Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
A1	
A2	
A3	
A4	
A5	
A6	
B7	
B8	
B9	
B10	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2010

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 18 January 2010 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.

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. Answers written in margins or on blank pages will not be marked.
- 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 20 marks in this section.

1 The table shows the total UK energy consumption of various energy sources during 2007.

energy type	**energy consumption 10^{17} J**
nuclear	6.5
coal	17.1
gas	37.8
oil	31.8
renewable and biofuels	1.8

Calculate the percentage of the total UK energy consumption that is derived from nuclear energy.

.....

.....

.....

.....

percentage ..... %

(3 marks)

2 Circle the letter that corresponds to the best completion of the statement.

The effect of human activity on global warming is

A almost entirely due to the release of sulphur dioxide.

B not accepted by all scientists.

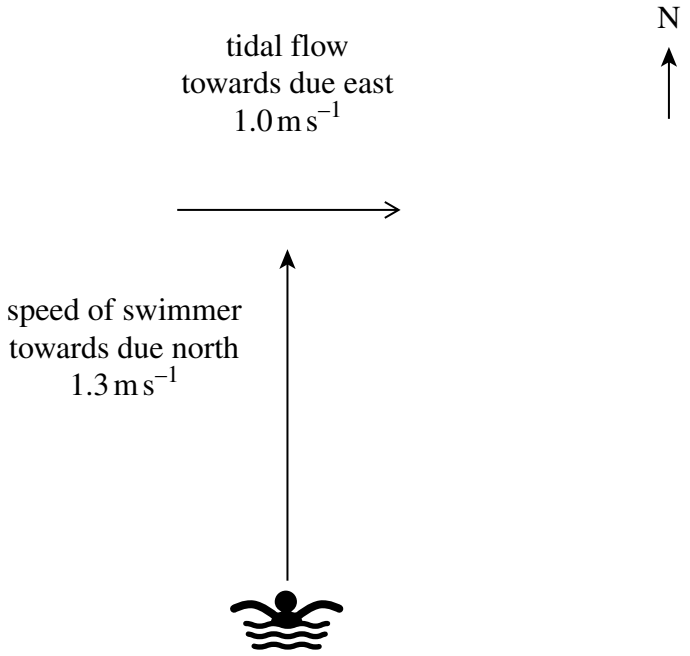
C almost entirely due to radioactive decay from nuclear power.

D mainly caused by changes in the ozone layer.

(1 mark)

3 **Figure 1** shows a long-distance swimmer swimming due north at $1.3\,m\,s^{-1}$ in a tide that flows at $1.0\,m\,s^{-1}$ due east.

Figure 1



3 (a) Calculate the magnitude of the resultant velocity of the swimmer.

.....

.....

.....

.....

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

(2 marks)

3 (b) Calculate the angle the resultant velocity of the swimmer makes with due north.

.....

.....

.....

.....

angle ..... degrees

(2 marks)

Turn over ▶

4 A teacher wishes to construct a 2.0 Ω resistor from a metal wire of length 0.94 m. The metal wire has an electrical resistivity of 4.9×10^{-7} Ω m.
Calculate the required diameter of the wire.

.....

.....

.....

.....

.....

diameter ..... mm

(4 marks)

5 A student wishes to compare an energy-efficient lamp with a conventional filament lamp.
State **two** factors that will determine which of the two lamps is the more cost-effective.

factor 1 .....

.....

factor 2 .....

.....

(2 marks)

6 A car of mass 1300 kg is stopped by a constant horizontal braking force of 6.2 kN.

6 (a) Show that the deceleration of the car is about 5 m s^{-2}.

.....

.....

.....

.....

.....

(3 marks)

6 (b) The initial speed of the car is 27 m s^{-1}.
Calculate the distance travelled by the car as it decelerates to rest.

.....

.....

.....

.....

.....

