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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4254431813

PHYSICS **9702/23**

Paper 2 AS Structured Questions **May/June 2013**

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 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.

Electronic calculators may be used.
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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Total	

This document consists of **14** printed pages and **2** blank pages.

DC (SJF/CGW) 57980/4

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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,	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
	$(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\ \mathrm{m\,F^{-1}})$
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,	$\phi = -\dfrac{Gm}{r}$
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.,	$v = v_0 \cos \omega t$ $v = \pm\, \omega\sqrt{(x_0^{\,2} - x^2)}$
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.

For Examiner's Use

1 (a) State the SI base units of force.

.... [1]

(b) Two wires each of length l are placed parallel to each other a distance x apart, as shown in Fig. 1.1.

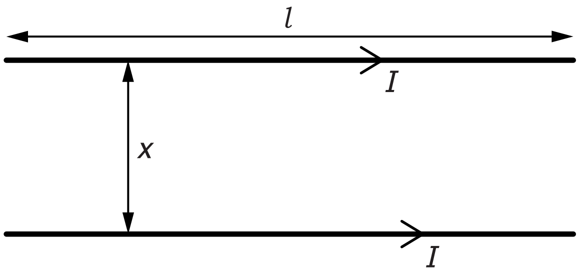

Fig. 1.1

Each wire carries a current I. The currents give rise to a force F on each wire given by

$$F = \frac{KI^2 l}{x}$$

where K is a constant.

(i) Determine the SI base units of K.

units of K .... [2]

(ii) On Fig. 1.2, sketch the variation with x of F. The quantities I and l remain constant.

Fig. 1.2 [2]

(iii) The current I in both of the wires is varied.

On Fig. 1.3, sketch the variation with I of F. The quantities x and l remain constant.

Fig. 1.3 [1]

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2 **(a)** A student walks from A to B along the path shown in Fig. 2.1.

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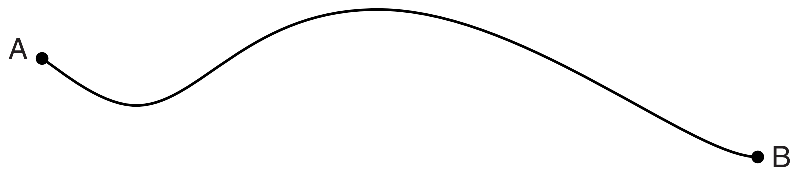

Fig. 2.1

The student takes time t to walk from A to B.

(i) State the quantity, apart from t, that must be measured in order to determine the average value of

1. speed,

....

....[1]

2. velocity.

....

....[1]

(ii) Define *acceleration*.

....[1]

(b) A girl falls vertically onto a trampoline, as shown in Fig. 2.2.

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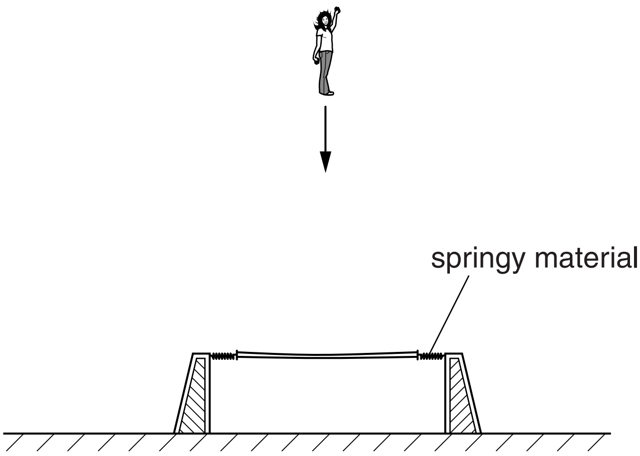

Fig. 2.2

The trampoline consists of a central section supported by springy material. At time t = 0 the girl starts to fall. The girl hits the trampoline and rebounds vertically. The variation with time t of velocity v of the girl is illustrated in Fig. 2.3.

