MERIDIAN JUNIOR COLLEGE
Preliminary Examination
Higher 1

H1 Physics 8866/2

Paper 2 **21 September 2015**

2 hours

Class Reg Number

Candidate Name ______________________________

Class	Reg Number

READ THESE INSTRUCTIONS FIRST

This booklet contains Sections A and B of the Preliminary Examination Paper 2.

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

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

You are advised to spend about one hour on each section.
Write your answers on this question booklet in the blanks provided.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question. Marks will be deducted if units are not stated where necessary or if answers are not quoted to the appropriate number of significant figures.

All working for numerical answers must be shown. You are reminded of the need for good English and clear presentation of your answers.

Examiner's Use	
Section A	
Q1	**/ 10**
Q2	**/ 8**
Q3	**/ 8**
Q4	**/ 14**
Section B	
Circle the questions you have attempted	
Q5	**/20**
Q6	**/20**
Q7	**/20**
Deductions	
Total	**/80**

This question paper consists of 21 printed pages

DATA AND FORMULAE

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	=	ρgh
resistors in series	R	=	$R_1 + R_2 + \ldots$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

Section A

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

1 **(a)** **(i)** State *Newton's first law of motion*.

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

(ii) Define *inertia*.

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

(iii) Discuss the relationship between inertia and Newton's first law of motion.

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

(b) Fig. 1.1 below shows a tower crane which is in equilibrium. The crane is made up of the tower (section **AB**), jib (section **CD**) and a counter-weight. The tower and jib are connected by a fulcrum along their centre axes and it can rotate freely in its vertical plane.

The jib has a mass of 1150 kg and its centre of mass is 6.2 m to right of the fulcrum. A counter-weight of 4000 kg is placed with its centre of mass 8.3 m to the left of the fulcrum.

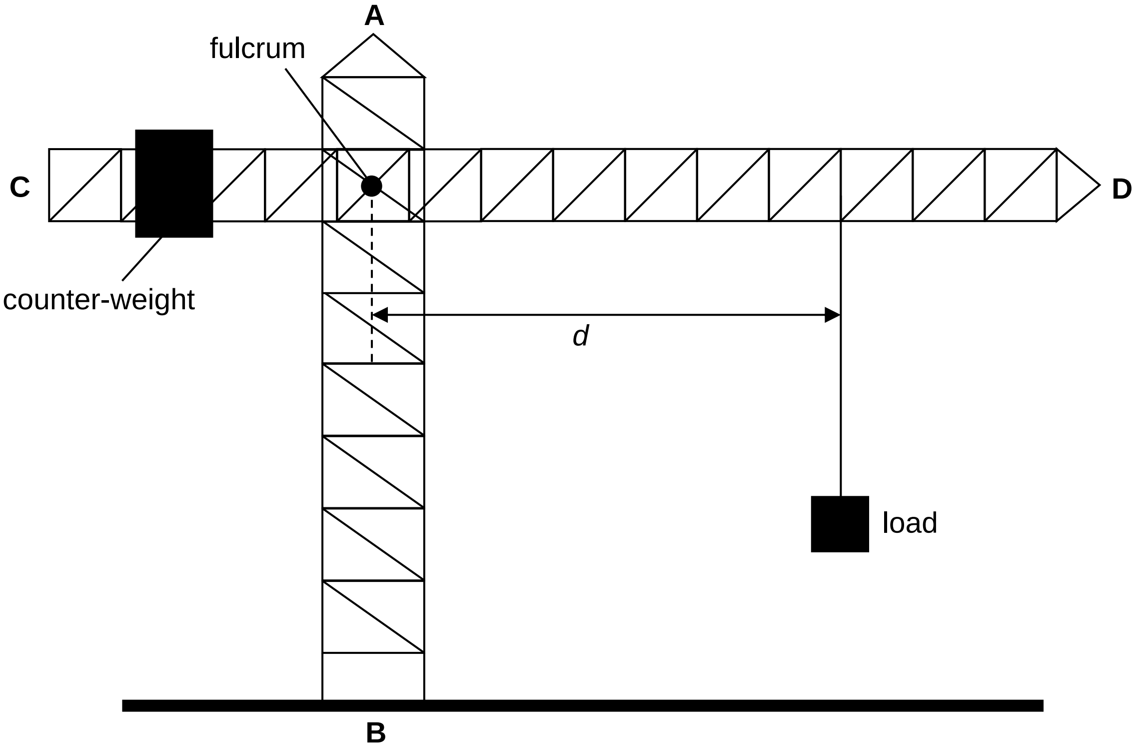

Fig. 1.1

(i) The crane is used to lift a load of 970 kg at a constant velocity. Determine the distance *d* of this load from the fulcrum.

d = ………………………………. m [2]

(ii) The load is then accelerated upwards.

