**For 2016, only Q1 to Q9 are relevant.*

Candidate's Name ………………………………. CTG **1**………..

YISHUN JUNIOR COLLEGE
JC1 PROMOTIONAL EXAMINATION 2014

PHYSICS **9646/02**
HIGHER 2
Paper 2

10 October 2014
Friday
0800h – 1000h
2 hours

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name and CTG in the spaces provided above.

Write in dark blue or black pen on both sides of the paper.

Do not use paper clips, highlighters, glue or correction fluid.

The use of approved scientific calculator is expected, where appropriate.

Answer **all** questions.

Paper 1A	
	/12
Paper 1B	
	/25
Paper 2	
Q1	**/10**
Q2	**/9**
Q3	**/6**
Q4	**/6**
Q5	**/9**
Q6	**/7**
Q7	**/12**
Q8	**/11**
Q9	**/5**
Q10	**/5**
Penalty	
Sub-Total	**/80**
Total (Paper 1A, 1B & 2)	
	/117

This question paper consists of **18** printed pages, inclusive of the cover page.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_0	=	8.85×10^{-12} F m^{-1}
			$(1/(36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
molar gas constant,	R	=	8.31 J K^{-1} mol^{-1}
the Avogadro constant,	N_A	=	6.02×10^{23} mol^{-1}
the Boltzmann constant,	k	=	1.38×10^{-23} J K^{-1}
gravitational constant,	G	=	6.67×10^{-11} N m^{2} kg^{-2}
acceleration of free fall,	g	=	9.81 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	=	$\rho g h$
gravitational potential,	ϕ	=	$-\frac{Gm}{r}$
displacement of particle in s.h.m.	x	=	$x_o \sin \omega t$
velocity of particle in s.h.m.,	v	=	$v_o \cos \omega t$
		=	$\pm \omega \sqrt{(x_o^2 - x^2)}$
mean kinetic energy of a molecule of an ideal gas,	E	=	$\frac{3}{2}kT$
resistors in series,	R	=	$R_1 + R_2 + \ldots\ldots\ldots$
resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$
electric potential,	V	=	$\frac{Q}{4\pi\varepsilon_o r}$
alternating current/voltage,	x	=	$x_o \sin \omega t$
transmission coefficient	T	=	$\exp(-2kd)$
	where k	=	$\sqrt{\frac{8\pi^2 m(U-E)}{h^2}}$
radioactive decay,	x	=	$x_o \exp(-\lambda t)$
decay constant,	λ	=	$\frac{0.693}{t_{\frac{1}{2}}}$

Answer all questions. Show your working clearly in the spaces provided.

1 The airplane shown in Fig. 1.1 is travelling horizontally at 90 m s^{-1}. It has to drop a 500 kg crate of emergency supplies to a rural community following an earthquake disaster. To avoid damage to the crate, the maximum vertical speed of the object landing should be 36 m s^{-1}.

Fig. 1.1

(a) Assuming that air resistance is negligible,

(i) calculate the maximum height from which the crate can be dropped.

maximum height = ………………….. m [2]

(ii) calculate the time taken for the crate to reach the ground from the height in **(a)(i)**.

time taken = ………………….. s [2]

(iii) Using Newton's laws of motion, explain why the mass of the crate has no effect on your answers to parts **(a)(i)** and **(a)(ii)**.

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(iv) The crate has to land at a particular place, marked **X** on Fig.1.1. Calculate the horizontal distance of the airplane from **X** when the crate is released.

distance = ………………….. m [1]

(b) In practice, air resistance is not negligible. Suggest and explain how the quantities you have calculated in parts **(a)(i)** and **(a)(ii)** will change, if any.

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2 **(a)** State the *Principle of Conservation of Momentum*.

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…… [2]

(b) The graph in Fig. 2.1 shows how the momentum of two colliding railway carriages varies with time. Carriage **A** has a mass of 2.0×10^4 kg and carriage **B** has a mass of 3.0×10^4 kg. The carriages are travelling in the same direction.