.....

distance travelled ..... m

(3 marks)

20

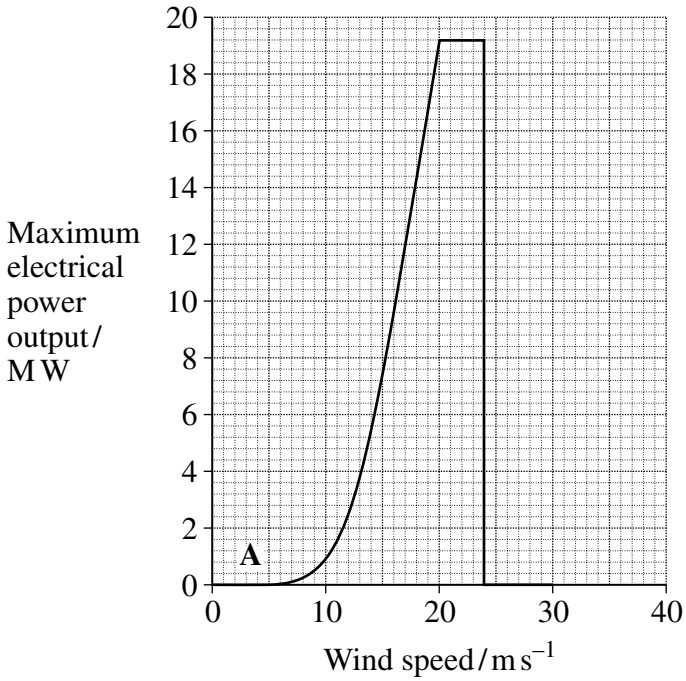
Section B

Answer **all** questions in this section.

There are 50 marks in this section.

7 **Figure 2** shows how the maximum electrical power output of a wind turbine varies with wind speed.

Figure 2



The percentage efficiency of a wind turbine is given by

$$\frac{\text{maximum electrical power output}}{\text{maximum power available from the wind}} \times 100\ \%$$

7 (a) (i) When the wind speed is $16\,\text{m s}^{-1}$ the maximum power available from the wind is 32 MW. Calculate the minimum length of one of the blades in the turbine.
density of air = $1.3\,\text{kg m}^{-3}$

.....

.....

.....

.....

.....

minimum blade length ..... m
(3 marks)

7 (a) (ii) Using **Figure 2**, determine the maximum electrical power output of the wind turbine when the wind speed is $16\,m\,s^{-1}$.

.....

.....

output power ..... MW

(1 mark)

7 (a) (iii) Calculate the percentage efficiency of the wind turbine for a wind speed of $16\,m\,s^{-1}$.

.....

.....

percentage efficiency ..... %

(1 mark)

7 (b) (i) Suggest why there is no power output from the turbine in region **A** of **Figure 2**.

.....

.....

(1 mark)

7 (b) (ii) Explain why the power output falls to zero at high wind speeds.

.....

.....

(1 mark)

7 (b) (iii) Wind farms are often located in hilly areas.
State and explain any change in wind speed as air flows over a hill.

.....

.....

.....

.....

.....

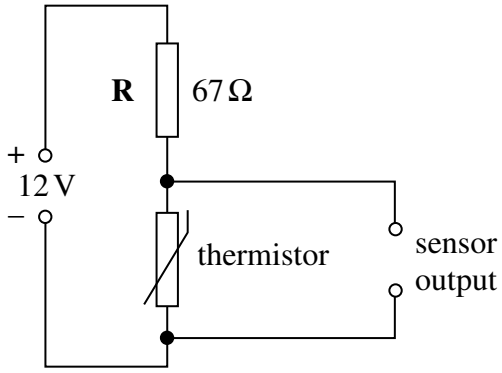
.....

(3 marks)

10

8 **Figure 3** shows a circuit that can be used to sense temperature changes. Sensing is possible because the potential difference across the thermistor changes as the temperature changes.

Figure 3



The power supply has a negligible internal resistance and the resistor **R** has a resistance of 67 Ω.

8 (a) When the thermistor is at a high temperature the potential difference across it is 4.5 V.

8 (a) (i) Calculate the potential difference across **R**.

.....

.....

potential difference V

(1 mark)

8 (a) (ii) Calculate the current in the circuit.

.....

.....

.....

current ..... A

(2 marks)

8 (b) (i) The temperature of the thermistor changes to 25 °C and its resistance becomes 360 Ω.
Show that the potential difference across the thermistor at 25 °C is about 10 V.

.....

.....

.....

.....

(3 marks)

8 (b) (ii) Calculate the power dissipated in the resistor **R** when the thermistor temperature is 25 °C, giving an appropriate unit for your answer.

.....

.....

.....

.....

.....

.....

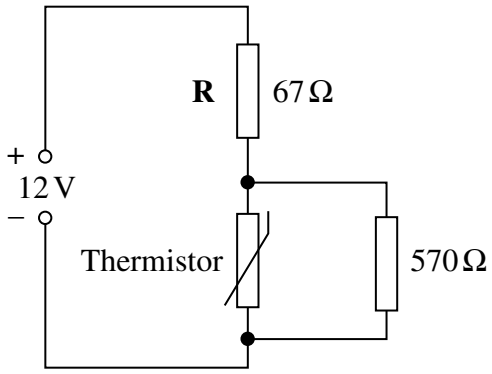
power dissipated .....

