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	

General Certificate of Education
Advanced Subsidiary Examination
January 2013

Physics (B): Physics in Context PHYB2

Unit 2 Physics Keeps Us Going

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

Friday 18 January 2013 9.00 am to 10.15 am

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

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 20 marks in this section.

1 A canoeist can paddle at a speed of $3.8\,m\,s^{-1}$ in still water.
She encounters a current which opposes her motion. The current has a velocity of $1.5\,m\,s^{-1}$ at 30^o to her original direction of travel as shown in **Figure 1**.

Figure 1

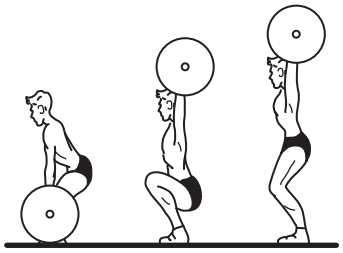
By drawing a scale diagram determine the magnitude of the canoeist's resultant velocity.

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

(3 marks)

2 **Figure 2** shows the phases in a 'snatch' lift performed by a weightlifter. The lifter positions his body so that the weight is raised vertically.

Figure 2



2 (a) The total energy used by a weightlifter is 4.5 kJ when lifting a 160 kg mass through 2.4 m.
Calculate the efficiency of the process of raising the weight.

efficiency .....
(2 marks)

2 (b) Suggest why the process is not 100% efficient.

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(1 mark)

3 The intensity of the Sun's energy arriving at the Earth's atmosphere is 1400 W m^{-2}.
The average distance from the Earth to the Sun is 1.5×10^{11} m.
Calculate the **total** energy emitted by the Sun in one day.
Assume that the Sun radiates energy equally in all directions.

total energy ..... J
(4 marks)

Turn over ▶

4 A cordless phone handset contains two rechargeable cells connected in series. Each cell has an emf of 2.0 V and, when fully charged, the combination stores energy sufficient to provide 850 mA for 1 hour.

4 (a) Calculate the total energy stored by the two cells when fully charged.

energy stored ..... J

(3 marks)

4 (b) The internal resistance of each cell is 0.60 Ω.
Calculate the potential difference across the two cells when they are connected in series across a 20.0 Ω load.

potential difference V

(3 marks)

5 (a) State Archimedes' principle.

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(2 marks)

5 (b) An ice sheet on land and an iceberg floating in the sea each melt, releasing equal volumes of water into the sea. Explain why the melting of the ice sheet affects the sea level much more than the melting of the iceberg.

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(2 marks)

20

Turn over for the next question

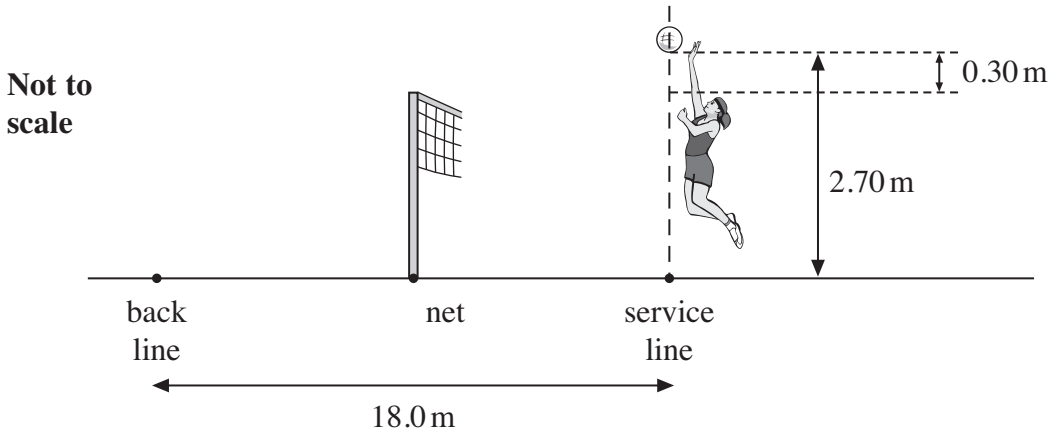
Section B

Answer **all** questions in this section.

