NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME

CLASS

TUTOR'S NAME

PHYSICS

8866/02

Paper 2 Structured questions

20 September 2011

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required

READ THESE INSTRUCTIONS FIRST

Write your name and class 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.

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	

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} Js
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	=	$R_1 + R_2 + ...$
resistors in parallel	$1/R$	=	$1/R_1 + 1/R_2 + ...$

For Examiner's Use

Section A

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

1 (a) Fig 1.1 shows two blocks, P and Q connected by an inextensible cord over a pulley system. The mass of blocks P and Q are *m* and 5.0 kg respectively. Block P is suspended freely on one end of the cord, while block Q is placed on ramp with rough surface at an angle of inclination of 25^0.

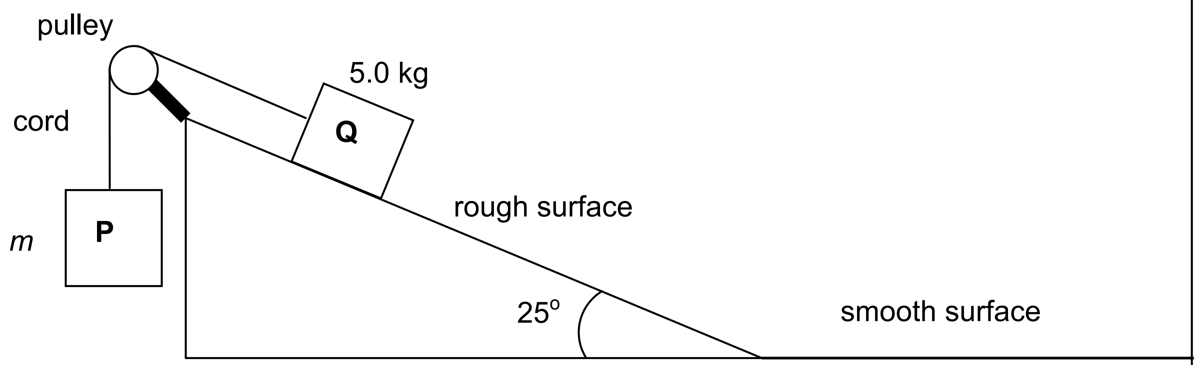


Fig 1.1

Given that block Q is sliding down the ramp with a constant acceleration of 0.50 m s^{-2} and the frictional force between the ramp and Q is 7.0 N, determine the mass of block P.

mass of block P = ………………… kg [2]

(b) The cord was cut when block Q is moving at a speed of 0.10 m s^{-1} and is 1.2 m away from the bottom of the rough ramp, as shown in Fig 1.2. The frictional force opposing the motion of Q increases with its speed.

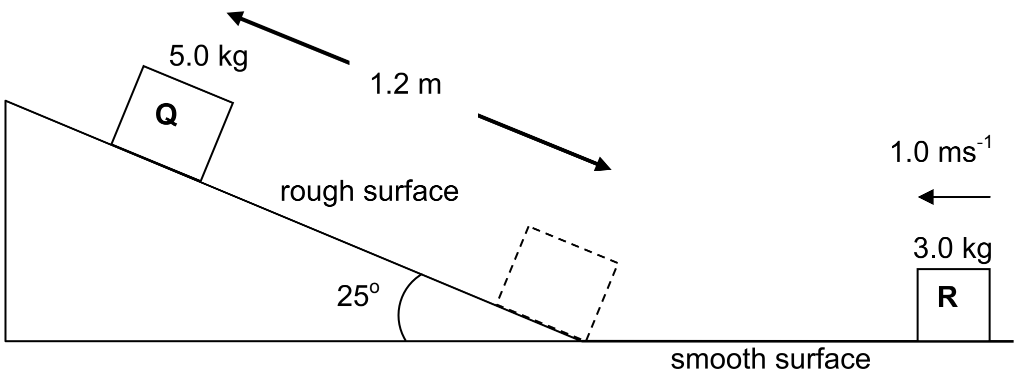


Fig 1.2

For Examiner's Use

(i) Given that the average frictional force on Q after the cord was cut is 10.7 N, calculate average acceleration of Q as it slides 1.2 m to the bottom of the ramp.

average acceleration = ………………… m s^{-2} [1]

(ii) Show that the speed of Q as it leaves the ramp is 2.2 m s^{-1}.