Explain why the jib is no longer in equilibrium and suggest what can be done to maintain the jib in its horizontal position.

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……………………………………………………………………………………… [3]

(iii) In reality, the fulcrum is a fixed joint and not allowed to rotate freely in the vertical plane. Suggest a reason for this.

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……………………………………………………………………………………… [1]

2 A cylindrical rod of mass 50 g is resting freely on two horizontal smooth conducting rails **Y** and **Z** of negligible widths. Rails **Y** and **Z** are placed 0.15 m apart and connected to a 24 V battery of negligible internal resistance. A uniform magnetic field of flux density 0.55 T is applied perpendicularly out of the paper as shown in Fig. 2.1. The rod has a diameter of 0.010 m and length 0.20 m. The resistivity of the rod is 2.3 x 10^{-3} Ω m.

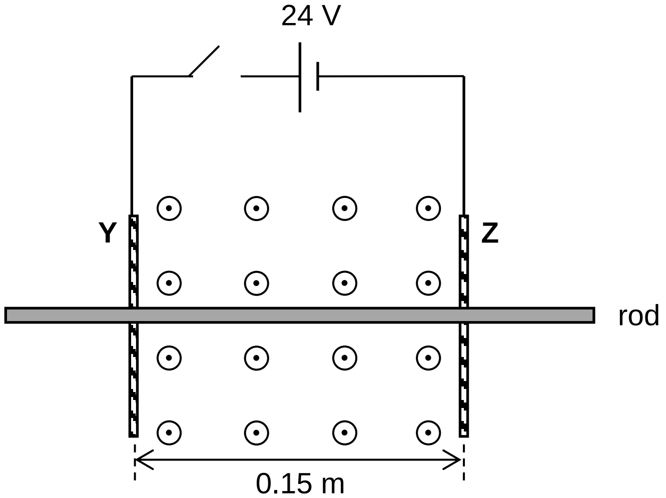

Fig. 2.1

(a) Explain what is meant by a magnetic field of flux density 0.55 T.

………………………………………………………………………………………………

………………………………………………………………………………………………

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

(b) **(i)** Indicate on the diagram the direction of the magnetic force when the switch is closed. [1]

(ii) Explain your answer to **(b)(i)**.

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

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

(iii) Show that the current through the rod is 5.5 A. [2]

(iv) Hence or otherwise, determine the initial acceleration experienced by the rod.

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

3 Two cool gases, A and B, placed in a specially designed chamber are separated by a thick transparent glass as shown in Fig. 3.1. To excite the atoms of gas A, electrons with kinetic energy of 5.00×10^{-19} J each is directed as shown.

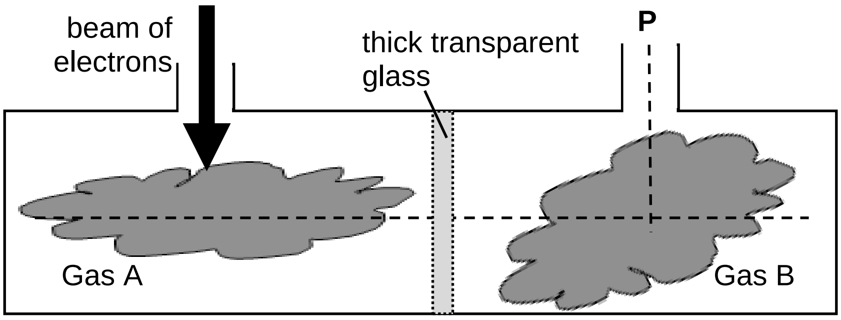


Fig. 3.1

Fig. 3.2 shows the energy states within the atoms of gas A, with level A_1 being the lowest energy state.

