

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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



General Certificate of Education
Advanced Level Examination
June 2010

Physics A

PHYA5/1

Unit 5 Nuclear and Thermal Physics
Section A

Tuesday 29 June 2010 1.30 pm to 3.15 pm

For this paper you must have:

- a calculator
- a ruler
- a question paper/answer book for Section B (enclosed).

Time allowed

- The total time for both sections of this paper is 1 hour 45 minutes. You are advised to spend approximately 55 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. 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.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this section is 40.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert in Section B.
- You will be marked on your ability to:
 - use good English
 - organise information clearly
 - use specialist vocabulary where appropriate.



J U N 1 0 P H Y A 5 1 0 1

Section A

The maximum mark for this section is 40 marks. You are advised to spend approximately 55 minutes on this section.

- 1** Molten lead at its melting temperature of 327°C is poured into an iron mould where it solidifies. The temperature of the iron mould rises from 27°C to 84°C , at which the mould is in thermal equilibrium with the now solid lead.

mass of lead = 1.20 kg

specific latent heat of fusion of lead = $2.5 \times 10^4 \text{ J kg}^{-1}$

mass of iron mould = 3.00 kg

specific heat capacity of iron = $440 \text{ J kg}^{-1} \text{ K}^{-1}$

- 1 (a)** Calculate the heat energy absorbed by the iron mould.

answer = J
(2 marks)

- 1 (b)** Calculate the heat energy given out by the lead while it is changing state.

answer = J
(1 mark)



1 (c) Calculate the specific heat capacity of lead.

answer = $\text{J kg}^{-1} \text{K}^{-1}$
(3 marks)

1 (d) State **one** reason why the answer to part 1 (c) is only an approximation.

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(1 mark)

7

Turn over for the next question

Turn over ►



- 2 (a)** In a thermal nuclear reactor, one fission reaction typically releases 2 or 3 neutrons. Describe and explain how a constant rate of fission is maintained in a reactor by considering what events or sequence of events may happen to the released neutrons.

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

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(7 marks)



- 2 (b)** Uranium is an α emitter. Explain why spent fuel rods present a greater radiation hazard than unused uranium fuel rods.

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(3 marks)

10

Turn over for the next question

Turn over ►



- 3** The age of an ancient boat may be determined by comparing the radioactive decay of $^{14}_6\text{C}$ from living wood with that of wood taken from the ancient boat. A sample of 3.00×10^{23} atoms of carbon is removed for investigation from a block of living wood. In living wood one in 10^{12} of the carbon atoms is of the radioactive isotope $^{14}_6\text{C}$, which has a *decay constant* of $3.84 \times 10^{-12} \text{ s}^{-1}$.

- 3 (a)** What is meant by the decay constant?

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(1 mark)

- 3 (b)** Calculate the half-life of $^{14}_6\text{C}$ in years, giving your answer to an appropriate number of significant figures.

$$1 \text{ year} = 3.15 \times 10^7 \text{ s}$$

answer = years
(3 marks)

- 3 (c)** Show that the rate of decay of the $^{14}_6\text{C}$ atoms in the living wood sample is 1.15 Bq.

(2 marks)



- 3 (d)** A sample of 3.00×10^{23} atoms of carbon is removed from a piece of wood taken from the ancient boat. The rate of decay due to the $^{14}_6\text{C}$ atoms in this sample is 0.65 Bq. Calculate the age of the ancient boat in years.

answer = years
(3 marks)

- 3 (e)** Give **two** reasons why it is difficult to obtain a reliable age of the ancient boat from the carbon dating described.

