UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER					

9048802011

PHYSICS **9702/22**

Paper 2 AS Structured Questions **October/November 2012**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
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4	
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7	
Total	

This document consists of **12** printed pages.

DC (CW/CGW) 43270/4

UNIVERSITY *of* CAMBRIDGE International Examinations

[Turn over

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,	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
	$(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\ \mathrm{m\,F^{-1}})$
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,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
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,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2\rangle$
simple harmonic motion,	$a = -\omega^2 x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $v = \pm\, \omega\sqrt{(x_0^2 - x^2)}$
electric potential,	$V = \frac{Q}{4\pi\varepsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
alternating current/voltage,	$x = x_0 \sin \omega t$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

Answer **all** the questions in the spaces provided.

1 **(a)** The drag force D on an object of cross-sectional area A, moving with a speed v through a fluid of density ρ, is given by

$$D = \frac{1}{2} C \rho A v^2$$

where C is a constant.

Show that C has no unit.

[2]

(b) A raindrop falls vertically from rest. Assume that air resistance is negligible.

(i) On Fig. 1.1, sketch a graph to show the variation with time t of the velocity v of the raindrop for the first 1.0 s of the motion.

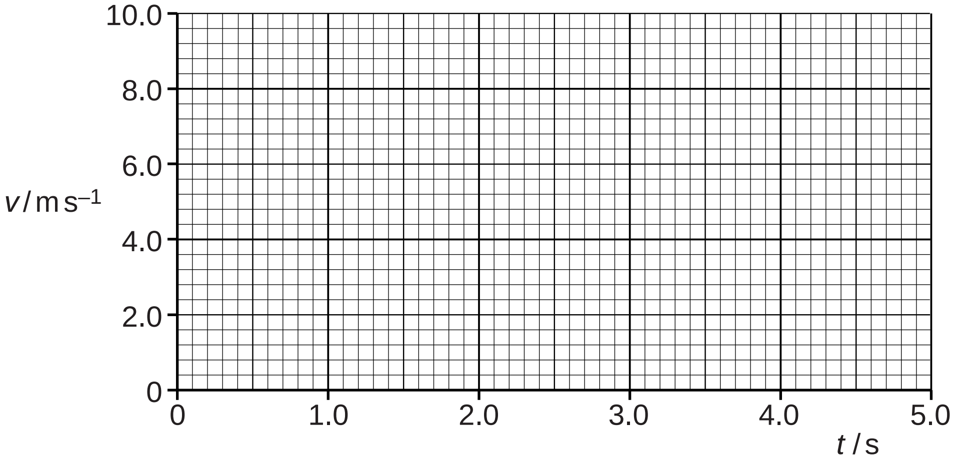

Fig. 1.1

[1]

(ii) Calculate the velocity of the raindrop after falling 1000 m.

velocity = ... $m\,s^{-1}$ [2]

(c) In practice, air resistance on raindrops is not negligible because there is a drag force. This drag force is given by the expression in **(a)**.

(i) State an equation relating the forces acting on the raindrop when it is falling at terminal velocity.

[1]

(ii) The raindrop has mass 1.4×10^{-5} kg and cross-sectional area $7.1 \times 10^{-6}\,\text{m}^2$. The density of the air is $1.2\,\text{kg}\,\text{m}^{-3}$ and the initial velocity of the raindrop is zero. The value of *C* is 0.60.

1. Show that the terminal velocity of the raindrop is about $7\,\text{m}\,\text{s}^{-1}$.

[2]

2. The raindrop reaches terminal velocity after falling approximately 10 m. On Fig. 1.1, sketch the variation with time *t* of velocity *v* for the raindrop. The sketch should include the first 5 s of the motion.

[2]

2 **(a)** State Newton's second law.

....

.... [1]

(b) A ball of mass 65 g hits a wall with a velocity of $5.2\,\mathrm{m\,s^{-1}}$ perpendicular to the wall. The ball rebounds perpendicularly from the wall with a speed of $3.7\,\mathrm{m\,s^{-1}}$. The contact time of the ball with the wall is 7.5 ms.

