EUNOIA JUNIOR COLLEGE
JC1 PROMO EXAMINATIONS 2022
General Certificate of Education Advanced Level
Higher 2

CANDIDATE NAME							
CIVICS GROUP	2	2	-			REGISTRATION NUMBER	

PHYSICS

9749/02

Structured Questions

4th October 2022

2 hours

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.
The use of an approved scientific calculator is expected where appropriate.
Answer **all** questions.

Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Q1	4
Q2	12
Q3	11
Q4	10
Q5	8
Q6	6
Q7	9
Q8	7
Q9	4
Q10	9
s.f.	
P2 Total	80

This document consists of **24** printed pages and **4** blank pages.

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,	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$
	$(1/(36\pi)) \times 10^{-9}\ \text{F m}^{-1}$
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,	$g = 9.81\ \text{m s}^{-2}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
hydrostatic pressure,	$p = \rho gh$
gravitational potential,	$\phi = -\frac{Gm}{r}$
temperature,	$T / \text{K} = T / {}^\circ\text{C} + 273.15$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $= \pm \omega \sqrt{\left(x_0^2 - x^2\right)}$
electric current,	$I = Anvq$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \frac{Q}{4\pi\varepsilon_0 r}$
alternating current/voltage,	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_0 N I}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 n I$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

1 The velocity v of the falling ball can be obtained by using the following equation as shown below.

$$\mu = \frac{2}{9} g r^2 \left(\frac{\rho_{ball} - \rho_{liquid}}{v} \right)$$

In an experiment to determine v, the following values were recorded in the laboratory:

viscosity of the liquid, μ = 3.8 ± 0.1 Pa s
gravitational acceleration on Earth, g = 9.81 m s^{-2} (assume no uncertainty)
radius of the ball, r = 0.06 ± 0.01 m
density of the ball, ρ_{ball} = 7000 ± 50 kg m^{-3}
density of ~~the falling ball~~ liquid, ρ_{liquid} = 1250 ± 20 kg m^{-3}

(a) Calculate the absolute uncertainty Δv of velocity v .

Δv = ……………………… m s^{-1} [2]

(b) Using your answers in **(a)**, determine the value of v together with its associated uncertainty.

$v \pm \Delta v$ = ………………… ± ……………… m s^{-1} [2]

[Total: 4]

2 **(a)** A ball is fired on an unknown planet at an elevation angle of 20° from the horizontal as shown in Fig 2.1 and the motion of the ball follows that of a projectile motion. The ball lands on a target which is at the same height as when it is fired.

The **initial horizontal velocity** of the ball is 8.0 m s^{-1} and the horizontal distance between the initial position of the ball and the target is 10 m. You may ignore air resistance.

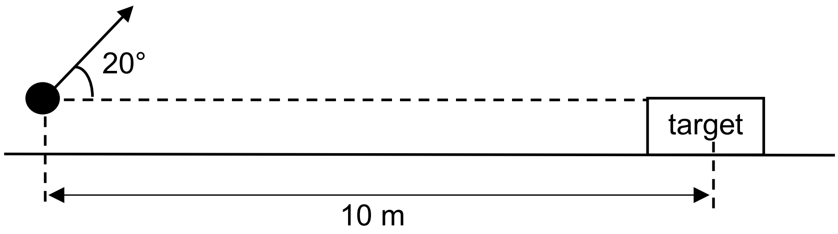

Fig. 2.1

Determine the gravitational acceleration on the unknown planet.

gravitational acceleration = ………………………m s^{-2} [3]

(b) Fig 2.2 shows the displacement-time graph for a car on a road.

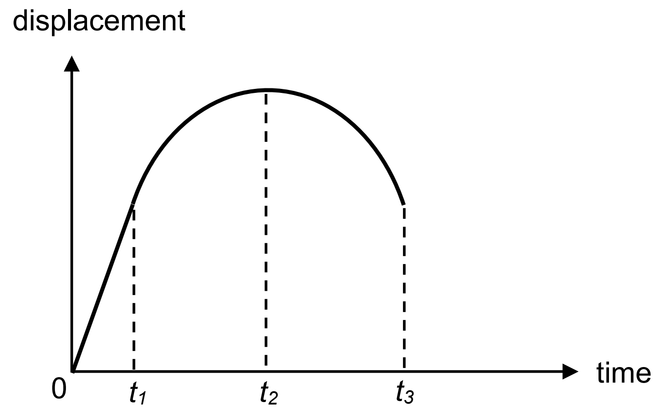

Fig. 2.2

Describe the motion of the car at each stage.

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

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………………………………………………………………………………………………. [3]

(c) Fig 2.3 shows the variation of velocity with time t of a car travelling on a road for the first 22 s.

Sketch the corresponding displacement-time graph and acceleration-time graph of the car in the graphs provided below.

For the displacement-time graph, state the displacement at 22 s clearly on the axis.
For the acceleration-time graph, state all accelerations clearly on the axis.