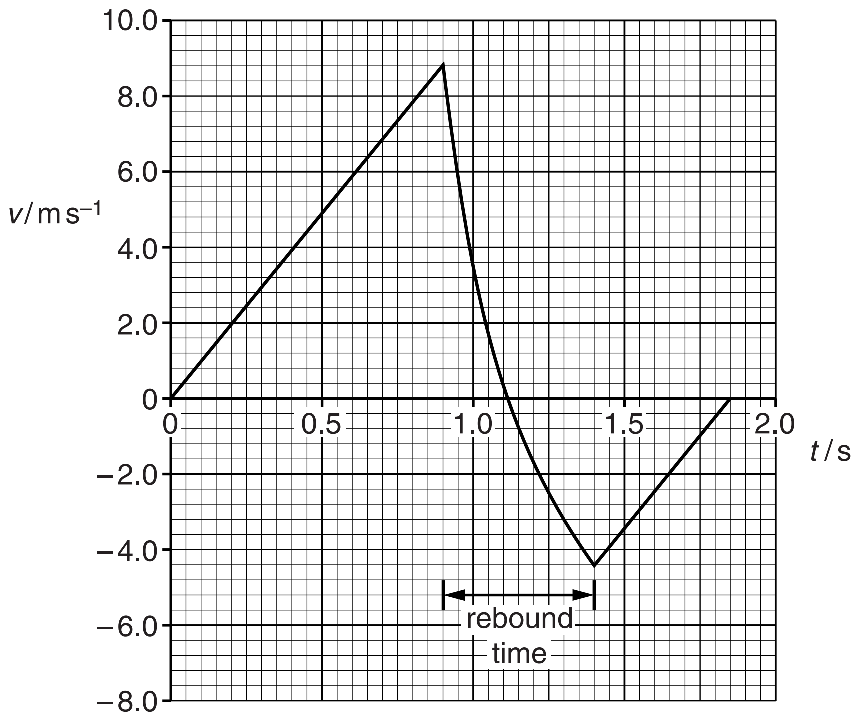

Fig. 2.3

For the motion of the girl, calculate

(i) the distance fallen between time t = 0 and when she hits the trampoline,

distance = ... m [2]

(ii) the average acceleration during the rebound.

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

(c) (i) Use Fig. 2.3 to compare, without calculation, the accelerations of the girl before and after the rebound. Explain your answer.

....

....

.... [2]

(ii) Use Fig. 2.3 to compare, without calculation, the potential energy of the girl at $t = 0$ and $t = 1.85$ s. Explain your answer.

....

....

.... [2]

3 **(a)** **(i)** State the principle of conservation of momentum.

....

....

.... [2]

(ii) State the difference between an elastic and an inelastic collision.

.... [1]

(b) An object A of mass 4.2 kg and horizontal velocity 3.6 m s^{-1} moves towards object B as shown in Fig. 3.1.

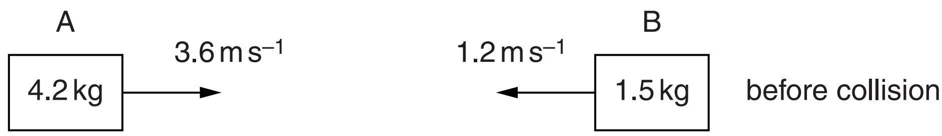

Fig. 3.1

Object B of mass 1.5 kg is moving with a horizontal velocity of 1.2 m s^{-1} towards object A.

The objects collide and then both move to the right, as shown in Fig. 3.2.

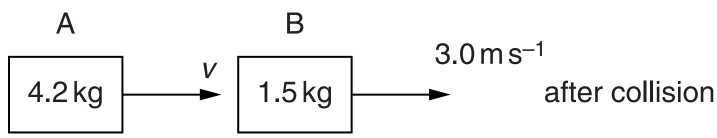

Fig. 3.2

Object A has velocity v and object B has velocity 3.0 m s^{-1}.

(i) Calculate the velocity v of object A after the collision.

velocity = ... m s^{-1} [3]

(ii) Determine whether the collision is elastic or inelastic.

[3]

4 **(a)** Define

(i) stress,

.... [1]

(ii) strain.

.... [1]

(b) The Young modulus of the metal of a wire is 0.17 TPa. The cross-sectional area of the wire is 0.18 mm^2.

The wire is extended by a force F. This causes the length of the wire to be increased by 0.095 %.

Calculate

(i) the stress,

stress = ... Pa [4]

(ii) the force F.

F = ... N [2]

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For Examiner's Use

5 **(a)** Explain the principle of superposition.

....

....

.... [2]

(b) Sound waves travel from a source S to a point X along two paths SX and SPX, as shown in Fig. 5.1.