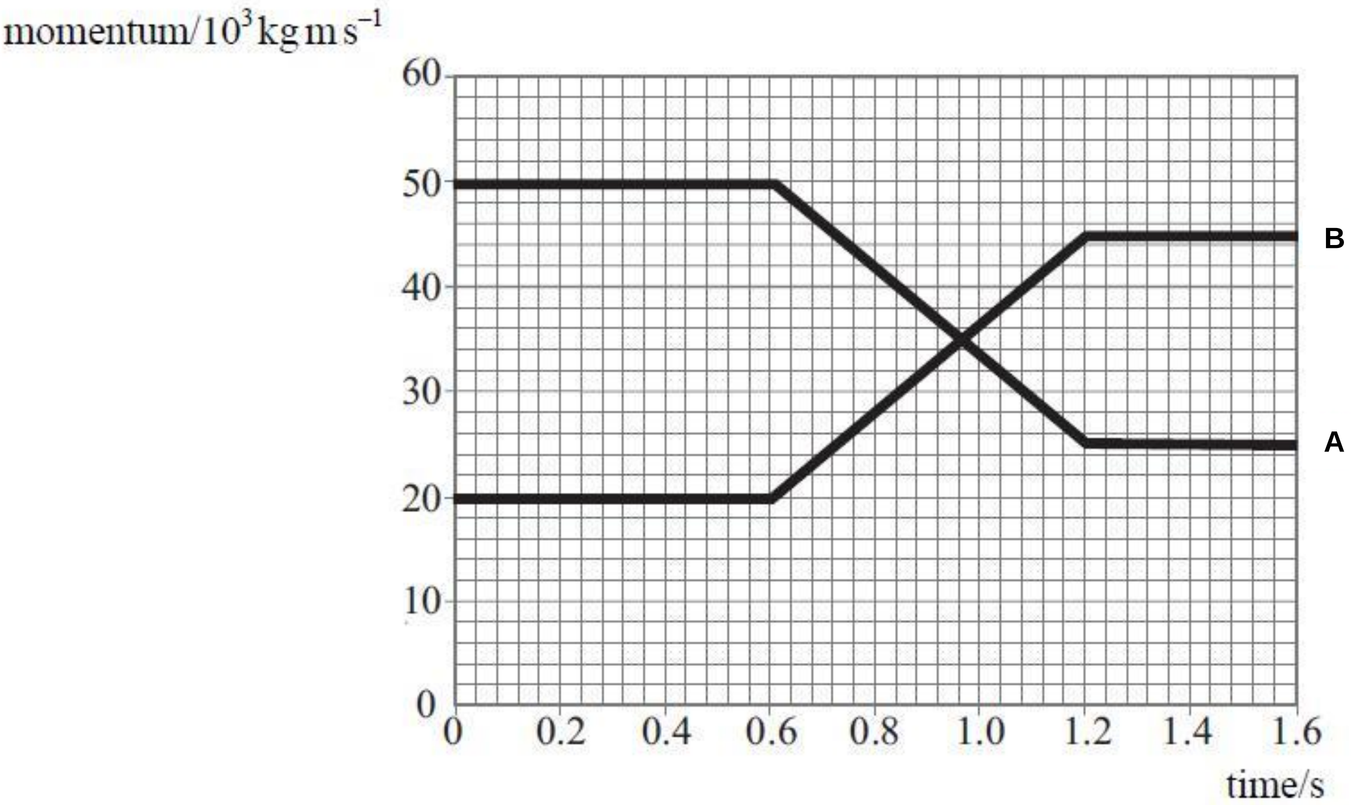

Fig. 2.1

(i) State and explain which carriage is travelling in front of the other.

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…… [2]

(ii) The collision begins at instant t_1 and ends at instant t_2. State the two instants.

t_1 = ……………………… s

t_2 = ……………………… s [1]

(iii) By making suitable calculations, deduce whether the collision of the two carriages is an example of an elastic collision.

[4]

3 **(a)** A giant piece of ice of mass 150 kg is floating in a fresh-water lake as shown in Fig. 3.1.

