Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

5192052766

PHYSICS **9702/22**

Paper 2 AS Structured Questions **May/June 2015**

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 an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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.

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

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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, $\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$

$$\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\ \text{m F}^{-1}\right)$$

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, $g = 9.81\ \text{m s}^{-2}$

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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.

1 **(a)** Use the definition of work done to show that the SI base units of energy are $kg\,m^2\,s^{-2}$.

[2]

(b) Define potential difference.

.....

..... [1]

(c) Determine the SI base units of resistance. Show your working.

units ..... [3]

2 A stone is thrown vertically upwards. The variation with time t of the displacement s of the stone is shown in Fig. 2.1.

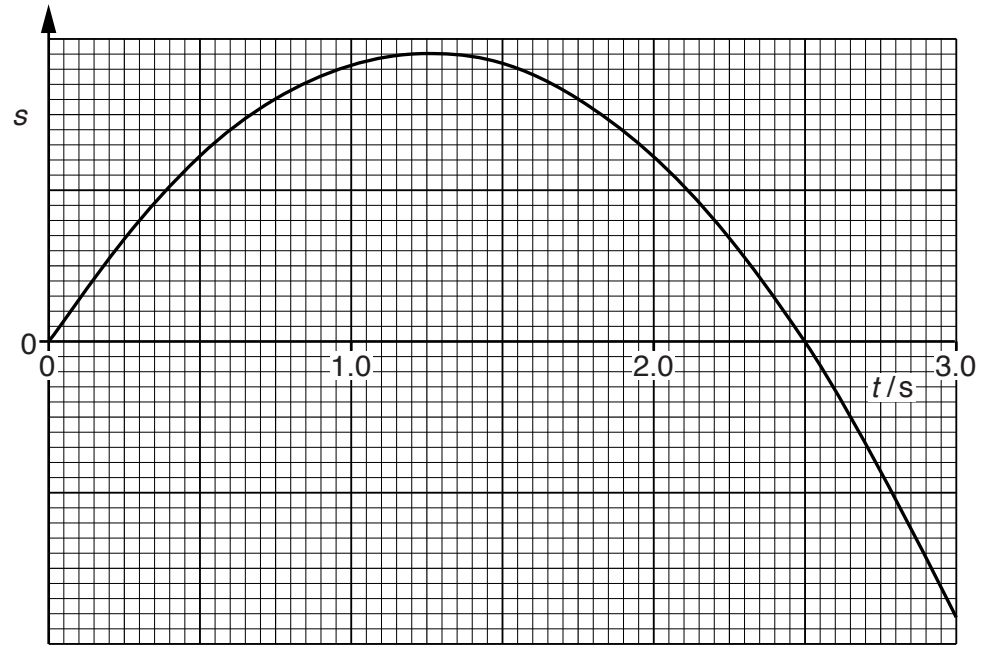

Fig. 2.1

(a) Use Fig. 2.1 to describe, without calculation, the speed of the stone from $t = 0$ to $t = 3.0$ s.

.....

.....

..... [2]

(b) Assume air resistance is negligible and therefore the stone has constant acceleration.

Calculate, for the stone,

(i) the speed at 3.0 s,

speed = ... $m\,s^{-1}$ [3]

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(ii) the distance travelled from $t = 0$ to $t = 3.0\,s$,

distance = ... m [3]

(iii) the displacement from $t = 0$ to $t = 3.0\,s$.

displacement = ... m

direction .....
[2]

(c) On Fig. 2.2, draw the variation with time t of the velocity v of the stone from $t = 0$ to $t = 3.0\,s$.

