Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6500258880

PHYSICS **9702/21**

Paper 2 AS Structured Questions **May/June 2014**

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 **15** printed pages and **1** blank page.

DC (NF/SW) 75240/2

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,	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
	$(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\ \mathrm{m\,F^{-1}})$
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,	$\phi = -\frac{Gm}{r}$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}<c^2>$
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,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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

1 **(a)** **(i)** Define *velocity*.

....

.... [1]

(ii) Distinguish between *speed* and *velocity*.

....

.... [2]

(b) A car of mass 1500 kg moves along a straight, horizontal road. The variation with time t of the velocity v for the car is shown in Fig. 1.1.

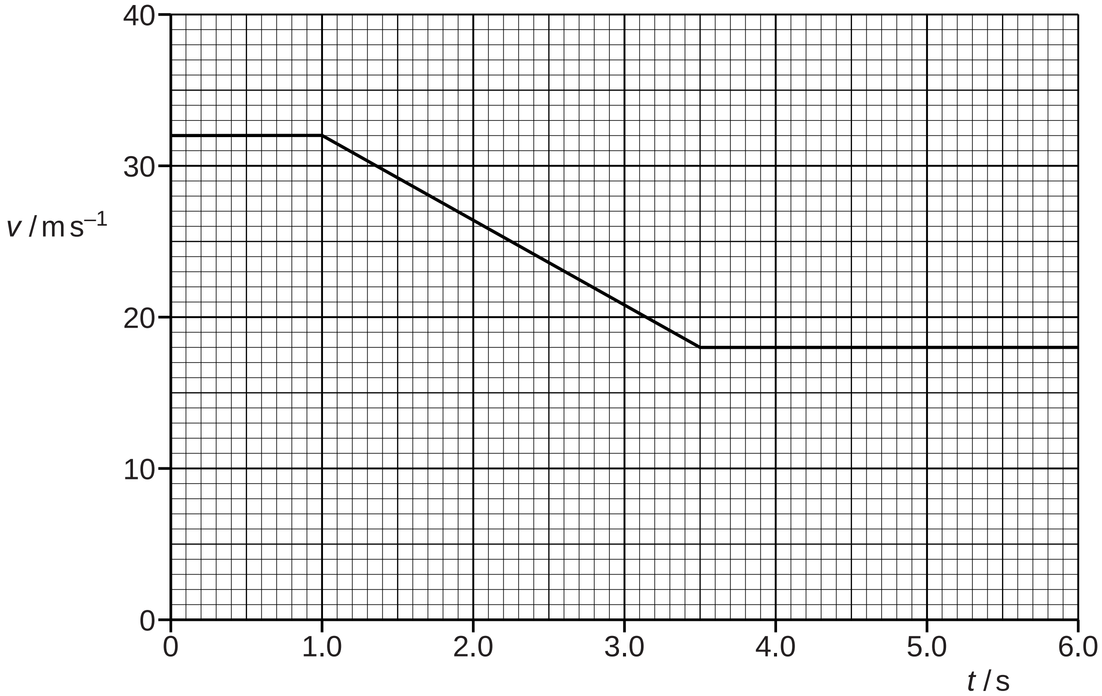

Fig. 1.1

The brakes of the car are applied from t = 1.0 s to t = 3.5 s.
For the time when the brakes are applied,

(i) calculate the distance moved by the car,

distance = ... m [3]

(ii) calculate the magnitude of the resultant force on the car.

resultant force = ... N [3]

(c) The direction of motion of the car in **(b)** at time t = 2.0 s is shown in Fig. 1.2.

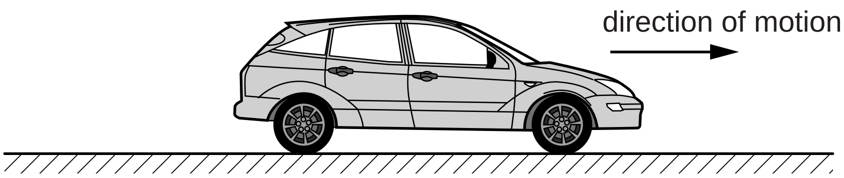

Fig. 1.2

On Fig. 1.2, show with arrows the directions of the acceleration (label this arrow A) and the resultant force (label this arrow F). [1]

BLANK PAGE

2 **(a)** **(i)** Define *power*.