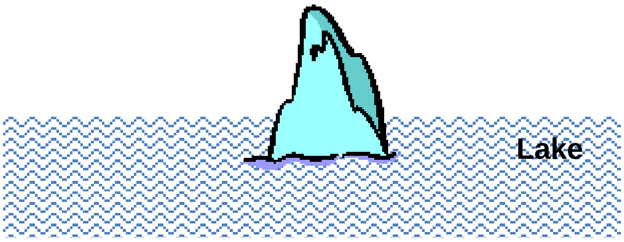

Fig. 3.1

The density of the fresh-water is 1000 kg m^{-3}. Determine

(i) the upthrust on the block of ice, and

upthrust = ……………………… N [2]

(ii) the volume of fresh-water displaced.

volume displaced = …………….. m^3 [2]

(b) Consider a jug of water with ice cubes. State and explain what happens to the water level after all the ice cubes have melted.

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

4 In order to lift a metal wheel over a kerb of height 0.200 m, a force F = 160 N is applied horizontally at the axle as shown in Fig. 4.1. The radius of the wheel is 0.500 m.

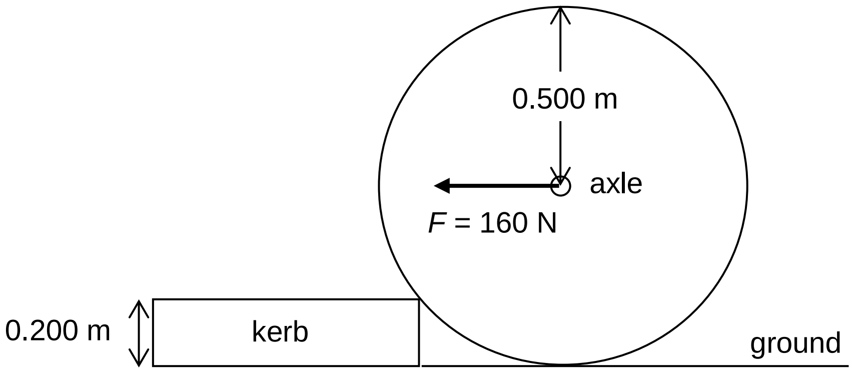

Fig. 4.1

(a) On Fig. 4.1, draw and name the other forces acting on the wheel the instant it just loses contact with the ground. [2]

(b) Determine the weight of the wheel.

weight of wheel = …………………….. N [3]

(c) A force of smaller magnitude can be applied at the axle to lift the wheel. On Fig. 4.1, draw the minimum force required and label it as F_{min}. [1]

5 **(a)** A wooden block of mass 3.40 kg is pushed from the bottom to the top of a smooth incline 5.00 m long to a height of 3.00 m above the ground as shown in Fig. 5.1.

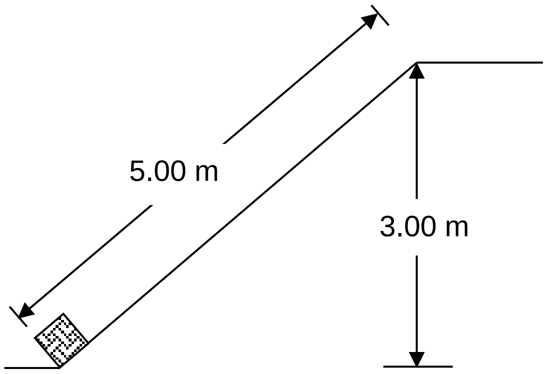

Fig. 5.1

(i) The block is moving at constant speed. Determine the magnitude of the force, F_p parallel to the incline that is pushing the block up.

F_p = ……………… N [2]

(ii) Given that the block makes the above journey in 12.5 s, calculate amount of power provided by F_P.

power = ……………… W [2]

(b) For the same vertical ascent, if the block was instead lifted up vertically, state and explain qualitatively the change (if any) in the work done and force required.

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……. [3]

(c) When the block arrives at the top, it proceeds to travel horizontally, with the same speed as before, along a smooth surface until it is brought to rest by a spring of force constant 25 N m^{-1} as shown in Fig. 5.2.

