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

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| CANDIDATE NAME | |

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| CENTRE NUMBER | | CANDIDATE NUMBER | |

*2077712634*

**PHYSICS** **9702/22**

Paper 2 AS Structured Questions **October/November 2011**

**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 **12** printed pages.

DC (CW/CGW) 34888/4

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**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, | $s = ut + \frac{1}{2}at^2$<br>$v^2 = u^2 + 2as$ |
| work done on/by a gas, | $W = p\Delta V$ |
| gravitational potential, | $\phi = -\dfrac{Gm}{r}$ |
| hydrostatic pressure, | $p = \rho gh$ |
| pressure of an ideal gas, | $p = \frac{1}{3}\dfrac{Nm}{V}\langle c^2\rangle$ |
| simple harmonic motion, | $a = -\omega^2 x$ |
| velocity of particle in s.h.m., | $v = v_0 \cos \omega t$<br>$v = \pm\,\omega\sqrt{(x_0{}^2 - x^2)}$ |
| electric potential, | $V = \dfrac{Q}{4\pi\varepsilon_0 r}$ |
| 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, | $\lambda = \dfrac{0.693}{t_{\frac{1}{2}}}$ |

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

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**1** The variation with time *t* of the displacement *s* for a car is shown in Fig. 1.1.

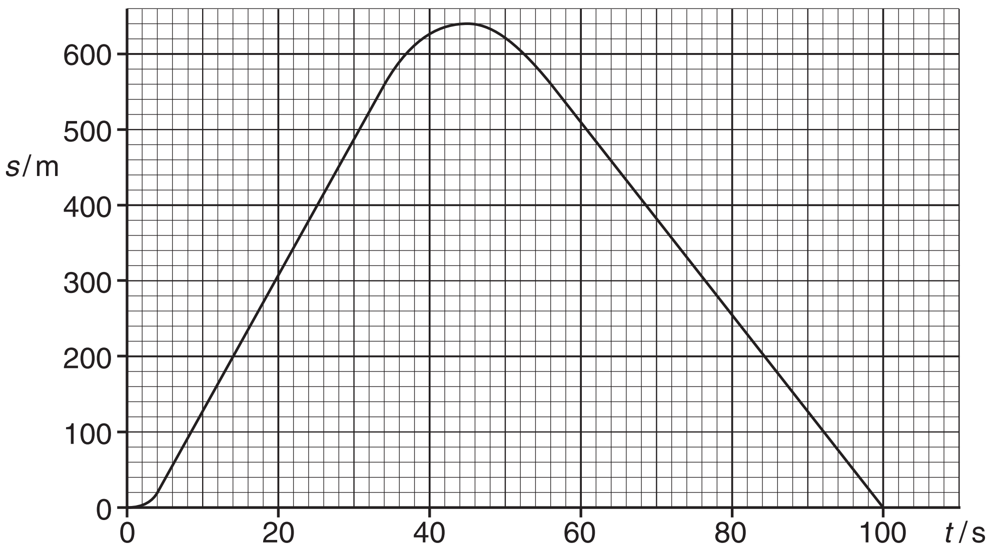


**Fig. 1.1**

**(a)** Determine the magnitude of the average velocity between the times 5.0 s and 35.0 s.

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

**(b)** On Fig. 1.2, sketch the variation with time *t* of the velocity *v* for the car.

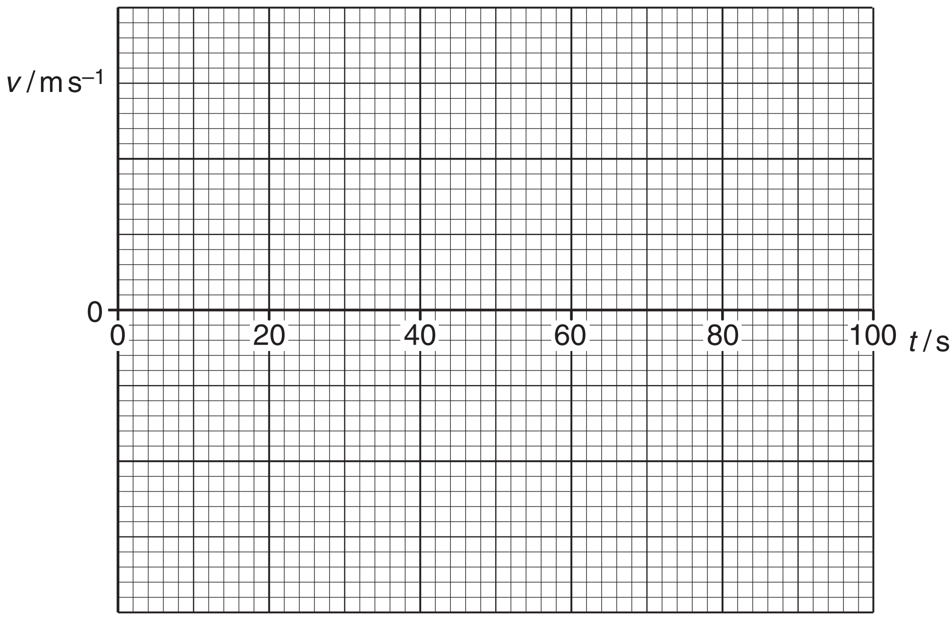


**Fig. 1.2**

[4]

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**2** **(a)** Define

**(i)** *force*,

..........................................................................................................................

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

**(ii)** *work done*.

..........................................................................................................................

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

**(b)** A force $F$ acts on a mass $m$ along a straight line for a distance $s$. The acceleration of the mass is $a$ and the speed changes from an initial speed $u$ to a final speed $v$.

**(i)** State the work $W$ done by $F$.

[1]

**(ii)** Use your answer in **(i)** and an equation of motion to show that kinetic energy of a mass can be given by the expression

$$\text{kinetic energy} = \tfrac{1}{2} \times \text{mass} \times (\text{speed})^2.$$

