RECOGNISING ACHIEVEMENT

ADVANCED GCE

PHYSICS A

Unifying Concepts in Physics

WEDNESDAY 11 JUNE 2008

2826/01

Morning

Time: 1 hour 15 minutes

Candidates answer on the question paper

Additional materials (enclosed): None

Additional materials (required):
Electronic Calculator

CUP/T45681

Candidate Forename		Candidate Surname	
Centre Number		Candidate Number	

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **60**.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**14**	
2	**12**	
3	**8**	
4	**16**	
5	**10**	
TOTAL	**60**	

This document consists of **14** printed pages and **2** blank pages.

Data

speed of light in free space,	$c = 3.00 \times 10^8\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^2\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
refractive index,	$n = \frac{1}{\sin C}$
capacitors in series,	$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
capacitor discharge,	$x = x_0 e^{-t/CR}$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}<c^2>$
radioactive decay,	$x = x_0 e^{-\lambda t}$
	$t_{\frac{1}{2}} = \frac{0.693}{\lambda}$
critical density of matter in the Universe,	$\rho_0 = \frac{3H_0^2}{8\pi G}$
relativity factor,	$= \sqrt{(1 - \frac{v^2}{c^2})}$
current,	$I = nAve$
nuclear radius,	$r = r_0 A^{1/3}$
sound intensity level,	$= 10 \lg \left(\frac{I}{I_0}\right)$

Answer **all** the questions.

1 The acceleration – time graph for a firework rocket from launch is as shown in Fig. 1.1. The rocket is a plain one with no exploding stars high in the sky. The rocket leaves the ground at time $t = 0$ and the remains of the rocket reach the ground at time $t = 6.0$ s.