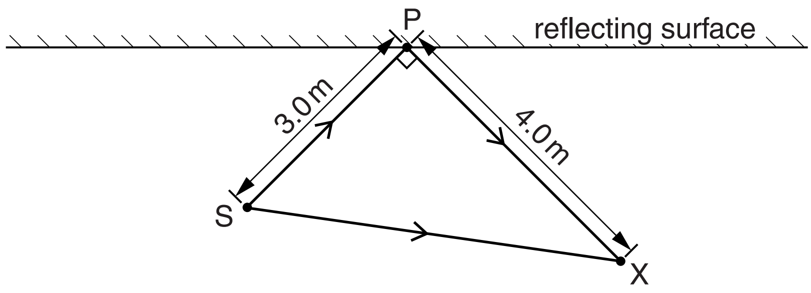

Fig. 5.1

(i) State the phase difference between these waves at X for this to be the position of

1. a minimum,

phase difference = ... unit .... [1]

2. a maximum.

phase difference = ... unit .... [1]

(ii) The frequency of the sound from S is 400 Hz and the speed of sound is 320 m s^{-1}. Calculate the wavelength of the sound waves.

wavelength = ... m [2]

(iii) The distance SP is 3.0 m and the distance PX is 4.0 m. The angle SPX is 90°. Suggest whether a maximum or a minimum is detected at point X. Explain your answer.

....

.... [2]

For Examiner's Use

6 **(a)** Define *potential difference* (p.d.).

.... [1]

(b) A battery of electromotive force 20 V and zero internal resistance is connected in series with two resistors R_1 and R_2, as shown in Fig. 6.1.

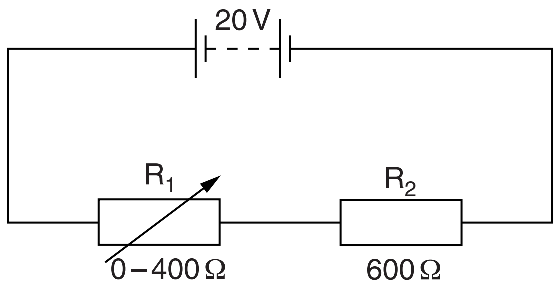

Fig. 6.1

The resistance of R_2 is 600 Ω. The resistance of R_1 is varied from 0 to 400 Ω.

Calculate

(i) the maximum p.d. across R_2,

maximum p.d. = ... V [1]

(ii) the minimum p.d. across R_2.

minimum p.d. = ... V [2]

(c) A light-dependent resistor (LDR) is connected in parallel with R_2, as shown in Fig. 6.2.

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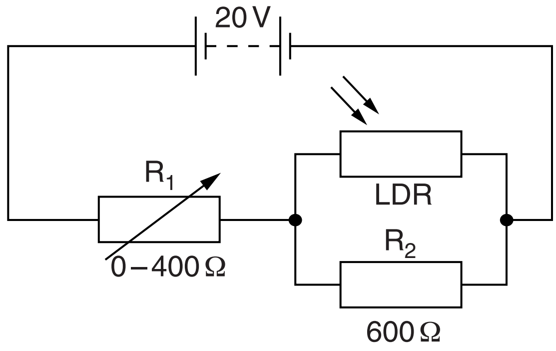

Fig. 6.2

When the light intensity is varied, the resistance of the LDR changes from 5.0 kΩ to 1.2 kΩ.

(i) For the **maximum** light intensity, calculate the total resistance of R_2 and the LDR.

total resistance = ... Ω [2]

(ii) The resistance of R_1 is varied from 0 to 400 Ω in the circuits of Fig. 6.1 and Fig. 6.2. State and explain the difference, if any, between the minimum p.d. across R_2 in each circuit. Numerical values are not required.

....

....

.... [2]

Please turn over for Question 7.

For Examiner's Use

7 **(a)** Two isotopes of uranium are uranium-235 ($^{235}_{92}U$) and uranium-238 ($^{238}_{92}U$).

(i) Describe in detail an atom of uranium-235.

....

....

....

....

.... [4]

(ii) With reference to the two forms of uranium, explain the term *isotopes*.

....

....

.... [2]

(b) When a uranium-235 nucleus absorbs a neutron, the following reaction may occur:

$$^{235}_{92}U + ^{W}_{X}n \rightarrow ^{148}_{57}La + ^{Z}_{Y}Q + 3^{W}_{X}n$$

(i) Determine the values of *Y* and *Z*.

Y = ...

Z = ...

[2]

(ii) Explain why the sum of the masses of the uranium nucleus and of the neutron does not equal the total mass of the products of the reaction.

....

....

.... [2]