[1]

(c) Block Q continues to move along the smooth horizontal ground until it collides head-on with block R. Block R has a mass of 3.0 kg and a speed of 1.0 m s^{-1} just before the collision. Given that the collision is perfectly inelastic, determine the direction and speed of R after the collision.

direction of R is …………………

speed of R = ………………… m s^{-1} [3]

(d) The duration of collision between Q and R is 30 ms. Calculate the magnitude of the average force exerted on R by Q.

average force = ………………… N [1]

For Examiner's Use

2 **(a)** Explain the meaning of the terms *longitudinal* and *transverse* when applied to a wave.

....

....

....

.... [2]

(b) Fig 2.1 shows the wave profile at time t = 0 of a wave with wavelength 2.0 m and speed 20 m s^{-1} moving along a string. Points X and Y are on the string.

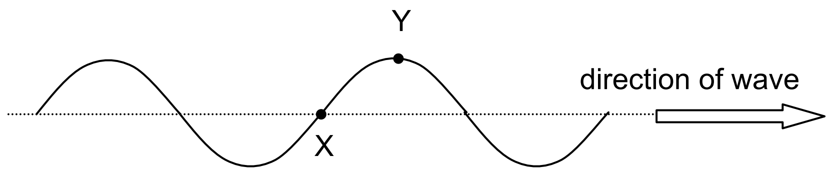


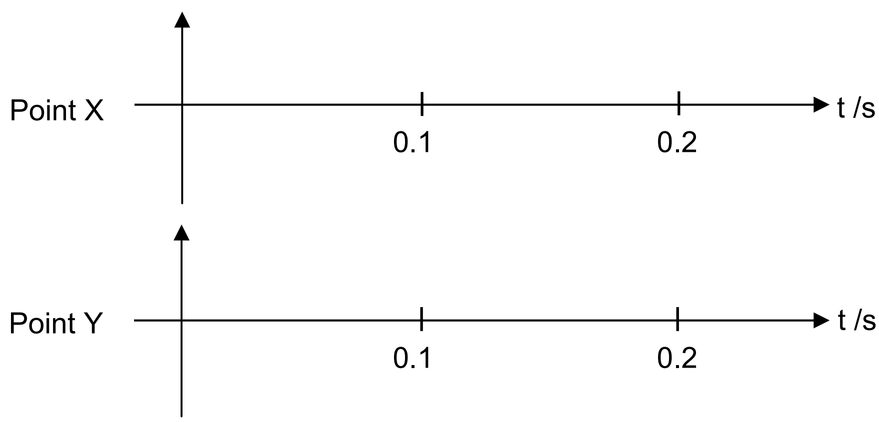
Fig 2.1

(i) Calculate the frequency of the wave.

frequency = ……………… Hz [1]

(ii) Sketch the variation with time of the displacement of points X and Y for a time interval of 0.2 s.

[4]



(iii) Calculate the phase difference between points X and Y.

phase difference = ……………… rad [1]

3 Fig 3.1 shows a metal wire of weight 0.100 N carrying a current of 5.0 A suspended by two springs having a combined spring constant of 2.50 N m^{-1}.

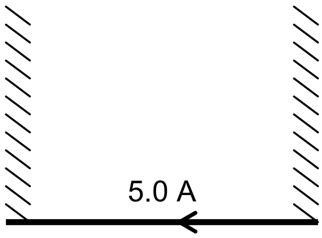


Fig 3.1

(a) Explain how the tension in the springs may be reduced using a magnet.

....

....

.... [2]

(b) If the effective flux density at the wire due to the magnet used is 36 mT and the effective width of the magnet is 20 cm, calculate the change in vertical displacement of the wire.

change in displacement = ……………… cm [3]

For Examiner's Use

(c) Deduce what will happen if the wire carries a current that changes direction periodically instead.

....

.... [1]

(d) Power transmission cable carries a current that changes direction periodically in the Earth's magnetic field. State with reasons if that described in **(c)** is observed in these cables.

....

....

.... [2]

4 **(a)** State what is meant by the *photoelectric effect*.

....

....

.... [2]

(b) A lamp is placed above a metal surface and an electron requires a minimum energy of 2.0 eV before it can be emitted from the metal surface.

(i) Calculate the maximum wavelength of the incident photons from the lamp to cause emission of electrons.

maximum wavelength = ……………… m [2]

(ii) State the component of electromagnetic spectrum which the radiation that is emitted from the lamp belongs to.

....

.... [1]

(iii) The metal surface contains atoms of radius 2.0×10^{-10} m. It may be assumed that the electron can collect energy from a circular area which has a radius equal to that of the atom. The intensity of light is 0.40 W m^{-2} at the metal surface. Estimate, on the basis of wave theory, the time required for an electron to collect sufficient energy for it to be emitted from the metal.

time required = ……………… s [2]

(iv) Explain why your answer to **(b)(iii)** contradicts the observation from photoelectric effect.

....

....

.... [1]

For Examiner's Use

5 According to the U.S. National Electrical Code, copper wire used for interior wiring of houses, hotels, office buildings, and industrial plants is permitted to carry no more than a specified maximum amount of current. The "wire gauge" is a standard method used to describe the diameter of wires. Note that the larger diameter of the wire, the smaller the wire gauge.

Fig. 5.1 shows the graph of I_{max} against the diameter of the gauge.

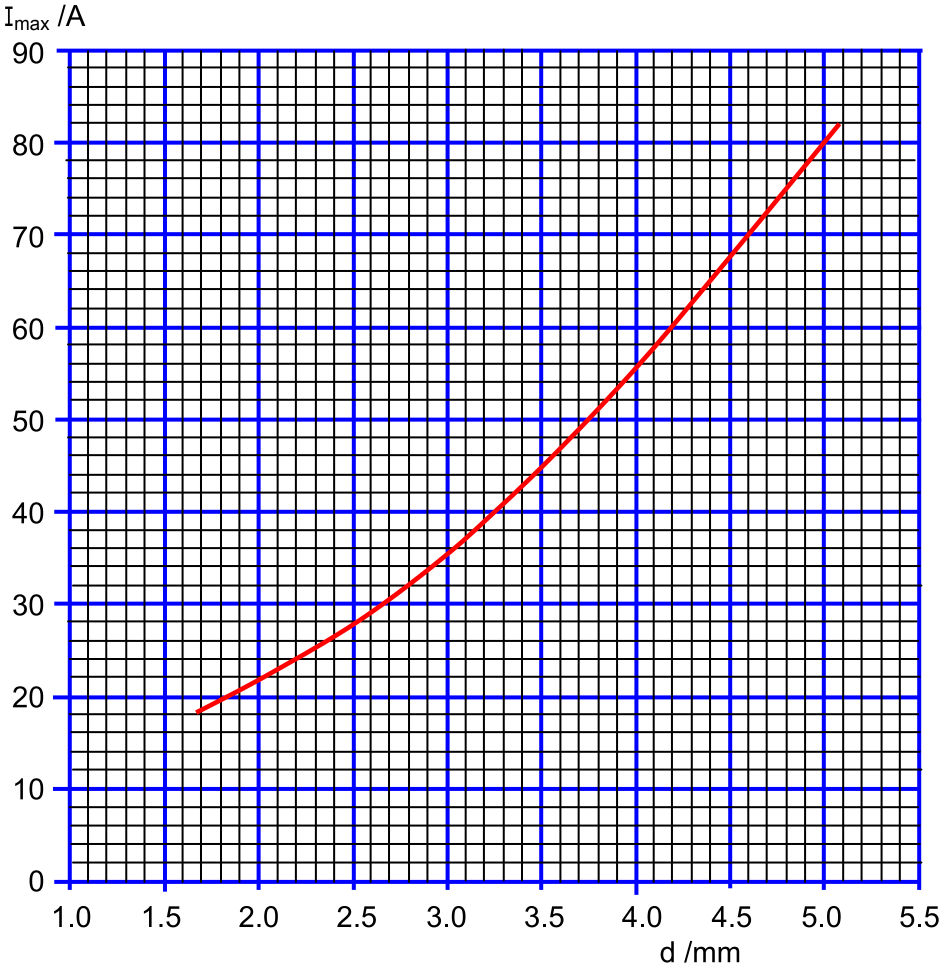


Fig. 5.1

Table 5.2 shows the diameter and resistance of a length of 120m of copper wire for various wire gauges.

Wire Gauge	Diameter / mm	R / Ω (for a length of 120 m)
14	1.63	0.989
12	2.05	0.625
10	2.59	0.392
8	3.26	0.247
6	4.12	0.155
5	4.62	0.123
4	5.19	0.0976

Table 5.2

(a) Using data given in Table 5.2, compute the resistivity of copper.

resistivity of copper = ……………… Ω m [3]

(b) A boiler, with resistance of 2.5 kΩ and rated at 5.4 MW is to be connected to two wires of length 120 m each as shown in Fig. 5.3 below.

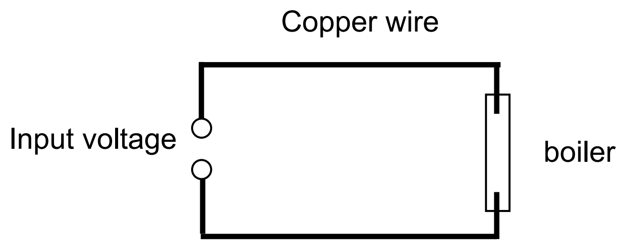


Fig 5.3

(i) Determine the thinnest permissible wire that can be used with the boiler. Choose a suitable gauge from Table 5.2 and explain your choice.

suitable wire gauge is ……………… [3]

(ii) Suggest a reason why a manufacturer would use the thinnest possible wire.

....

.... [1]

(iii) State and explain an advantage of using a thicker wire for this boiler.

....

.... [1]

Section B

Answer **two** questions in this section

6 Fig 6.1 shows a block of mass 0.500 kg resting on a 4.50 kg beam which is hinged to the wall at an angle of 60°. A light rubber stopper is placed beside the block to prevent the block from sliding.

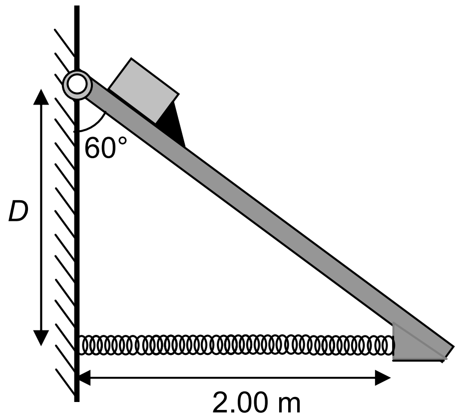


Fig 6.1

(a) Fig 6.2 shows a free body diagram of the beam-block system, with the weight, *W*, of the system given.

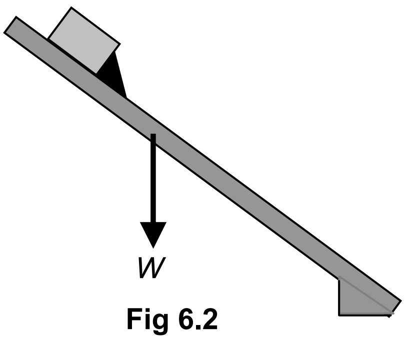


Fig 6.2

(i) Indicate with an arrow, *T*, the force exerted by the spring on the system. [1]

(ii) Indicate with an arrow, *R*, the force exerted by the hinge on the system. [1]

(b) **(i)** Calculate *D* as shown in Fig 6.1.

D = ……………… m [1]

(ii) Given that the horizontal distance from the hinge to the centre of gravity of the beam-block system is 0.80 m, show that *T* is 34 N.

[2]

For Examiner's Use

(iii) A horizontal spring, compressed by 20 cm due to the setup, is attached between the wall and the beam. Calculate the spring constant of the horizontal spring.

spring constant = ……………… N m^{-1} [1]

(iv) Determine the magnitude of *R.*

magnitude of R = ……………… N [3]

(c) In Fig 6.3 below, the stopper is removed but the mass does not slide down the beam. The maximum static friction between the block and the beam is 3.50 N.

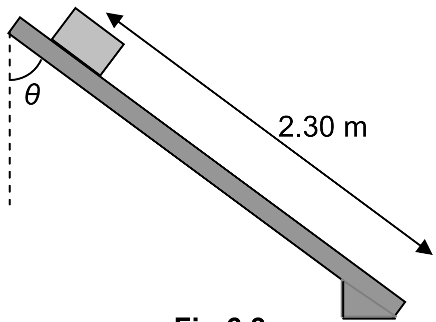


Fig 6.3

(i) Draw a free body diagram of the block, with relevant labels.

[3]

For Examiner's Use

(ii) Show that, in order for the block to slide down the beam, θ must be smaller than 44.5°. [2]

(iii) At a certain θ value, the block starts to slide and has an acceleration of 1.50 m s^{-2}. Calculate the speed of the block just before it falls off the beam.

'

speed = ……………… m s^{-1} [2]

(d) The block eventually falls off the edge of the beam, as shown in figure 6.4.

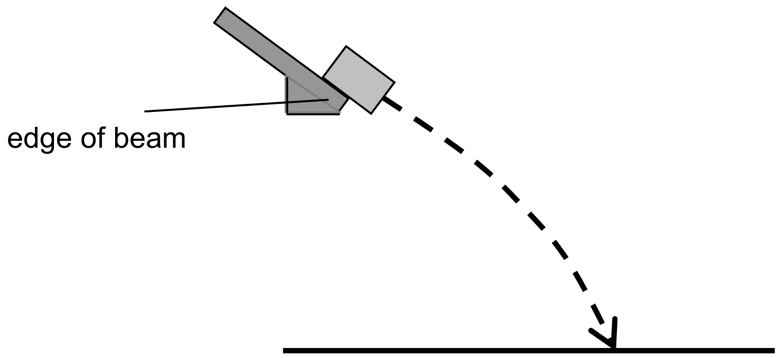


Fig 6.4

(i) Neglecting air resistance, the dotted arrow in Fig 6.4 is the expected projectile path of the block.

1. Sketch the subsequent path of the block on Fig 6.4 if air resistance is present. [1]

For Examiner's Use

2. Explain your answer to **part 1**.

....

....

.... [1]

(ii) Fig 6.5 shows the variation with time of the vertical component of the velocity of the falling block when there is no air resistance
On the same graph, draw a graph for the block with air resistance (assuming terminal velocity is reached when falling).

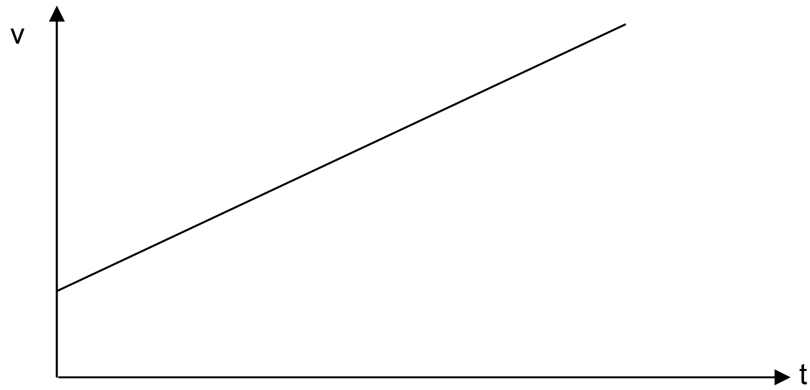


Fig 6.5

[2]

7 A glass tube, closed at one end, has fine power sprinkled along its length. A sound source is placed near the open end of the tube, as shown in Fig. 7.1.

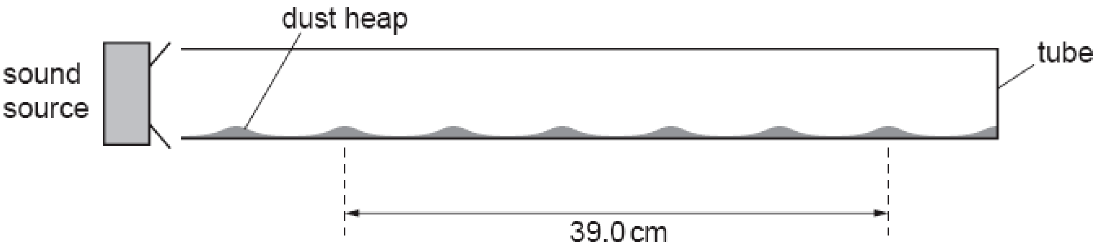


Fig 7.1

The frequency of the sound emitted by the source is varied and, at one frequency, the fine powder forms small heaps in the tube as shown above.

(a) **(i)** Explain the formation of stationary sound waves in the tube.

....

....

....

.... [3]

(ii) At the positions where the small heap is formed, suggest and explain whether it is anti-nodes or nodes.

....

....

.... [2]

(b) **(i)** One frequency at which heaps are formed is 2.14 kHz as shown in Fig 7.1. Calculate the speed of sound in the tube.

speed of sound = ……………. m s^{-1} [2]

For Examiner's Use

(ii) The wave in the tube is a stationary wave. Explain the significance of the speed calculated in **(b)(i)**.

....

....

....

.... [2]

(iii) The experiment is repeated on a day when the temperature of the air in the tube is higher. The mean separation of the heaps is observed to have increased for the same frequency of the source S. Suggest a possible reason for this.

....

....

.... [2]

Fig 7.2 shows the wavefronts produced by two coherent sources vibrating in phase.

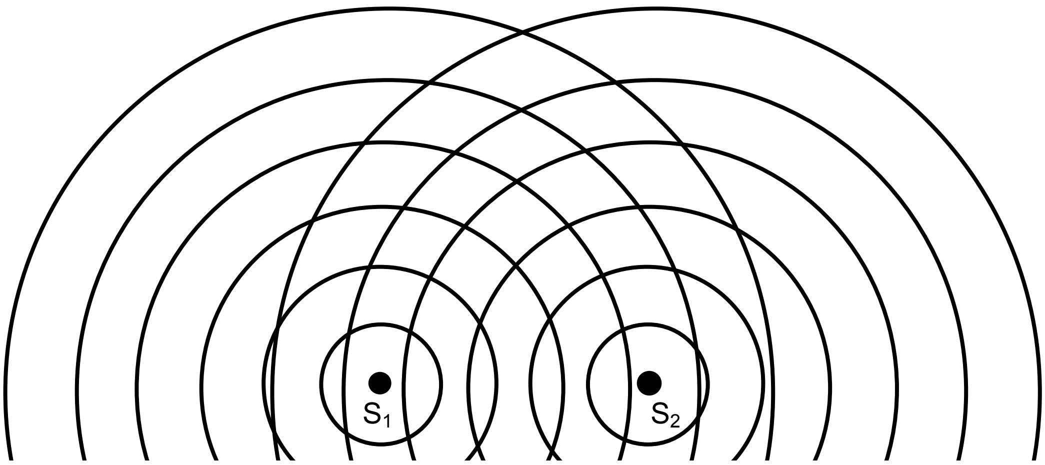


Fig 7.2

(c) **(i)** On Fig 7.2, draw a line each to show the points at which

1. the waves interfere constructively.(label it C)
2. the waves interfere destructively. (label it D)

[2]

For Examiner's Use

(ii) Explain the choice of your answer in **(c)(i) 2.**

....

....

....

.... [2]

(iii) Explain how the wavefronts shown in Fig 7.2 provide evidence that the two sources S_1 and S_2 are coherent.

....

....

.... [2]

(iv) State one other condition for the interference pattern seen in Fig 7.2 to be observable.

....

.... [1]

(v) Describe explain how the interference pattern will change as the two sources S_1 and S_2 are gradually shifted closer to each other until the distance between them is less than one wavelength.

....

....

....

.... [2]

For Examiner's Use

8 **(a)** Define resistance and derive its base unit.

....

....

.... [2]

(b) A certain electric hotplate, designed to operate on a 250V supply, has two coils of nichrome wire of resistivity 9.8 x 10^{-7} Ω m. Each coil consists of 15 m of wire of cross-sectional area 0.20 mm^2.

(i) For each of the coils calculate

1. its resistance

resistance = ……………… Ω [2]

2. the power dissipated when a 250 V supply is connected across the coil, assuming its resistance does not change with temperature.

Power dissipated = ……………… W [2]

For Examiner's Use

(ii) Show by means of separate diagrams, how these coils may be arranged so that the hotplate may be made to operate at three different powers.
In each case, calculate the power rating

[5]

(c) A set of coloured lamps are designed for use with a 240 V supply. The set up have 12 lamps connected as seen in Fig 8.1 below.

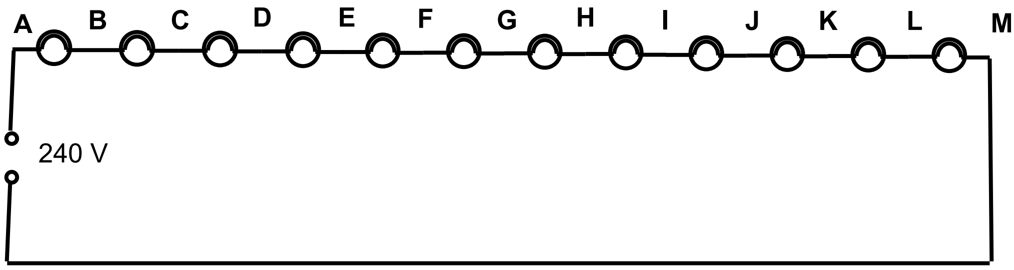


Fig 8.1

However, the lamps do not light up when the set is plugged in. Therefore, a voltmeter is used to test the circuit. For each of the following observations, identify the fault.

(i) The potential difference is zero across every lamp except **EF**, across which the potential difference is 240 V.

....

.... [1]

For Examiner's Use

(ii) The potential difference between **A** and **M** is 240 V but the potential difference is zero across every lamp.

....

.... [1]

(d) Two resistors having the resistances of 1.8 kΩ and 4.7 kΩ are connected in series with a battery of e.m.f 12 V and negligible internal resistance as shown in Fig.8.2. When a particular voltmeter of fixed resistance R, is placed across the 1.8 kΩ, it reads 2.95 V. When placed across the 4.7 kΩ resistor, it reads 7.70 V.

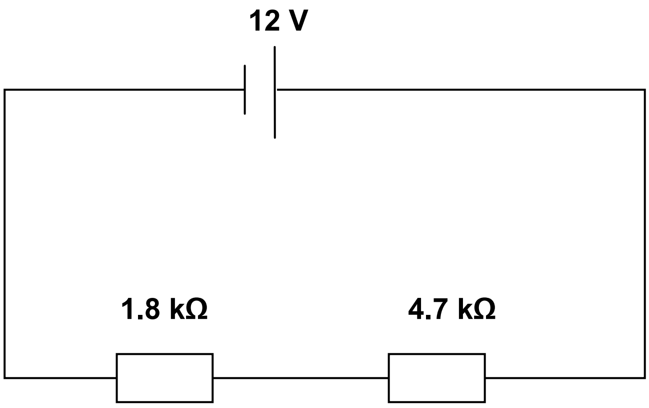


Fig. 8.2

(i) Explain why these two readings not add up to 12 V ?

....

....

....

....

.... [3]

(ii) Calculate the resistance of the voltmeter.

resistance = ……………… Ω [4]

End of paper