Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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11	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2012

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 20 January 2012 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).

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) State what is meant by a vector quantity.

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(1 mark)

1 (b) Give **one** example of a vector quantity.

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(1 mark)

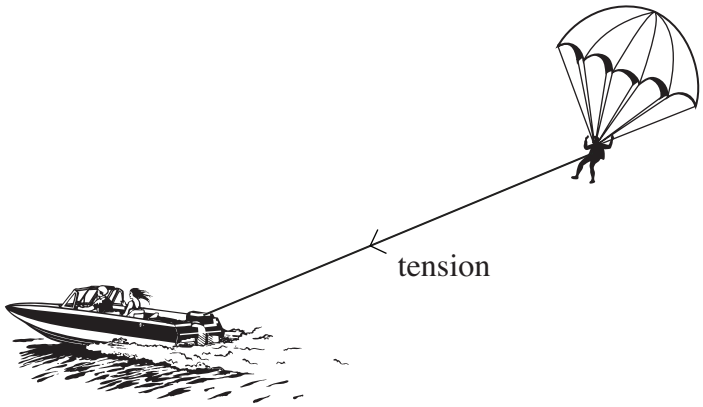
2 A spring has a stiffness of 125 $N\,m^{-1}$.
Calculate the extension of the spring when a weight of 8.0 N is suspended on it.
Give your answer in metres.

extension of spring ..... m

(2 marks)

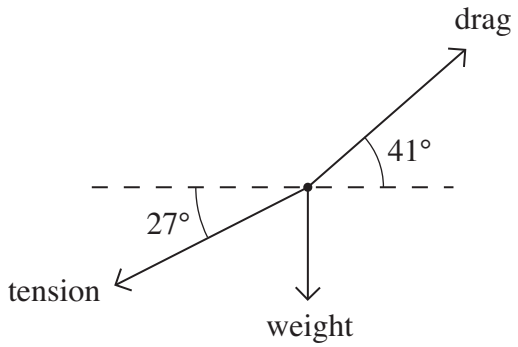
3 **Figure 1** shows a parascender being towed at a constant velocity.

Figure 1



The forces acting on the parascender are shown in the free-body diagram in **Figure 2**.

Figure 2



not to scale

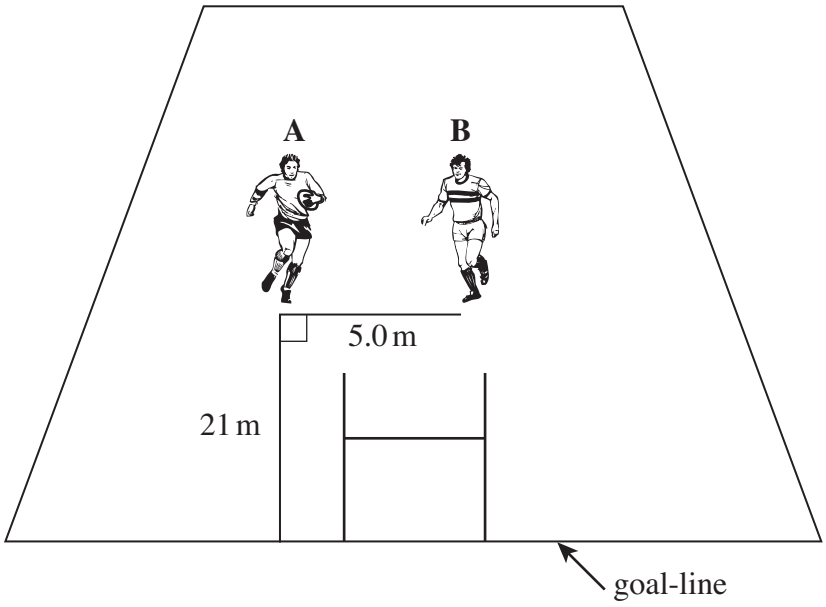
The rope towing the parascender makes an angle of 27° with the horizontal and has a tension of 2.2 kN. The drag force of 2.6 kN acts at an angle of 41° to the horizontal. Calculate the weight of the parascender.

weight ..... N

(3 marks)

4 **Figure 3** shows the positions of two players, **A** and **B**, at the moment when **A** receives the ball during a rugby match.

Figure 3



4 (a) Player **A** sprints directly towards the goal-line and covers the distance of 21 m in 2.5 s. Calculate his average speed during the sprint.

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

(1 mark)

4 (b) At the moment when player **A** receives the ball, player **B** begins to run in order to intercept **A**.
Calculate the minimum average speed of player **B** that will enable him to intercept **A** at the moment **A** reaches the goal-line.

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

(3 marks)

5 An exterior brick wall of a building has an area of 11 m^2. The internal temperature of the building is 15°C while the external temperature is 25°C.
Calculate the *U*-value of this wall if the rate of heat flow through it is 50 W.