There are 50 marks in this section.

6 **Figure 3** shows a volleyball court in which a player is serving. The player jumps upwards and strikes the ball so that it starts to move horizontally. When the ball is struck the bottom of the ball is at a height of 2.70 m. It falls by 0.30 m to just clear the top of the net.

Figure 3



6 (a) (i) Calculate the time the volleyball takes to fall 0.30 m.
Neglect air resistance.

time ..... s
(2 marks)

6 (a) (ii) Calculate the initial speed of the volleyball if it is to just clear the net. The net is midway between the service line and the back line.
Neglect air resistance.

initial speed ..... $m\,s^{-1}$
(2 marks)

6 (a) (iii) Suggest why the volleyball will not hit the ground inside the court.

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(2 marks)

6 (b) Suggest how the server may alter her serve to ensure that the ball lands in the court.

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(1 mark)

6 (c) On a separate occasion the server strikes the ball horizontally from rest so that it moves with a speed of $31\,m\,s^{-1}$. The server's hand is in contact with the ball for 70 ms. The mass of the volleyball is 0.27 kg.

6 (c) (i) Calculate the average force that the server's hand exerts on the volleyball.

average force ..... N

(3 marks)

6 (c) (ii) Discuss the energy changes that occur when the ball hits the ground.

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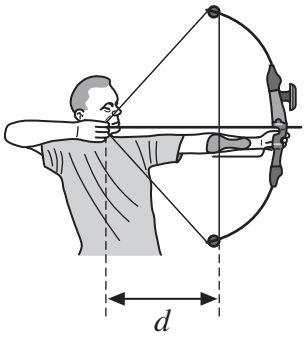
(2 marks)

12

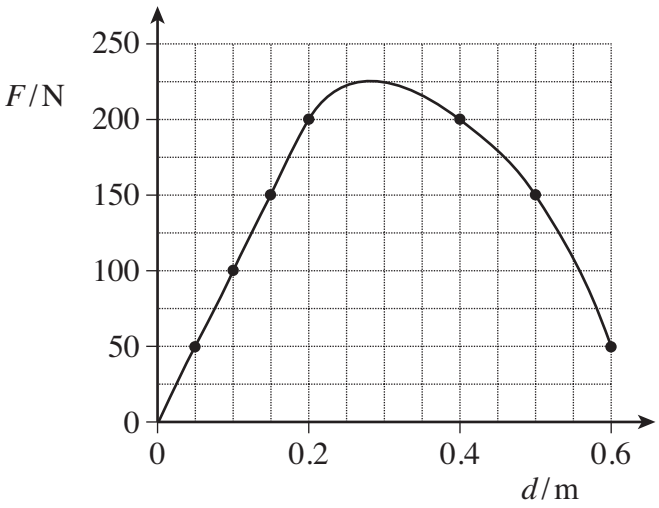
7 **Figure 4** shows an archer with a compound bow.

Figure 4



The force F required to bend the bow and the corresponding displacement d of the arrow are measured.
Figure 5 shows the plot of F against d.

Figure 5



7 (a) A novice pulls the string back so that the arrow is displaced by 0.20 m. An experienced archer pulls it back further so that the displacement is 0.40 m.
Suggest an advantage that this extra displacement gives to the experienced archer.

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(1 mark)

7 (b) Estimate the elastic energy stored in the bow when the arrow is displaced by 0.50 m.

energy stored ..... J

(3 marks)

7 (c) Calculate the maximum possible speed of an arrow of mass 3.5×10^{-2} kg when it is released from a bow that stores 58 J of elastic energy.

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

(3 marks)

7 (d) State and explain the effect of air resistance on the motion of the arrow after it has been released from the bow.

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(2 marks)

9

8 In 2011 the Global Wind Energy Council stated that wind energy is the only technology for power generation that can enable CO_2 levels to be reduced in the period up to 2020. This is the year by which it claims that greenhouse gas levels must have begun to fall to avoid dangerous climate change.