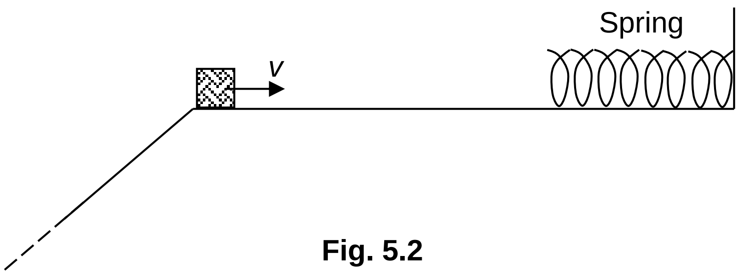

Fig. 5.2

Determine the maximum compression length of the spring.

maximum compression length = …………….. m [2]

6 A 0.800 kg metal ball is tied to a light, inextensible string of length 0.400 m and attached to a fixed support. It is made to rotate in a horizontal circle on a smooth and flat table top as shown in Fig. 6.1.

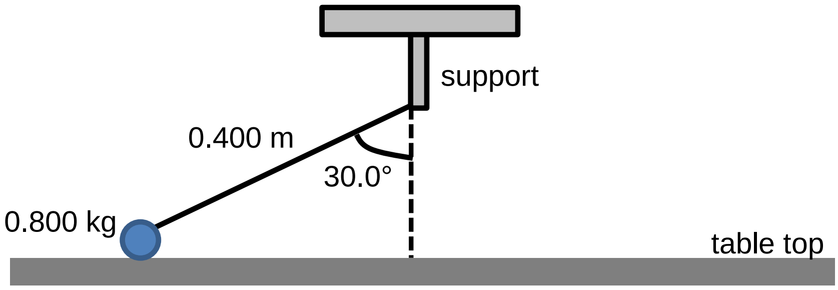

Fig. 6.1

(a) In the space below, draw a free body diagram of the metal ball.

[2]

(b) Given that the metal ball moves with an angular speed of 1.80 rad s^{-1}, calculate the resultant force experienced by the ball.

resultant force = ………………….. N [1]

(c) Hence or otherwise, determine the tension of the string.

tension = ………………….. N [2]

(d) Hence or otherwise, calculate the force exerted on the metal ball by the table top.

force on metal ball = ………………….. N [2]

7 (a) Define *gravitational field strength* at a point.

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…… [2]

(b) A moon is in a circular orbit of radius r about a planet. The angular speed of the moon in its orbit is ω. The planet and its moon may be considered to be point masses that are isolated in space.

Show that r and ω are related by the expression

$$r^3 \omega^2 = \text{constant}$$

[3]

(c) Phobos and Deimos are moons that are in circular orbits about the planet Mars. Data for Phobos and Deimos are shown in Fig. 7.1.

Moon	Radius of orbit/ m	Period of rotation about Mars/ hours
Phobos Deimos	9.39×10^6 2.35×10^7	7.65

Fig. 7.1

(i) Use data from Fig. 7.1 to determine

1. the mass of Mars, and

mass = ……………………………………kg [3]

2. the period of Deimos in its orbit about Mars.

period =………………………………..hrs [3]

(ii) The period of rotation of Mars about its own axis is 24.6 hours.

Deimos is in an equatorial orbit, orbiting in the same direction as the rotation of Mars about its axis.

Explain whether Deimos is in geostationary orbit.

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8 **(a)** An object undergoing simple harmonic motion oscillates about an equilibrium point **O** as shown in Fig. 8.1. The time taken to travel from **A** to **B** of length 8.0 cm is 1.5 s.

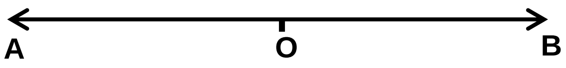

Fig. 8.1

For the object, determine its

(i) amplitude,

amplitude =…………………….m [1]

(ii) angular velocity, and

angular velocity =…………………rad s^{-1} [1]

(iii) maximum velocity.

maximum velocity = ……………………………..m s^{-1} [2]

(iv) The object is traveling towards **B** and it passes **O** at time t = 0.0 s. At time t = 2.0 s, determine its

1. displacement and

displacement = ………………….. m [2]

2. velocity.

velocity =……………………..m s^{-1} [2]

(b) **(i)** With reference to the answers in part **(a) (i)** and **(iii)**, sketch a graph showing how velocity v varies with displacement x on Fig. 8.2. Label the critical values on both axes.