U-value ..... $W\,m^{-2}\,K^{-1}$
(2 marks)

6 A hot metal block undergoes cooling by forced convection in air. Its initial temperature is 280°C and the air temperature is 0°C. The block reaches a temperature of 70°C after cooling for 120 seconds.
Calculate the temperature of the block after cooling for a further 60 seconds.

temperature of block ..... °C
(3 marks)

Turn over for the next question

7 A cyclist travelling along a level road at a constant speed of $15\,m\,s^{-1}$ experiences a resistive force of 12 N due to air resistance.

7 (a) Calculate the power output of the cyclist maintaining this constant speed.

power output ..... W
(2 marks)

7 (b) State and explain any change in the power output of the cyclist when cycling at a higher, constant speed.

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(2 marks)

20

Turn to page 8 for the next question.

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Section B

Answer **all** questions in this section.

There are 50 marks in this section.

8 (a) The rating of a car headlamp is 12 V, 55 W.
The resistance in this headlamp is due to a thin piece of wire. At its working temperature, the wire has a length of 5.0×10^{-2} m and a cross-sectional area of 1.9×10^{-8} m^2.
Calculate, at the working temperature, the resistivity of the metal used to make the wire. State an appropriate unit for your answer.

resistivity ..... unit .....

(5 marks)

8 (b) (i) Define the term electromotive force (emf).

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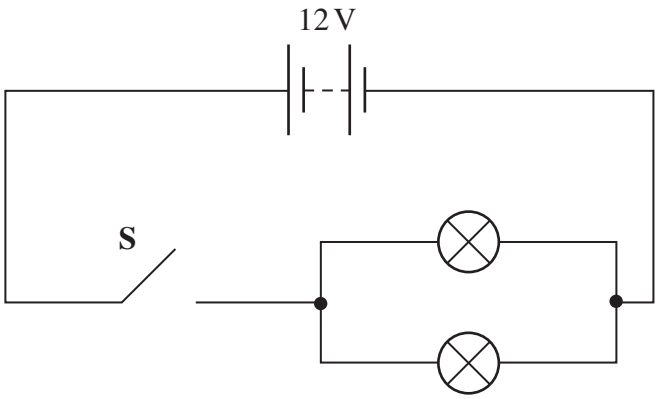
(2 marks)

8 (b) (ii) **Figure 4** is a circuit diagram illustrating how two of these headlamps are connected to a car battery.

Figure 4



The car battery has an emf of 12 V.

When the switch **S** is closed there is a current of 9.1 A through the battery and a potential difference of 11.9 V across the headlamps.
Calculate the internal resistance of the car battery.

internal resistance ..... Ω
(2 marks)

8 (c) A fault develops in one of the headlamps in **Figure 4** causing its resistance to decrease. State and explain how this fault affects the brightness of the other headlamp.

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(3 marks)

12

9 (a) A conventional hydroelectric power station has a power output of 9.0×10^7 W. The height difference between its reservoir and its turbine unit is 610 m. Assuming that the generation process is 95% efficient, calculate the mass of water passing through the turbine unit per second.

mass per second ..... kg s^{-1}

(4 marks)

9 (b) (i) The power station has an average annual output of 180 GW h of electrical energy. Calculate, in hours, the average time during which the power station is in operation per day.

average time ..... hours

(3 marks)

9 (b) (ii) Without considering energy losses, explain why this power station is unable to produce significantly more than 180 GW h of electrical energy per year.

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(1 mark)

9 (c) The UK's first pumped storage hydroelectric power station was opened fifty years ago. Outline the main arguments scientists used to support the development of pumped storage hydroelectric power stations.

Your discussion should include a description of:

- how pumped storage systems function
- the benefits of pumped storage systems
- the problems that have limited the development of pumped storage systems in the UK.

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

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(6 marks)

14

10 (a) A car, of mass 970 kg, is travelling at 15 m s^{-1} along a level road when its driver performs an emergency stop. The car's braking system applies a constant braking force of 6.1 x 10^3 N to the car. Assume that the braking force is the resultant force acting on the car.

10 (a) (i) Calculate the change of momentum of the car during the emergency stop.

change of momentum ..... kg m s^{-1}

(1 mark)

10 (a) (ii) Calculate the distance the car moves in coming to a halt during the emergency stop.

distance ..... m

(4 marks)

10 (b) The car is now loaded with passengers and luggage and again travels at $15\,m\,s^{-1}$.
State and explain how this affects the braking distance of the car.
Assume that the car experiences the same braking force as in part (a).