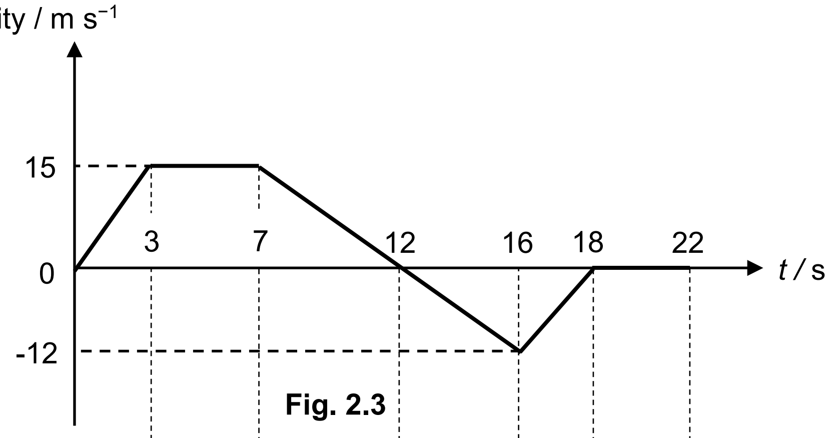
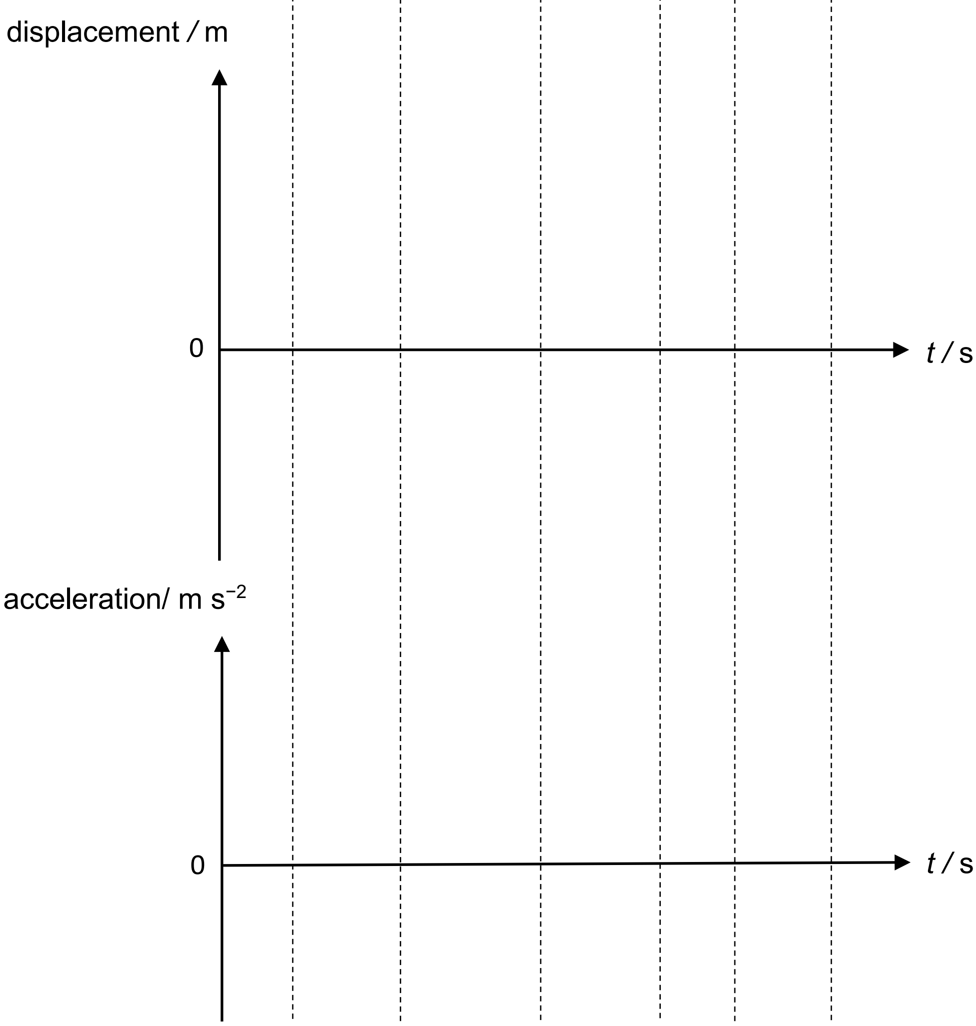


Fig. 2.3



[6]
[Total: 12]

3 A 50 kg barn door of uniform density has a width and a length of 0.70 m and 1.5 m respectively.

(a) It is hung by two ropes A and B as shown in Fig 3.1. One edge of the door is in contact with a vertical rough wall. Rope B is vertical and is experiencing a tension of 200 N. The horizontal distances from the centre of gravity CG and rope B to the wall are 0.80 m and 1.6 m respectively.