[3]

**(c)** A resultant force of 3800 N causes a car of mass of 1500 kg to accelerate from an initial speed of $15\,\text{m}\,\text{s}^{-1}$ to a final speed of $30\,\text{m}\,\text{s}^{-1}$.

**(i)** Calculate the distance moved by the car during this acceleration.

distance = ............................................ m [2]

**(ii)** The same force is used to change the speed of the car from $30\,\text{m}\,\text{s}^{-1}$ to $45\,\text{m}\,\text{s}^{-1}$. Explain why the distance moved is not the same as that calculated in **(i)**.

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**3** **(a)** Define

**(i)** *stress*,

.......................................................................................................................................

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

**(ii)** *strain*.

.......................................................................................................................................

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

**(b)** Explain the term *elastic limit*.

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

**(c)** Explain the term *ultimate tensile stress*.

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**(d)** **(i)** A **ductile** material in the form of a wire is stretched up to its breaking point. On Fig. 3.1, sketch the variation with extension $x$ of the stretching force $F$.


**Fig. 3.1**

[2]

**(ii)** On Fig. 3.2, sketch the variation with $x$ of $F$ for a **brittle** material up to its breaking point.

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**Fig. 3.2**

[1]

**(e)** **(i)** Explain the features of the graphs in **(d)** that show the characteristics of ductile and brittle materials.

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**(ii)** The force $F$ is removed from the materials in **(d)** just before the breaking point is reached. Describe the subsequent change in the extension for

**1.** the ductile material,

..........................................................................................................................................

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

**2.** the brittle material.

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

For Examiner's Use

4 **(a)** Define *electric field strength*.

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

**(b)** Two horizontal metal plates are 20 mm apart in a vacuum. A potential difference of 1.5 kV is applied across the plates, as shown in Fig. 4.1.