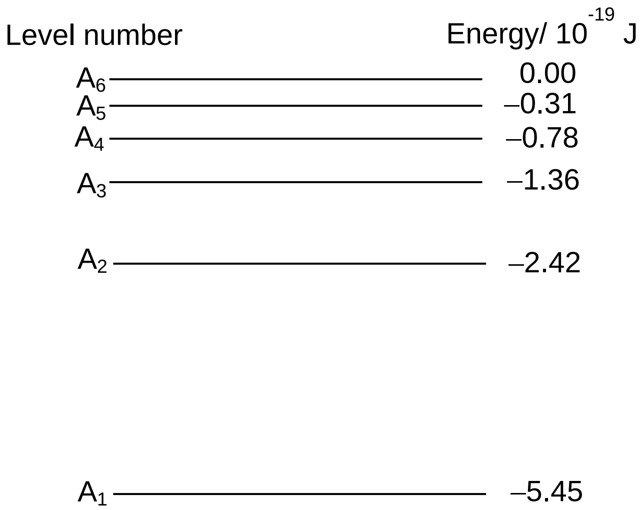


Fig. 3.2

(a) State the highest energy level in which the atoms of gas A can be excited to in this setup.

level number = ………………… [1]

(b) Determine the shortest wavelength of the photons emitted from gas A. State the region of the electromagnetic spectrum in which the radiation occurs.

wavelength = ………………… m

region: …………………………………… [3]

(c) The transparent glass in Fig. 3.1 is designed such that it allows only photons but not electrons to pass through it.

Fig. 3.3 shows the energy states within the atoms of gas B, with level B_1 being the lowest energy state. Electromagnetic radiation of various wavelengths is detected at point **P**.

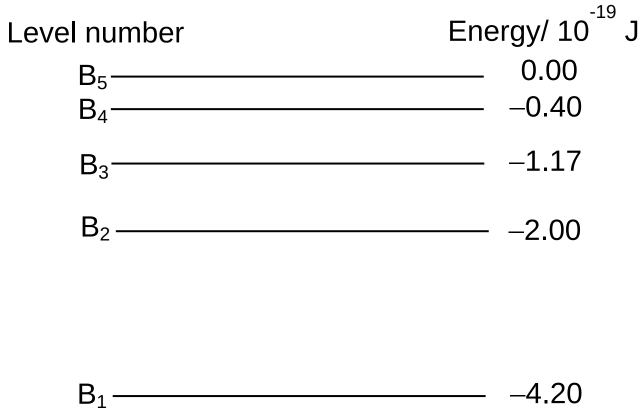


Fig. 3.3

(i) State all the transitions that resulted in the electromagnetic radiation detected at **P**.

transitions: ……………………………………………………

…………………………………………………… [2]

(ii) Electrons with kinetic energy of 4.7 x 10^{-20} J are also detected at point **P**. Calculate the wavelength of the electrons.

wavelength = ………………… m [2]

4 A photovoltaic cell is a device which converts light energy directly to electrical energy. A potential difference is developed between the two terminals of the photovoltaic cell. The magnitude of the potential difference *V* depends on the intensity of the light incident on the surface of the cell.

Fig. 4.1 shows the variation of *V* with I for a particular photovoltaic cell of surface area 4.0×10^{-4} m^2 when illuminated normally with light of intensity 1100 W m^{-2}.