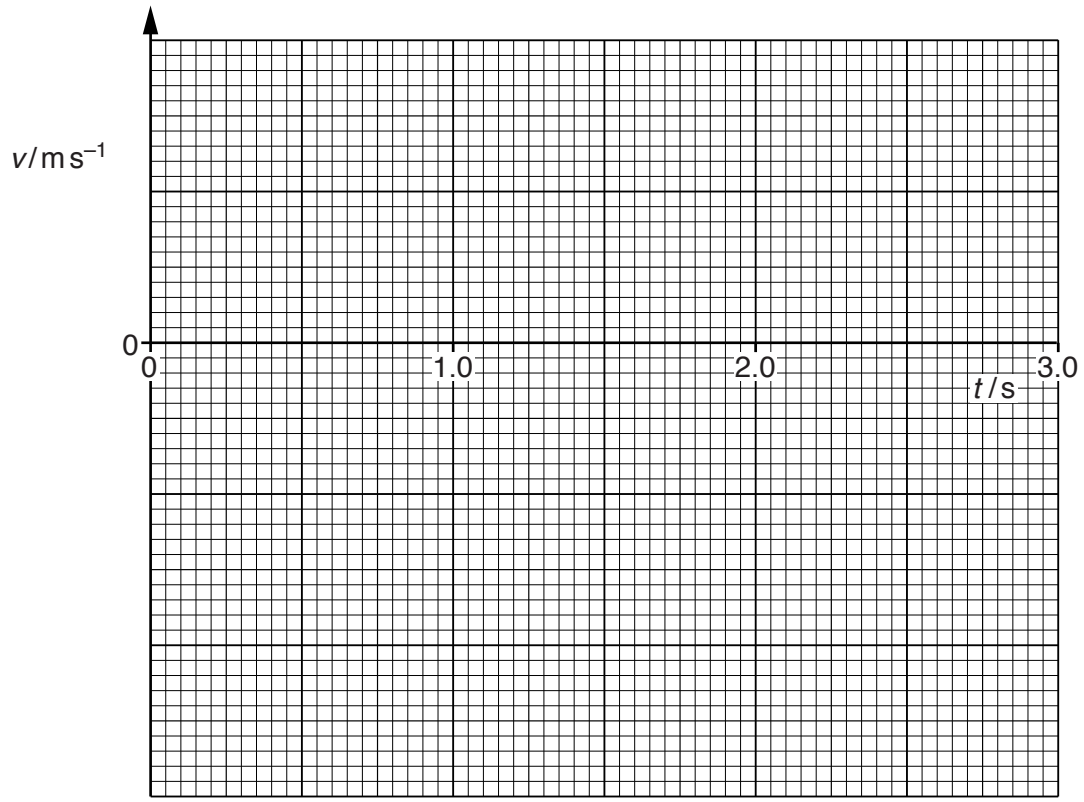

Fig. 2.2

[3]

3 A rod PQ is attached at P to a vertical wall, as shown in Fig. 3.1.

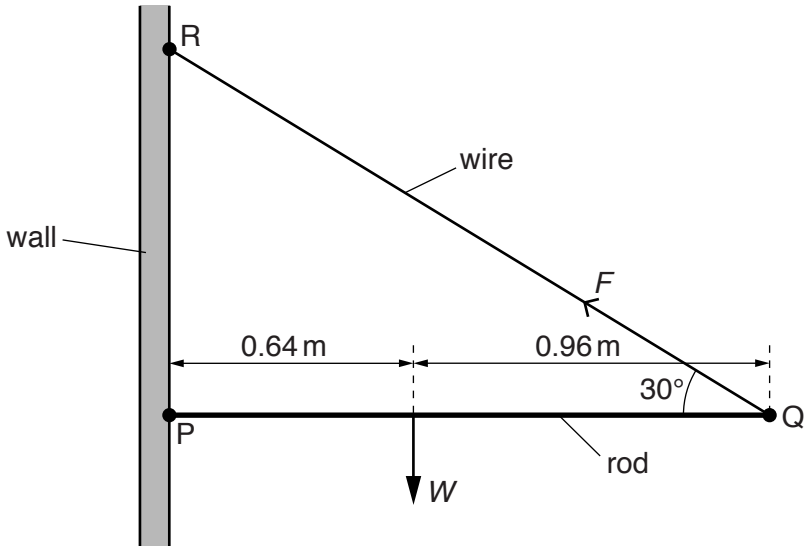

Fig. 3.1

The length of the rod is 1.60 m. The weight W of the rod acts 0.64 m from P. The rod is kept horizontal and in equilibrium by a wire attached to Q and to the wall at R. The wire provides a force F on the rod of 44 N at 30° to the horizontal.

