Candidate's name ………………………………………. CTG …………

YISHUN JUNIOR COLLEGE
JC 2 Preliminary Examinations 2014

PHYSICS — 8866/2
HIGHER 1

Monday 18th August 2014
8.00 am – 10.00 am

Paper 2 Structured Questions — 2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

For Examiner's Use	
Section A	
1	/5
2	/6
3	/6
4	/5
5	/5
6	/4
7	/9
Section B	
8	/20
9	/20
10	/20
Penalty	
Paper 2 Total	/80
Paper 1 Total	/30
Grand Total	/110

READ THESE INSTRUCTIONS FIRST

Write your name and CTG in the spaces provided on this cover page.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

Write your answers in the spaces provided on the question paper.
For numerical answers, **all** working should be shown clearly.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-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
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	=	$\rho g h$
resistors in series,	R	=	$R_1 + R_2 + \ldots\ldots\ldots\ldots$
resistors in parallel,	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots\ldots$

For Examiner's Use

Section A

Answer **all** the questions in this Section.

1 **(a)** Express *watt*, in terms of the SI base units.

SI Base Units of Watt = …………………. [2]

(b) Intensity I of a wave propagated in radial directions from a point source, measured at a particular position, is determined by

$$I = \frac{P}{4\pi r^2}$$

where P = power of the wave propagated from the source and r = distance from the source to that position measured.

Determine the intensity I, with its associated uncertainty, given

$P = (120 \pm 5)$ W

$r = (165 \pm 2)$ cm

Intensity I = (…………………… ± ……………) W m^{-2} [3]

For Examiner's Use

2 A toy rocket is propelled vertically upwards. The graph of Fig. 2.1 shows the variation with time t of the velocity v of a toy rocket from the moment the fuel of the rocket is used up.

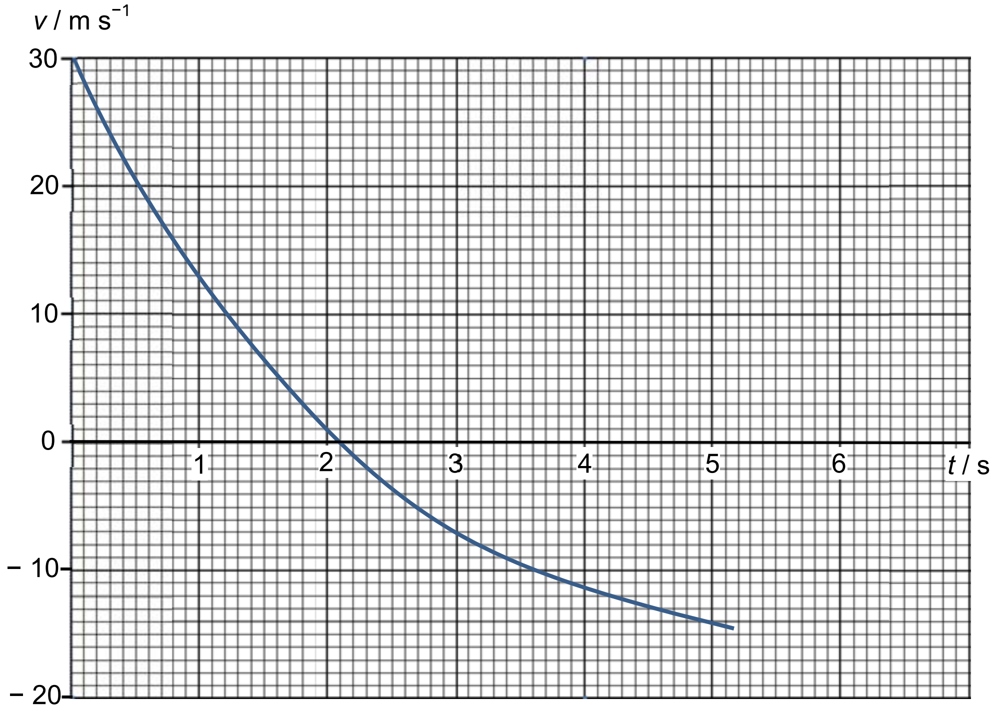

Fig. 2.1

(a) State the time at which the acceleration equals to acceleration of free fall.

time =…………………… s [1]

(b) Sketch on Fig. 2.2, the acceleration-time graph for the toy rocket for the first 3 seconds of the motion after the fuel is used up. (Find the acceleration of the toy rocket when t = 0) [2]