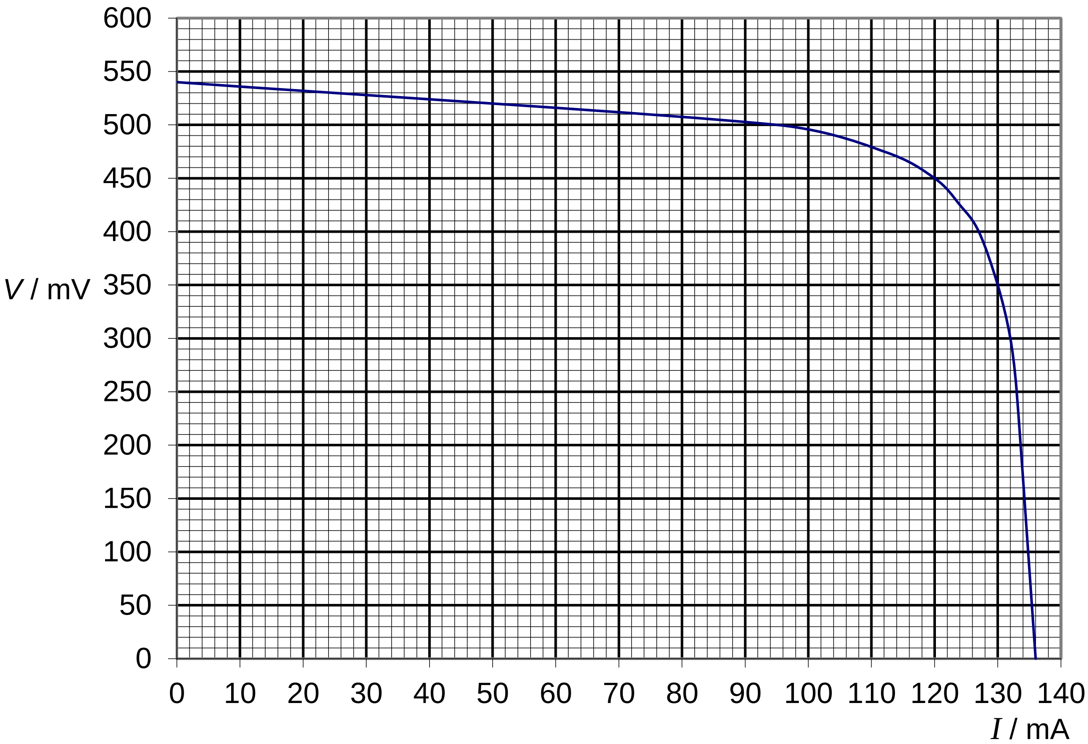
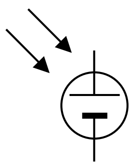


Fig. 4.1

(a) **(i)** Design an experiment to obtain the readings for the graph in Fig. 4.1 for the photovoltaic cell. Draw the circuit in the space below and describe the steps to obtain the readings.

Symbol for photovoltaic cell : 

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

(ii) Use the data supplied in Fig. 4.1 to complete the table below with values of current, I, and power, P, for the values of potential difference, V. [2]

V / mV	I / mA	P / mW
250		
350	130	45.5
450	120	54.0
470		
480	110	52.8
510	70	35.7

(b) **(i)** Using the values from the table in **(a)(ii)**, plot a graph of P against V on the axes given in Fig. 4.2. [2]