.... [1]

(ii) Use your definition in **(i)** to show that power may also be expressed as the product of force and velocity.

[2]

(b) A lorry moves up a road that is inclined at 9.0° to the horizontal, as shown in Fig. 2.1.

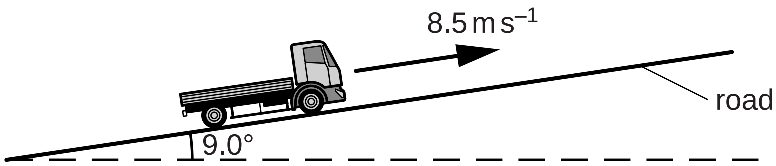

Fig. 2.1

The lorry has mass 2500 kg and is travelling at a constant speed of 8.5 m s^{-1}. The force due to air resistance is negligible.

(i) Calculate the useful power from the engine to move the lorry up the road.

power = ... kW [3]

(ii) State two reasons why the rate of change of potential energy of the lorry is equal to the power calculated in **(i)**.

1. ....

....

2. ....

....

[2]

3 A uniform plank AB of length 5.0 m and weight 200 N is placed across a stream, as shown in Fig. 3.1.

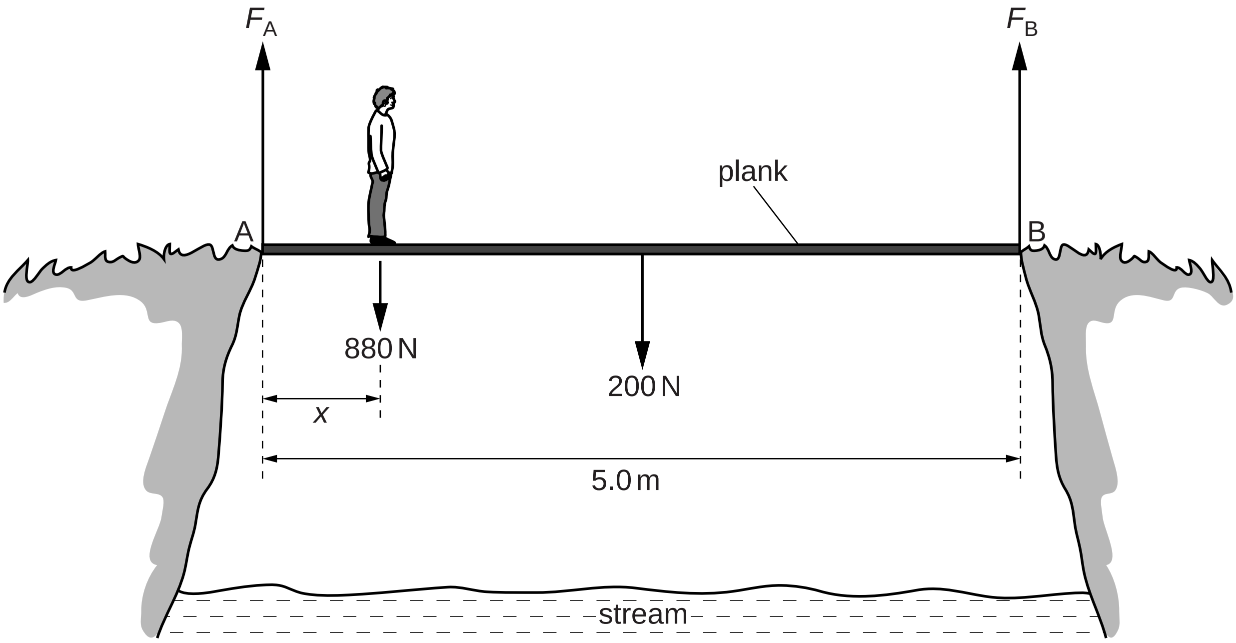

Fig. 3.1

A man of weight 880 N stands a distance x from end A. The ground exerts a vertical force F_A on the plank at end A and a vertical force F_B on the plank at end B.
As the man moves along the plank, the plank is always in equilibrium.

