9.5\,\text{km per litre}$ based on an average speed of $120\,\text{km h}^{-1}$. The energy content of petrol is $10\,\text{kWh per litre}$.

4 (a) Calculate the energy content, in J, of the petrol used by the car when travelling a distance of $60\,\text{km}$ on a motorway at a speed of $120\,\text{km h}^{-1}$.

[3 marks]

energy used ..... J

4 (b) Calculate the average power consumption of the car during this $60\,\text{km}$ journey.

[2 marks]

average power consumption ..... W

4 (c) State and explain why environmental groups might oppose any government plans to increase motorway speed limits.

[2 marks]

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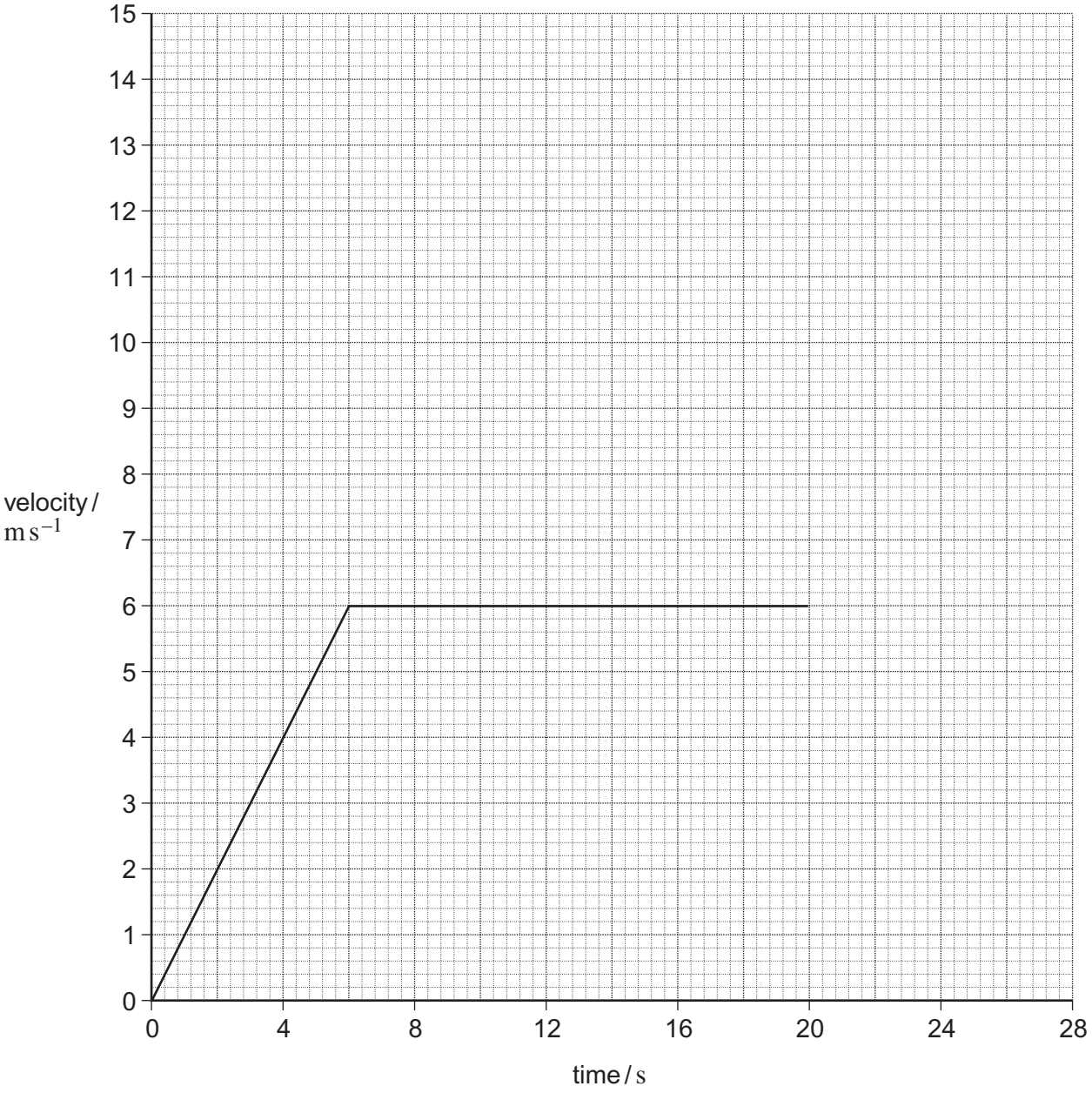
Turn over ▶

5 **Figure 4** is a velocity-time graph for a cyclist, **A**, during the first 20 seconds of a race.