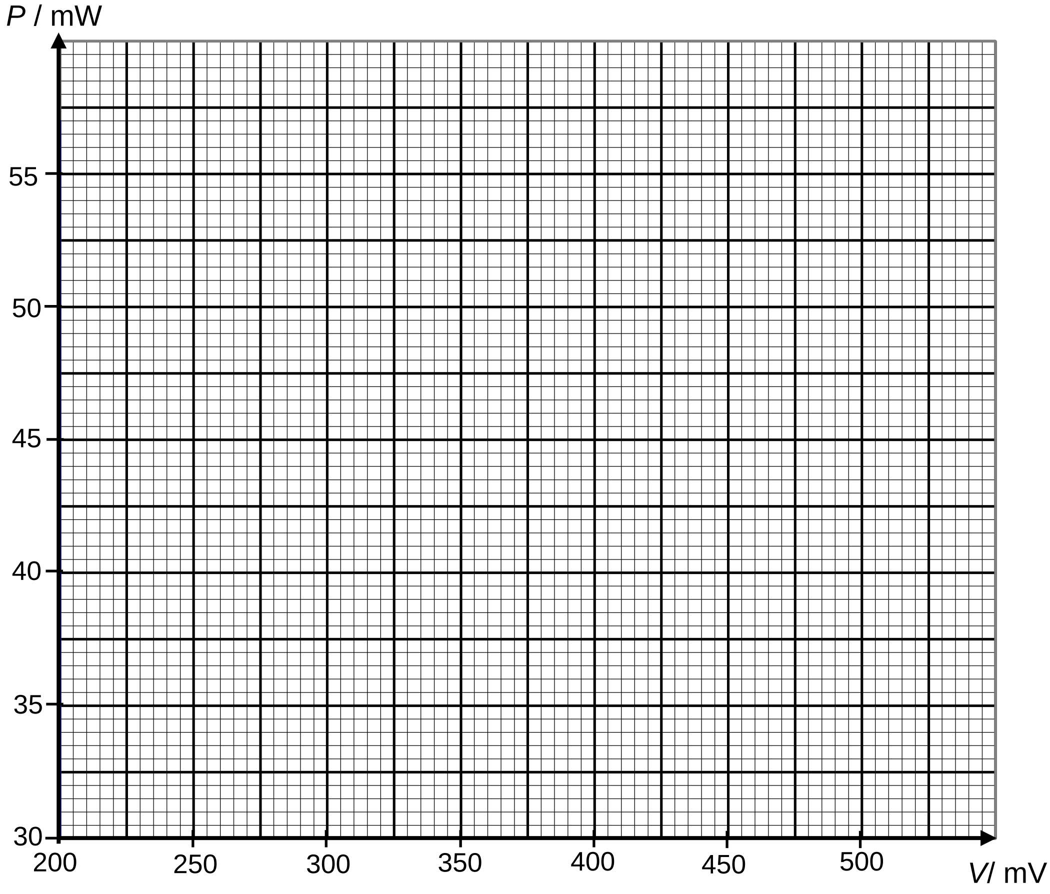

Fig. 4.2

(ii) State the maximum power output P_{max} of the cell from the graph drawn in Fig. 4.2.

P_{max} = ………………….. mW [1]

(iii) Using the value of the maximum power output P_{max} and any other data, calculate the maximum efficiency in the conversion of light energy into electrical energy.

maximum efficiency = ………………….. % [3]

(c) Another type of photovoltaic cells produces an output power of 250 mW at an output potential of 500 mV. A set-up requires a maximum power output of 0.75 W at 1.0 V using a number of these photovoltaic cells in a suitable arrangement.

1. Determine total number of photovoltaic cells which are required to produce the maximum power output of 0.75 W.

2. Describe how, with the number of photovoltaic cells determined in **(1)**, you can obtain 1.0 V. Draw the arrangement of the photovoltaic cells for the set-up in the space below.

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

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

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

Section B

Answer **two** questions in this section.

5 **(a)** **(i)** During a Physics test, Alice gave the definition of speed as distance travelled per second. State and explain whether she would attain full credit for her answer.

…………………………………………………………………………………………..

…………………………………………………………………………………………..

…………………………………………………………………………………………..

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

(ii) Bob travels in his car for 30 min. State and explain whether it is possible for the average velocity of Bob's car during this trip to be zero while his average speed is non-zero.

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…………………………………………………………………………………………..

…………………………………………………………………………………………..

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

(b) During a stunt, a daredevil plans to ride up a ramp, of angle 60° to the horizontal and of height 10.0 m, on a motorcycle and jump over a metal spike of height 30.0 m before landing on another ramp on the other side. Fig. 5.1 shows a layout of the course. Total mass of the motorcycle and the daredevil is 230 kg.

Assume that air resistance is negligible for this question.

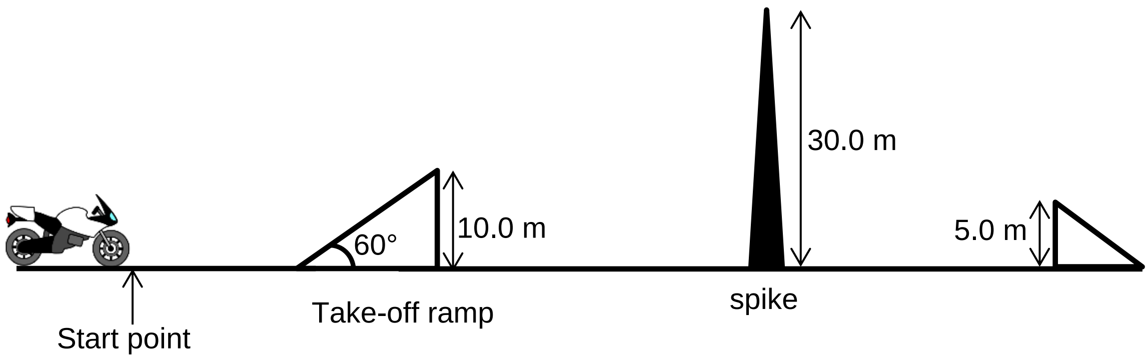


Fig 5.1

(i) The daredevil wishes to attain the minimum speed of 22.9 m s^{-1} in 5.0 s from the start point to just before going up the take-off ramp. Assuming he started from rest at the start point, determine the acceleration required.

acceleration = ……………………… m s^{-2} [2]

(ii) The surface of the course exerts an average resistive force of 120 N. Determine the driving force exerted by the motorcycle engine during the first 5.0 s.

driving force = ……………………………. N [2]

(iii) The daredevil needs to maintain this speed as he travels up the ramp. Assuming the surface of the ramp exerts the same resistive force of 120 N, determine the additional power that the motorcycle engine needs to produce.