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(3 marks)

8

Turn over for the next question

11 (a) (i) The solar radiation falling on the Earth's surface is absorbed by the Earth.
This solar radiation has an average intensity of $5.0 \times 10^2\,W\,m^{-2}$ and falls on an area of $2.6 \times 10^{14}\,m^2$.
Calculate the energy per second that is absorbed by the Earth due to this solar radiation.

energy per second ..... W
(2 marks)

11 (a) (ii) The Earth has acquired a mean equilibrium temperature due to the energy per second absorbed from the Sun being in balance with the power radiated from the Earth's surface into Space.
How much power must be radiated from the Earth's surface so that it achieves a steady equilibrium temperature?

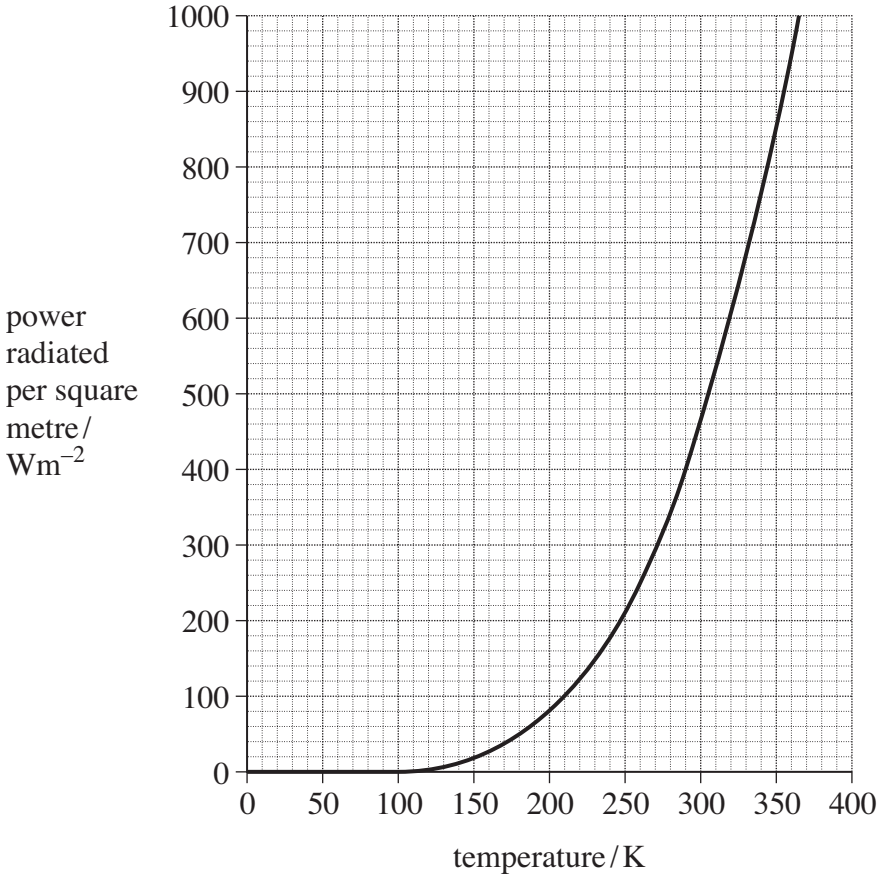
power radiated ..... W
(1 mark)

11 (a) (iii) Assuming that the Earth radiates this power uniformly from all points on its surface, calculate the radius of the Earth. Each square metre of the Earth's surface radiates a power of 250 W.

radius of Earth ..... m
(2 marks)

11 (a) (iv) **Figure 5** shows how the power radiated per square metre by a black body varies with temperature.

Figure 5



Using data from **Figure 5** determine the mean equilibrium temperature, in °C, of the Earth assuming that it behaves as a black body.

mean equilibrium temperature ..... °C

(2 marks)

11 (a) (v) The Earth has acquired a higher mean equilibrium temperature than the value determined in part (a) (iv).

State the name of the effect responsible for this higher mean equilibrium temperature.

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(1 mark)

Question 11 continues on the next page

11 (b) Scientists believe that human activity has further increased the Earth's mean equilibrium temperature.
Describe how scientists have used knowledge of physics to explain how human activity has caused this further increase.

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(3 marks)

11 (c) Large proportions of the Earth's ice will melt if the Earth's equilibrium temperature increases.

11 (c) (i) Greenland has an ice sheet that covers a land area of $1.7 \times 10^6\,\text{km}^2$. The mass of the ice in this sheet is $2.8 \times 10^{18}\,\text{kg}$.
Calculate the volume of water produced if all of this ice were to melt.

density of water = $1.0 \times 10^3\,\text{kg}\,\text{m}^{-3}$

volume of water ..... m^3

(2 marks)

11 (c) (ii) Arctic pack ice mostly consists of frozen salt water that floats on the surface of the Arctic Ocean. Until recently, this ice remained frozen but now significant amounts of it melt during the summer.
State and explain any change in sea levels that may occur should all of this floating pack ice melt.

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(3 marks)

16

END OF QUESTIONS

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