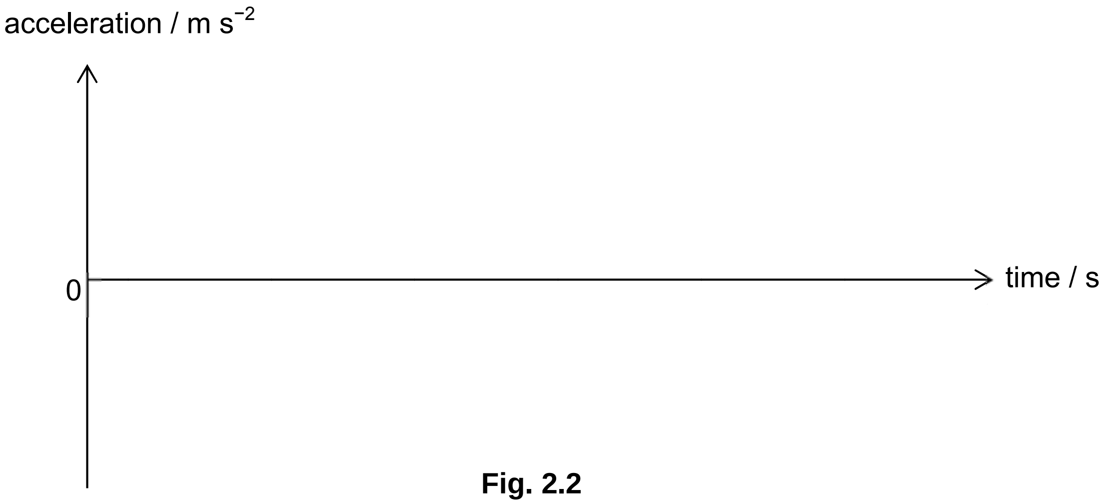

Fig. 2.2

For Examiner's Use

(c) Without further calculations, sketch on Fig. 2.3, the displacement-time graph of the toy rocket for the first 3 seconds of the motion **after** the fuel is used up. (Measure the displacement with respect to the displacement where the fuel has been used up. Label the time when maximum height is reached) [3]

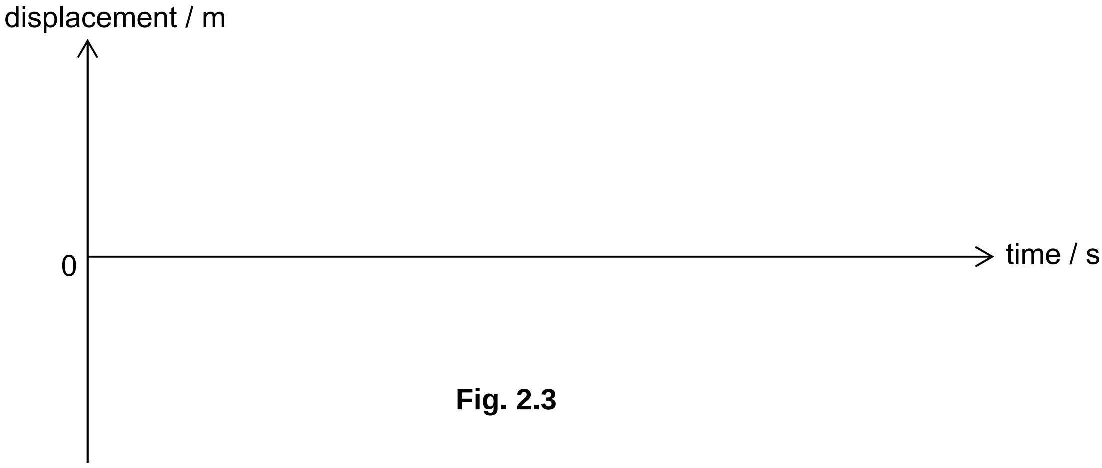

Fig. 2.3

3 **(a)** State the conditions required for a rigid body acted upon by two or more forces to be in equilibrium.

....

....

....[2]

(b) Fig. 3 shows a heavy rod **OA** of weight 120 N and length 1.0 m is hinged at **O** and held in the position shown by a force *F* acting at right angles to the rod and applied at **A**.

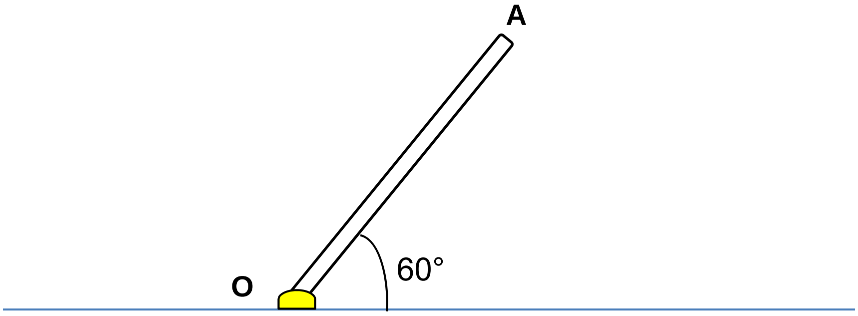

Fig. 3

(i) Indicate and label force *F* on Fig. 3. [1]

(ii) Explain the direction of *F* as indicated in Fig. 3.

....

....

....[1]

For Examiner's Use

(iii) Calculate the magnitude of *F*.

F = ... N [2]

4 Fig. 4 shows two electrical cables, Cable **A** and Cable **B** used to connect a power supply to a lamp. Each cable has a length of 0.45 m and has a resistance of 0.50 Ω m^{-1}.