Figure 4



5 (a) Show that cyclist **A** travelled $66\,\text{m}$ during the first 14 seconds of the race.

[2 marks]

5 (b) Cyclist **B** began the race 3.0 seconds after cyclist **A**. He accelerated uniformly from rest until he drew level with cyclist **A** at a distance of $66\,\text{m}$ from the starting line.

Draw, on **Figure 4**, a velocity-time graph to represent the motion of cyclist **B** during the time it took him to travel $66\,\text{m}$.

[3 marks]

21

Section B

Answer **all** questions in this section.

There are 49 marks in this section.

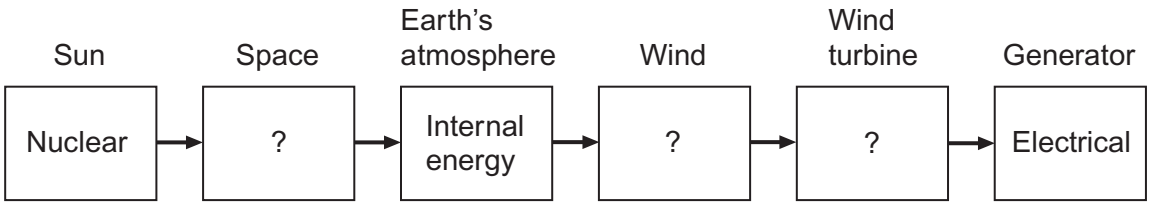
6 (a) **Table 1** lists some forms of energy.

Table 1

A	Electrical
B	Nuclear
C	Rotational kinetic
D	Internal energy
E	Radiation
F	Kinetic
G	Sound

The boxes in **Figure 5** show the useful energies in some of the stages in the transfer of energy from the Sun to electrical energy using a wind turbine.

Figure 5



From **Table 1** above, put the correct letter in each of the boxes **below** to show the most useful energy at the position labelled in **Figure 5**:

6 (a) (i) Space ☐

[1 mark]

6 (a) (ii) Wind ☐

[1 mark]

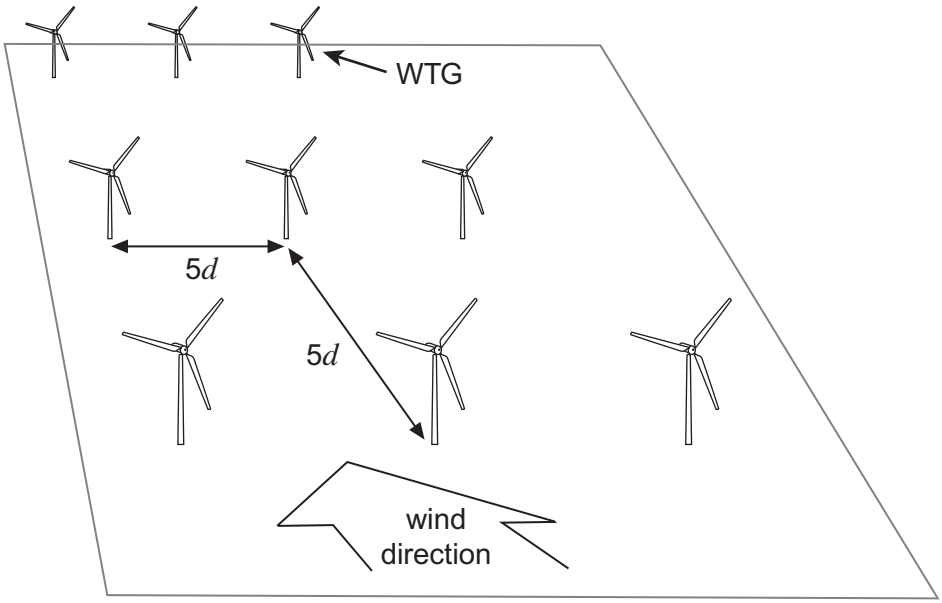
6 (a) (iii) Wind turbine ☐

[1 mark]

Question 6 continues on the next page

6 (b) Engineers have determined that wind turbine generators (WTGs) in a wind farm must have a minimum distance between them to maximise efficiency. This minimum distance is five times the diameter, d, of the circle described by the rotating blades of the WTGs. **Figure 6** shows a section of a wind farm where the WTGs are separated from each other by this minimum distance, $5d$.