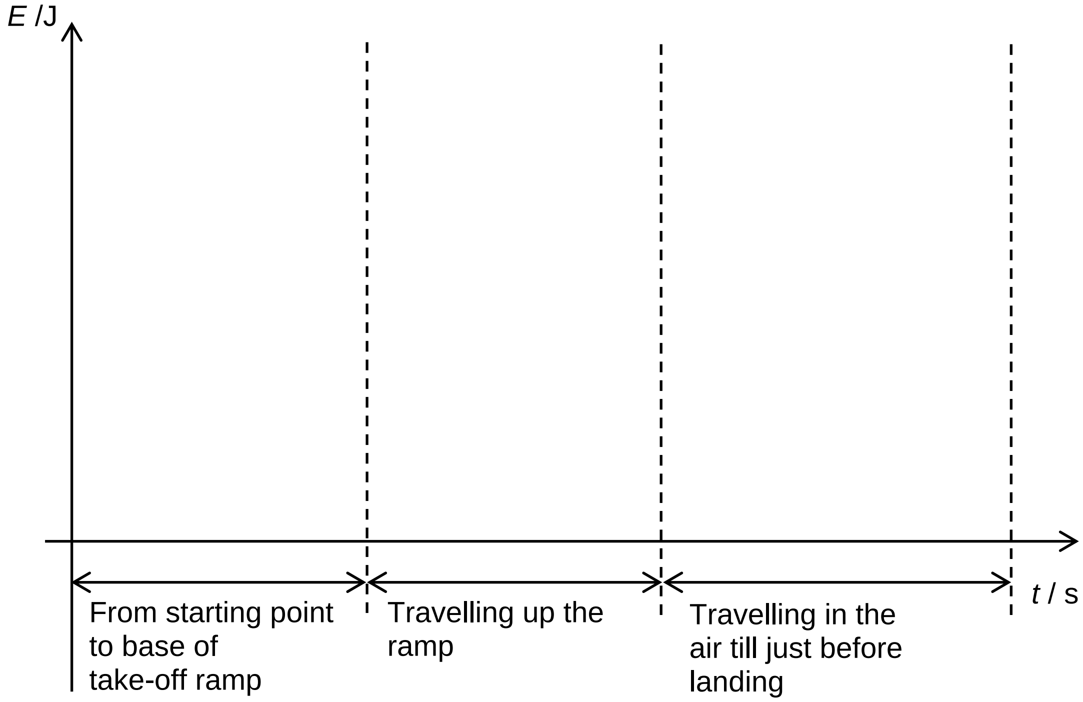
additional power = ... W [3]

(iv) Show, quantitatively, that the minimum launch speed the daredevil requires to just clear the spike is 22.9 m s^{-1}. Explain your answer clearly. [2]

(v) Calculate the distance that the landing ramp needs to be placed from the take-off ramp.

distance = …………………………… m [3]

(v) Starting from t = 0 s, on the same axes below, sketch separate graphs of how gravitational potential energy and total energy of the daredevil and his motorcycle varies with time from the starting point of the course till just before he lands on the landing ramp. Label each graph clearly. Additional calculation is not required. [4]



6 **(a)** State *Newton's second law of motion*.

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……………………………………………………………………………………………………

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

(b) A man of weight 700 N stands on a weighing scale in an elevator. As the elevator moves, the reading on the weighing scale varies.

In the following scenarios, state how the reading on the weighing scale varies as compared to the man's weight (i.e. more than / less than / same as his weight).

Scenario	**State <u>more</u> / <u>less</u> / <u>same</u>.**
Elevator moving with constant speed	
Elevator moving up and speeding up	
Elevator moving up and slowing down	
Elevator moving down and speeding up	
Elevator moving down and slowing down	

[2]

(c) State and explain whether the person described in the following scenarios is experiencing apparent weightlessness.

(i) A parachutist who just opened her parachute in mid-air.