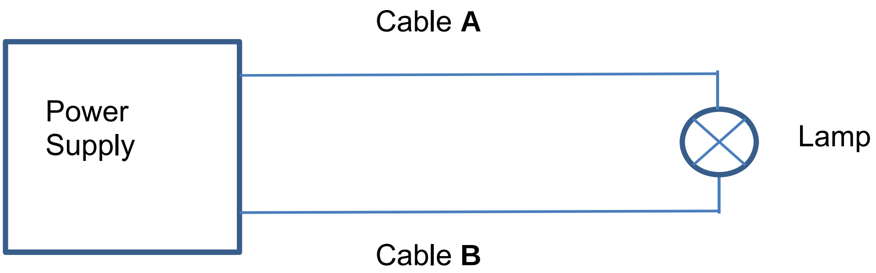

Fig. 4

The lamp is rated at 36 W, 6.0 V. The power supply has an internal resistance of 2.5 Ω and its output is adjusted so that the potential difference across the lamp is 6.0 V.

(a) Calculate the resistance of the lamp when it is operating at 6.0 V.

Resistance of lamp = ... Ω [2]

(b) Calculate the e.m.f of the power supply.

E.m.f of power supply = ... V [3]

For Examiner's Use

5 **(a)** As shown in Fig. 5.1, two resistors of resistances R_1 and R_2 respectively are connected in parallel. Derive a formula, using principal of conservation of energy, for the total resistance R of this combination of resistors. [2]

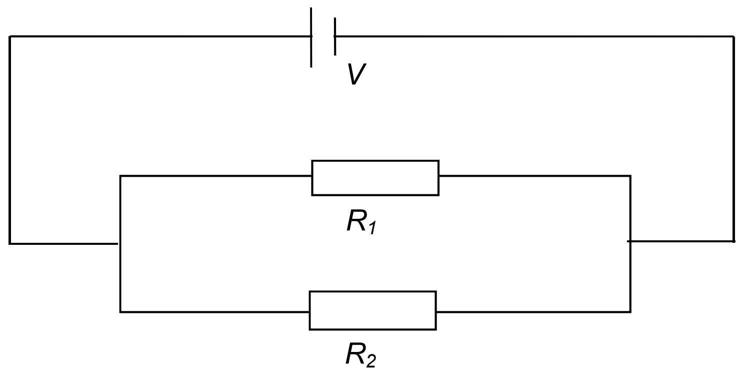

Fig. 5.1

(b) Fig. 5.2 shows a circuit which contains a component Y in parallel with a thermistor.

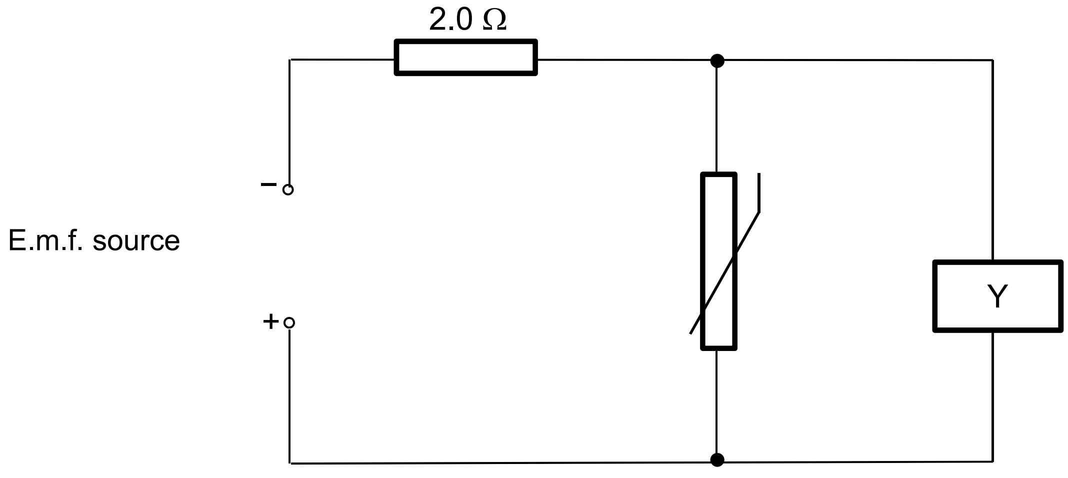

Fig. 5.2

At a particular temperature, the potential difference across Y is 5.00 V while the resistances of component Y and the thermistor are 125 Ω and 50.0 Ω respectively.

Calculate

(i) the total resistance of the circuit.

Total resistance = ……………………… Ω [1]

(ii) the potential difference across the power supply.

Potential difference across power supply = ……………………… V [2]

6 An overhead power line consists of two parallel identical cables, each with a cross sectional area of 0.100 m^2 and separated by a distance of 15.0 m. The current in each cable is 150 A and the magnetic field strength due to each cable is 5.85 x 10^{-6} T.

(a) Calculate the force per unit length on each cable.

Force per unit length = …….........N m^{-1} [2]

(b) A junior electrician claims that he is able to detect current flow in the cables by observing the movement of the cables. Explain why this is not possible.

…………………………………………………………………………………………

…………………………………………………………………………………………[1]

(c) Explain how your answer in (a) will be affected if the separation between the cables decreases.

....

....[1]

7 **(a)** Fig 7.1 shows the variation of the photocurrent *I* with the potential of the anode with respect to the cathode, *V* in the photoelectric experiment.