(a) Determine

(i) the vertical component of F,

vertical component = ... N [1]

(ii) the horizontal component of F.

horizontal component = ... N [1]

(b) By taking moments about P, determine the weight W of the rod.

W = ... N [2]

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(c) Explain why the wall must exert a force on the rod at P.

.....

.....

..... [1]

(d) On Fig. 3.1, draw an arrow to represent the force acting on the rod at P. Label your arrow with the letter S. [1]

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4 **(a)** A gas molecule has a mass of 6.64×10^{-27} kg and a speed of $1250\,m\,s^{-1}$. The molecule collides normally with a flat surface and rebounds with the same speed, as shown in Fig. 4.1.

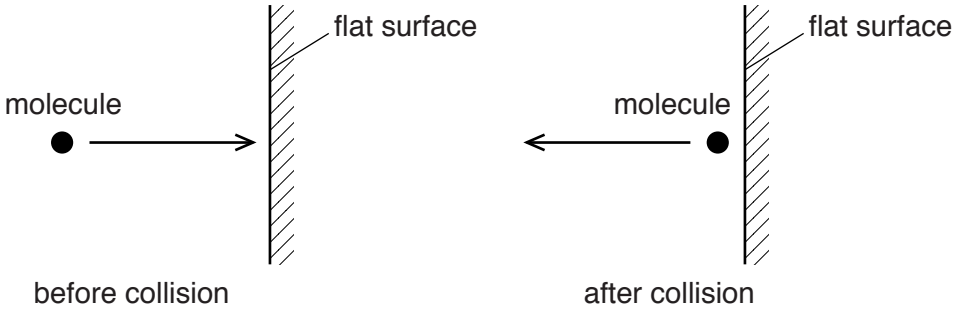

Fig. 4.1

Calculate the change in momentum of the molecule.

change in momentum = ... N s [2]

(b) **(i)** Use the kinetic model to explain the pressure exerted by gases.

.....

.....

.....

.....

.....

..... [3]

(ii) Explain the effect of an increase in density, at constant temperature, on the pressure of a gas.

.....

..... [1]

5 **(a)** On Fig. 5.1, sketch the temperature characteristic of a thermistor.

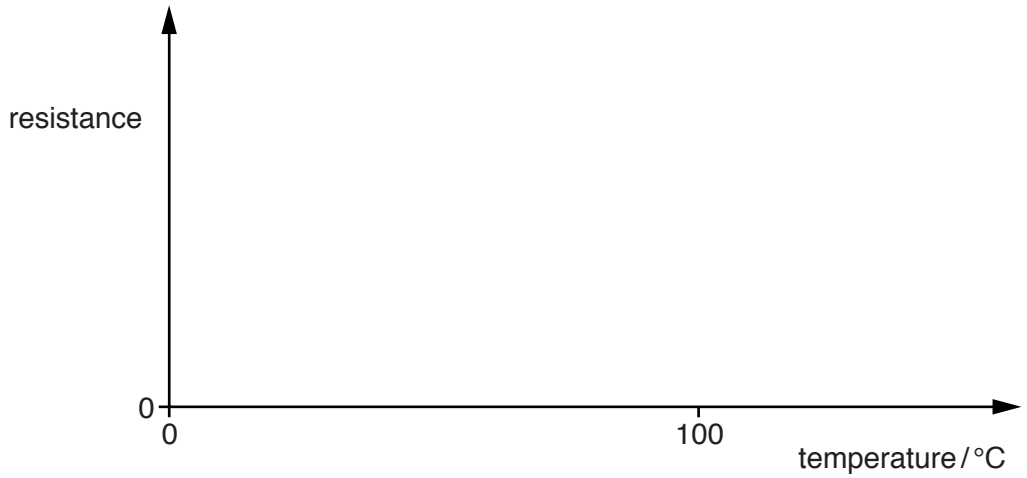

Fig. 5.1

[2]

(b) A potential divider circuit is shown in Fig. 5.2.