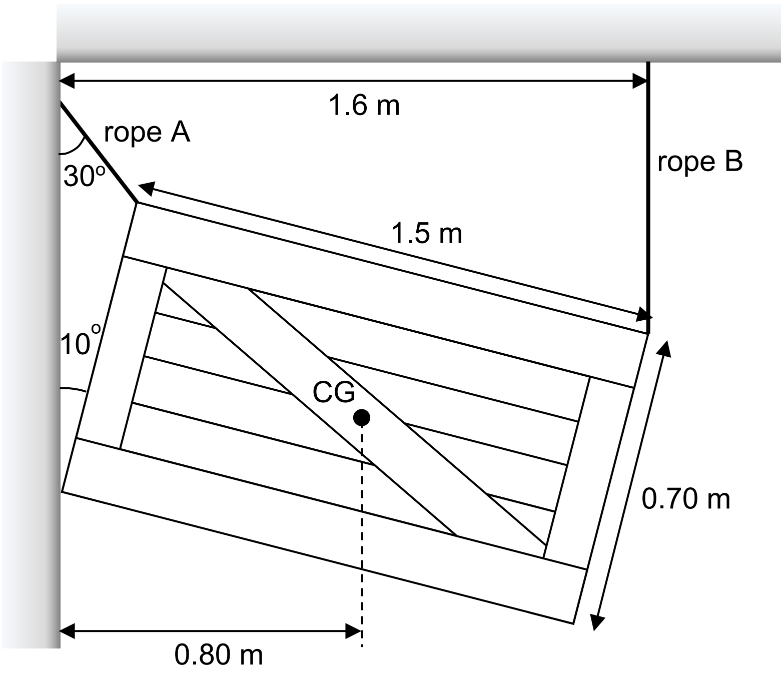


Fig. 3.1

(i) Determine the magnitude of tension in rope A.

tension in rope A = ……………………….N [3]

(ii) Determine the magnitude of the normal contact force by the wall on the barn door.

normal contact force = ………………………N [2]

(iii) Determine the magnitude of the friction by the wall on the barn door.

friction = ………………………N [2]

(b) Rope A breaks and part of the door falls into water of density 1000 kg m^{-3} as shown in Fig 3.2. The total volume of the door is 0.16 m^3

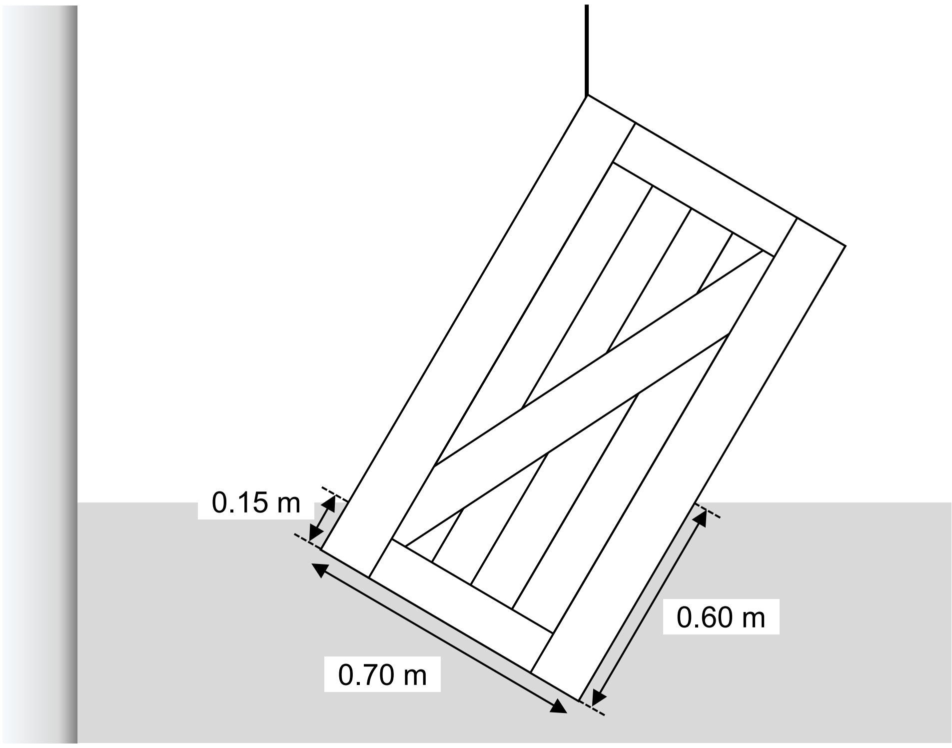


Fig. 3.2

(i) Calculate the magnitude of the upthrust experienced by the door.

upthrust = ………………………N [2]

(ii) Hence, calculate the magnitude of the tension in rope B.

tension in rope B = ………………………N [2]

[Total: 11]

4 **(a)** Three boxes of masses 8.0 kg, 7.0 kg and 4.0 kg are connected by light springs and pushed up a smooth slope inclined at 30° to the horizontal by an applied force of 150 N, as shown in Fig. 4.1.