(a) **(i)** Explain why the sum of the forces F_A and F_B is constant no matter where the man stands on the plank.

....

....

.... [2]

(ii) The man stands a distance x = 0.50 m from end A. Use the principle of moments to calculate the magnitude of F_B.

F_B = ... N [4]

(b) The variation with distance x of force F_A is shown in Fig. 3.2.

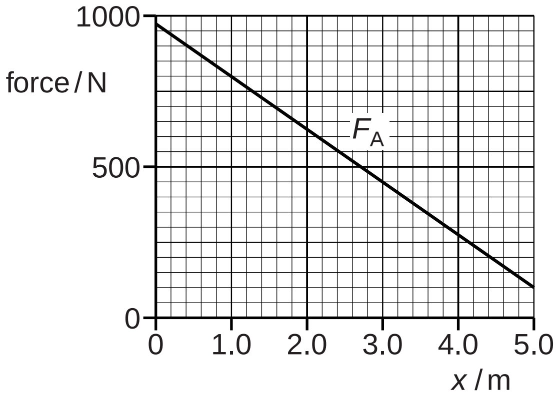

Fig. 3.2

On the axes of Fig. 3.2, sketch a graph to show the variation with x of force F_B. [3]

4 A metal ball of mass 40 g falls vertically onto a spring, as shown in Fig. 4.1.

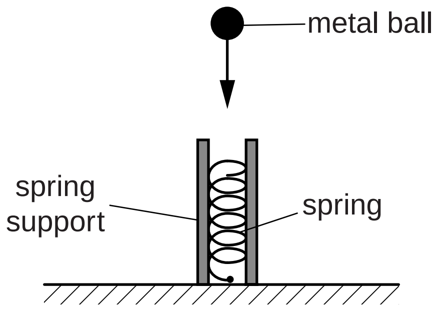

Fig. 4.1 (not to scale)

The spring is supported and stands vertically. The ball has a speed of 2.8 m s^{-1} as it makes contact with the spring. The ball is brought to rest as the spring is compressed.

(a) Show that the kinetic energy of the ball as it makes contact with the spring is 0.16 J.

[2]

(b) The variation of the force F acting on the spring with the compression x of the spring is shown in Fig. 4.2.

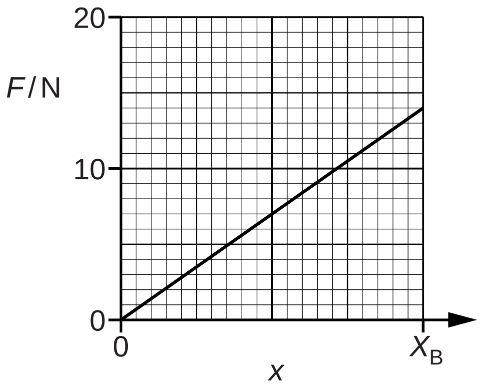

Fig. 4.2

The ball produces a maximum compression X_B when it comes to rest. The spring has a spring constant of 800 N m^{-1}.
Use Fig. 4.2 to

(i) calculate the compression X_B,

X_B = ... m [2]

(ii) show that not all the kinetic energy in **(a)** is converted into elastic potential energy in the spring.

[2]

5 **(a)** Explain what is meant by the following quantities for a wave on the surface of water:

(i) displacement and amplitude,

displacement ....

amplitude ....
[2]

(ii) frequency and time period.

frequency ....

time period ....
[2]

(b) Fig. 5.1 represents waves on the surface of water in a ripple tank at one particular instant of time.

