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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

7976032303

PHYSICS **9702/23**

Paper 2 AS Structured Questions **May/June 2010**

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	
3	
4	
5	
6	
7	
Total	

This document consists of **17** printed pages and **3** blank pages.

UNIVERSITY of CAMBRIDGE International Examinations

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,	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
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,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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

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1 A digital voltmeter with a three-digit display is used to measure the potential difference across a resistor. The manufacturers of the meter state that its accuracy is ±1% and ±1 digit. The reading on the voltmeter is 2.05 V.

(a) For this reading, calculate, to the nearest digit,

(i) a change of 1% in the voltmeter reading,

change = ...V [1]

(ii) the maximum possible value of the potential difference across the resistor.

maximum value = ...V [1]

(b) The reading on the voltmeter has high precision. State and explain why the reading may not be accurate.

....

....

....[2]

For Examiner's Use

2 **(a)** State the two conditions that must be satisfied for a body to be in equilibrium.

1. ....

....

2. ....

.... [2]

(b) Three co-planar forces act on a body that is in equilibrium.

(i) Describe how to draw a vector triangle to represent these forces.

....

....

....

....

....

....

....[3]

(ii) State how the triangle confirms that the forces are in equilibrium.

....

....[1]

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(c) A weight of 7.0 N hangs vertically by two strings AB and AC, as shown in Fig. 2.1.

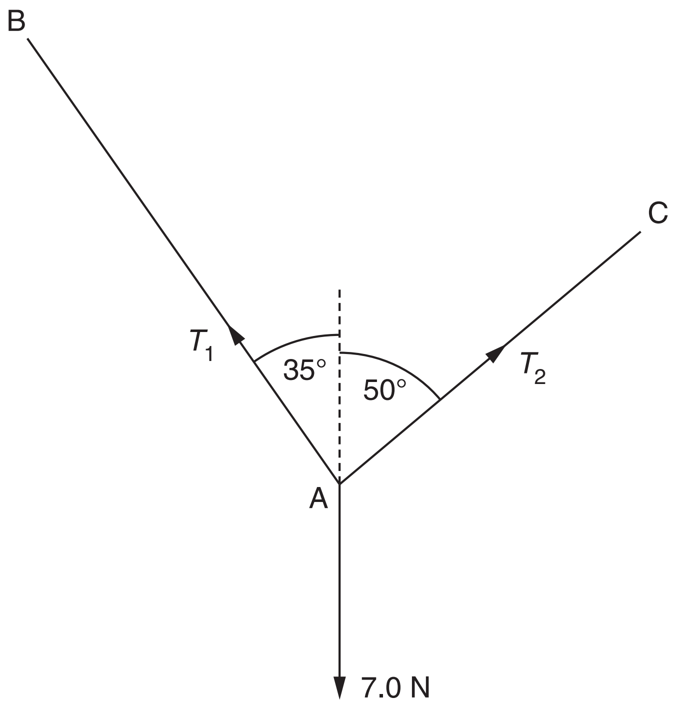

Fig. 2.1

For the weight to be in equilibrium, the tension in string AB is T_1 and in string AC it is T_2.

On Fig. 2.1, draw a vector triangle to determine the magnitudes of T_1 and T_2.

T_1 = ... N

T_2 = ... N
[3]

(d) By reference to Fig. 2.1, suggest why the weight could not be supported with the strings AB and AC both horizontal.

....

....[2]

3 A cyclist is moving up a slope that has a constant gradient. The cyclist takes 8.0 s to climb the slope.
The variation with time t of the speed v of the cyclist is shown in Fig. 3.1.