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(ii) A boy being kept "afloat" above a big fan blowing air upwards with a high velocity (see Fig. 6.1).

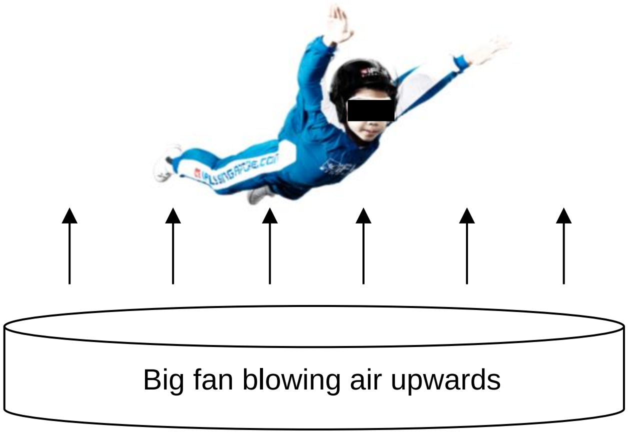

Fig. 6.1

……………………………………………………………………………………………

……………………………………………………………………………………………

………………………………………………………………………………….. [2]

(d) State the *principle of conservation of momentum*.

……………………………………………………………………………………………

……………………………………………………………………………………………

………………………………………………………………………………… [2]

(e) Fig. 6.2 below shows 2 rubber balls colliding.
Ball A has a mass of 0.53 kg and moving to the right with a speed of 7.2 m s^{-1}.
Ball B has a mass of 0.34 kg and moving to the left with a speed of 9.6 m s^{-1}.
The collision is head-on and elastic.

After the collision, Ball A and Ball B moves with velocities v_A and v_B respectively.

Take rightwards as positive for this entire question.

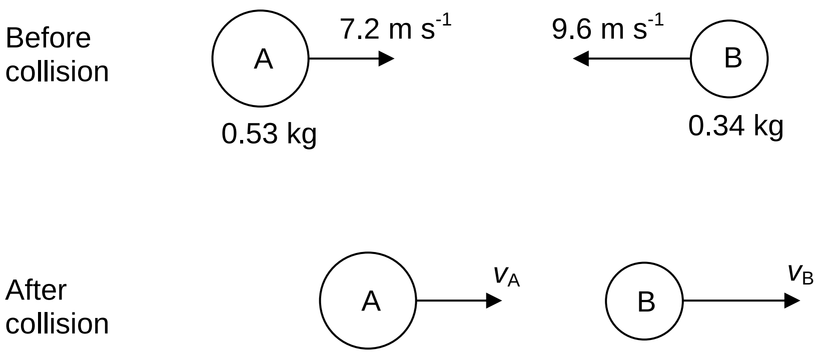

Fig. 6.2

(i) Show that $v_A = -5.9 \text{ m s}^{-1}$ and $v_B = 11 \text{ m s}^{-1}$. [3]

(ii) During the collision, it can be assumed that the forces acting on each of the balls vary linearly.

Given that t_1 is the time which the balls first touch and t_2 is the time which the balls first separate, sketch on Fig. 6.3,

1. a **solid** line to show the force acting on Ball A,

2. a **dotted** line to show the force acting on Ball B. [2]

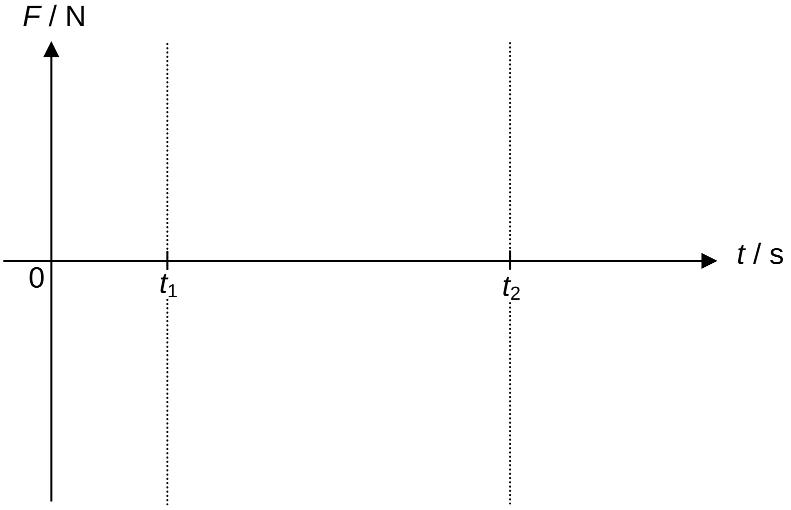

Fig. 6.3

(iii) Hence, or otherwise, determine the maximum force experienced by each of the balls given that the duration of collision, ($t_2 - t_1$) = 0.42 s.