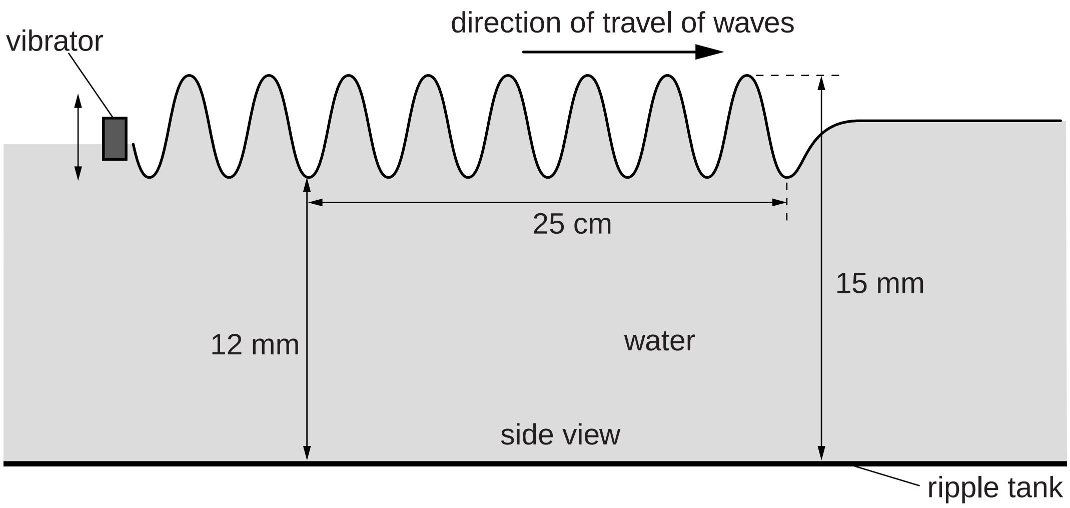

Fig. 5.1 (not to scale)

A vibrator moves the surface of the water to produce the waves of frequency *f*. The speed of the waves is 7.5 cm s^{-1}. Where the waves travel on the water surface, the maximum depth of the water is 15 mm and the minimum depth is 12 mm.

(i) Calculate, for the waves,

1. the amplitude,

amplitude = ... mm [1]

2. the wavelength.

wavelength = ... m [2]

(ii) Calculate the time period of the oscillations of the vibrator.

time period = ... s [2]

(c) State and explain whether the waves on the surface of the water shown in Fig. 5.1 are

(i) progressive or stationary,

....

.... [1]

(ii) transverse or longitudinal.

....

.... [1]

6 **(a)** Distinguish between *electromotive force* (e.m.f.) and *potential difference* (p.d.).

....

....

.... [2]

(b) A battery of e.m.f. 12V and internal resistance 0.50Ω is connected to two identical lamps, as shown in Fig. 6.1.

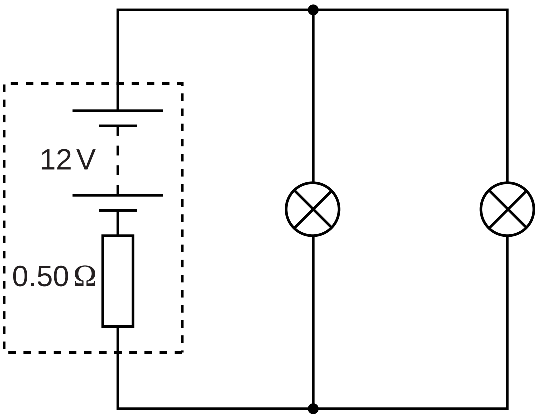

Fig. 6.1

Each lamp has constant resistance. The power rating of each lamp is 48W when connected across a p.d. of 12V.

(i) Explain why the power dissipated in each lamp is not 48W when connected as shown in Fig. 6.1.

....

....

.... [1]

(ii) Calculate the resistance of one lamp.

resistance = ... Ω [2]

(iii) Calculate the current in the battery.

current = ... A [2]

(iv) Calculate the power dissipated in one lamp.

power = ... W [2]

(c) A third identical lamp is placed in parallel with the battery in the circuit of Fig. 6.1. Describe and explain the effect on the terminal p.d. of the battery.

....

....

....

.... [2]

Please turn over for Question 7.

7 **(a)** State what is meant by

α-particle: ....

β-particle: ....

γ-radiation: ....
[2]

(b) Describe the changes to the proton number and the nucleon number of a nucleus when emission occurs of

(i) an α-particle,

....

.... [1]

(ii) a β-particle,

....

.... [1]

(iii) γ-radiation.

....

.... [1]