Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2010

Physics A PHYA5/2C

Unit 5C Applied Physics
Section B

Tuesday 29 June 2010 1.30 pm to 3.15 pm

For this paper you must have:
- a calculator
- a ruler
- a Data and Formulae Booklet.

Time allowed
- The total time for both sections of this paper is 1 hour 45 minutes. You are advised to spend approximately 50 minutes on this section.

Instructions
- Use black ink or black ball-point pen.
- 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.

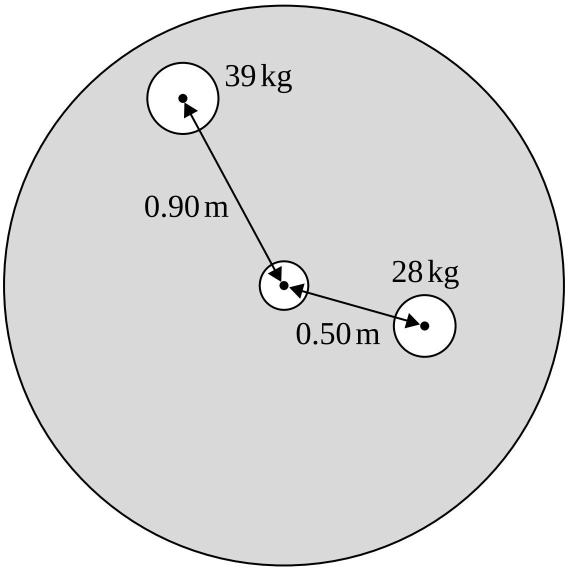
Information
- The marks for questions are shown in brackets.
- The maximum mark for this section is 35.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Section B

The maximum mark for this section is 35 marks. You are advised to spend approximately 50 minutes on this section.

1 (a) A playground roundabout has a moment of inertia about its vertical axis of rotation of 82 kg m^2. Two children are standing on the roundabout which is rotating freely at 35 revolutions per minute. The children can be considered to be point masses of 39 kg and 28 kg and their distances from the centre are as shown in **Figure 1**.

Figure 1



1 (a) (i) Calculate the total moment of inertia of the roundabout and children about the axis of rotation. Give your answer to an appropriate number of significant figures.

answer = ... kg m^2

(3 marks)

1 (a) (ii) Calculate the total rotational kinetic energy of the roundabout and children.

answer = ... J

(2 marks)

Do not write outside the box

1 (b) The children move closer to the centre of the roundabout so that they are both at a distance of 0.36 m from the centre. This changes the total moment of inertia to 91 kg m^2.

1 (b) (i) Explain why the roundabout speeds up as the children move to the centre of the roundabout.

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(2 marks)

1 (b) (ii) Calculate the new angular speed of the roundabout. You may assume that the frictional torque at the roundabout bearing is negligible.

answer = ... rad s^{-1}

(2 marks)

1 (b) (iii) Calculate the new rotational kinetic energy of the roundabout and children.

answer = ... J

(1 mark)

1 (c) Explain where the increase of rotational kinetic energy of the roundabout and children has come from.

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(1 mark)

11

Turn over ▶

2 A grinding wheel is used to sharpen chisels in a school workshop. A chisel is forced against the edge of the grinding wheel so that the tangential force on the wheel is a steady 7.0 N as the wheel rotates at 120 rad s^{-1}. The diameter of the grinding wheel is 0.15 m.

2 (a) (i) Calculate the torque on the grinding wheel, giving an appropriate unit.

answer = ...

(2 marks)

2 (a) (ii) Calculate the power required to keep the wheel rotating at 120 rad s^{-1}.

answer = ... W

(1 mark)

2 (b) When the chisel is removed and the motor is switched off, it takes 6.2 s for the grinding wheel to come to rest.

Calculate the number of rotations the grinding wheel makes in this time.

answer = ...

(2 marks)

5

3 (a) The coefficient of performance of a refrigerator is given by

$$COP_{\text{ref}} = \frac{Q_{\text{out}}}{Q_{\text{in}} - Q_{\text{out}}}$$

With reference to a refrigerator, explain the terms Q_{in} and Q_{out}.