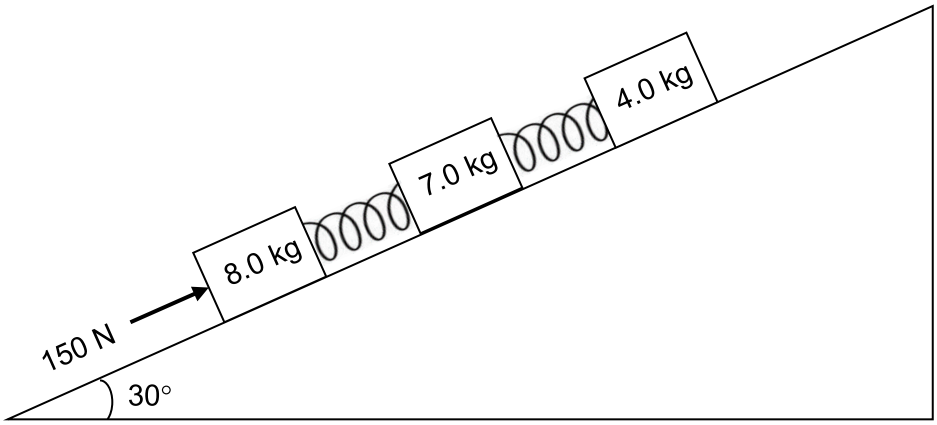


Fig. 4.1

(i) Calculate the magnitude of the force in the spring between the 8.0 kg mass and the 7.0 kg mass.

magnitude of force in spring = ………………………N [3]

(ii) Without any calculation, state and explain whether the magnitude of the force in the spring between the 7.0 kg and 4.0 kg mass would be smaller or larger than that calculated in part **(a)(i)**.

……………………………………………………………………………………………….

……………………………………………………………………………………………….

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

(b) Two masses A and B, of masses 900 g and 600 g respectively, move towards each other.

Fig. 4.2 is a momentum-time graph showing how the momentum of each mass varies.

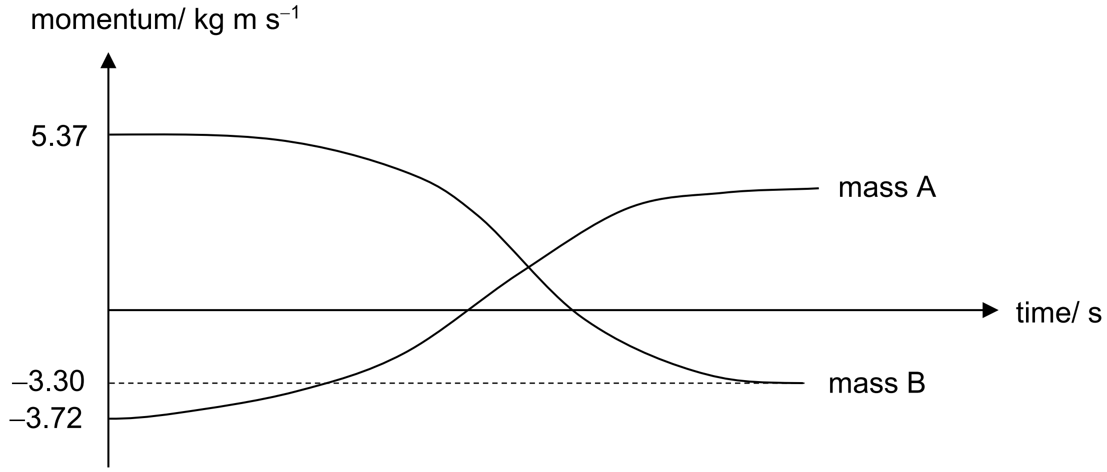


Fig. 4.2

(i) Show that the magnitude of final velocity of mass A is 5.5 m s^{-1}. [2]

(ii) Mass A and B have the speeds of 4.1 m s^{-1} and 9.0 m s^{-1} respectively, before collision. Deduce if the collision is elastic.

…………………………………………………………………………………………………

…………………………………………………………………………………………………. [3]

[Total: 10]

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5 **(a)** Two springs, A and B of the same unextended length of 12.0 cm are used to support a 5.1 kg metal ball, M as shown in Fig. 5.1.

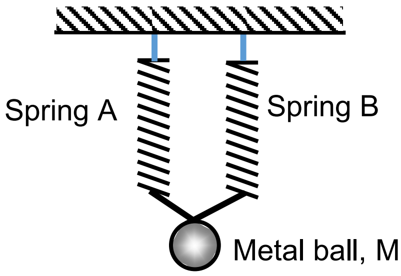

Fig. 5.1

The springs were investigated to obey the force-extension graphs as indicated in Fig. 5.2.