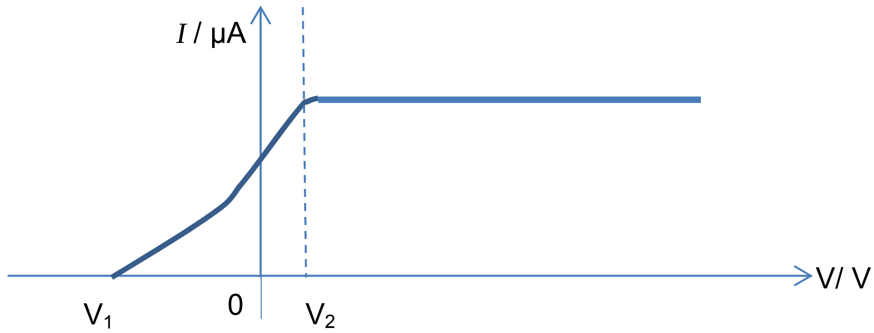

Fig. 7.1

Suggest possible reasons for the following observations as seen from Fig. 7.1.

(i) For values of V between V_1 and 0 V, the photocurrent increases as V becomes less negative.

....

....

....[1]

(ii) For values of V more negative than V_1, no photocurrent is detected.

....

....

....[1]

(iii) For values of V between 0 V and V_2, saturation current was not achieved.

....

....

....

....[2]

(b) An incident photon is incident on a metallic surface of work function energy of 5.32 eV. However, the photoelectron emitted has zero kinetic energy. Calculate the momentum of the photon.

Momentum of the photon = …………..N s [2]

(c) An electron in the ground state of an atom with energy levels as shown in Fig. 7.2 is struck by a photon.

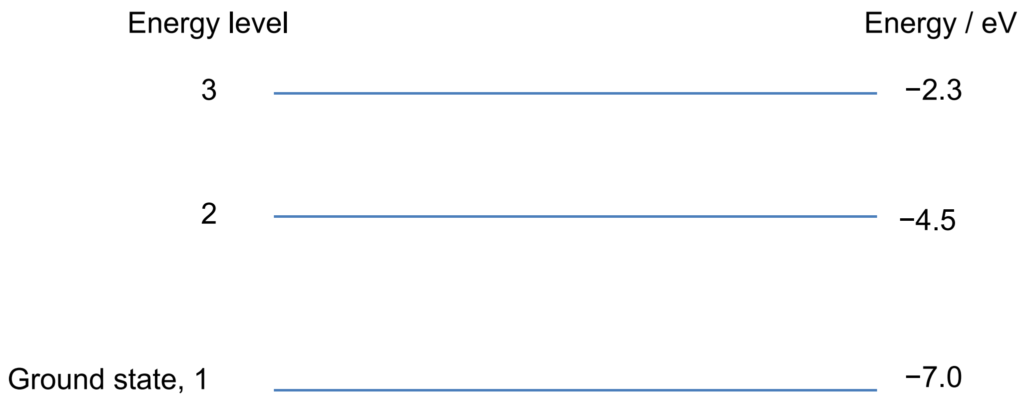

Fig. 7.2

State and explain what happens to the electron when the energy of the photon is

(i) 2.5 eV

…………………………………………………………………………………………..

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

(ii) 4.5 eV

…………………………………………………………………………………………..

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

For Examiner's Use

Section B

Answer **two** of the questions in this section.

8 **(a)** Define the *tesla*.

....

....

....[2]

(b) A student decides to design a simple motor to be used for his toy trolley. He sets up a current carrying square coil of wire as shown in Fig.8.1. The coil **ABCD** has length 5.00 cm and width 5.00 cm. The number of turns in the coil, N is 110. The current passing through the wire is 3.50 A while the magnetic field strength is 1.85 T.