maximum force on Ball A = ………………….. N

maximum force on Ball B = ………………….. N [3]

(iv) On Fig. 6.4, sketch a labelled graph to show the variation with time of the velocity of

1. Ball A using a **solid** line;

2. Ball B using a **dotted** line. [2]

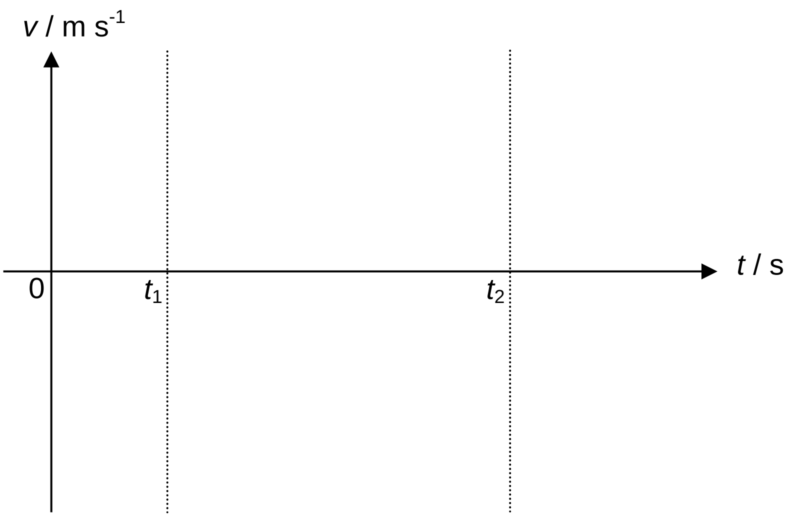

Fig. 6.4

7 **(a)** State three conditions necessary for the superposition of two waves to give rise to a well-defined interference pattern.

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....

.... [3]

(b) Fig. 7.1 shows two point sources of sound S_1 and S_2 separated by a distance of 1.7 m. They are connected to a signal generator such that they produce tones of the same frequency, phase and amplitude. The frequency of the signal generator can be varied between 100 Hz to 800 Hz.

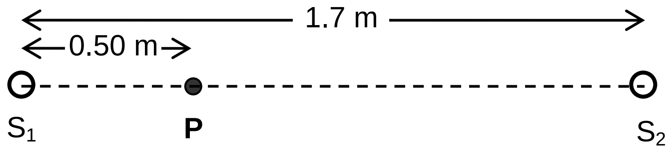

Fig. 7.1

Between S_1 and S_2 is a point **P** that is 0.50 m from S_1.

Determine the phase difference between the waves from the sources arriving at **P** with both S_1 and S_2 switched on when the frequency of the generator was set to 800 Hz. (speed of sound = 330 m s^{-1})

phase difference = …………………… rad [3]

(c) The frequency of the signal generator, is gradually decreased until a minimum intensity of sound is observed at **P**.

(i) Calculate the frequency at which this is observed.

frequency = …………………… Hz [2]

(ii) Determine the total number of points between S_1 and S_2 at which sound of minimum intensity is observed.

number of points = ……………… [3]

(iii) Each of the point sources of sound has an output power of 600 W. Calculate the resultant intensity of the sound at point **P**.

resultant intensity = …………………… W m^{-2} [3]

(iv) State and explain how the intensity of the sound at the minima at **P** will be affected if the power of S_2 is slightly increased.

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....

....

.... [2]

(d) An observer starts walking from a point **Q**, 180 m away from the 2 sources, along a path parallel to S_1S_2. With both sources switched on and the frequency of the signal generator set at 800 Hz, he observes fluctuations in the intensity of the sound heard as he walks.

(i) Explain the observation.

....

....

....

.... [2]

(ii) Calculate the distance the observer walks between consecutive maxima.

distance = …………………… m [2]

End of Paper