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(2 marks)

3 (b) A refrigerator is designed to make ice at –10°C from water initially at room temperature. The energy needed to make 1.0 kg of ice at –10°C from water initially at room temperature is 420 kJ. The refrigerator has a coefficient of performance of 4.5.

3 (b) (i) Calculate the power input to the refrigerator if it is required to make 5.5 kg of ice every hour.

answer = ... W

(2 marks)

3 (b) (ii) Calculate the rate at which energy is delivered to the surroundings of the refrigerator.

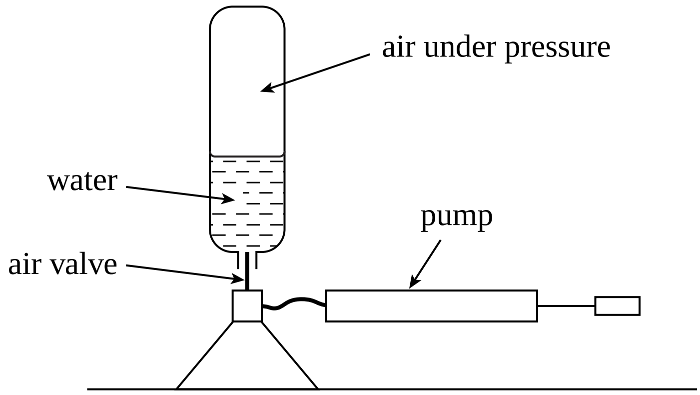
answer = ... W

(1 mark)

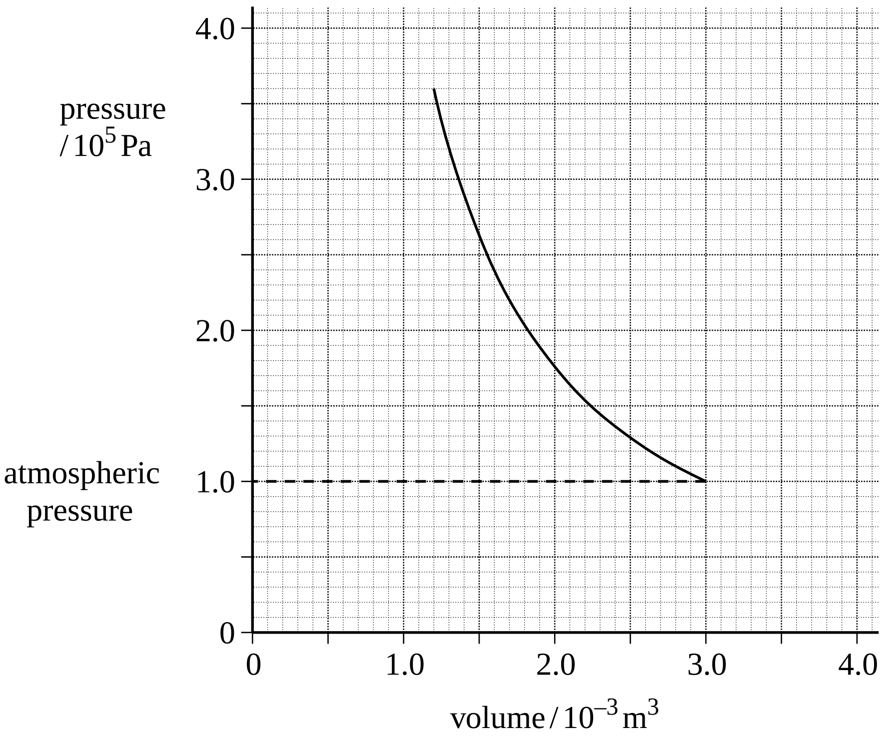
5

4 **Figure 2** shows a model rocket for demonstrating the principle of rocket propulsion. Air is pumped into an upside-down plastic bottle that has been partly filled with water. When the pressure reaches 3.6×10^5 Pa, (i.e. 2.6×10^5 Pa above atmospheric pressure) the air valve is forced out by the water pressure and the air in the bottle expands. The expanding air forces the water out of the neck of the bottle at high speed; this provides the thrust that lifts the bottle high into the air.