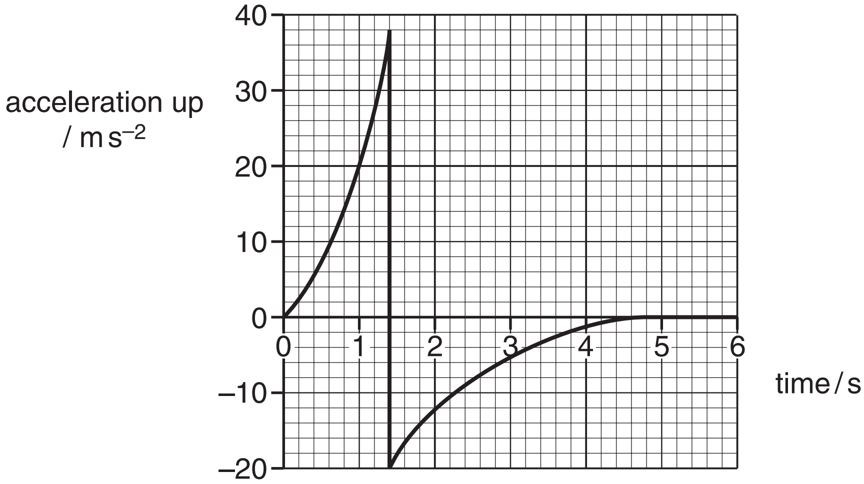

Fig. 1.1

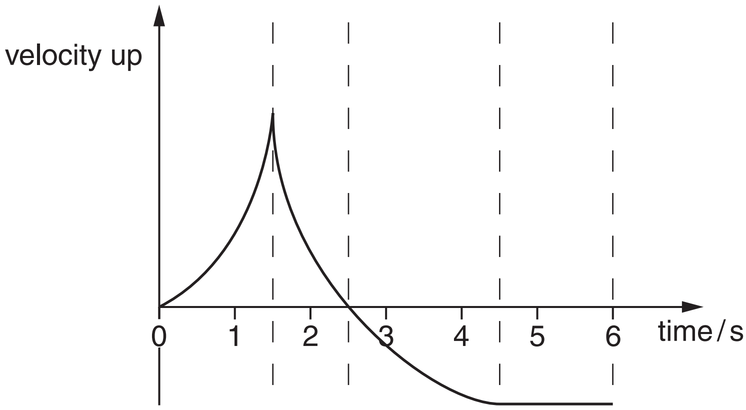

Fig. 1.2

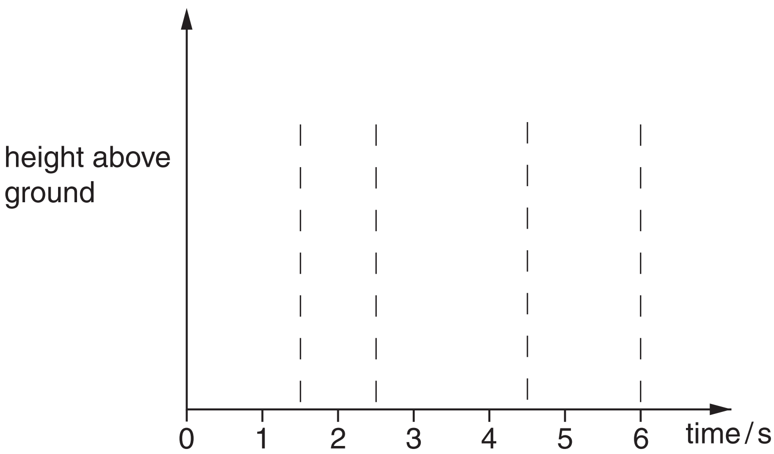

Fig. 1.3

(a) **(i)** Mark with an **A** on Fig. 1.1 the point at which the acceleration has its maximum value. [1]

(ii) During the first 1.4 s the accelerating force is constant yet the rocket's acceleration increases. Explain how this is possible.

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....[2]

(iii) Explain why the acceleration suddenly changes from positive to negative.

....

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....[2]

(iv) State the **two** forces acting downwards which cause the negative acceleration of magnitude $20\,m\,s^{-2}$.

1. .... 2. ....[1]

(b) The corresponding velocity-time sketch graph is shown in Fig. 1.2.

(i) Mark on the sketch graph

1. a point **P** at which the rocket reaches maximum height
2. a region **R** where the remains of the rocket travel with terminal velocity. [2]

(ii) Use the acceleration-time graph, Fig. 1.1, to find an approximate value of the maximum velocity of the rocket.

maximum velocity = ...$m\,s^{-1}$ [3]

(c) Use the information from Fig. 1.2 to sketch the shape of the height-time graph in Fig. 1.3. [3]

[Total: 14]

2 **(a)** Why is the internal energy of an ideal gas only kinetic energy?

....

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....[2]

Fig. 2.1, on the facing page, is a graph used to describe the speed distribution of molecules in an ideal gas at a temperature of 1000 K. In this graph the area of the graph between two different speeds is equal to the percentage of molecules with speeds between the two values. For example it shows that 9.3% of all the molecules have a speed in the range 500 $m s^{-1}$ to 600 $m s^{-1}$ and 20% of all the molecules have a speed in the range 500 $m s^{-1}$ to 700 $m s^{-1}$.

(b) **(i)** Using Fig. 2.1, estimate the percentage of molecules which have speed greater than twice the most common speed.

percentage = ...% [3]

(ii) For a real gas, state an effect in which the high speed molecules have more influence than the low speed ones.

....

....[1]

(c) In answering this question you are asked how the overall shape of the graph of Fig. 2.1 changes under different conditions. For guidance, the four graphs of Fig. 2.2 show the overall shape of the graph in Fig. 2.1 when the temperature is 1000 K.

(i) On **A**, sketch a graph to show the speed distribution for the gas at a higher temperature. [2]

(ii) On **B**, sketch a graph to show the speed distribution for the gas at a lower temperature. [1]

(iii) On **C**, sketch a graph to show the speed distribution for the gas at 1000 K but compressed to a higher pressure and lower volume. [2]

(iv) On **D**, sketch a graph to show the speed distribution for the gas at 1000 K after 20% of the molecules have leaked from the container. [1]

[Total: 12]

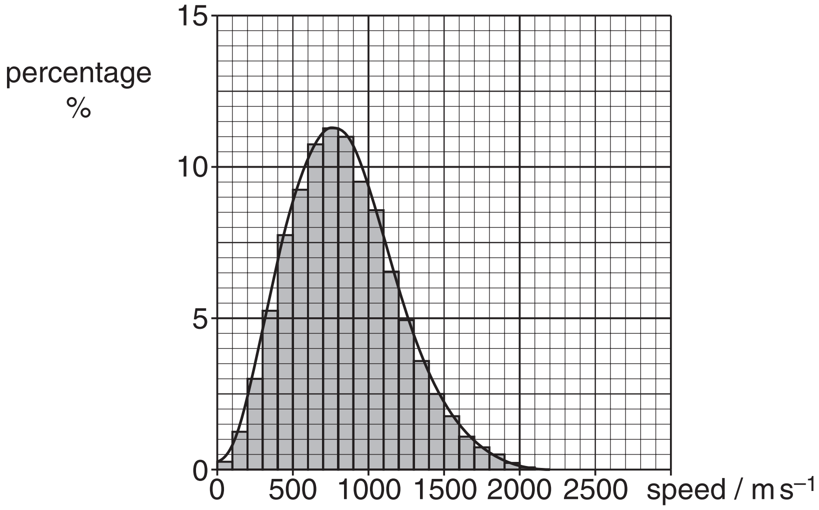
15
percentage
%
10
5
0
0
500
1000
1500
2000
2500
speed / m s–1