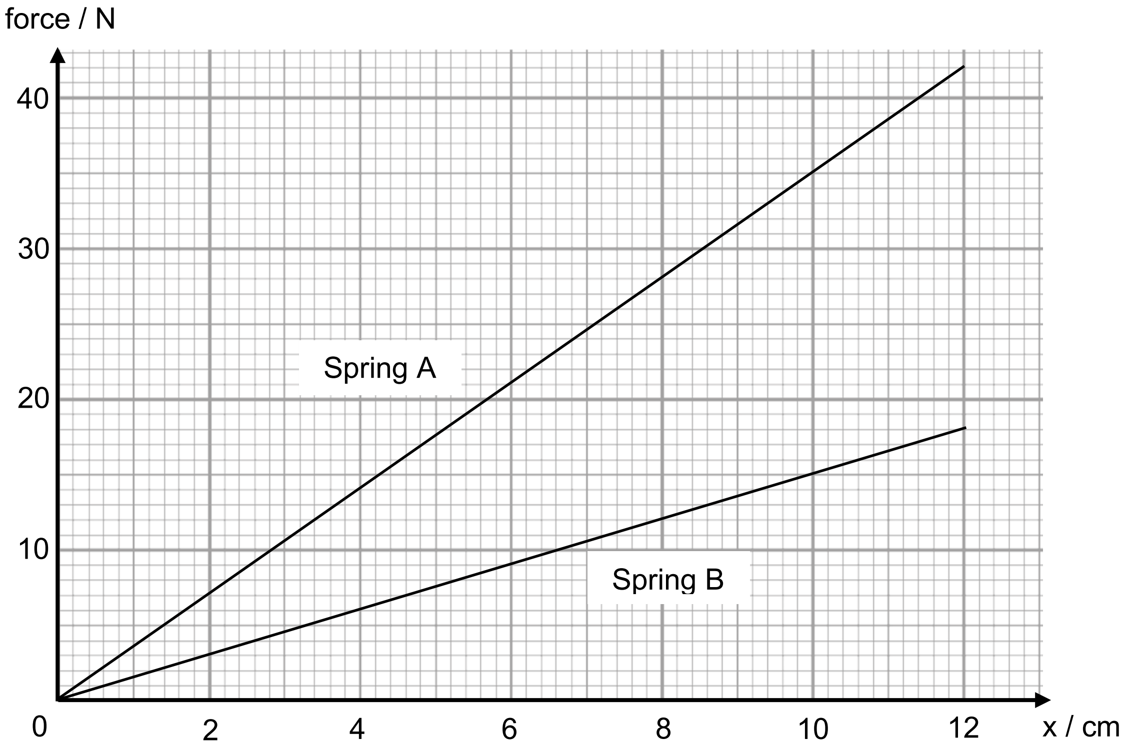

Fig 5.2

Using the graphs provided, determine

(i) the extension of spring A and

extension in spring A = …………………… cm [3]

(ii) the total elastic potential energy stored in springs A and B when the springs-mass system in Fig. 5.1 is in equilibrium.

total elastic potential energy = ……………. J [2]

(b) A space vehicle of mass m re-enters the Earth's atmosphere at an angle θ to the horizontal. Because of air resistance, the vehicle travels at a constant speed, v.

The heat-shield of the vehicle dissipates heat at a rate P so that the mean temperature of the vehicle remains constant.

Taking g as the value of acceleration of free fall, express the speed v in terms of P, m, g and θ.

v = …………..…………… [3]

[Total: 8]

6 **(a)** Define what is meant by angular velocity.

....

.... [1]

(b) A bob of mass 0.30 kg tied to a string of 1.1 m is undergoing vertical circular motion. The string makes an angle of θ measured from the vertical as shown in Fig. 6.1.

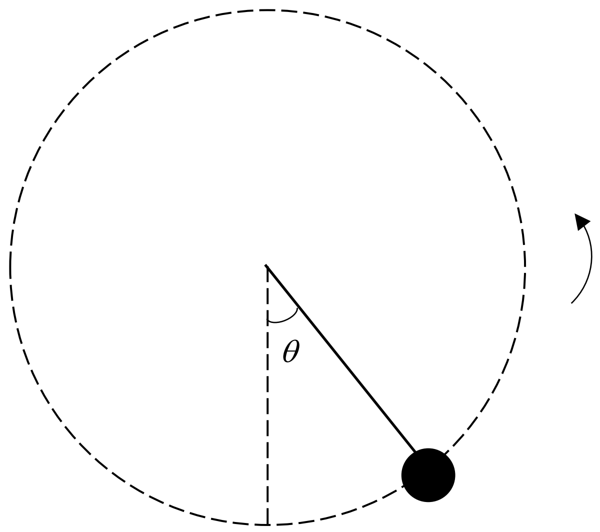

Fig. 6.1

Fig. 6.2 shows the variation with angle θ of the centripetal force F_C of the bob as it executes the vertical circular motion.

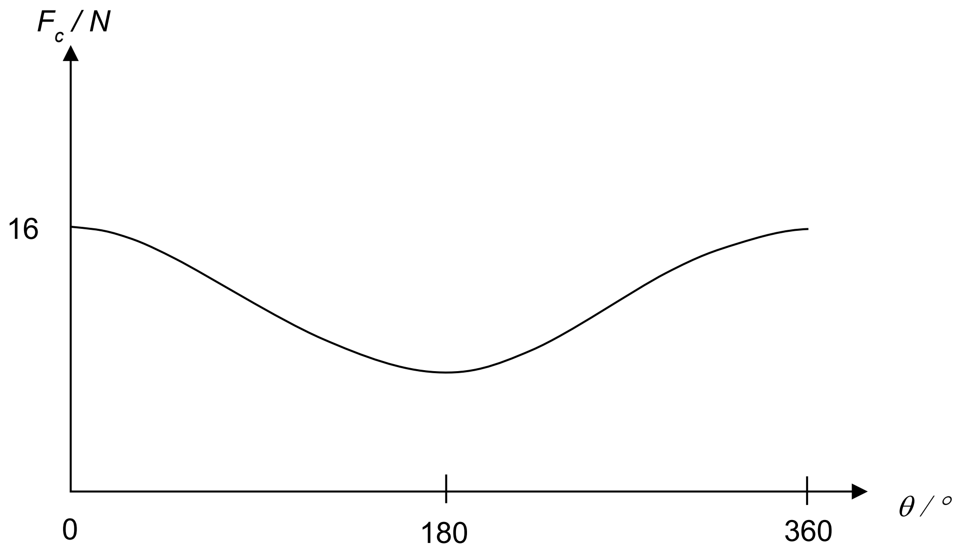

Fig. 6.2

(i) Explain why the bob experiences the maximum tension at the bottom of the circular motion.