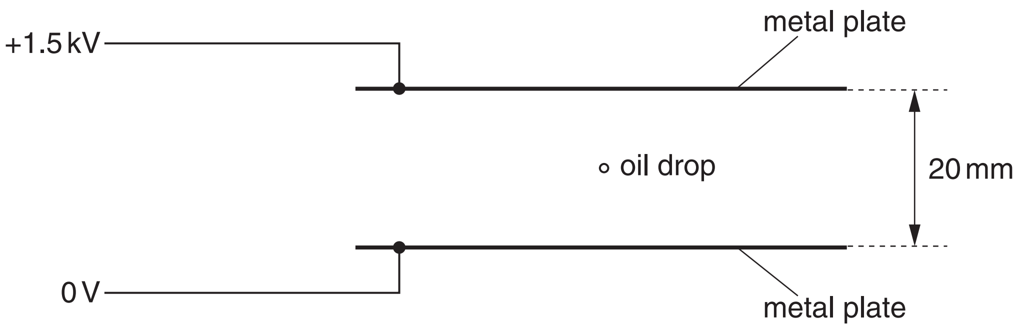


**Fig. 4.1**

A charged oil drop of mass $5.0 \times 10^{-15}$ kg is held stationary by the electric field.

**(i)** On Fig. 4.1, draw lines to represent the electric field between the plates. [2]

**(ii)** Calculate the electric field strength between the plates.

electric field strength = ...................................... $\text{V m}^{-1}$ [1]

**(iii)** Calculate the charge on the drop.

charge = ............................................ C [4]

**(iv)** The potential of the upper plate is increased. Describe and explain the subsequent motion of the drop.

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**5** A potentiometer circuit that is used as a means of comparing potential differences is shown in Fig. 5.1.

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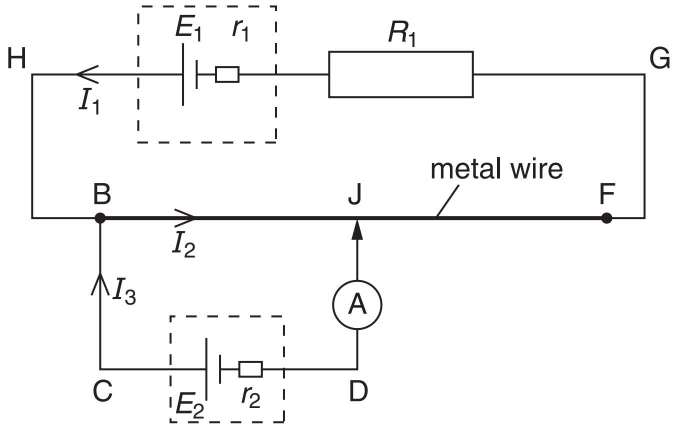


**Fig. 5.1**

A cell of e.m.f. $E_1$ and internal resistance $r_1$ is connected in series with a resistor of resistance $R_1$ and a uniform metal wire of total resistance $R_2$.
A second cell of e.m.f. $E_2$ and internal resistance $r_2$ is connected in series with a sensitive ammeter and is then connected across the wire at BJ. The connection at J is halfway along the wire. The current directions are shown on Fig. 5.1.

**(a)** Use Kirchhoff's laws to obtain the relation

**(i)** between the currents $I_1$, $I_2$ and $I_3$,

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

**(ii)** between $E_1$, $R_1$, $R_2$, $r_1$, $I_1$ and $I_2$ in loop HBJFGH,

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

**(iii)** between $E_1$, $E_2$, $r_1$, $r_2$, $R_1$, $R_2$, $I_1$ and $I_3$ in the loop HBCDJFGH.

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

**(b)** The connection at J is moved along the wire. Explain why the reading on the ammeter changes.

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

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**6** **(a)** State the *principle of superposition*.

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**(b)** An arrangement that can be used to determine the speed of sound in air is shown in Fig. 6.1.

