

Centre Number	Candidate Number

Candidate Name _____

CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Subsidiary Level

PHYSICS

8702/2

PAPER 2

OCTOBER/NOVEMBER SESSION 2001

1 hour

Candidates answer on the question paper.
No additional materials.

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [] at the end of each question or part question.

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

FOR EXAMINER'S USE

This question paper consists of 14 printed pages and 2 blank pages.



Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant,	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

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,	$\phi = -\frac{Gm}{r}$
simple harmonic motion,	$a = -\omega^2x$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$
electric potential,	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel,	$C = C_1 + C_2 + \dots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin \omega t$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \frac{3H_0^2}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number,	$R_e = \frac{\rho v r}{\eta}$
drag force in turbulent flow,	$F = Br^2 \rho v^2$

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

- 1 Distinguish between the *mass* of a body and its *weight*.

mass

.....

weight

.....[4]

- 2 A student determines the acceleration of free fall using the apparatus illustrated in Fig. 2.1.

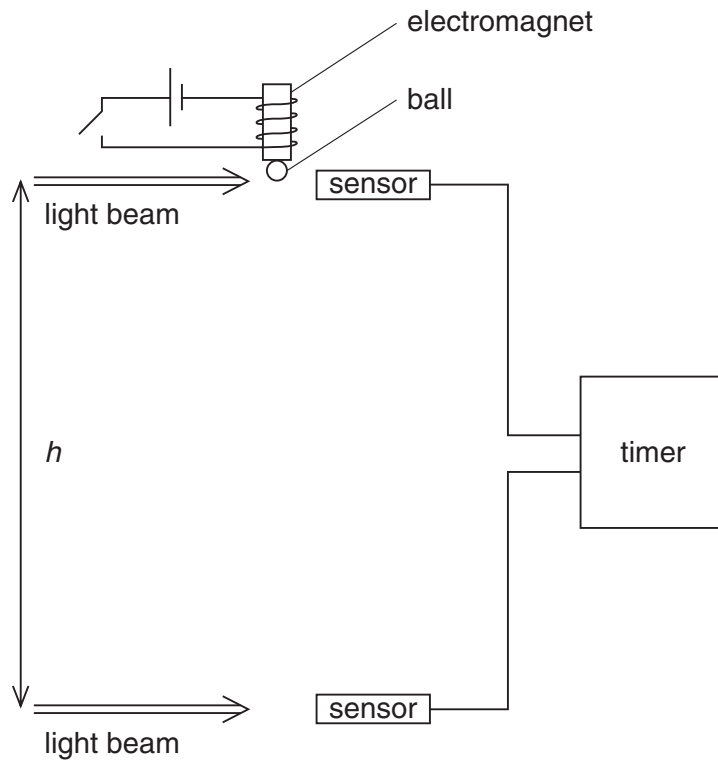


Fig. 2.1

A steel ball is held on an electromagnet. When the electromagnet is switched off, the ball immediately interrupts a beam of light and a timer is started. As the ball falls, it interrupts a second beam of light and the timer is stopped. The vertical distance h between the light beams and the time t recorded on the timer are noted. The procedure is repeated for different values of h . The student calculates values of t^2 and then plots the graph of Fig. 2.2.