Figure 6



6 (b) (i) Suggest **one** way in which engineers have ensured that the WTGs in this wind farm maintain maximum efficiency when the wind direction changes.

[1 mark]

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6 (b) (ii) The average power available from the wind for one of the WTGs in **Figure 6** is $1.6 \times 10^6\,\text{W}$. The diameter of the circle swept out by the blades of the WTG is $82\,\text{m}$.

Calculate the average wind speed.

density of air = $1.2\,\text{kg m}^{-3}$

[3 marks]

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

6 (c) Describe how the average power available from the wind per square metre of land occupied by a wind farm would be affected by the use of WTGs of longer blade length. Assume that the average wind speed and air density are the same as part **(b)**.

[2 marks]

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9

Turn over for the next question

7 (a) Define the term *U*-value.

[1 mark]

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7 (b) An office building is maintained at a constant temperature of 18 °C.
A room in this building has one exterior brick wall of dimensions 6.4 m by 2.5 m.
This wall, shown in **Figure 7**, has a window of area 7.5 m^2.

Figure 7

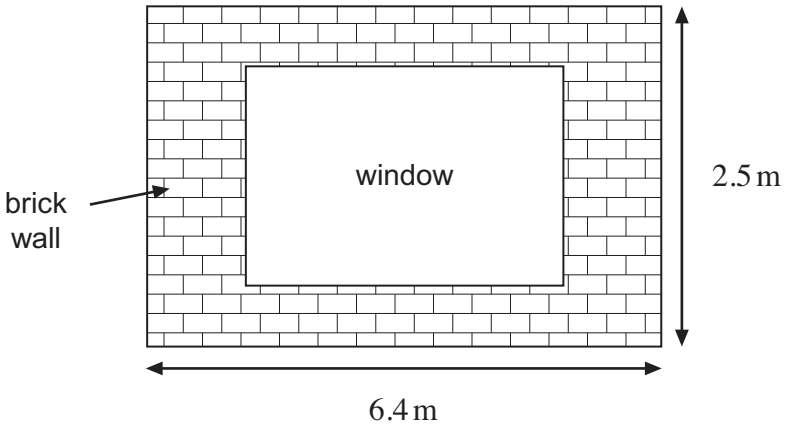
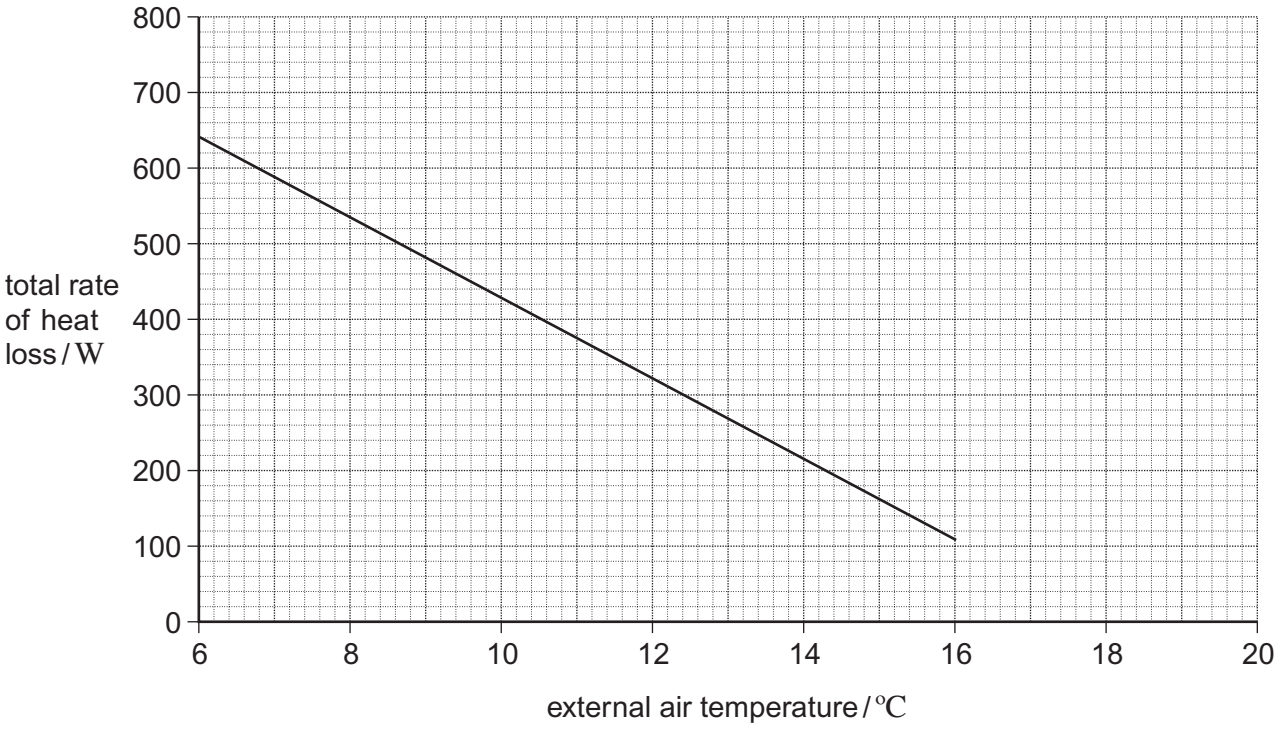