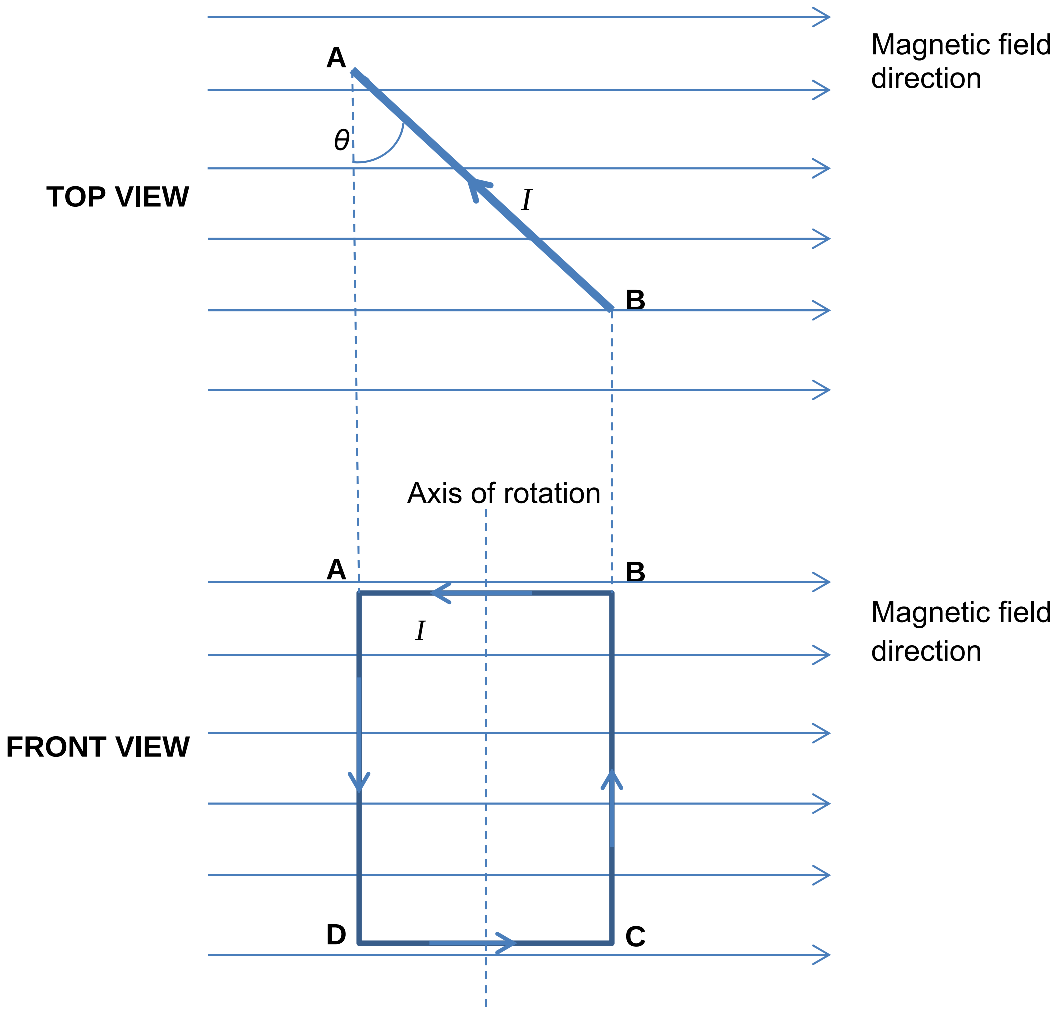

Fig.8.1

For Examiner's Use

(i) Determine the direction and magnitude of the torque exerted on the coil when $\theta = 30^{o}$.

Torque exerted on coil = ………… N m [2]

Direction when viewed from top = ……………………………[1]

(ii) Later, it was observed that arm **BC** actually experiences a resistive force. This resistive force causes 0.175 Nm of torque in the clockwise direction viewed from the top when $\theta = 30^{o}$. Calculate the new magnetic field strength required in order to ensure the net torque remains the same as **(i)**. (Assume the resistive force remains unchanged)

New magnetic field strength = …………………… T [2]

(c) The student installs the motor in his toy trolley, **A**. Trolley **A** of mass 2.0 kg is then connected to trolley **B** of mass 6.0 kg using a light cable. Both trolleys are accelerating down a slope at an angle of 30° and a constant force *F* is applied on trolley **A** by the motor to reduce the acceleration as shown in Fig. 8.2. Neglect friction and effects of air resistance.

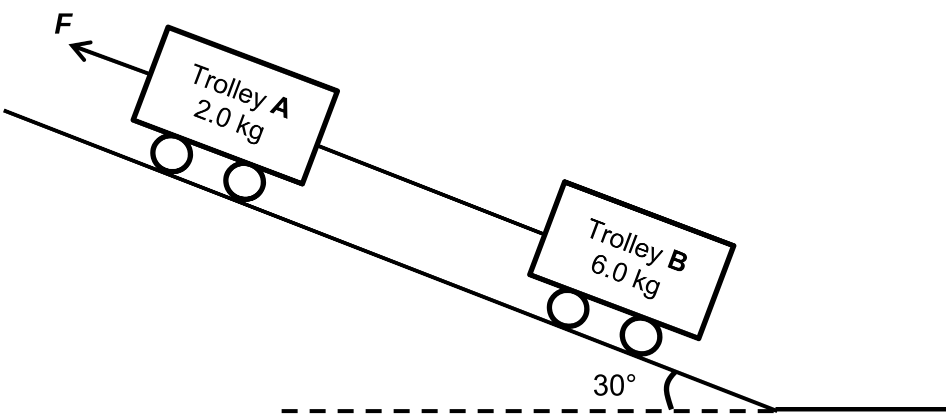

Fig. 8.2

For Examiner's Use

(i) Write an equation which relates the acceleration a_A of trolley **A** with its mass m_A, the tension in the cable T and the pulling force F. [1]

(ii) Write an equation which relates the acceleration a_B of trolley **B** with its mass m_B and the tension T in the cable. [1]

(iii) Hence, determine the tension in the cable T in terms of F. [2]

For Examiner's Use

The cable is now cut. Trolley **B** reaches the bottom of the slope with a speed of 5.0 m s^{-1}. Trolley **B** then collides head-on with trolley **C** of mass 10 kg travelling at a speed of 3.0 m s^{-1} to the left as shown in Fig. 8.3. Trolley **C** then travels to the right after the collision with a speed of 2.0 m s^{-1}.