…………………………………………………………………………………………………

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

(ii) Show that the speed experienced at the bottom of the circular motion is 7.7 m s^{-1}. [1]

(iii) Hence, or otherwise, determine the magnitude of the minimum tension experienced by the bob. Assume that the total energy of the circular motion remains the same.

magnitude of minimum tension = …………………… N [3]

[Total: 6]

7 A satellite of mass m orbits planet Mars of mass M in a circular path of radius r.

(a) **(i)** Show that the kinetic energy of the satellite is [2]

$$\frac{GMm}{2r}.$$

(ii) Show that the total energy of the satellite is [2]

$$-\frac{GMm}{2r}.$$

(b) It was discovered that for every revolution of the satellite around Mars, Mars has rotated about its axis three times.

Given: Duration of one day on Mars = 24.6 hours
Mass of Mars, $M = 6.39 \times 10^{23}$ kg
Mass of satellite, $m = 470$ kg

(i) Determine the radius of the circular path r.

r = ……………………… m [3]

(ii) Determine the work done in bringing the satellite to twice its original orbit.

work done = ………….…….. MJ [2]

[Total: 9]

8 **Fig. 8.1** and **Fig. 8.2** below shows how the velocity of an object moving in simple harmonic motion varies with displacement from equilibrium and time for one period *T* respectively.

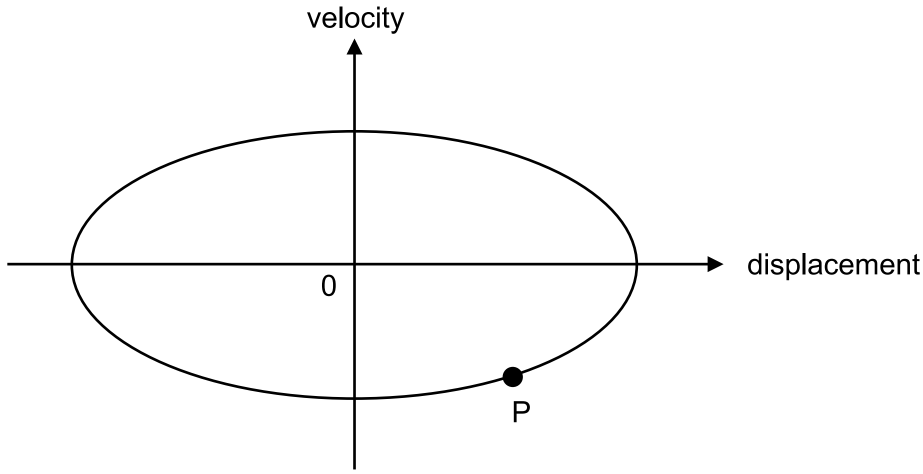

Fig. 8.1

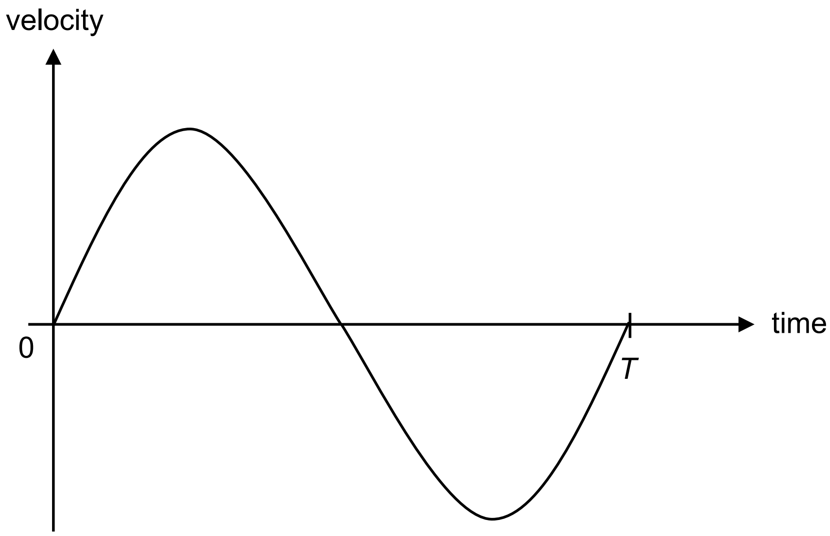

Fig. 8.2

(a) **(i)** Sketch the displacement-time graph for **one** period *T* in **Fig. 8.3** below. [1]