Fig. 2.1

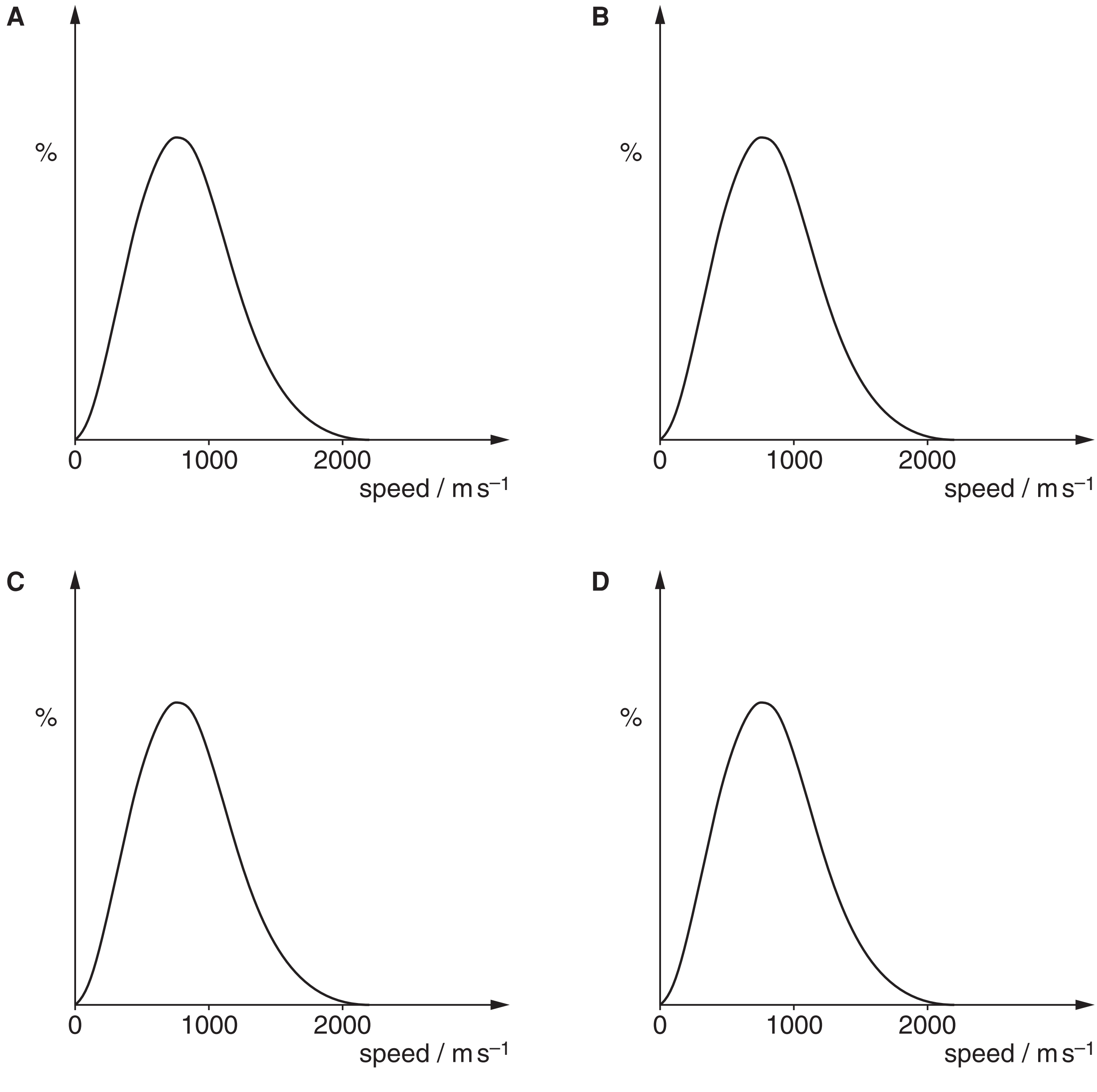
A
%
0
1000
2000
speed / m s–1
B
%
0
1000
2000
speed / m s–1
C
%
0
1000
2000
speed / m s–1
D
%
0
1000
2000
speed / m s–1

Fig. 2.2

3 The following three calculations all contain a mistake. For each case

- state how you would have known that a mistake has been made
- write down the correct calculation.

(a) The mass of water in water tank = volume × density
= $4.0\,\text{m} \times 1.0\,\text{m} \times 0.5\,\text{m} \times 1\,\text{kg}\,\text{m}^{-3} = 2.0\,\text{kg}$.