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(2 marks)

11

Turn over for the next question

Turn over ►



4

Figure 1

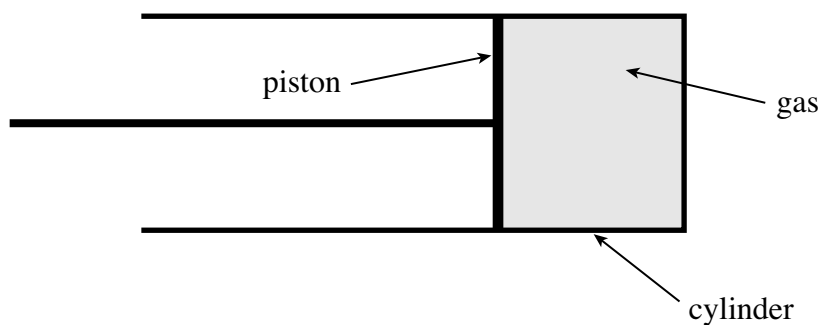
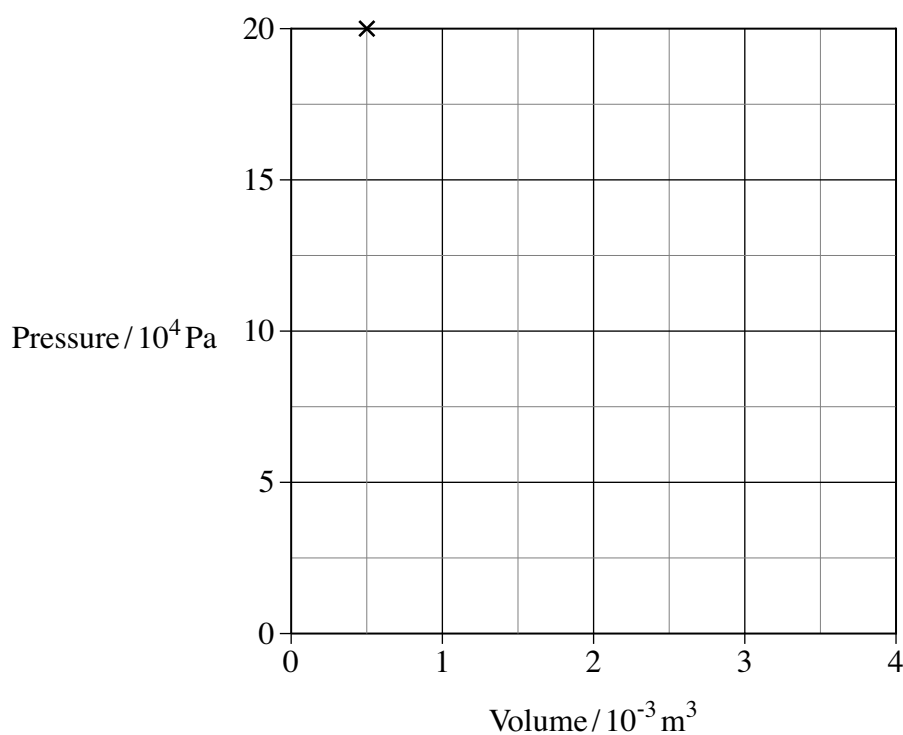


Figure 1 shows a cylinder, fitted with a gas-tight piston, containing an ideal gas at a constant temperature of 290 K. When the pressure, p , in the cylinder is $20 \times 10^4 \text{ Pa}$ the volume, V , is $0.5 \times 10^{-3} \text{ m}^3$.

Figure 2 shows this data plotted.

Figure 2



- 4 (a)** By plotting two or three additional points draw a graph, on the axes given in **Figure 2**, to show the relationship between pressure and volume as the piston is slowly pulled out. The temperature of the gas remains constant.

(3 marks)



4 (b) (i) Calculate the number of gas molecules in the cylinder.

answer = molecules
(2 marks)

4 (b) (ii) Calculate the total kinetic energy of the gas molecules.

answer = J
(3 marks)

4 (c) State **four** assumptions made in the molecular kinetic theory model of an ideal gas.

(i)

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(ii)

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(iii)

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(iv)

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(4 marks)

END OF SECTION A



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