8 (a) Discuss the physics relating to the origin of the energy in the wind and to the harnessing of this energy in wind farms.

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

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(6 marks)

8 (b) A wind turbine, having 15.0 m long blades, operates on an island where the average annual wind speed is $9.5\,m\,s^{-1}$.

8 (b) (i) Calculate, in MW, the maximum power available to the turbine from the wind when the wind speed is $9.5\,m\,s^{-1}$.
Give your answer to an appropriate number of significant figures.
density of air = $1.2\,kg\,m^{-3}$

maximum power available ..... MW
(3 marks)

8 (b) (ii) Give **two** reasons why the power harnessed by the turbine will be different from the maximum power available from the wind.

Reason 1 .....

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Reason 2 .....

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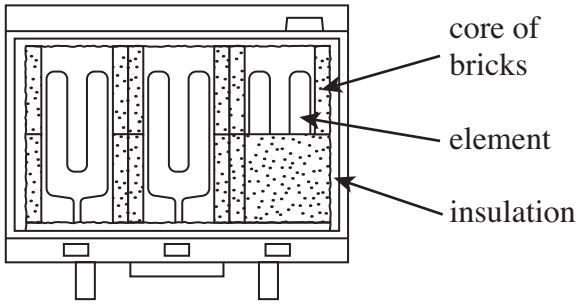
(2 marks)

11

9 **Figure 6** shows a section through a storage heater.

Figure 6



The core of a storage heater consists of electrical elements embedded in bricks. The bricks gain internal energy during the night and release this energy gradually during the day. Storage heaters give out their heat by radiation from the front panel and by *natural convection* or *forced convection*.

9 (a) Explain the difference between natural convection and forced convection.

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(2 marks)

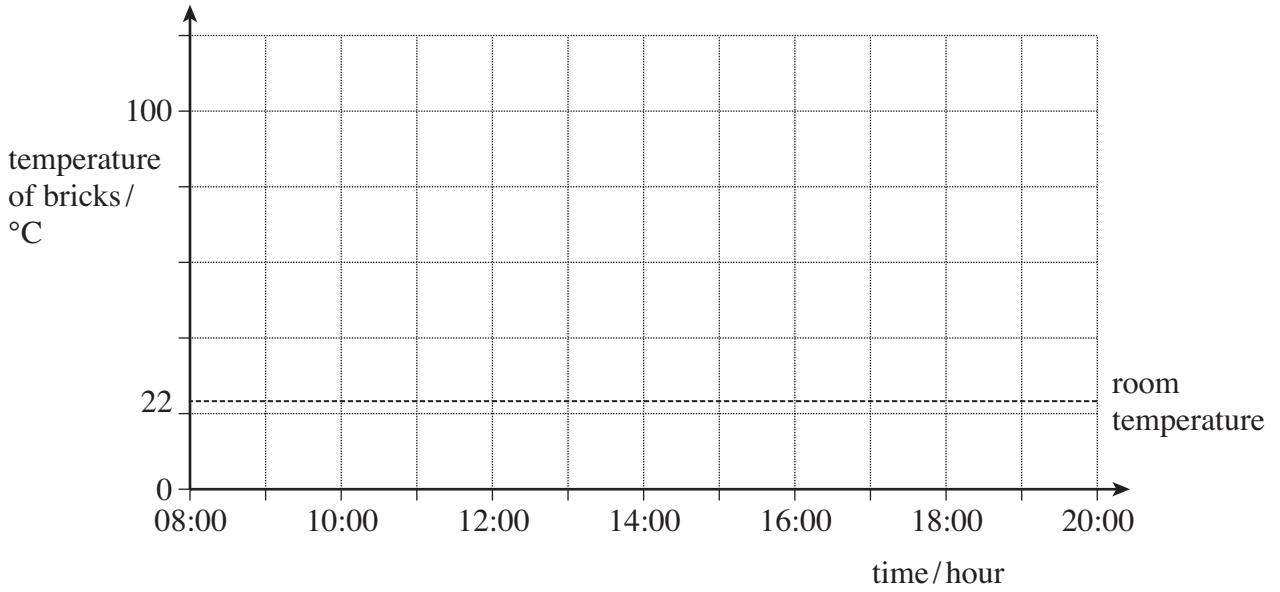
9 (b) At 08:00 hours the bricks in a storage heater are at a temperature of 74 °C and the room is at a temperature of 22 °C. By 12:00 hours the temperature of the bricks has fallen to 48 °C and the room has continued to be maintained at 22 °C. The bricks are cooled by forced convection.