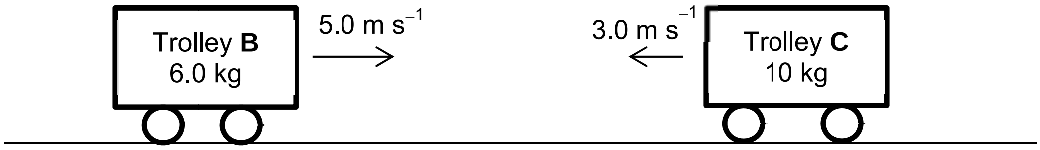

Fig. 8.3

(iv) Determine the velocity of trolley **B** after the collision.

speed = …………….m s^{-1} [2]

Direction = …………………. [1]

(v) Fig. 8.4 shows the variation of the velocity of trolley **C,** v with respect to time, t. Sketch the corresponding velocity-time graph for trolley **B**. [2]

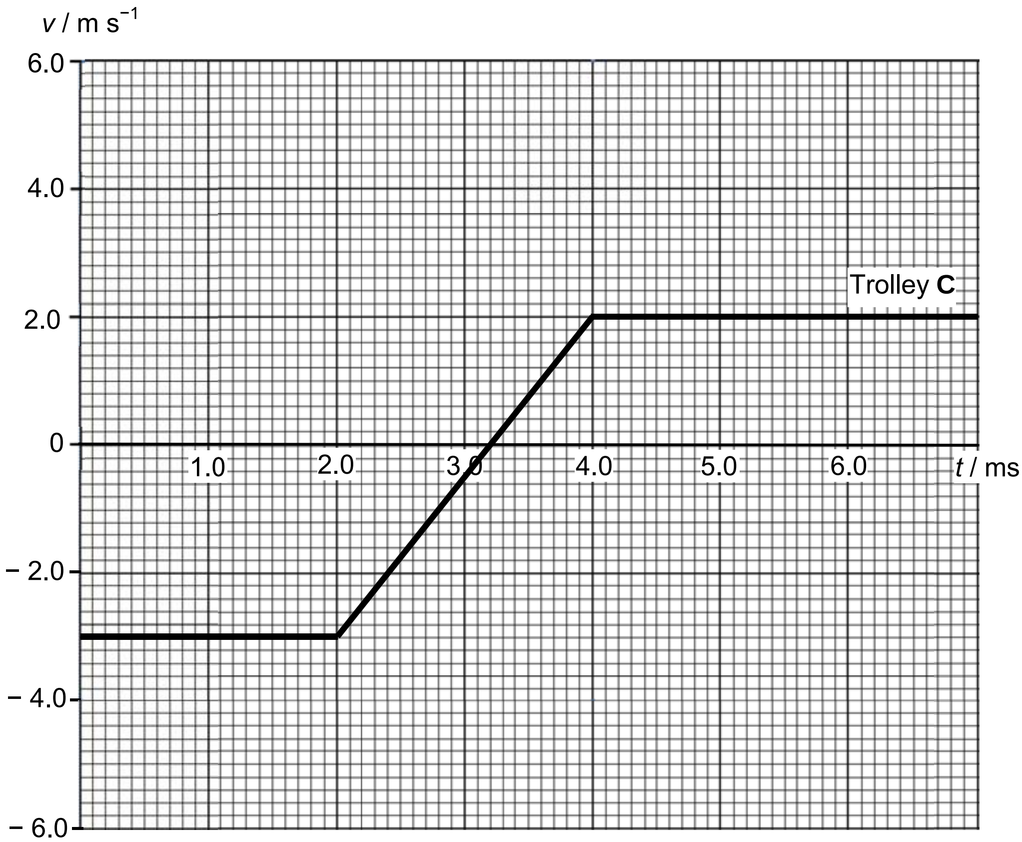

Fig. 8.4

For Examiner's Use

(vi) Explain whether the collision is an elastic collision. Substantiate your conclusion with workings.

Conclusion: …………………………………………………………………………..

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

(vii) Determine the average force experienced by trolley **C** during the collision.

average force = …………………… N [2]

9 **(a)** A bungee jumper is attached to an elastic rope which is tied at one end to a pole. At the start of the jump, the man is initially at rest at the edge of a cliff. The man then jumps off from the cliff. Fig. 9.1 shows the graph of the net force, F_{net} acting on the man against the vertical distance, h travelled by man with respect to the point he jumps from. The natural length of the rope is 10 m and the weight of the man is 500 N.