Calculate, for the ball hitting the wall,

(i) the change in momentum,

change in momentum = ... N s [2]

(ii) the magnitude of the average force.

force = ... N [1]

(c) **(i)** For the collision in **(b)** between the ball and the wall, state how the following apply:

1. Newton's third law,

....

....

....

.... [2]

2. the law of conservation of momentum.

....

.... [1]

(ii) State, with a reason, whether the collision is elastic or inelastic.

....

.... [1]

3 **(a)** With reference to the arrangement of atoms, distinguish between metals, polymers and amorphous solids.

metals: ....

....

polymers: ....

....

amorphous solids: ....

....
[3]

(b) On Fig. 3.1, sketch the variation with extension *x* of force *F* to distinguish between a metal and a polymer.

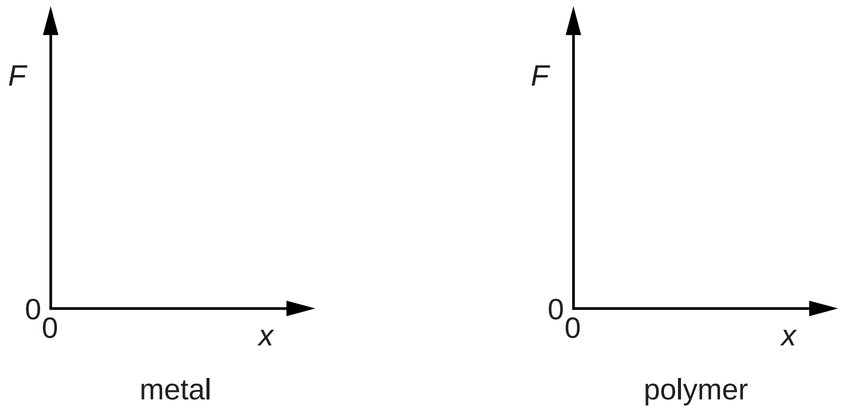

Fig. 3.1

[2]

4 Fig. 4.1 shows an arrangement for producing stationary waves in a tube that is closed at one end.

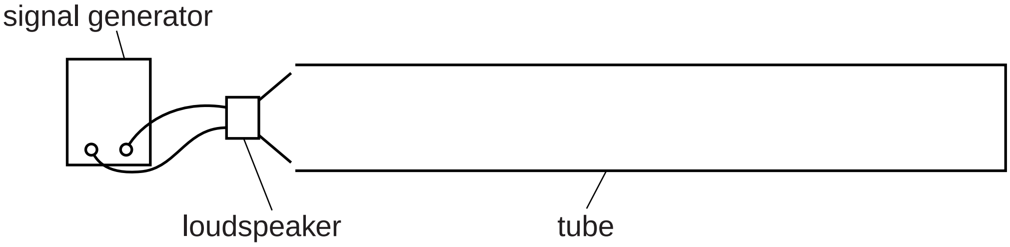

Fig. 4.1

(a) Explain how waves from the loudspeaker produce stationary waves in the tube.

....

....

....

....

.... [3]

(b) One of the stationary waves that may be formed in the tube is represented in Fig. 4.2.

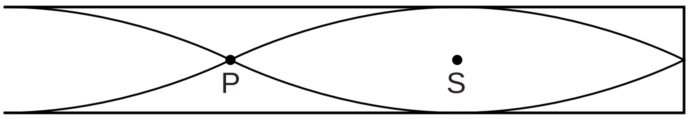

Fig. 4.2

(i) Describe the motion of the air particles in the tube at

1. point P,

.... [1]

2. point S.

.... [1]

(ii) The speed of sound in the tube is $330\,\mathrm{m\,s^{-1}}$ and the frequency of the waves from the loudspeaker is 880 Hz. Calculate the length of the tube.

length = ... m [3]

5 Fig. 5.1 shows a 12 V power supply with negligible internal resistance connected to a uniform metal wire AB. The wire has length 1.00 m and resistance 10 Ω. Two resistors of resistance 4.0 Ω and 2.0 Ω are connected in series across the wire.