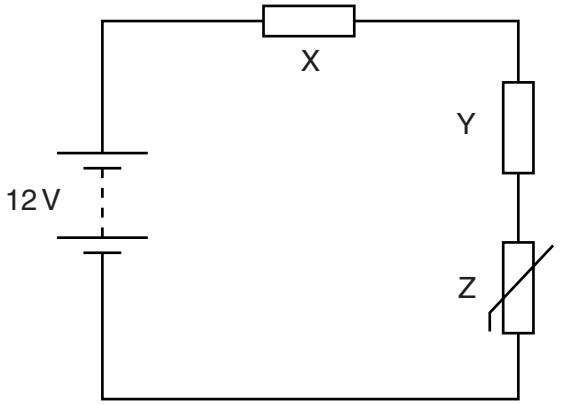

Fig. 5.2

The battery of electromotive force (e.m.f.) 12 V and negligible internal resistance is connected in series with resistors X and Y and thermistor Z. The resistance of Y is 15 kΩ and the resistance of Z at a particular temperature is 3.0 kΩ. The potential difference (p.d.) across Y is 8.0 V.

(i) Explain why the power transformed in the battery equals the total power transformed in X, Y and Z.

..... [1]

(ii) Calculate the current in the circuit.

current = ... A [2]

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(iii) Calculate the resistance of X.

resistance = ... Ω [3]

(iv) The temperature of Z is increased.

State and explain the effect on the potential difference across Z.

.....

.....

.....

..... [2]

6 **(a)** State two differences between progressive waves and stationary waves.

1. .....

.....

2. .....

..... [2]

(b) A source S of microwaves is placed in front of a metal reflector R, as shown in Fig. 6.1.

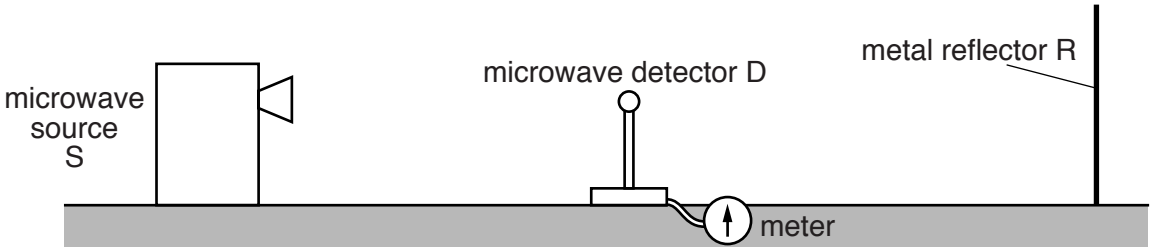

Fig. 6.1

A microwave detector D is placed between R and S.

Describe

(i) how stationary waves are formed between R and S,

.....

.....

.....

..... [3]

(ii) how D is used to show that stationary waves are formed between R and S,

.....

.....

..... [2]

(iii) how the wavelength of the microwaves may be determined using the apparatus in Fig. 6.1.

.....

.....

..... [2]

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(c) The wavelength of the microwaves in **(b)** is 2.8 cm. Calculate the frequency, in GHz, of the microwaves.

frequency = ... GHz [3]

Please turn over for Question 7.

7 A uranium-235 nucleus absorbs a neutron and then splits into two nuclei. A possible nuclear reaction is given by

$$^{235}_{92}\text{U} + {}^{a}_{b}\text{n} \rightarrow {}^{93}_{37}\text{Rb} + {}^{c}_{d}\text{X} + 2{}^{a}_{b}\text{n} + \text{energy}.$$

(a) State the constituent particles of the uranium-235 nucleus.

..... [1]

(b) Complete Fig. 7.1 for this reaction.

	value
a	
b	
c	
d	

[3]

Fig. 7.1

(c) Suggest a possible form of energy released in this reaction.

..... [1]

(d) Explain, using the law of mass-energy conservation, how energy is released in this reaction.

.....

.....

..... [2]

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