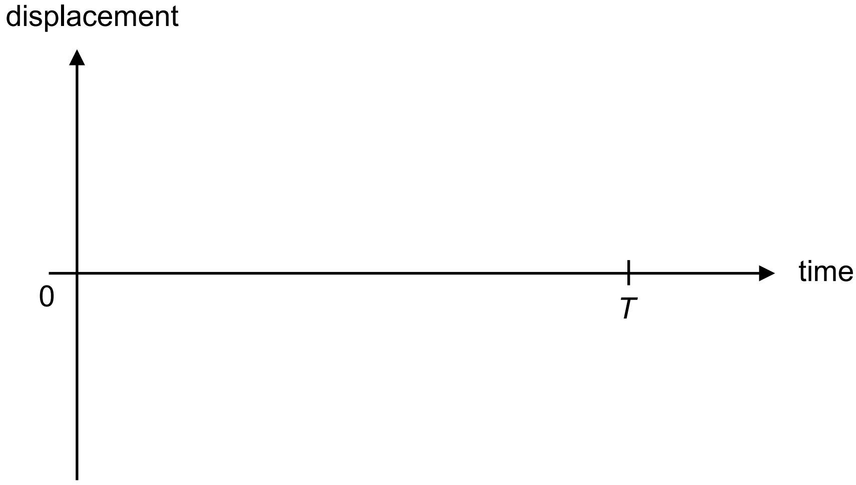

Fig. 8.3

(ii) Mark out where point P corresponds to on **Fig. 8.2** and label this point P' [1]

(iii) The oscillator has a mass of 0.50 kg and it oscillates with an amplitude of 0.030 m and a period of 0.80 s.

Calculate the total energy of the oscillation.

total energy = ……………………………… J [3]

(b) The system undergoes damping. Sketch, from t = 0 to t = T,

(i) the velocity-displacement graph in **Fig 8.1**. [1]

(ii) the kinetic-energy time graph in **Fig. 8.4**. [1]

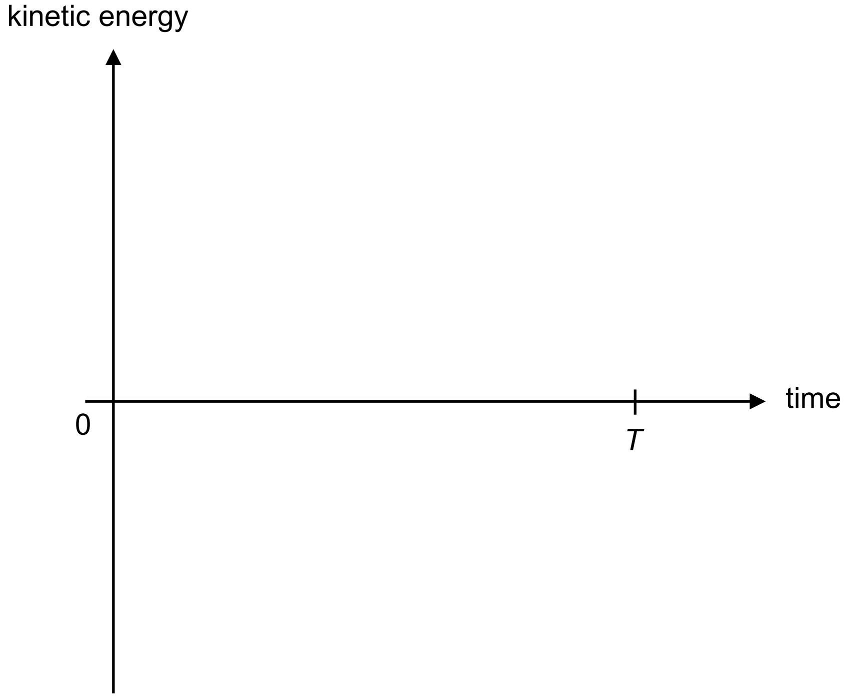

Fig. 8.4

[Total: 7]

9 Vertical plane-polarised light of amplitude A and intensity I is passed through two polarising filters as shown in Fig 9.1.

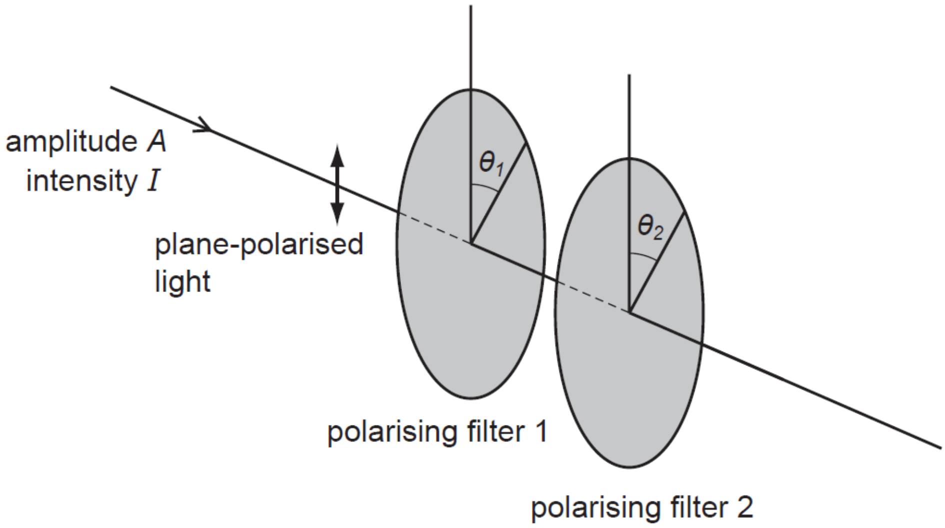

Fig. 9.1

The light passes through polarising filter 1, followed by polarising filter 2, where they are rotated θ_1 and θ_2 respectively with respect to the vertical.