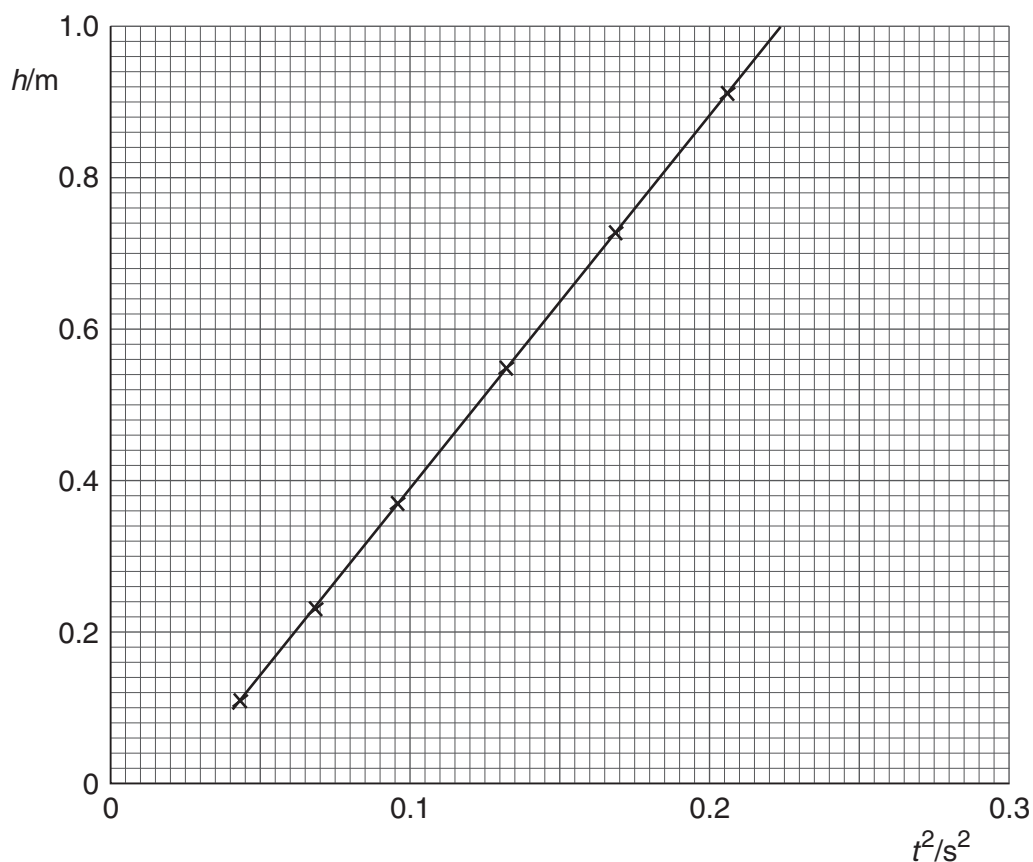


Fig. 2.2

- (a) Use Fig. 2.2 to calculate a value for g , the acceleration of free fall of the ball. Explain your working.

$g = \dots\dots\dots \text{ms}^{-2}$ [4]

- (b) Identify one possible source of random error in the determination of g and suggest how this error may be reduced.

.....

[2]

- 3 (a) State the two conditions necessary for the equilibrium of a body which is acted upon by a number of forces.

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

- (b) Three identical springs S_1 , S_2 and S_3 are attached to a point A such that the angle between any two of the springs is 120° , as shown in Fig. 3.1.

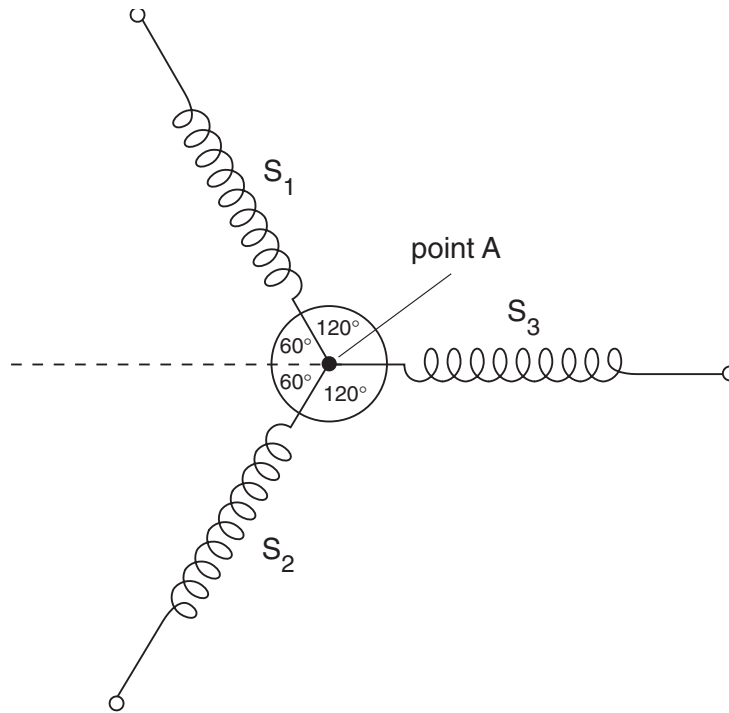


Fig. 3.1

The springs have extended elastically and the extensions of S_1 and S_2 are x . Determine, in terms of x , the extension of S_3 such that the system of springs is in equilibrium. Explain your working.

extension of $S_3 = \dots\dots\dots$ [3]

(c) The lid of a box is hinged along one edge E, as shown in Fig. 3.2.

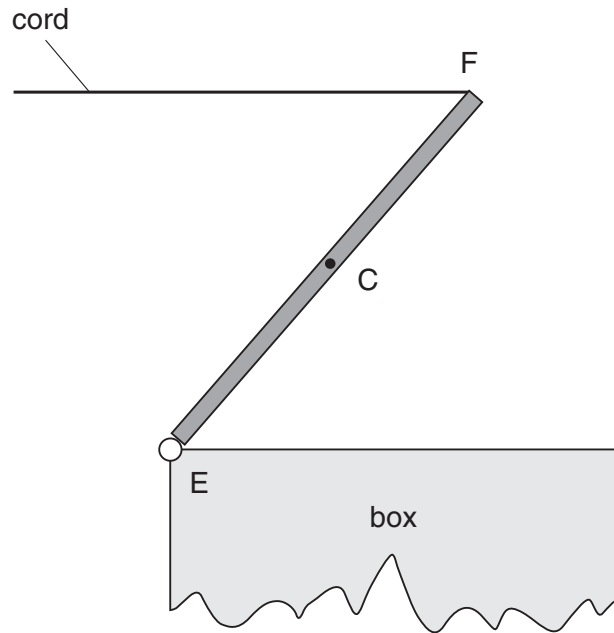


Fig. 3.2

The lid is held open by means of a horizontal cord attached to the edge F of the lid. The centre of gravity of the lid is at point C.

On Fig. 3.2 draw

- (i) an arrow, labelled W, to represent the weight of the lid,
- (ii) an arrow, labelled T, to represent the tension in the cord acting on the lid,
- (iii) an arrow, labelled R, to represent the force of the hinge on the lid.

[3]

4 A sphere has volume V and is made of metal of density ρ .

(a) Write down an expression for the mass m of the sphere in terms of V and ρ .

.....[1]

(b) The sphere is immersed in a liquid. Explain the apparent loss in the weight of the sphere.

.....
.....
.....
.....[3]

(c) The sphere in (b) has mass 2.0×10^{-3} kg. When the sphere is released, it eventually falls in the liquid with a constant speed of 6.0 cm s^{-1} .

(i) For this sphere travelling at constant speed, calculate

1. its kinetic energy,

kinetic energy = J

2. its rate of loss of gravitational potential energy.

rate = J s^{-1} [5]

(ii) Suggest why it is possible for the sphere to have constant kinetic energy whilst losing potential energy at a steady rate.

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

5 (a) In the following list of solids, underline those materials which are crystalline.

rubber copper nylon glass aluminium [2]

(b) The three graphs A, B and C of Fig. 5.1 represent the variation with extension x of the tension F in specimens of three different materials. One of the materials is polymeric, one is brittle and the other is ductile. They are not shown in that order in Fig. 5.1.

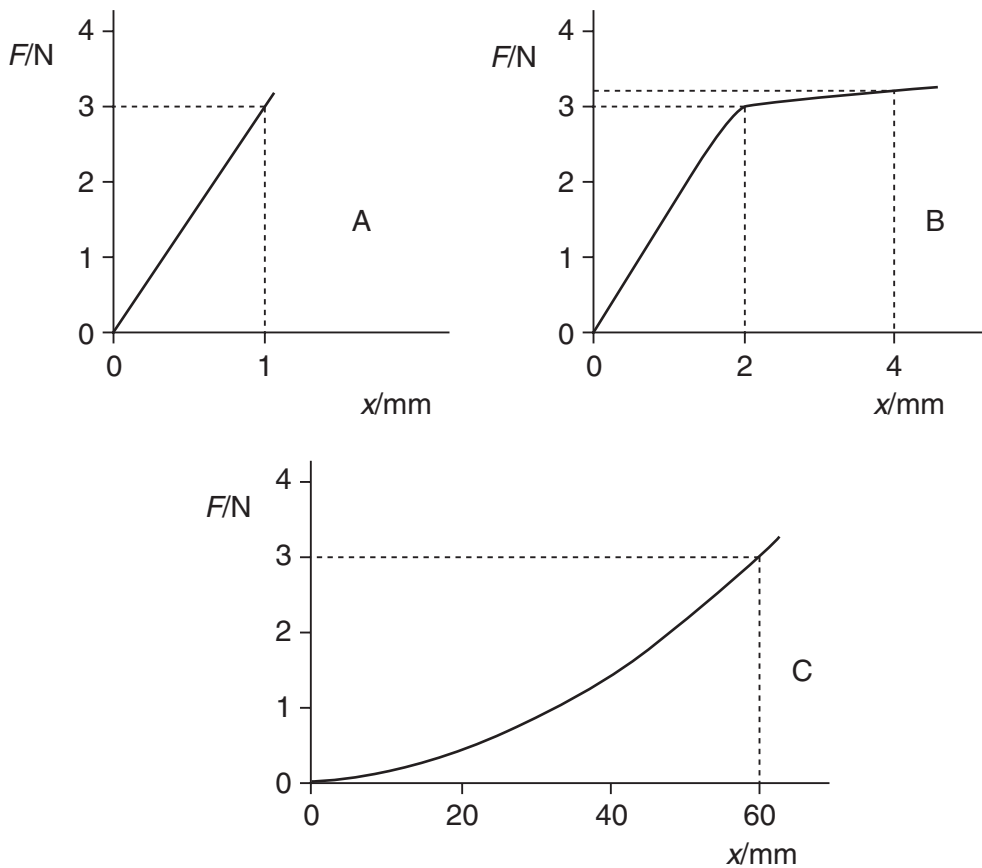


Fig. 5.1

(i) State the type of material which would produce the line shown in each graph.

Graph A is for a material.

Graph B is for a material.

Graph C is for a material. [2]

(ii) Use graph B to estimate the work done in stretching the specimen from 0 to 4 mm.

work done = J [3]

6 Light of frequency 4.8×10^{14} Hz is incident normally on a double slit, as illustrated in Fig. 6.1.

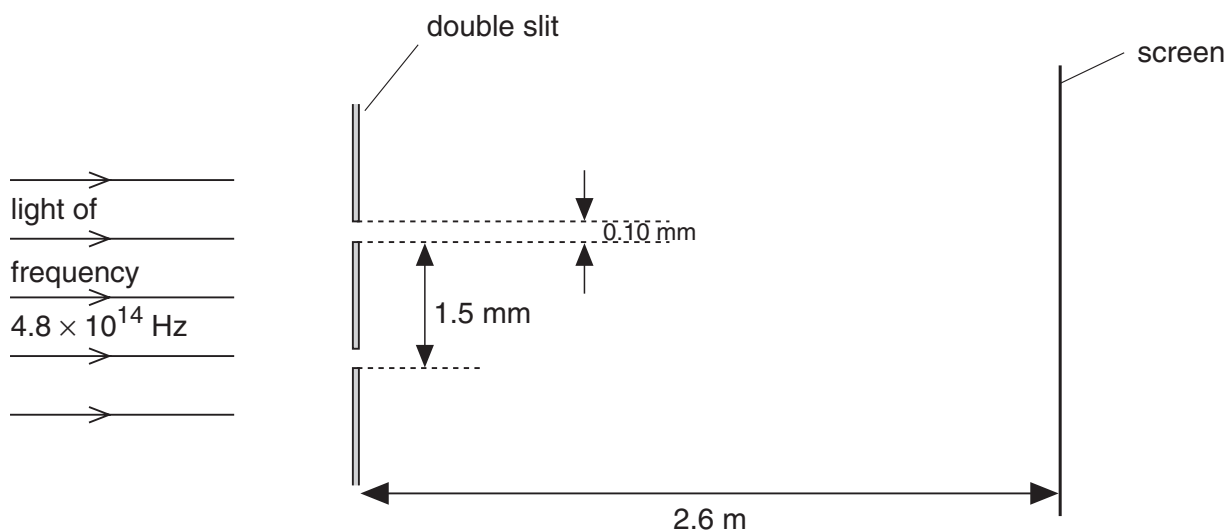


Fig. 6.1 (not to scale)

Each slit of the double slit arrangement is 0.10 mm wide and the slits are separated by 1.5 mm. The pattern of fringes produced is observed on a screen at a distance 2.6 m from the double slit.

(a) (i) Show that the width of each slit is approximately 160 times the wavelength of the incident light.

[3]

(ii) Hence explain why the pattern of fringes on the screen is seen over a *limited* area of the screen.

.....

.....

.....

.....[3]

(b) Calculate the separation of the fringes observed on the screen.

separation = mm [3]

(c) The intensity of the light incident on the double slit is increased. State the effect, if any, on the separation and on the appearance of the fringes.

.....
.....
.....
.....
.....[3]

- 7 (a) A student has been asked to make an electric heater. The heater is to be rated as 12 V 60 W, and is to be constructed of wire of diameter 0.54 mm. The material of the wire has resistivity $4.9 \times 10^{-7} \Omega \text{ m}$.

(i) Show that the resistance of the heater will be 2.4Ω .

[2]

(ii) Calculate the length of wire required for the heater.

length = m [3]

- (b) Two cells of e.m.f. E_1 and E_2 are connected to resistors of resistance R_1 , R_2 and R_3 as shown in Fig. 7.1.

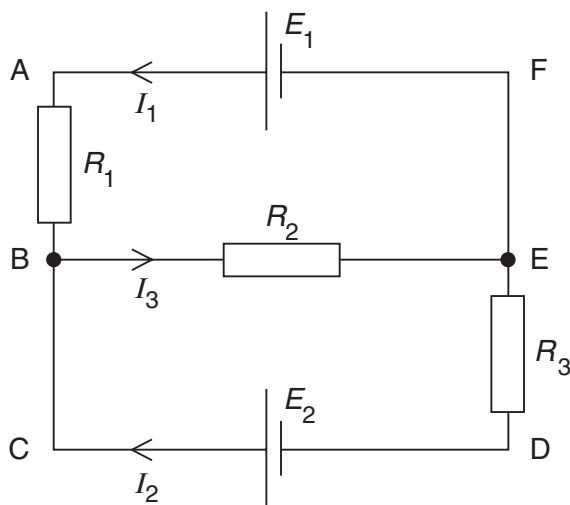


Fig. 7.1

The currents I_1 , I_2 and I_3 in the various parts of the circuit are as shown.

- (i) Write down an expression relating I_1 , I_2 and I_3 .

.....[1]

- (ii) Use Kirchhoff's second law to write down a relation between

1. E_1 , R_1 , R_2 , I_1 and I_3 for loop ABEFA,

.....

2. E_1 , E_2 , R_1 , R_3 , I_1 and I_2 for loop ABCDEFA.

.....

[2]

8 (a) One isotope of gold is represented as



State the number of neutrons in one nucleus of this isotope.

number = [1]

(b) In an α -particle scattering experiment, an α -particle approaches an isolated gold nucleus, as illustrated in Fig. 8.1.



Fig. 8.1

Complete Fig. 8.1 to show the path of the α -particle as it passes by, and moves away from, the gold nucleus. [2]

(c) The α -particle in (b) is replaced by one having greater initial kinetic energy.

State what change, if any, will occur in the final deviation of the α -particle.

.....[1]