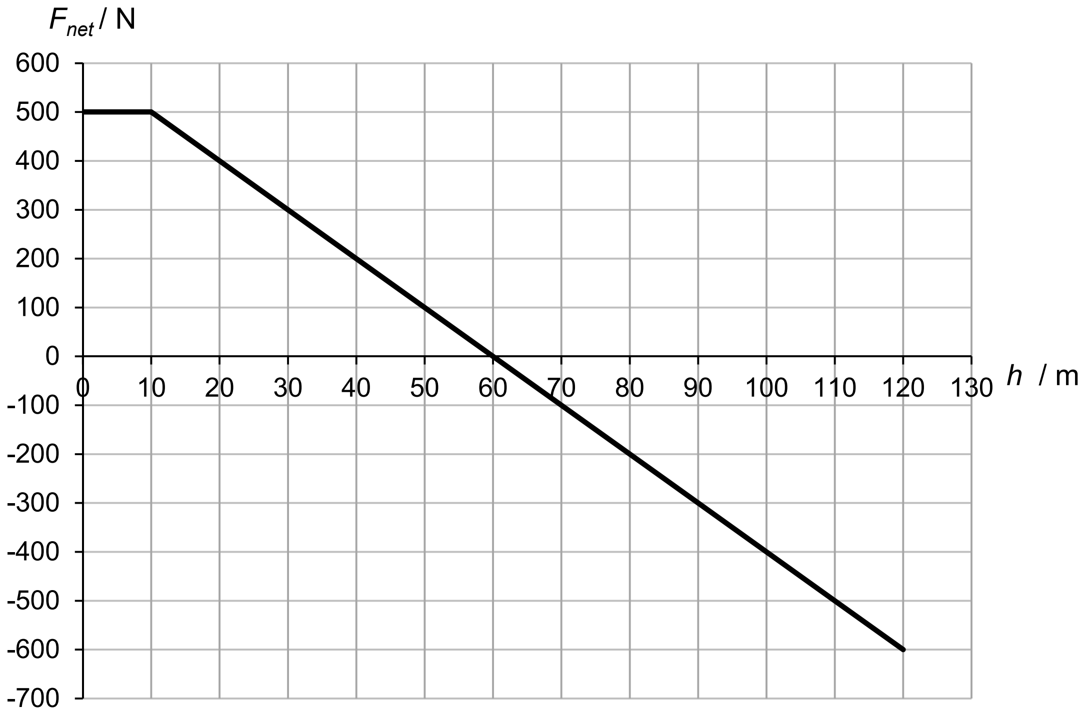

Fig. 9.1

(i) Calculate the spring constant of the elastic rope.

Spring constant = ……………………………… N m^{-1} [2]

(ii) Calculate the distance, h travelled where he reaches the lowest point.

Distance = …………………………… m [2]

For Examiner's Use

(iii) Sketch a graph of kinetic energy, E_k of the man against the distance, h from the start to the lowest point reached. Label on the graph the value of highest kinetic energy attained and the kinetic energy attained when h = 10 m . Hint: Consider the area of $F_{net} - h$ graph. [3]

(iv) Sketch a graph of elastic potential energy, E_p of the rope against the distance, h from the start to the lowest point reached. Indicate on the graph the greatest E_p attained to two significant figures. [2]

(v) Sketch a graph of gravitational potential energy, E_g of the rope against the distance, *h* from the start to the lowest point reached, assuming that the E_g is zero at the lowest point. Label on the graph the value of greatest E_g attained to two significant figures.

(b) A box is pulled up along a slope at a constant speed of 3.0 m s^{-1} by a string tied to a motor as shown in Fig. 9.2. The slope exerts a frictional force of 6.0 N on the box and the mass of the box is 1.0 kg. The motor has an efficiency of 80 %.

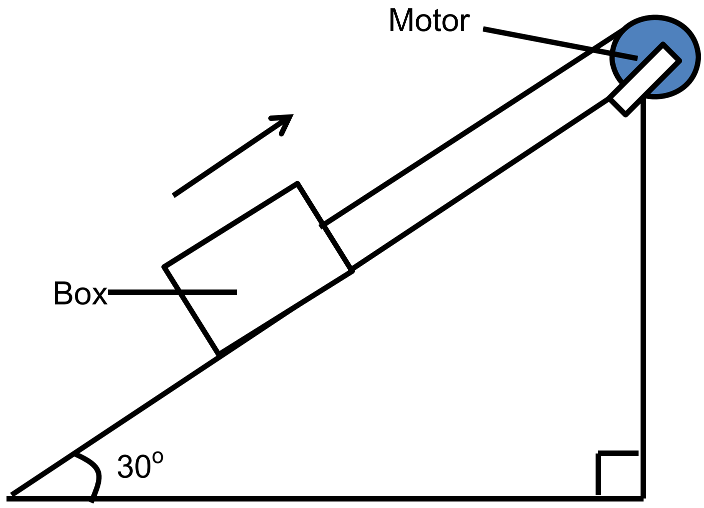

Fig. 9.2

(i) Calculate the tension in the string.

Tension = ………………………. [2]

For Examiner's Use

(ii) Calculate the input power of the motor required to pull up the box.

Input power = ……………………….. W [2]

(iii) Calculate the total input energy supplied to the motor when the box moved up through a vertical height of 15 m.

Input energy = …………………. J [2]

(iv) State the relationship between the power of the motor and the frictional force, such that the speed of the box remains unchanged at 3.0 m s^{-1}.

……………………………………………………………………………………….

…………………………………………………………………………………… [1]

(v) State the energy conversion of the box as the box is pulled up along the slope.

………………………………………………………………………………………

………………………………………………………………………………………

…………………………………………………………………………………… [2]

For Examiner's Use

10 **(a)** Define *wavelength, frequency and speed*, as applied to wave motion.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………[3]

(b) Based on the definitions in **(a)**, deduce the equation for the speed of wave is in terms of its wavelength and frequency. [3]

(c) At time $t = 0$, the displacement-distance graph of a progressive wave is shown in Fig. 10.1. The wave is progressing to the left at 0.50 m s^{-1}.