Figure 2



The graph shows the variation of pressure with volume for the air initially in the bottle as it expands from 3.6×10^5 Pa to atmospheric pressure, assuming the expansion is adiabatic.



4 (a) Use the graph to estimate the work done by the air as it expands from a pressure of 3.6×10^5 Pa to atmospheric pressure.

answer = ... J

(3 marks)

4 (b) With reference to the graph on **page 6**, state and explain whether the rocket would have reached the same height if the air had expanded isothermally.

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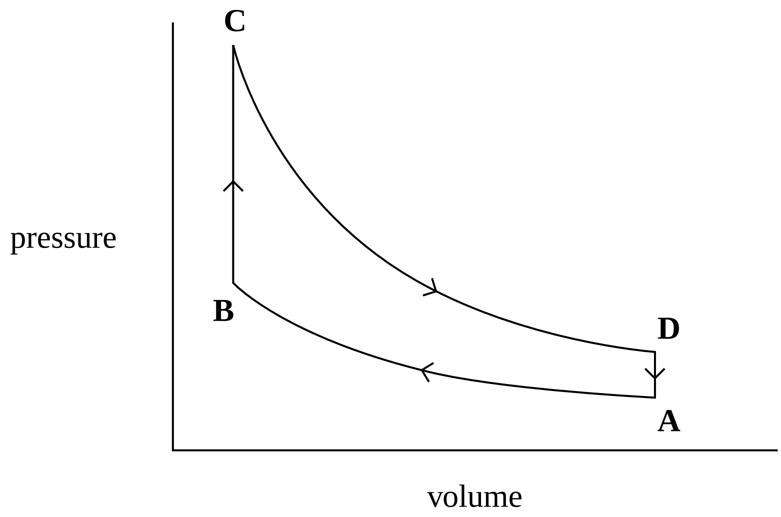
(3 marks)

6

Turn over for the next question

5 (a) **Figure 3** shows the indicator diagram for a theoretical or ideal four-stroke petrol engine (Otto) cycle.

Figure 3



Use **Figure 3** to describe the process that occurs during each of the parts **A** to **B**, **B** to **C**, **C** to **D** and **D** to **A** of the cycle. Describe whether heating or cooling is taking place, the type of process and whether work is being done on or by the air.

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

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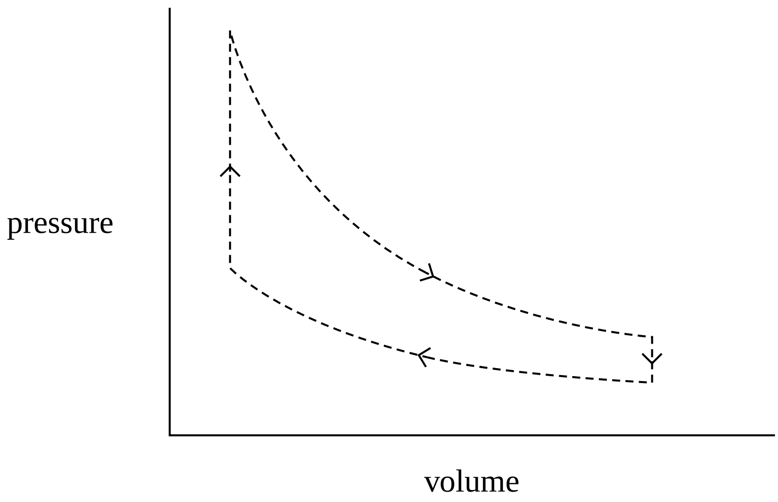
(6 marks)

5 (b) Show, on **Figure 4**, how the indicator diagram might be expected to appear if measurements of pressure and volume were made on a real four-stroke petrol engine of the same volume under operating conditions. The ideal cycle is shown in dashed lines as a guide.

Figure 4



(2 marks)

8

END OF QUESTIONS

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