(4 marks)

Question 8 continues on the next page

8 (c) The circuit is modified as shown in **Figure 4**. A resistor of resistance 570 Ω is connected in parallel with the thermistor.

Figure 4



For the circuit in **Figure 4** calculate the current in the 67 Ω resistor when the thermistor temperature is 25 °C.

.....

.....

.....

.....

.....

current in 67 Ω resistor ..... A

(4 marks)

8 (d) Explain, in terms of charge carriers, why the resistance of the thermistor decreases as the temperature rises.

.....

.....

.....

.....

.....

.....

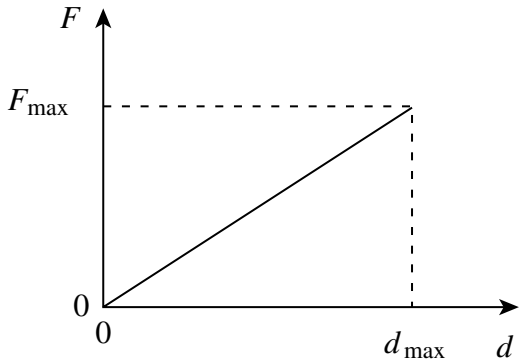
.....

(3 marks)

17

9 English longbows from the time of Henry VIII were found on board a sunken Tudor warship. **Figure 5** shows how the horizontal force, F, exerted by an archer on the bow string varies with the horizontal displacement, d, of the arrow as the bow is drawn.

Figure 5



9 (a) (i) Show that the energy stored in the bow is

$$\frac{1}{2} F_{\max} d_{\max}$$

where $F_{\max}$ is the maximum force in the bow and $d_{\max}$ is the maximum displacement of the bow string.

.....

.....

.....

.....

(2 marks)

9 (a) (ii) Show that the maximum speed, v, with which an arrow can leave the bow is given by

$$v = \sqrt{\frac{F_{\max} d_{\max}}{m}}$$

where m is the mass of the arrow.

.....

.....

.....

.....

.....

(2 marks)

Question 9 continues on the next page

Turn over ▶

9 (b) Each arrow had a mass of 0.060 kg and the bow string was displaced by a maximum of 0.60 m before releasing the arrow. The archers needed to exert a maximum force of 650 N.

9 (b) (i) Show that the maximum speed of the arrow as it leaves the bow is about $80\,m\,s^{-1}$.

.....

.....

.....

.....

(2 marks)

9 (b) (ii) State **one** reason why the speed of the arrow as it leaves the bow is likely to be less than $80\,m\,s^{-1}$.

.....

.....

(1 mark)

9 (c) The initial speed of an arrow as it leaves a bow is $65\,m\,s^{-1}$. When leaving the bow the arrow travels at an angle of 55° to the horizontal. Assume that the air resistance is negligible.

9 (c) (i) Show that the vertical component of the initial speed of the arrow is about $53\,m\,s^{-1}$.

.....

.....

.....

.....

(1 mark)

9 (c) (ii) The arrow is fired from ground level across a flat, level field.
Show that the arrow is in flight for about 11 s.

.....

.....

.....

.....

.....

.....

(3 marks)

9 (c) (iii) Calculate the horizontal distance travelled by the arrow when fired from level ground.

.....

.....

.....

.....

.....

horizontal distance travelled ..... m

(2 marks)

13

Turn over for the next question

10 The Cresta Run is a toboggan run in Switzerland. The curving track has an overall length of 1.2 km. During a run, the toboggan drops through a vertical distance of 150 m.

10 (a) A one-man toboggan ride down the Cresta Run takes 65 s.
Calculate the average speed along the track.

.....

.....

.....

.....

average speed ..... $m\,s^{-1}$

(1 mark)

10 (b) By considering the loss of gravitational potential energy, calculate the theoretical maximum speed at the end of the run.

.....

.....

.....

.....

.....

.....

theoretical maximum speed ..... $m\,s^{-1}$

(3 marks)

10 (c) Shuttlecock Corner on the Cresta Run is designed so that riders who are out of control can leave the run relatively safely. Riders falling here land on a mixture of straw and snow.

Explain why the straw and snow mixture provides a safer landing area than the frozen ground on which the mixture rests.

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6 marks)

END OF QUESTIONS

10

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED