DUNMAN HIGH SCHOOL
Preliminary Examination
Higher 1

CANDIDATE NAME	

CLASS	6	C			INDEX NUMBER		

PHYSICS

8866/02

Paper 2 Structured Questions

September 2014
2 hours

Candidates are to answer on the Question Paper.

No additional materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
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.

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

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

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

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
Section B	
6	
7	
8	
Total	

This document consists of **26** printed pages.

For Examiner's Use

Data

speed of light in free space,	c	$= 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	e	$= 1.60 \times 10^{-19}$ C
the Planck constant,	h	$= 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	u	$= 1.66 \times 10^{-27}$ kg
rest mass of electron,	m_e	$= 9.11 \times 10^{-31}$ kg
rest mass of proton,	m_p	$= 1.67 \times 10^{-27}$ 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	$= \rho gh$
resistors in series,	R	$= R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	$= 1/R_1 + 1/R_2 + \ldots$

For Examiner's Use

1 A helicopter is flying horizontally at a height of 20 m above the ground. It is moving with a constant velocity of 8.0 m s^{-1} when a package of emergency food supplies is dropped from the back of the helicopter. Assume air resistance to be negligible.

(a) Calculate the time taken for the package to reach the ground.

time taken = ……………………… s [2]

(b) Determine the horizontal distance between the package and the helicopter when the package hits the ground.

horizontal distance = ……………………… m [2]

(c) Determine the velocity of the package just before hitting the ground.

velocity = ……………………… m s^{-1}

direction : …………………………………………………………………… [4]

For Examiner's Use

2 Trolley A of mass 400 g is moving at a constant speed of 2.5 m s^{-1} to the right as shown in Fig. 2.1.

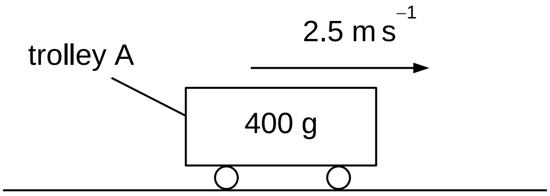

Fig. 2.1

(a) Show that the kinetic energy of trolley A is 1.3 J.

[1]

Trolley A then hits a spring of force constant k = 20 N m^{-1} and compresses the spring before coming to rest momentarily.

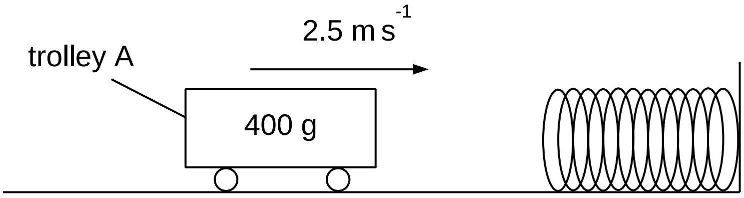

Fig. 2.2

(b) **(i)** Define *elastic potential energy*.

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

(ii) Calculate the maximum compression of the spring.

compression = ………………………………. m [2]

For Examiner's Use

(iii) The spring is then cut in half so that its length is now halved. Trolley A is, again, moving with a constant speed of 2.5 m s^{-1} and hits the spring.

State and explain a change, if any, in the maximum compression of the spring.

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(c) Two identical trolleys, A and B, start from rest at the same height above the ground and travel to the right on two frictionless tracks as shown in Fig. 2.3. Both trolleys travel the same horizontal distance to reach the finish line.

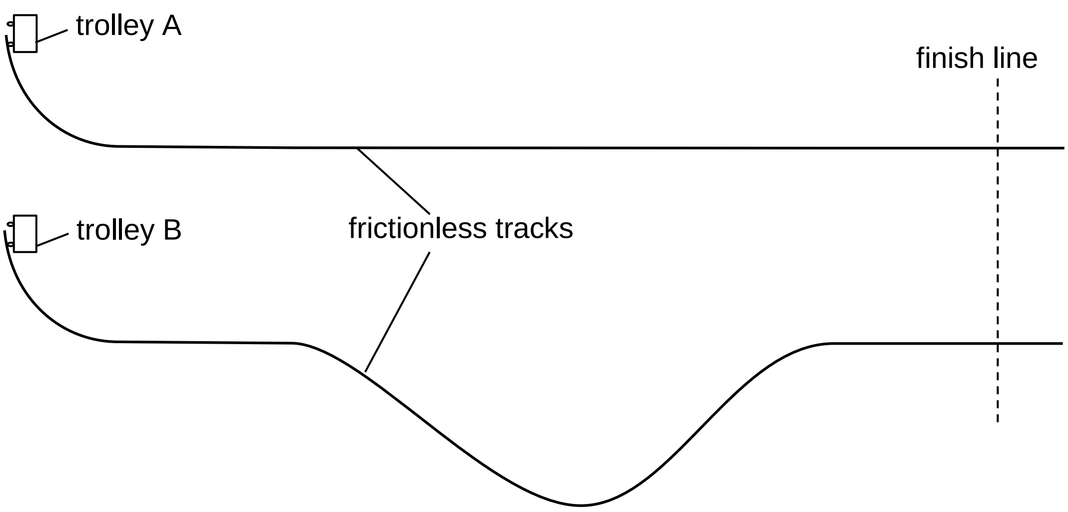

Fig. 2.3 (not to scale)

State and explain which trolley will reach the finish line first.

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For Examiner's Use

3 **(a)** Two long, straight, current-carrying wires, PQ and XY, are held a constant distance apart, as shown in Fig. 3.1.

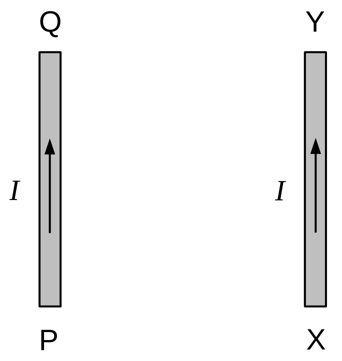

Fig. 3.1

The wires each carry a current of the same magnitude. The two currents flow in the same direction. A plan view from above the wires is shown in Fig. 3.2.

Fig. 3.2

(i) On Fig. 3.2, draw arrows to show the direction of:

1. the magnetic field at Q due to the current in wire XY (label this arrow B). [1]

2. the force exerted on wire PQ as a result of the magnetic field in 1. (label this arrow F). [1]

(ii) Wire PQ is now free to move.

Describe and explain the subsequent motion of wire PQ.

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.... [2]

(b) Wire PQ is now placed horizontally as shown in Fig. 3.3. Above PQ is a conductor CD that can slide up and down two vertical metal rods while making electrical contact with them. Assume that no friction acts on CD as it slides.

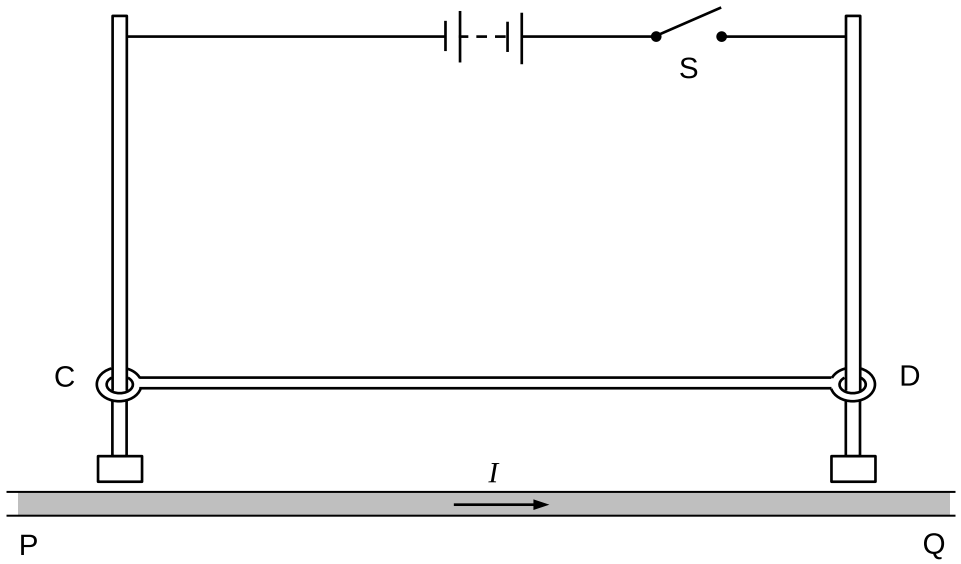

Fig. 3.3

When switch S is closed such that a current flows through CD, CD moves upwards and eventually comes to rest at a certain height above PQ.

(i) Explain why CD starts to move upwards.

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.... [2]

For Examiner's Use

(ii) Explain why CD eventually comes to rest at a certain height above PQ.

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4 Some electron energy levels in atomic hydrogen are illustrated in Fig 4.1.

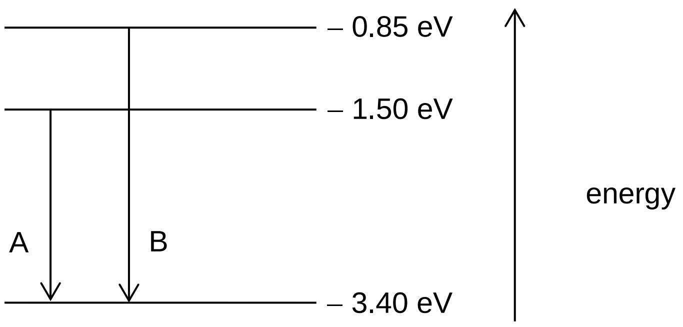

Fig. 4.1

(a) Two possible electron transitions A and B are shown. These electron transitions cause photons of wavelengths 654 nm and 488 nm to be emitted.

(i) On Fig 4.1, draw an arrow to show a third possible transition that will result in the emission of photons. [1]

(ii) Calculate the wavelength of the emitted photon for the transition in **(i)**.

wavelength = ... m [2]

For Examiner's Use

(b) A beam of white light is incident on some cool hydrogen gas as shown in Fig. 4.2.

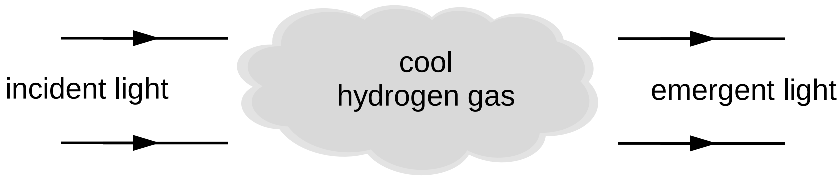

Fig. 4.2

Using the values of wavelength in **(a)**, state and explain the appearance of the spectrum of the emergent light.

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……………………………………………………………………………………………… [5]

For Examiner's Use

5 Pitot-static tubes are used on aircraft as speedometers. The Pitot-static tube is mounted on the aircraft so that the centre tube is always pointed in the direction of travel and the external holes are perpendicular to the centre tube.

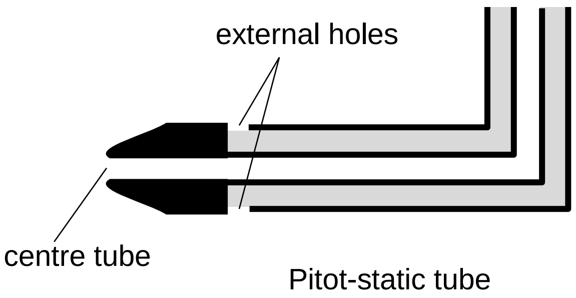

Fig. 5.1

A schematic Pitot-static tube is shown in Fig. 5.1. The external holes are at normal air pressure, otherwise known as static pressure P_S. The centre tube is pointed in the direction of travel. The pressure in the centre tube is known as total pressure P_T, and it increases as the speed of the aircraft increases.

The difference between total and static pressure is the dynamic pressure q,

$$q = P_T - P_S$$

(a) It is thought that dynamic pressure obeys a relation of the form

$$q = \tfrac{1}{2}\rho v^n$$

where n is a constant, ρ is the local value of air density and v is the velocity of the aircraft.

Explain how the relation may be tested by plotting a graph of (lg q) on the y-axis against (lg v) on the x-axis.

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(b) Fig. 5.2 shows the values of dynamic pressure *q*, measured by a Pitot-static tube when an aircraft is moving with velocity *v*.

v / m s^{-1}	*q* / N m^{-2}	lg (*v* / m s^{-1})	lg (*q* / N m^{-2})
80	2902	1.90	3.463
90	3689	1.95	3.567
100	4470	2.00	………………
110	5507	2.04	3.741
120	6408	2.08	3.807

Fig. 5.2

(i) Complete Fig. 5.2 for the velocity *v* of 100 m s^{-1}. [1]

(ii) Fig. 5.3 is a graph of some of the data in Fig. 5.2.

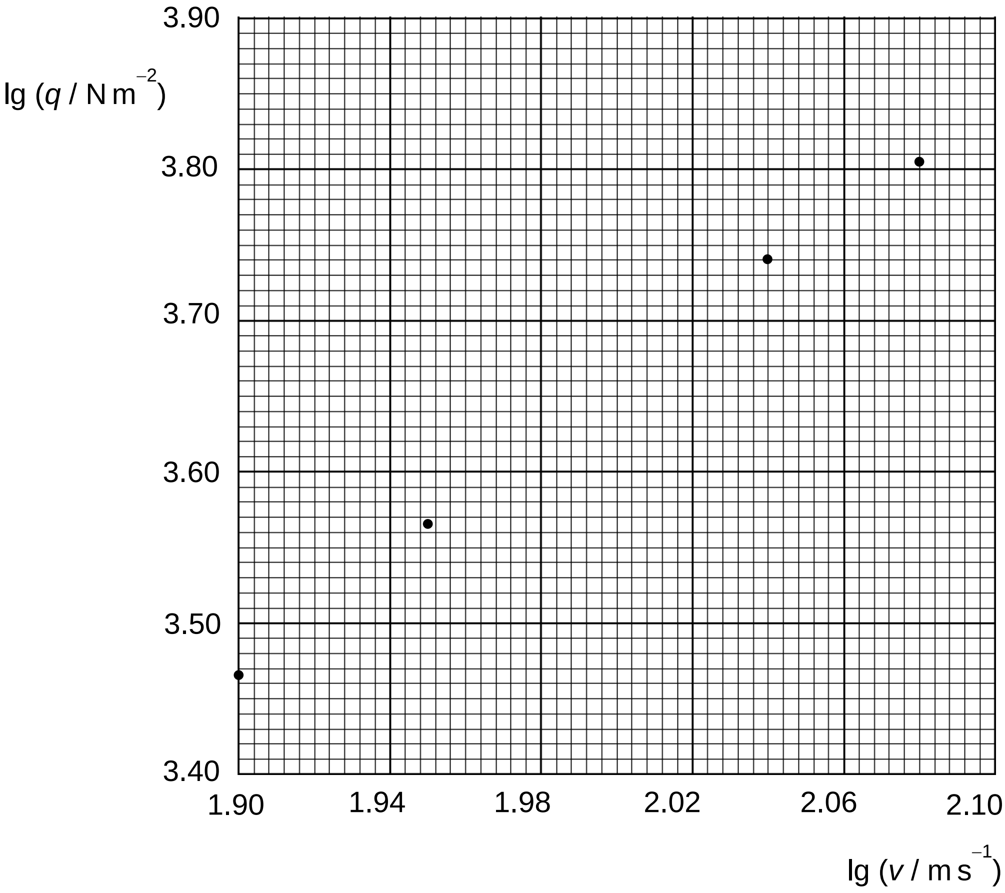

Fig. 5.3

On Fig. 5.3, plot the point corresponding to *v* = 100 m s^{-1}. [1]

For Examiner's Use

(c) A blocked Pitot-static tube will affect an aircraft's airspeed indicator.

(i) Explain how a blocked centre tube with constant P_T can cause the airspeed indicator to register a lower airspeed when the aircraft descends, even though actual airspeed is constant.

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(ii) Suggest what could possibly block the centre tube.

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For Examiner's Use

Section B

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

6 **(a)** Define *force*.

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.... [1]

(b) Blocks X and Y are being accelerated up a smooth slope as shown in Fig. 6.1. The masses of blocks X and Y are m_x and m_y respectively. Both ropes A and B have negligible masses and negligible extensions.

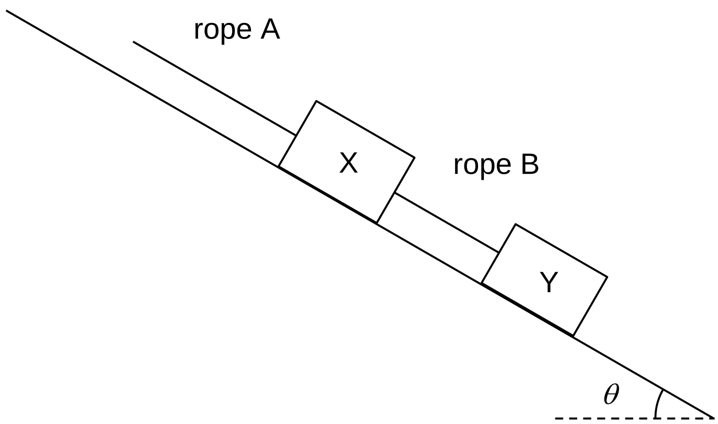

Fig. 6.1

The two blocks have acceleration *a* up the slope while the acceleration due to free fall is *g*. Assume that air resistance is negligible.

(i) Write an expression for the tension in rope B in terms of *a*, *g*, m_y and θ.

T_B = ... [2]

For Examiner's Use

(ii) Using part **(i)** or otherwise, write an expression for the tension in rope A in terms of a, g, m_x, m_y and θ.

T_A = ... [2]

(iii) Given that blocks X and Y have masses of 45 kg and 50 kg respectively, calculate the ratio $\frac{T_A}{T_B}$.

$\frac{T_A}{T_B}$ = ... [2]

(iv) The maximum tensions that ropes A and B can handle are 1000 N and 500 N respectively. The magnitude of the blocks' acceleration up the slope is now increased steadily. State and explain which rope will break first.

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.... [2]

For Examiner's Use

(c) Two different blocks P and Q are placed on a smooth slope. An external force acting on block P prevents both blocks from moving. A rope of negligible mass and negligible extension is attached to both blocks.

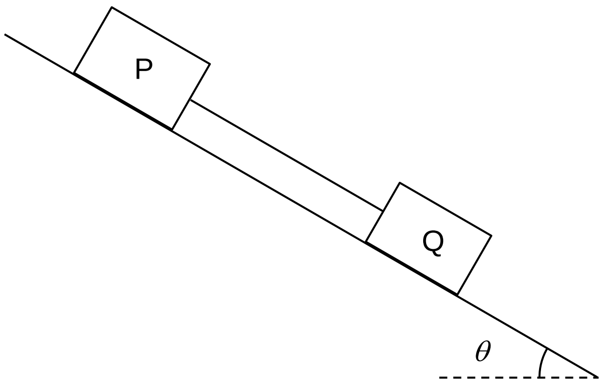

Fig. 6.2

When the external force is no longer acting on block P, both blocks start to slide down the slope. Assume that air resistance is negligible.

By considering the resultant forces acting on blocks P and Q, determine the tension in the rope as the blocks slide down the slope.

tension = ……………………… N [4]

For Examiner's Use

(d) The rope attached to blocks P and Q is now removed. Blocks P and Q are placed on a smooth slope where they are released from rest at the same time. The distance between blocks P and Q is 5.0 m initially. Assume that air resistance is negligible.

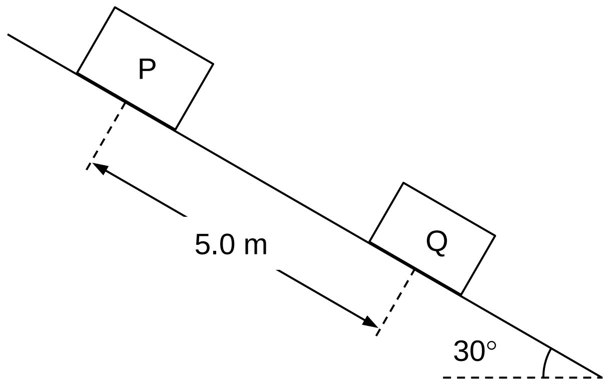

Fig. 6.3

State and explain how the distance between blocks P and Q will change as the blocks slide down the slope.

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.... [3]

For Examiner's Use

(e) A 20 kg block is placed on a uniform plank that is 32.0 m long and weighs 400 N. A man weighing 900 N is standing 12.0 m away from point M as shown in Fig. 6.4.

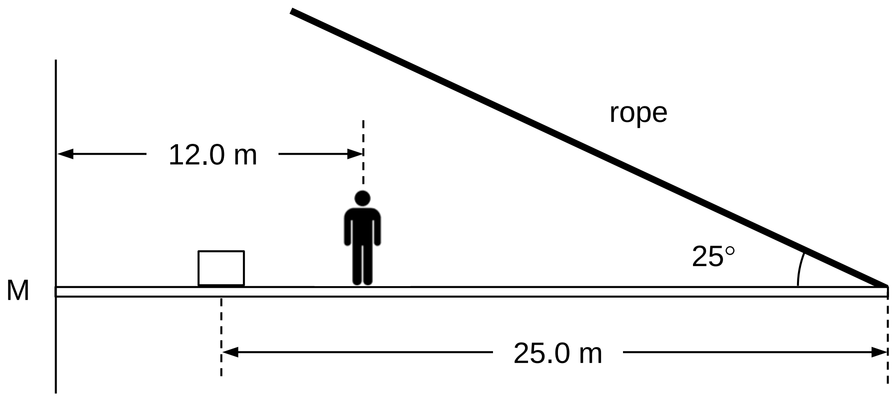

Fig. 6.4

(i) Calculate the tension in the rope.

tension = ……………………… N [2]

(ii) The man starts walking to the right of the plank. Given that the maximum tension that the rope can handle is 1800 N, determine the distance of the man from point M just before the rope snaps.

distance = ……………………… m [2]

7 **(a)** **(i)** State what is meant by the diffraction of a wave.

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.... [1]

(ii) Figures 7.1 (a) and (b) show plane wavefronts approaching a narrow gap and a wide gap respectively.

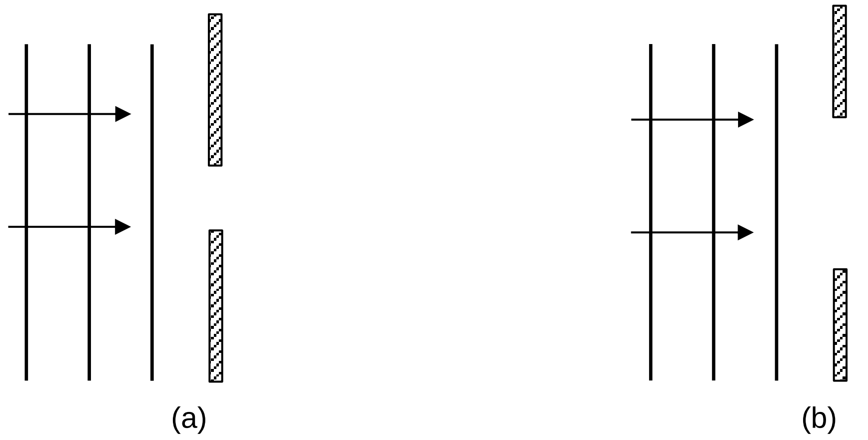

Fig. 7.1

On Figures 7.1 (a) and (b), draw three successive wavefronts to represent the wave after it has passed through each of the gaps. [5]

(b) Light from a light source is incident on a double slit after passing through a single slit, as shown in Fig. 7.2. Interference fringes are observed on the screen.

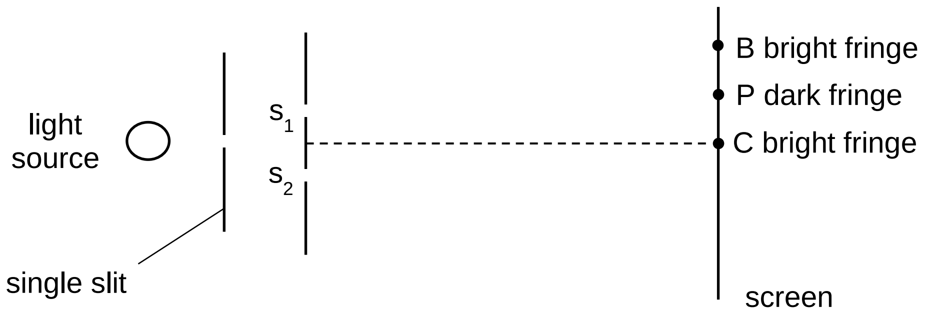

Fig. 7.2 (not to scale)

(i) Explain why a single slit is used in the experiment.

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.... [1]

For Examiner's Use

(ii) The intensity at C due to each wave is I. Determine, in terms of I, the resultant intensity of the waves at C.

resultant intensity = ………………………………. I [2]

(iii) State the phase difference between the two waves from s_1 and s_2 that meet at P.

phase difference = ………………………………. [1]

(iv) A third slit s_3 is now made at an equal distance below s_2, as shown in Fig. 7.3.

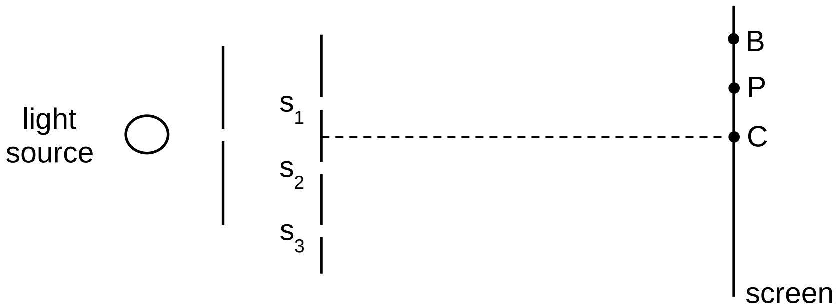

Fig. 7.3 (not to scale)

Explain if point P on the screen remains dark.

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(c) A glass tube, closed at one end, has fine dust sprinkled along its length. A sound source is placed near the open end of the tube, as shown in Fig. 7.4.

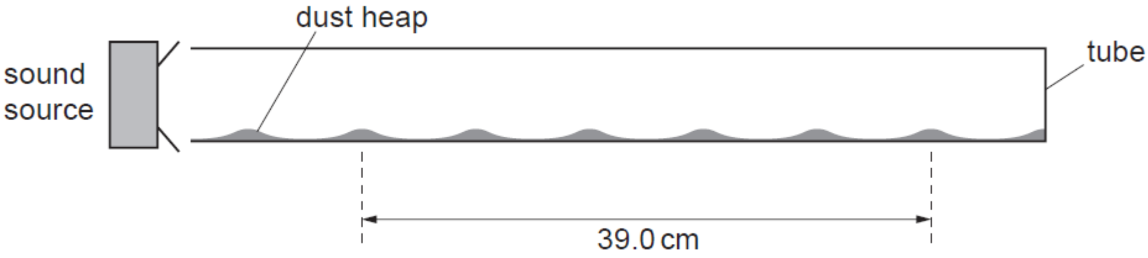

Fig. 7.4

The frequency of the sound emitted by the source is varied and, at one frequency, the dust forms small heaps in the tube.

(i) Explain how a stationary wave is formed in the tube.

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.... [3]

(ii) Explain, with reference to the properties of stationary waves, why the heaps of dust are formed.

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.... [3]

For Examiner's Use

(iii) One frequency at which heaps are formed is 2.14 kHz. The distance between six heaps, as shown in Fig. 7.4, is 39.0 cm. Calculate the speed of sound in the tube.

speed = ……………………………….m s^{-1} [2]

For Examiner's Use

8 **(a)** Define *resistance*.

…………………………………………………………………………………………………

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

(b) An electrical component C has an I-V characteristic as shown in Fig. 8.1.

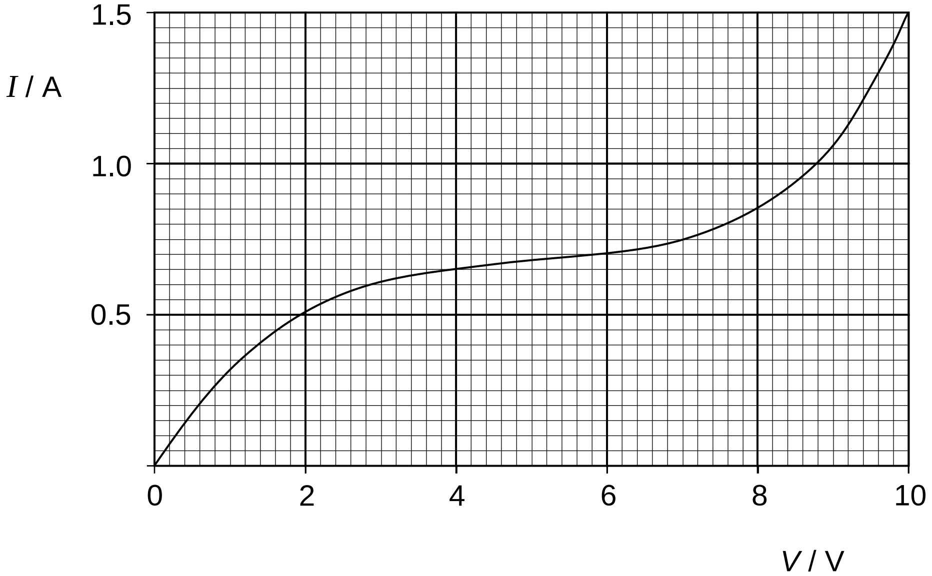

Fig. 8.1

(i) Explain how the resistance of component C can be obtained from Fig. 8.1.

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

(ii) Deduce the maximum value of the resistance of component C over the range 0 – 10 V.

resistance = ……………………… Ω [2]

For Examiner's Use

(c) Component C is connected to a circuit with a 12 V e.m.f. source of internal resistance *r* and two resistors of constant resistance 8.0 Ω and constant resistance *R*.

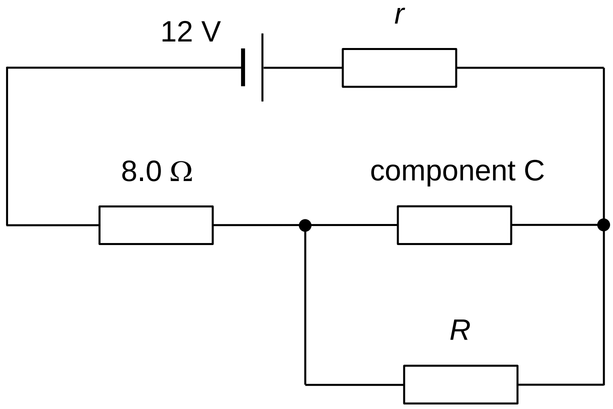

Fig. 8.2

A current of 0.65 A flows through component C while the potential difference across the 8.0 Ω resistor is 6.0 V. Calculate the internal resistance *r* of the e.m.f. source and the resistance *R* of the resistor.

r = ……………………… Ω

R = ……………………… Ω [3]

For Examiner's Use

(d) Component C is then connected to a different circuit with two resistors of constant resistance 8.0 Ω and a light dependent resistor (LDR) of variable resistance.

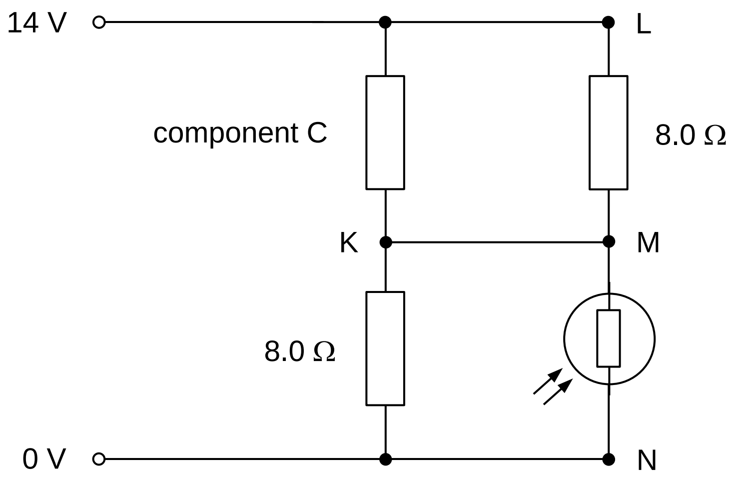

Fig. 8.3

(i) State and explain what the potential difference across points K and M is.

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

(ii) Determine the resistance of the LDR when a current of 1.3 A is flowing through component C.

resistance = ……………………… Ω [3]

(e) Component C is now replaced by a resistor of constant resistance 6.0 Ω and the wire connecting points K and M is removed.

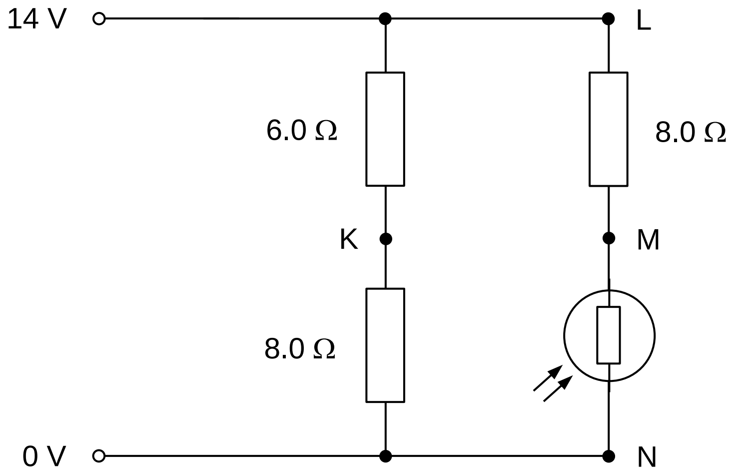

Fig. 8.4

(i) When light of high intensity is incident on the LDR, the potential at point K is 3.6 V higher than that at point M. When no light is incident on the LDR, the potential at point K is 5.2 V lower than that at point M.

Calculate the highest and lowest resistance of the LDR.

highest resistance = ……………………… Ω

lowest resistance = ……………………… Ω [5]

For Examiner's Use

(ii) A device is to be switched on when the intensity of light incident on the LDR is high and switched off when the intensity of light is low. To switch on the device, the potential difference across the device must be above a certain value.

State and explain which two of the points L, M and N should the device be connected across.

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