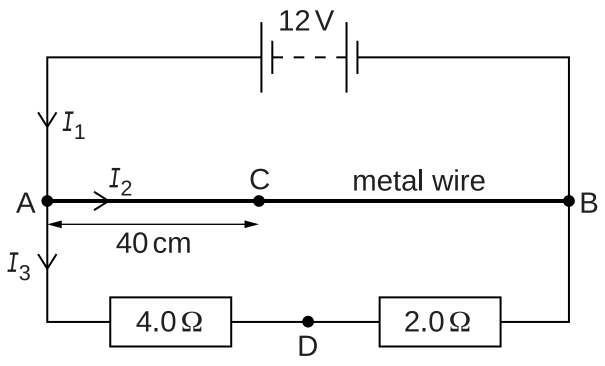

Fig. 5.1

Currents I_1, I_2 and I_3 in the circuit are as shown in Fig. 5.1.

(a) (i) Use Kirchhoff's first law to state a relationship between I_1, I_2 and I_3.

.... [1]

(ii) Calculate I_1.

I_1 = ... A [3]

(iii) Calculate the ratio *x*, where

$$x = \frac{\text{power in metal wire}}{\text{power in series resistors}}.$$

x = ... [3]

(b) Calculate the potential difference (p.d.) between the points C and D, as shown in Fig. 5.1. The distance AC is 40 cm and D is the point between the two series resistors.

p.d. = ... V [3]

6 **(a)** State Hooke's law.

....

....[1]

(b) A spring is attached to a support and hangs vertically, as shown in Fig. 6.1. An object M of mass 0.41 kg is attached to the lower end of the spring. The spring extends until M is at rest at R.

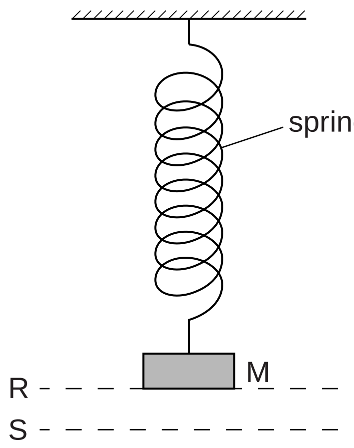

Fig. 6.1

The spring constant of the spring is 25 N m^{-1}. Show that the extension of the spring is about 0.16 m.

[2]

(c) The object M in Fig. 6.1 is pulled down a further 0.060 m to S and is then released.
For M, just as it is released,

(i) state the forces acting on M,

....[1]

(ii) calculate the acceleration of M.

acceleration = ... m s^{-2} [3]

(d) Describe and explain the energy changes from the time the object M in Fig. 6.1 is released to the time it first returns to R.

....

....

....

....[2]

Please turn over for Question 7.

7 A nuclear reaction between two helium nuclei produces a second isotope of helium, two protons and 13.8 MeV of energy. The reaction is represented by the following equation.

$$^{3}_{2}\text{He} + {}^{3}_{2}\text{He} \rightarrow {}^{\cdots\cdots\cdots}_{\cdots\cdots\cdots}\text{He} + 2\,{}^{\cdots\cdots\cdots}_{\cdots\cdots\cdots}\text{p} + 13.8\,\text{MeV}$$

(a) Complete the nuclear equation. [2]

(b) By reference to this reaction, explain the meaning of the term *isotope*.

....

....

.... [2]

(c) State the quantities that are conserved in this nuclear reaction.

....

....

....

....

.... [2]

(d) Radiation is produced in this nuclear reaction.

State

(i) a possible type of radiation that may be produced,

.... [1]

(ii) why the energy of this radiation is less than the 13.8 MeV given in the equation.

.... [1]

(e) Calculate the minimum number of these reactions needed per second to produce power of 60 W.

number = ... s^{-1} [2]