[3]

(b) The number of molecules in 3 mol of gas = $\dfrac{3}{N_A} = \dfrac{3}{6.02 \times 10^{23}} = 5.0 \times 10^{-24}$.

[2]

(c) The pressure p of 2.0 mol of an ideal gas in a container of volume $2.5 \times 10^{-3}\,\text{m}^3$ at a temperature of −20 °C is given by

$$p = \frac{nRT}{V} = \frac{2.0 \times 8.31 \times -20}{2.5 \times 10^{-3}} = -133\,000\,\text{Pa}.$$

[3]

[Total: 8]

4 Two systems are at present being considered to make use of tidal energy.

(a) The first is a barrage scheme, illustrated in Fig. 4.1.

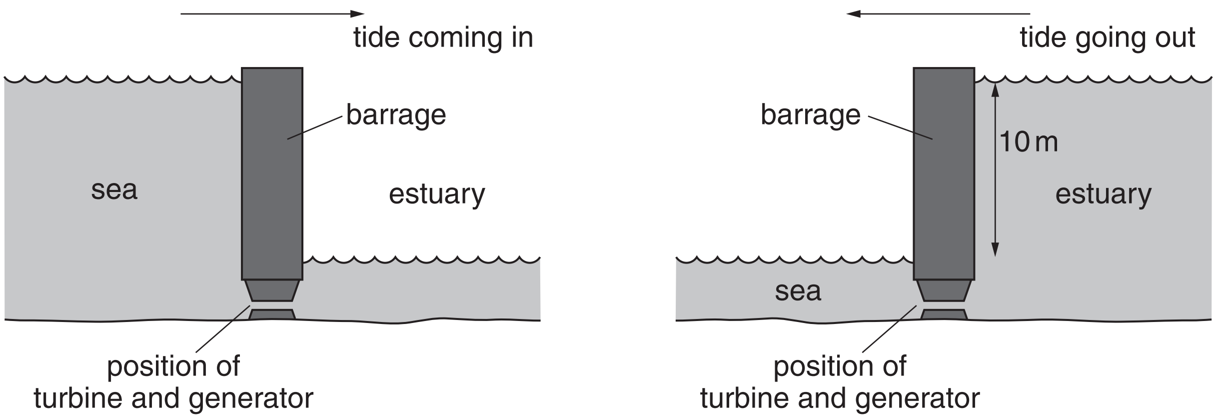

Fig. 4.1(a) **Fig. 4.1(b)**

In this scheme a barrage is built right across an estuary. The flow of water through the barrage is controlled in order to generate electricity. The turbine placed at the bottom of the barrage uses the maximum height difference between sea water and water in the estuary. Power can be generated for two periods of time per tide cycle from low to high and high to low.

An estuary has an area behind the barrage equal to 50 km^2 and a tide height of 10 m. As the tide goes out all the water is held back behind the barrage at the high tide level until the time of low tide. See Fig. 4.1(b). Calculate the potential energy of the retained water. The density of sea water is 1030 $kg\,m^{-3}$.

potential energy = ... J [4]

(b) The second system is a tidal stream system, rather like an underwater wind farm. It is illustrated in Fig. 4.2. In this scheme twin generating rotors each of 20 m diameter are mounted on a steel tube set into the sea bed. The rotors can be lowered or raised to a position for maximum water speed and for maintenance.

Fig. 4.2

At one state of the tide water flows past a rotor with a speed of 3.0 m s^{-1}. Calculate the kinetic energy of the cylinder of water which passes one rotor in one second. The density of sea water is 1030 kg m^{-3}.

kinetic energy = ... J [4]

(c) In the following table state **two** advantages and **two** disadvantages for both the barrage and the tidal stream system. Environmental, economic and technological issues may be considered. Do not write the same comment twice in the same column.

	ADVANTAGES	DISADVANTAGES
BARRAGE		
TIDAL STREAM		

[8]

[Total: 16]

5 **(a)** Alternating current is used in preference to direct current for the distribution of electrical energy throughout almost every country's national grid. Write a logical explanation, suitable for an intelligent non-scientist, of why all countries came to the same conclusion about this. Structure your explanation under the following headings

- the difference between alternating and direct current
- the principle of inducing an e.m.f.
- why high e.m.f.s are required for transmission of electrical energy
- why transformers make alternating current the choice for mains distribution.

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....[8]

(b) State **two** advantages of using above-ground cables supported by pylons for electrical transmission rather than burying the cables underground.

1. ....

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2. ....

....[2]

[Total: 10]

END OF QUESTION PAPER

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