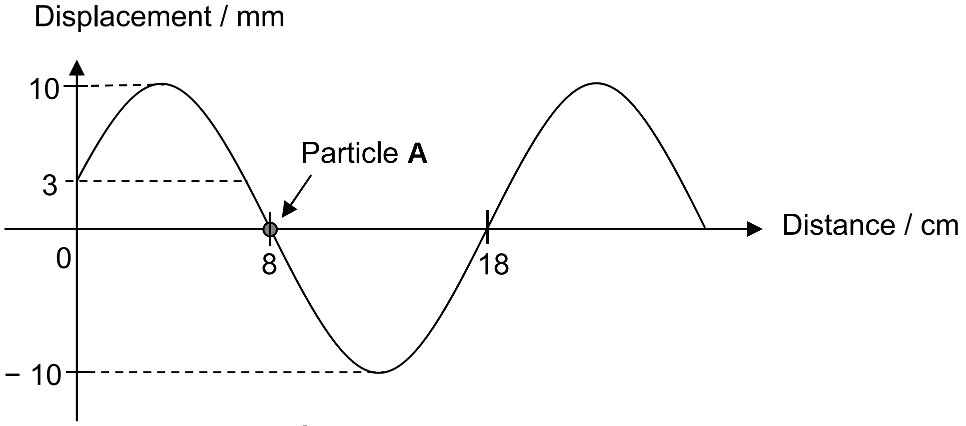

Fig. 10.1

[Turn over

For Examiner's Use

(i) Determine the frequency of the wave.

Frequency = ……………………… Hz [2]

(ii) On Fig.10.2, show the variation with time of the displacement of particle **A,** for at least one complete cycle. Label the critical values on the axes. [2]

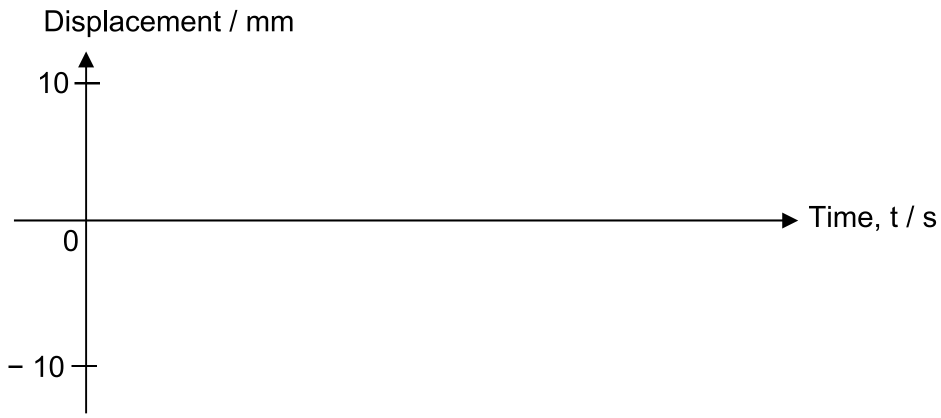

Fig.10.2

[Turn over

For Examiner's Use

(d) A small loudspeaker emitting sound of constant frequency is positioned a short distance above a long glass tube containing water. When water is allowed to run slowly out of the tube, the intensity of the sound heard increases whenever the length *l* (shown in Fig.10.3) takes certain values.

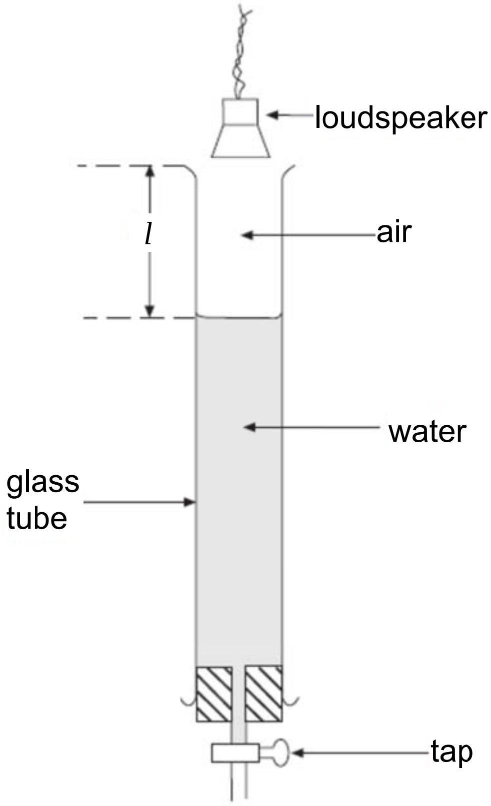

Fig.10.3

(i) Explain these observations by reference to the physical principles involved.

....

....

....

....

....

....

....[4]

[Turn over

For Examiner's Use

(ii) With the loudspeaker emitting sound of frequency 480 Hz, the effect described in **(i)** is first noticed when l = 168 mm. It next occurs when l = 523mm.

Use both values of l to calculate

1. the wavelength of the sound waves in the air column,

wavelength = ……………………… m [2]

2. the speed of the sound waves.

speed = ……………………… m s^{-1} [2]

3. At the fundamental frequency, the student commented that the wavelength of the sound is four times the length, l. He thus calculated the speed of sound using this value of wavelength. Explain why the speed of sound calculated in this manner is inaccurate and state whether this calculation is an overestimate or underestimate.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

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

--- End of Paper ---