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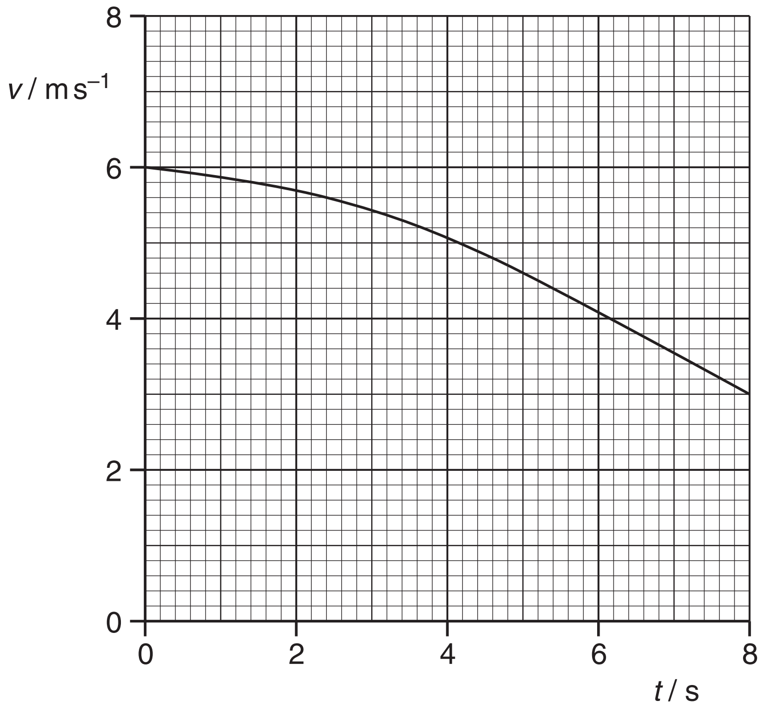

Fig. 3.1

(a) Use Fig. 3.1 to determine the total distance moved up the slope.

distance = ... m [3]

For Examiner's Use

(b) The bicycle and cyclist have a combined mass of 92 kg.
The vertical height through which the cyclist moves is 1.3 m.

(i) For the movement of the bicycle and cyclist between $t = 0$ and $t = 8.0$ s,

1. use Fig. 3.1 to calculate the change in kinetic energy,

change = ... J [2]

2. calculate the change in gravitational potential energy.

change = ... J [2]

(ii) The cyclist pedals continuously so that the useful power delivered to the bicycle is 75 W.
Calculate the useful work done by the cyclist climbing up the slope.

work done = ... J [2]

(c) Some energy is used in overcoming frictional forces.

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(i) Use your answers in **(b)** to show that the total energy converted in overcoming frictional forces is approximately 670 J.

[1]

(ii) Determine the average magnitude of the frictional forces.

average force = ...N [1]

(d) Suggest why the magnitude of the total resistive force would not be constant.

....

....

....[2]

For Examiner's Use

4 **(a)** State the evidence for the assumption that

(i) there are significant forces of attraction between molecules in the solid state,

....

....[1]

(ii) the forces of attraction between molecules in a gas are negligible.

....

....[1]

(b) Explain, on the basis of the kinetic model of gases, the pressure exerted by a gas.

....

....

....

....

....[4]

(c) Liquid nitrogen has a density of $810\,\text{kg}\,\text{m}^{-3}$. The density of nitrogen gas at room temperature and pressure is approximately $1.2\,\text{kg}\,\text{m}^{-3}$.
Suggest how these densities relate to the spacing of nitrogen molecules in the liquid and in the gaseous states.

....

....

....[2]

5 **(a)** A source of sound has frequency *f*. Sound of wavelength λ is produced by the source.

(i) State

1. what is meant by the *frequency* of the source,

....

....[1]

2. the distance moved, in terms of λ, by a wavefront during *n* oscillations of the source.

distance = ...[1]

(ii) Use your answers in **(i)** to deduce an expression for the speed *v* of the wave in terms of *f* and λ.

[2]

(b) The waveform of a sound wave produced on the screen of a cathode-ray oscilloscope (c.r.o.) is shown in Fig. 5.1.

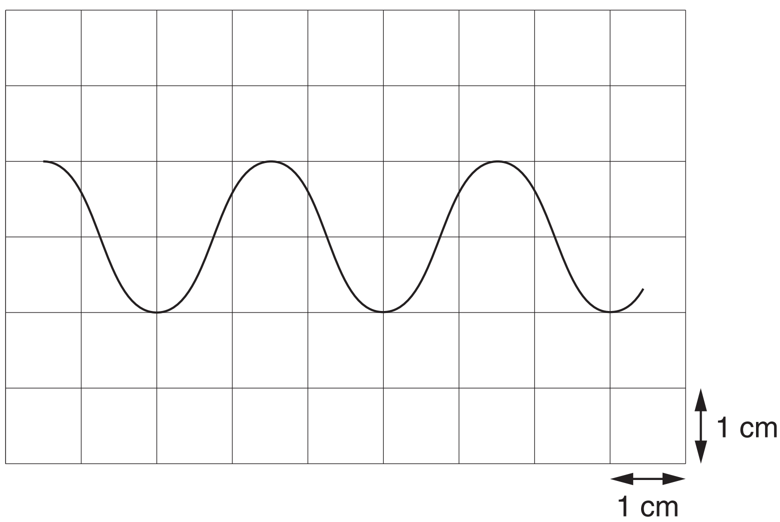

Fig. 5.1

The time-base setting of the c.r.o. is 2.0 ms cm^{-1}.

For Examiner's Use

(i) Determine the frequency of the sound wave.

frequency = ...Hz [2]

(ii) A second sound wave has the same frequency as that calculated in **(i)**. The amplitude of the two waves is the same but the phase difference between them is 90°.

On Fig. 5.1, draw the waveform of this second wave. [1]

For Examiner's Use

6 **(a)** **(i)** State what is meant by an *electric current*.

....

....[1]

(ii) Define *electric potential difference*.

....

....[1]

(b) The variation with potential difference V of the current I in a component Y and in a resistor R are shown in Fig. 6.1.

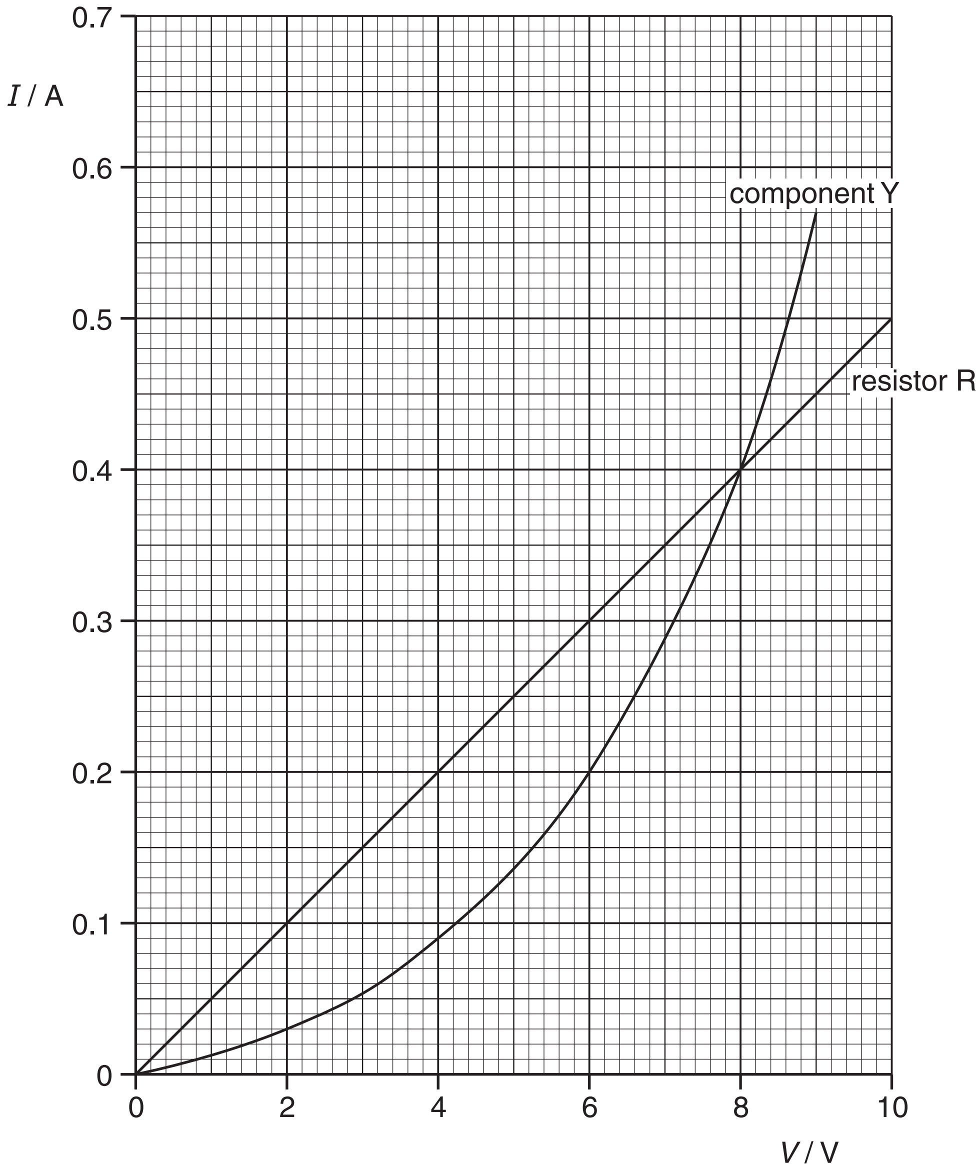

Fig. 6.1

Use Fig. 6.1 to explain how it can be deduced that resistor R has a constant resistance of 20 Ω.

....

....

....[2]

(c) The component Y and the resistor R in **(b)** are connected in parallel as shown in Fig. 6.2.

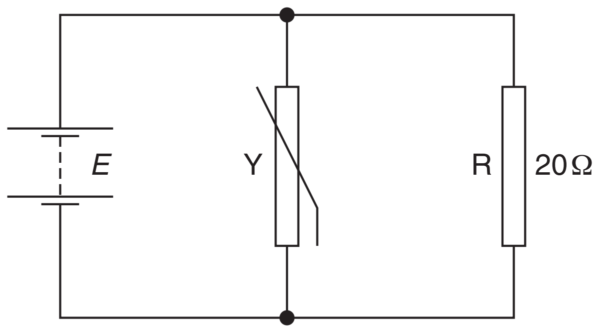

Fig. 6.2

A battery of e.m.f. *E* and negligible internal resistance is connected across the parallel combination.

Use data from Fig. 6.1 to determine

(i) the current in the battery for an e.m.f. *E* of 6.0 V,

current = ... A [1]

(ii) the total resistance of the circuit for an e.m.f. of 8.0 V.

resistance = ... Ω [2]

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(d) The circuit of Fig. 6.2 is now re-arranged as shown in Fig. 6.3.

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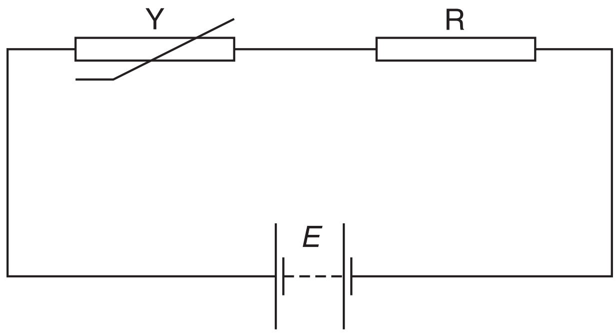

Fig. 6.3

The current in the circuit is 0.20 A.

(i) Use Fig. 6.1 to determine the e.m.f. *E* of the battery.

E = ...V [1]

(ii) Calculate the total power dissipated in component Y and resistor R.

power = ...W [2]

7 One property of α-particles is that they produce a high density of ionisation of air at atmospheric pressure. In this ionisation process, a neutral atom becomes an ion pair. The ion pair is a positively-charged particle and an electron.

For Examiner's Use

(a) State

(i) what is meant by an α-particle,

....

....[1]

(ii) an approximate value for the range of α-particles in air at atmospheric pressure.

range = ... cm [1]

(b) The energy required to produce an ion pair in air at atmospheric pressure is 31 eV. An α-particle has an initial kinetic energy of 8.5×10^{-13} J.

(i) Show that 8.5×10^{-13} J is equivalent to 5.3 MeV.

[1]

(ii) Calculate, to two significant figures, the number of ion pairs produced as the α-particle is stopped in air at atmospheric pressure.

number = ... [2]

(iii) Using your answer in **(a)(ii)**, estimate the average number of ion pairs produced per unit length of the track of the α-particle as it is brought to rest in air.

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number per unit length = ... [2]

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