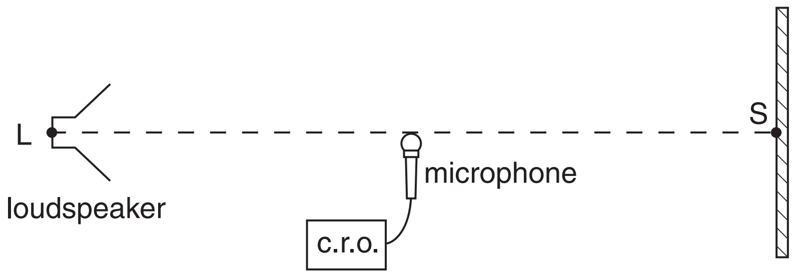


**Fig. 6.1**

Sound waves of constant frequency are emitted from the loudspeaker L and are reflected from a point S on a hard surface.
The loudspeaker is moved away from S until a stationary wave is produced.

Explain how sound waves from L give rise to a stationary wave between L and S.

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**(c)** A microphone connected to a cathode ray oscilloscope (c.r.o.) is positioned between L and S as shown in Fig. 6.1. The trace obtained on the c.r.o. is shown in Fig. 6.2.

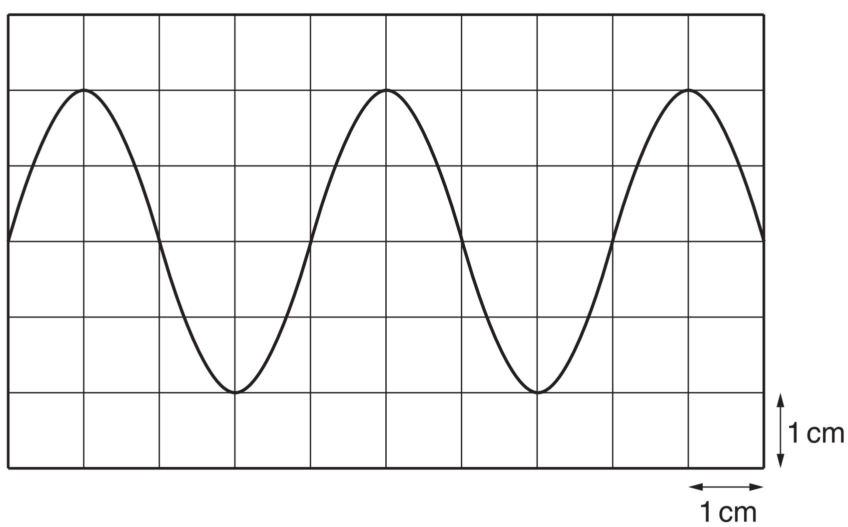


**Fig. 6.2**

The time-base setting on the c.r.o. is $0.10\,\text{ms}\,\text{cm}^{-1}$.

**(i)** Calculate the frequency of the sound wave.



frequency = ............................................ Hz [2]

**(ii)** The microphone is now moved towards S along the line LS. When the microphone is moved 6.7 cm, the trace seen on the c.r.o. varies from a maximum amplitude to a minimum and then back to a maximum.

**1.** Use the properties of stationary waves to explain these changes in amplitude.

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**2.** Calculate the speed of sound.

speed of sound = ........................................ m s$^{-1}$ [3]

**Please turn over for Question 7.**

7 **(a)** State the experimental observations that show radioactive decay is

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**(i)** spontaneous,

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**(ii)** random.

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

**(b)** On Fig. 7.1, complete the charge and mass of $\alpha$-particles, $\beta$-particles and $\gamma$-radiation. Give example speeds of $\alpha$-particles and $\gamma$-radiation emitted by a laboratory source.

| | $\alpha$-particle | $\beta$-particle | $\gamma$-radiation |
|---|---|---|---|
| charge | | | 0 |
| mass | 4u | | |
| speed | | up to 0.99*c* | |

**Fig. 7.1**

[3]

**(c)** Explain the process by which $\alpha$-particles lose energy when they pass through air.

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