

Candidate Name \_\_\_\_\_

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**CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
**General Certificate of Education Advanced Subsidiary Level**  
**and Advanced Level**

**PHYSICS**  
PAPER 2 AS Core

**9702/2****OCTOBER/NOVEMBER SESSION 2002**

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**

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**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 (a) (i) Define *density*.

.....  
 .....

- (ii) State the base units in which density is measured.

..... [2]

- (b) The speed  $v$  of sound in a gas is given by the expression

$$v = \sqrt{\left(\frac{\gamma p}{\rho}\right)},$$

where  $p$  is the pressure of the gas of density  $\rho$ .  $\gamma$  is a constant.

Given that  $p$  has the base units of  $\text{kg m}^{-1} \text{s}^{-2}$ , show that the constant  $\gamma$  has no unit. [3]

- 2 A student uses a metre rule to measure the length of an elastic band before and after stretching it.

The lengths are recorded as

length of band before stretching,  $L_0 = 50.0 \pm 0.1$  cm

length of band after stretching,  $L_S = 51.6 \pm 0.1$  cm.

Determine

- (a) the change in length ( $L_S - L_0$ ), quoting your answer with its uncertainty,

$$(L_S - L_0) = \dots\dots\dots \text{ cm [1]}$$

(b) the fractional change in length,  $\frac{(L_S - L_0)}{L_0}$ ,

fractional change = ..... [1]

(c) the uncertainty in your answer in (b).

uncertainty = ..... [3]

- 3 A ball falls from rest onto a flat horizontal surface. Fig. 3.1 shows the variation with time  $t$  of the velocity  $v$  of the ball as it approaches and rebounds from the surface.

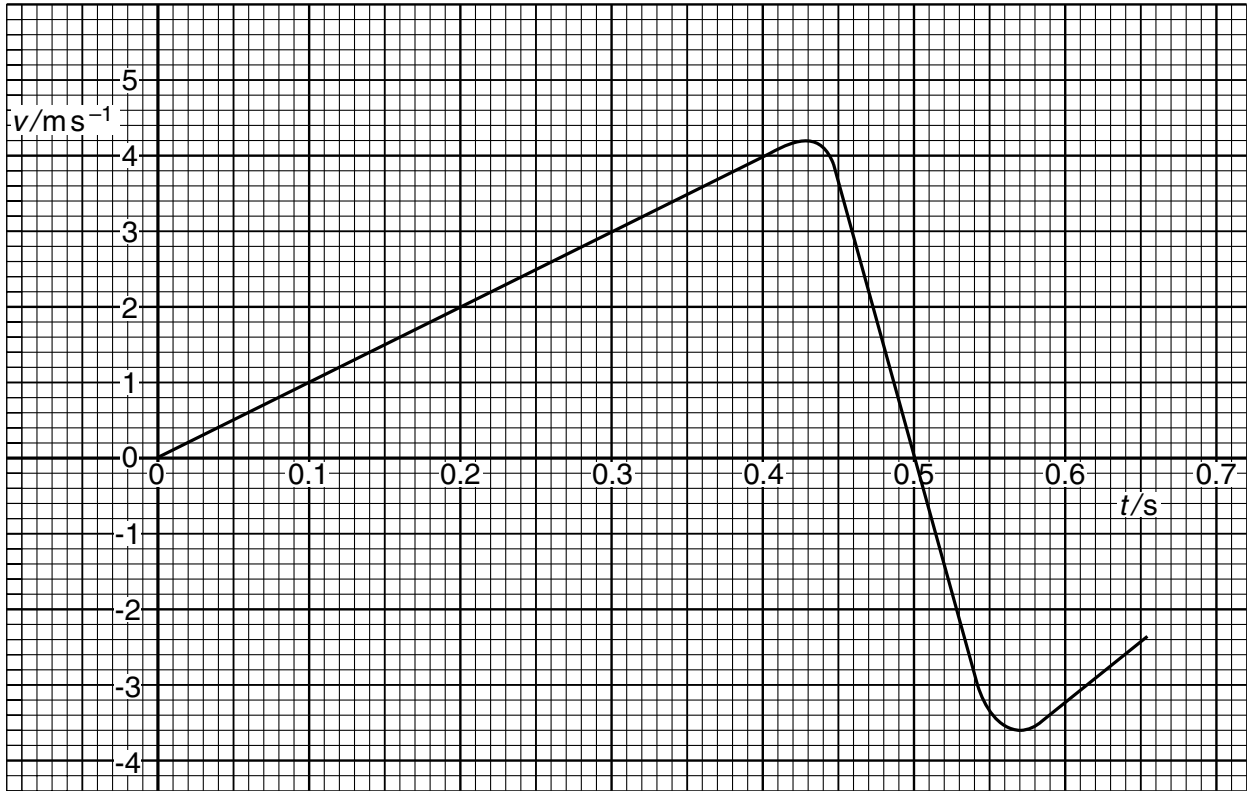


Fig. 3.1

Use data from Fig. 3.1 to determine

- (a) the distance travelled by the ball during the first 0.40 s,

distance = ..... m [2]

- (b) the change in momentum of the ball, of mass 45 g, during contact of the ball with the surface,

change = ..... N s [4]

- (c) the average force acting on the ball during contact with the surface.

force = ..... N [2]

- 4 (a) Explain what is meant by the concept of *work*.

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

- (b) Using your answer to (a), derive an expression for the increase in gravitational potential energy  $\Delta E_p$  when an object of mass  $m$  is raised vertically through a distance  $\Delta h$  near the Earth's surface.

The acceleration of free fall near the Earth's surface is  $g$ . [2]

- 5 The variation with time  $t$  of the displacement  $x$  of a point in a transverse wave  $T_1$  is shown in Fig. 5.1.

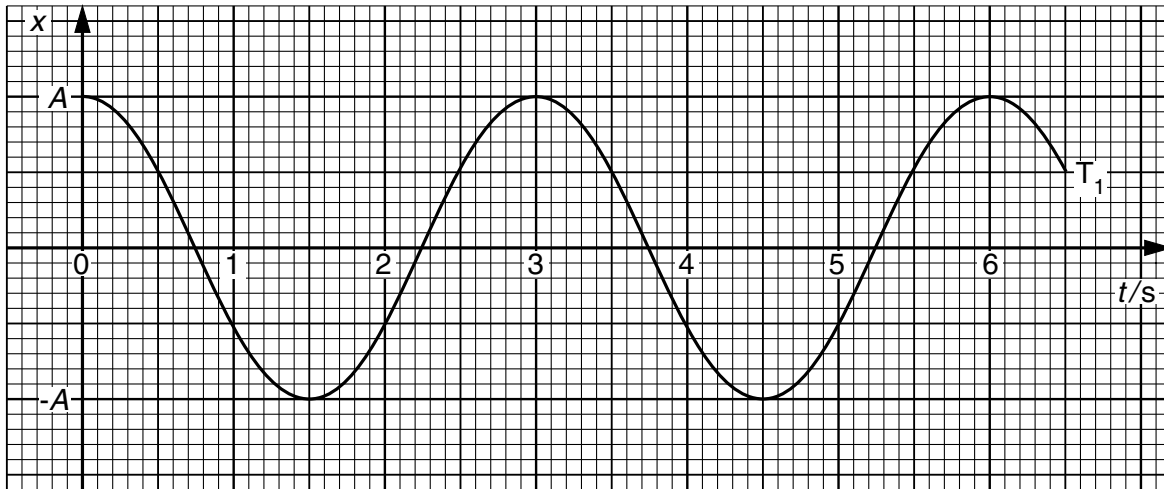


Fig. 5.1

- (a) By reference to displacement and direction of travel of wave energy, explain what is meant by a *transverse wave*.

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

- (b) A second transverse wave  $T_2$ , of amplitude  $A$  has the same waveform as wave  $T_1$  but lags behind  $T_1$  by a phase angle of  $60^\circ$ . The two waves  $T_1$  and  $T_2$  pass through the same point.

- (i) On Fig. 5.1, draw the variation with time  $t$  of the displacement  $x$  of the point in wave  $T_2$ . [2]

- (ii) Explain what is meant by the *principle of superposition* of two waves.

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

- (iii) For the time  $t = 1.0$  s, use Fig. 5.1 to determine, in terms of  $A$ ,

1. the displacement due to wave  $T_1$  alone,

displacement = .....

2. the displacement due to wave  $T_2$  alone,

displacement = .....

3. the resultant displacement due to both waves.

displacement = .....

[3]



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**Turn over for question 6**

- 6 An electron travelling horizontally in a vacuum enters the region between two horizontal metal plates, as shown in Fig. 6.1.

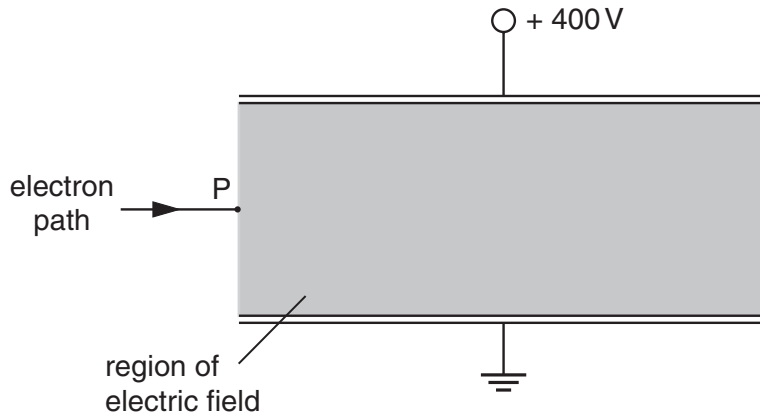


Fig. 6.1

The lower plate is earthed and the upper plate is at a potential of + 400 V. The separation of the plates is 0.80 cm.

The electric field between the plates may be assumed to be uniform and outside the plates to be zero.

- (a) On Fig. 6.1,
- (i) draw an arrow at P to show the direction of the force on the electron due to the electric field between the plates,
  - (ii) sketch the path of the electron as it passes between the plates and beyond them.
- [3]
- (b) Determine the electric field strength  $E$  between the plates.

$E = \dots\dots\dots \text{ V m}^{-1}$  [2]

(c) Calculate, for the electron between the plates, the magnitude of

(i) the force on the electron,

force = ..... N

(ii) its acceleration.

acceleration = .....  $\text{m s}^{-2}$   
[4]

(d) State and explain the effect, if any, of this electric field on the horizontal component of the motion of the electron.

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

- 7 A student set up the circuit shown in Fig. 7.1.

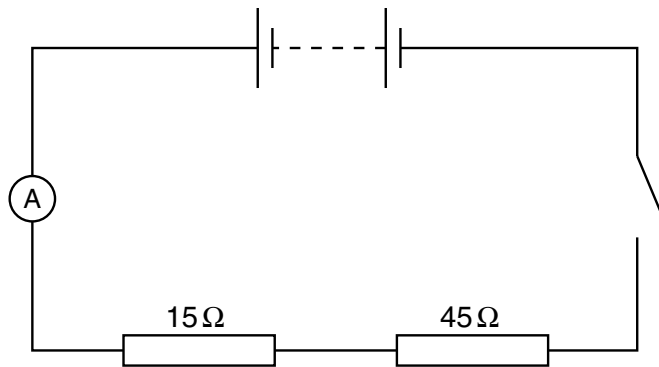


Fig. 7.1

The resistors are of resistance  $15\ \Omega$  and  $45\ \Omega$ . The battery is found to provide  $1.6 \times 10^5\ \text{J}$  of electrical energy when a charge of  $1.8 \times 10^4\ \text{C}$  passes through the ammeter in a time of  $1.3 \times 10^5\ \text{s}$ .

- (a) Determine

- (i) the electromotive force (e.m.f.) of the battery,

e.m.f. = ..... V

- (ii) the average current in the circuit.

current = ..... A  
[4]

(b) During the time for which the charge is moving,  $1.1 \times 10^5 \text{ J}$  of energy is dissipated in the  $45 \Omega$  resistor.

(i) Determine the energy dissipated in the  $15 \Omega$  resistor during the same time.

energy = ..... J

(ii) Suggest why the total energy provided is greater than that dissipated in the two resistors.

.....  
.....

[4]

8 A nucleus of an atom of francium (Fr) contains 87 protons and 133 neutrons.

(a) Write down the notation for this nuclide.

.....  
Fr  
.....

[2]

(b) The nucleus decays by the emission of an  $\alpha$ -particle to become a nucleus of astatine (At).

Write down a nuclear equation to represent this decay.

[2]

- 9 An aluminium wire of length 1.8 m and area of cross-section  $1.7 \times 10^{-6} \text{ m}^2$  has one end fixed to a rigid support. A small weight hangs from the free end, as illustrated in Fig. 9.1.

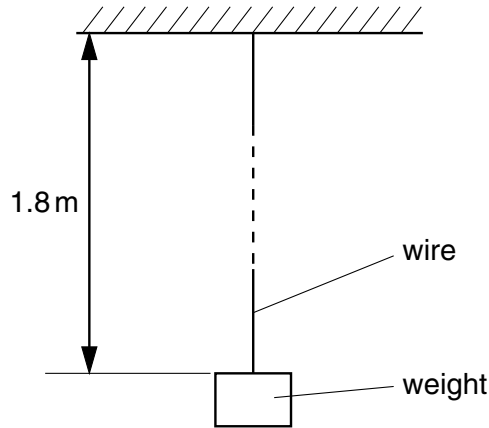


Fig. 9.1

The resistance of the wire is  $0.030 \Omega$  and the Young modulus of aluminium is  $7.1 \times 10^{10} \text{ Pa}$ .

The load on the wire is increased by 25 N.

(a) Calculate

- (i) the increase in stress,

increase = ..... Pa

- (ii) the change in length of the wire.

change = ..... m  
[4]

- (b) Assuming that the area of cross-section of the wire does not change when the load is increased, determine the change in resistance of the wire.

change = .....  $\Omega$  [3]