9 (b) (i) Determine the time at which the temperature of the bricks is 35 °C.
Assume that the room temperature is maintained at 22 °C.

time ..... hours

(2 marks)

9 (b) (ii) Using the data given, sketch on the grid a graph to show the variation of the temperature of bricks with time from 08:00 hours until 20:00 hours.



(2 marks)

9 (c) A heating engineer suggests changing the insulating material from one with *U*-value 1.0 W m^{-2} K^{-1} to one with *U*-value 0.4 W m^{-2} K^{-1}.

Calculate the percentage change in rate of heat transfer from the storage heater for a given temperature difference across the insulator.

percentage change in rate of heat transfer ..... %

(3 marks)

9

10 (a) Define the volt.

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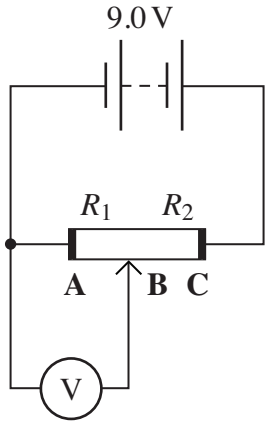
(1 mark)

10 (b) To test the potential differences in a potential divider circuit, a student sets up the circuit of **Figure 7**. R_1 is the resistance of section **AB** and R_2 that of section **BC** of the potential divider. The battery has an emf of 9.0 V and negligible internal resistance

Figure 7



10 (b) (i) Calculate the voltmeter reading when $R_1 = 2.2\,\text{k}\Omega$ and $R_2 = 1.8\,\text{k}\Omega$. Assume that the voltmeter has infinite resistance.

voltmeter reading V

(2 marks)

10 (b) (ii) State the benefit of using a high value of resistance in potential divider circuits.

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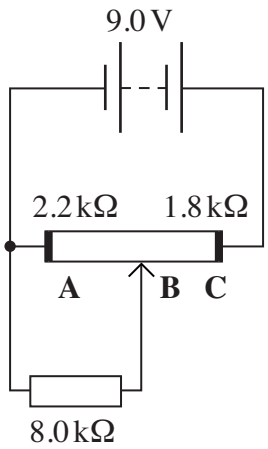
(1 mark)

10 (b) (iii) An 8.0 kΩ resistor is connected in the circuit to replace the voltmeter in **Figure 7**. This is shown in **Figure 8**.

Figure 8



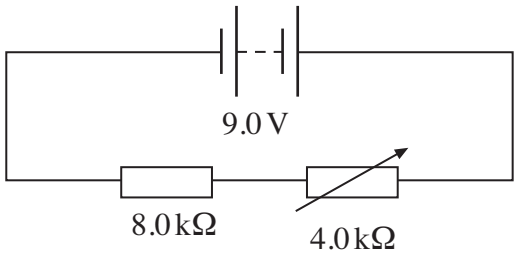
Calculate the potential difference across this resistor when the sliding contact **B** is in the position shown in **Figure 8**.

potential difference V

(3 marks)

10 (b) (iv) The 8.0 kΩ resistor is now connected in a circuit with a 4.0 kΩ variable resistor as shown in **Figure 9**.

Figure 9



10 (b) (iv) Compare this arrangement for controlling the current in the 8.0 kΩ resistor with the potential divider arrangement in **Figure 8**.

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(2 marks)

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END OF QUESTIONS