Figure 8 shows how the total rate of heat loss through the brick wall and window varies with the external air temperature.

Figure 8



7 (b) (i) Using data from **Figure 8**, explain why the graph confirms that the temperature inside the office building is 18 °C.

[2 marks]

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7 (b) (ii) Calculate the rate of heat loss through the brick wall when the external air temperature is 6.0 °C.

U-value of brick wall = $1.8\,\mathrm{W\,m^{-2}\,K^{-1}}$

[3 marks]

rate of heat loss ..... W

7 (b) (iii) Calculate the *U*-value of the window.

[2 marks]

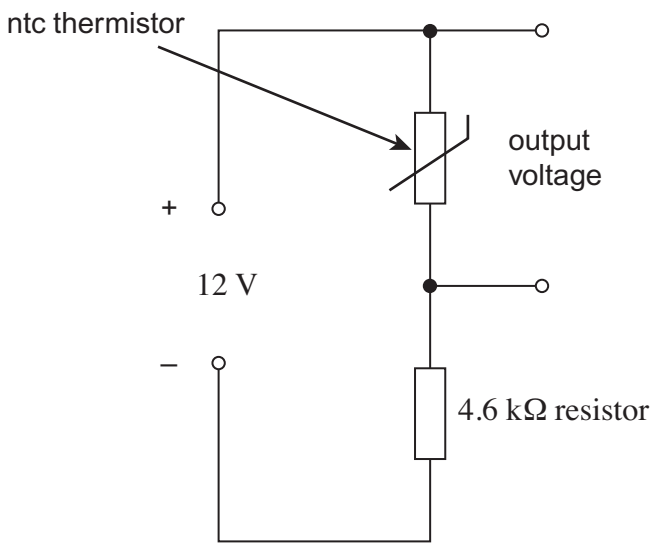
U-value of window ..... $\mathrm{W\,m^{-2}\,K^{-1}}$

8

Turn over ▶

8 **Figure 9** shows a temperature sensing circuit used to control a heating system. A power supply of negligible internal resistance provides an input voltage of 12 V.

Figure 9



8 (a) Calculate the output voltage when the resistance of the ntc thermistor is 950 Ω.

[3 marks]

output voltage V

8 (b) Describe in terms of the atomic structure of the material the changes that occur in an ntc thermistor as temperature increases. Explain how these changes affect the resistance of the ntc thermistor.

[3 marks]

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6

Turn over for the next question

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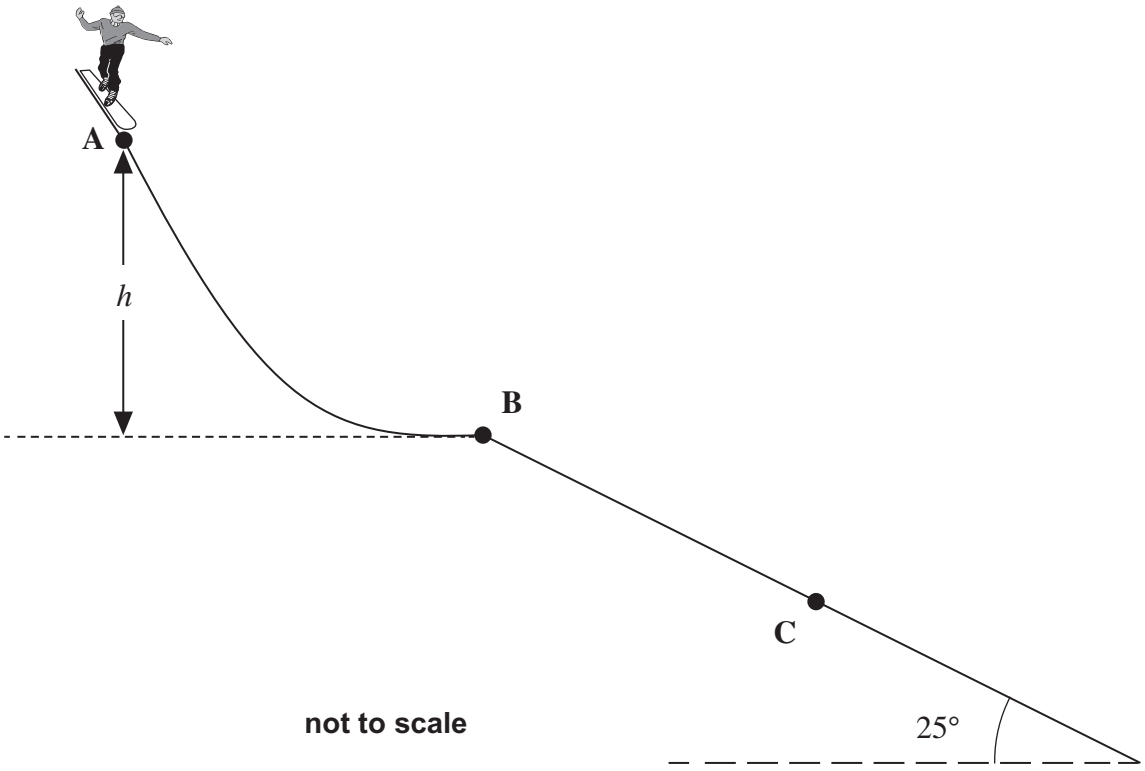
ANSWER IN THE SPACES PROVIDED

9 A snowboarder starts from rest at point **A** as shown in **Figure 10**.

Figure 10



In this question consider the snowboarder to be a point mass of 65 kg and ignore the effects of friction and air resistance.

9 (a) The snowboarder reaches a speed of $17\,\mathrm{m\,s^{-1}}$ at point **B**.

Calculate the height difference, h, between point **A** and point **B**.

[2 marks]

height difference ..... m

9 (b) The snowboarder takes off at point **B**, travelling horizontally with a velocity of $17\,\mathrm{m\,s^{-1}}$. She lands at point **C** after being in the air for $1.6\,\mathrm{s}$.

9 (b) (i) Calculate the vertical component of her velocity just before landing at point **C**.

[2 marks]

vertical component of velocity ..... $\mathrm{m\,s^{-1}}$

9 (b) (ii) Calculate the magnitude of her resultant velocity just before landing at point **C**.

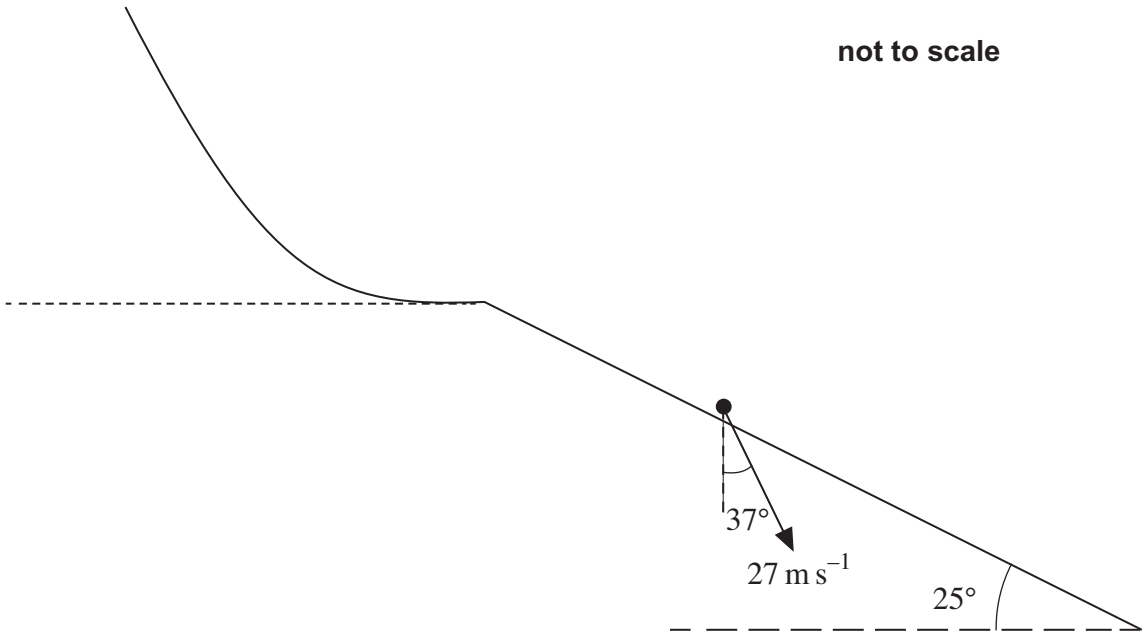
[2 marks]

magnitude of resultant velocity ..... $\mathrm{m\,s^{-1}}$

Question 9 continues on the next page

9 (c) On another occasion she has a resultant velocity of $27\,\mathrm{m\,s^{-1}}$ just before landing on the lower part of the slope. Her resultant velocity makes an angle of $37°$ to the vertical. An arrow representing her velocity at this instant is included in **Figure 11**.

Figure 11



Calculate the component of this velocity that is perpendicular to the slope.

[2 marks]

component of velocity ..... $\mathrm{m\,s^{-1}}$

9 (d) Explain in detail why it is safer for the snowboarder to land on a downward slope than on a horizontal surface. Assuming that the snowboarder stays upright when landing, go on to explain how her landing technique can further reduce her risk of injury.

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

[6 marks]

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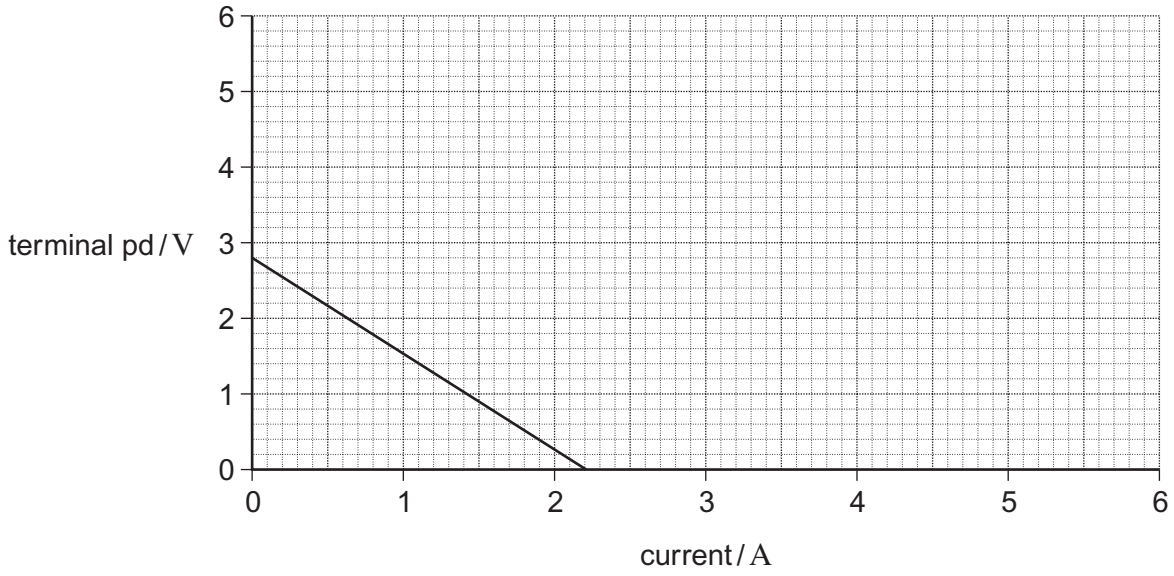
14

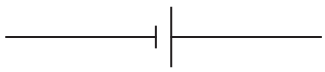
10 A student performed an experiment to determine the electromotive force (emf) and internal resistance of a cell. **Figure 12** is a graph showing how terminal pd across the cell varied with the current through it.

Figure 12



10 (a) Complete the circuit diagram below to show the circuit that the student could have used to obtain the data in this experiment.

[2 marks]



10 (b) Define electromotive force.

[2 marks]

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10 (c) Use data from the graph in **Figure 12** to determine the emf and internal resistance of the cell.

[4 marks]

Determination of the emf of the cell

emf V

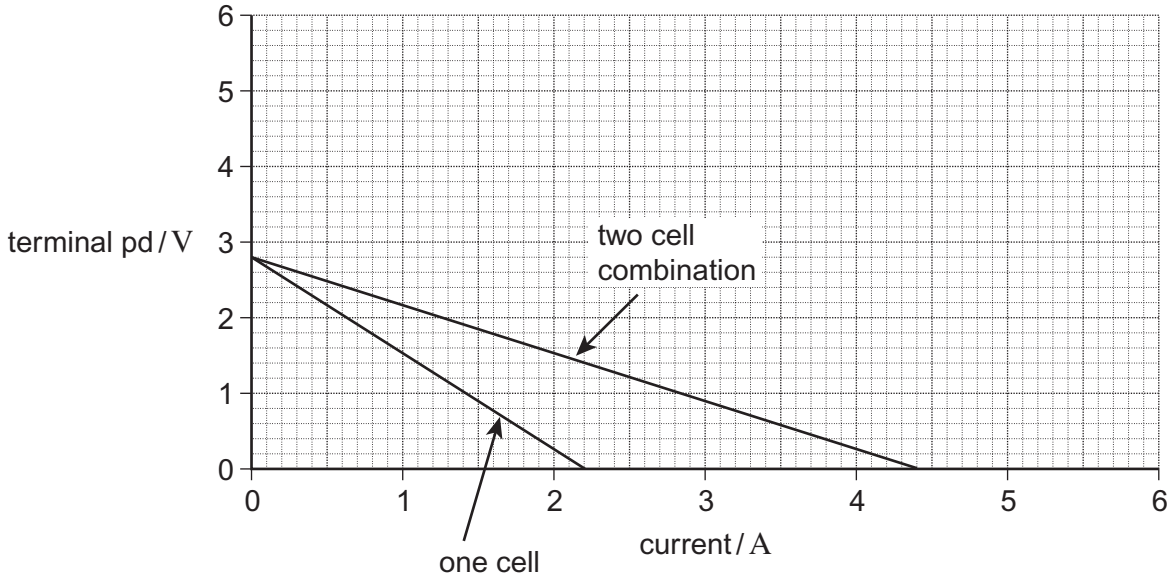
Determination of the internal resistance of the cell

internal resistance ..... Ω

Question 10 continues on the next page

10 (d) (i) The student repeats the experiment using a combination of two cells that are identical to the cell in part **(a)**. **Figure 13** shows the graphs obtained from both experiments.

Figure 13



Deduce the type of arrangement used for the combination of the two cells.
Explain your reasoning.

[2 marks]

Arrangement: .....

Explanation: .....

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10 (d) (ii) State and explain **one** advantage of using the two cell combination rather than using a single cell to power a small light bulb.

[2 marks]

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END OF QUESTIONS

12