Fill in the blanks with the amplitude and intensity in terms of A and I respectively after passing through the 2 polarising filters at the given θ_1 and θ_2.

θ_1 / °	θ_2 / °	amplitude	intensity
0	0	1.0 A	1.0 I
0	90		
30	30		
30	45		
90	90		

[Total: 4]

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10 **(a)** A single-slit of width 0.10 mm is shown in Fig 10.1. The slit is placed 3.0 m away from the screen and light of wavelength 400 nm is passed through it.

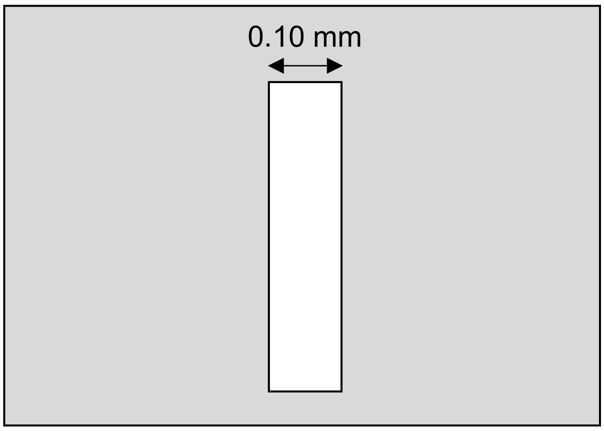

Fig. 10.1

The intensity pattern of the single-slit diffraction with monochromatic light of wavelength is proposed to be the one shown in Fig 10.2.

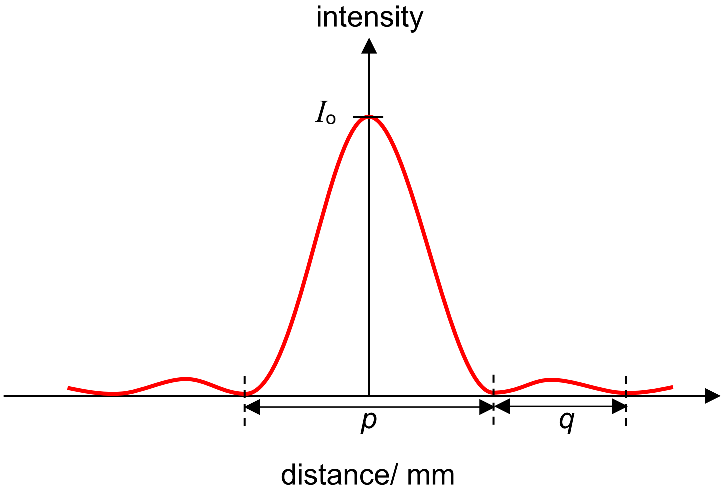

Fig. 10.2

(i) Determine the expected value of length *p*.

length *p* = ……………………… m [3]

(ii) Determine the expected value of length *q*.

length *q* = ……………………… m [1]

(iii) If the slit width were to increase to 3 times the original width, determine the new value of

1. length *p*

length *p* = ……………………… m [1]

2. intensity of the central maximum in terms of I_o

intensity = ……………………… I_o [1]

(b) Another slit is cut out of the material to conduct a Young's Double Slit experiment. The dimensions are shown in Fig. 10.3. It is placed at the same distance of 3.0 m away from the screen and the same light of wavelength 400 nm is passed through it.

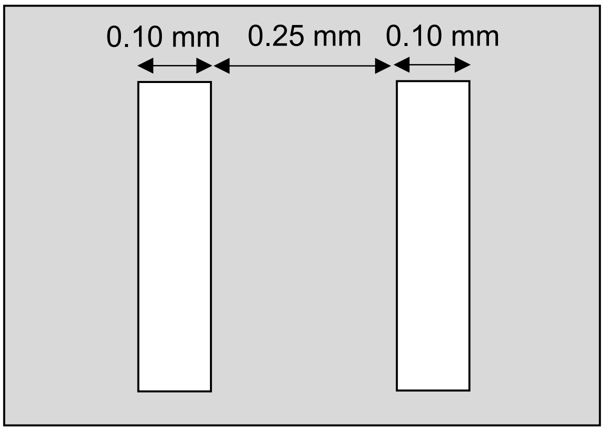

Fig. 10.3

(i) Determine the fringe separation.

fringe separation = …………………………. m [2]

(ii) Explain why the bright fringes have different intensities?

…………………………………………………………………………………………...

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

[Total: 9]

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