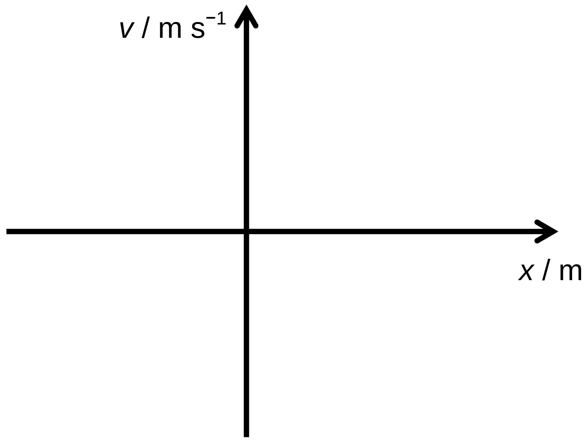

Fig. 8.2 [2]

(ii) On Fig. 8.2, mark a cross **X** that corresponds to the object at t = 2.0 s. [1]

9 The graph in Fig. 9.1 shows how particle displacement varies with distance for a progressive wave moving from right to left with a frequency of 250 Hz at time t = 0.0 s.

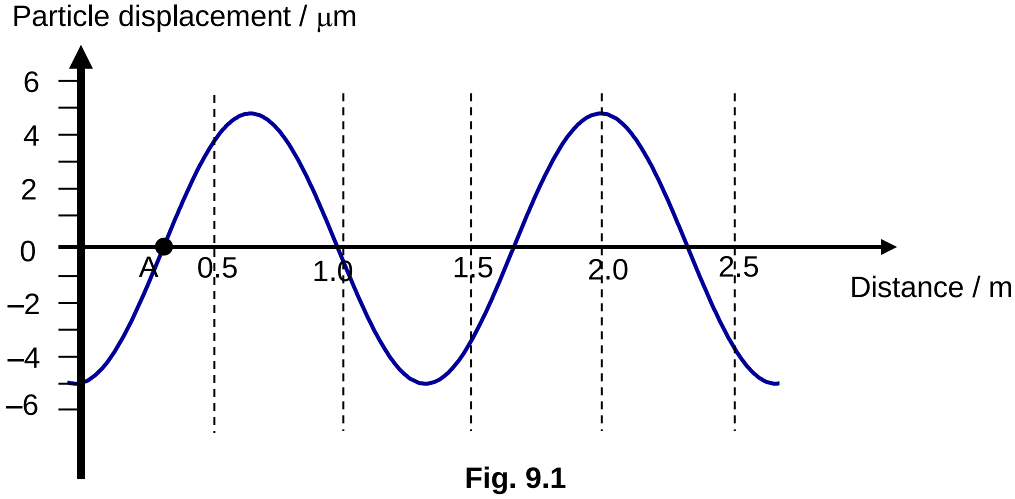

Fig. 9.1

(a) Using the graph in Fig.9.1,

(i) determine the wavelength of the wave. Show your working clearly.

wavelength = …………….. m [2]

(ii) state the amplitude of the wave.

amplitude = ………………μm [1]

(b) For the particle at position **A** shown on Fig. 9.1, sketch the variation with time of its displacement on the axes given below. Sketch the graph for the time range from t = 0.0 to 10 ms and include all relevant values on your graph.

[2]

10 Red light from a laser is passed normally through a diffraction grating which has 3600 slits per centimetre on it as shown in Fig. 10.1. The angle of diffraction θ of the 2nd order maxima on the screen was found to be 27.4°.

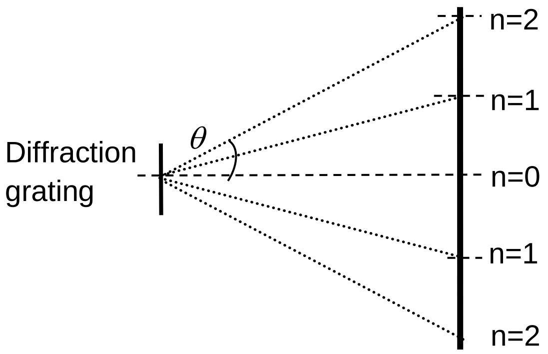

Fig. 10.1

(a) Calculate the wavelength of the red light used.

Wavelength = …………………. m [3]

(b) State how the spacing between the maxima would be affected if the following changes were made separately,

(i) the screen is brought nearer to the diffraction grating,

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(ii) the separation of the slits is decreased.

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END OF PAPER