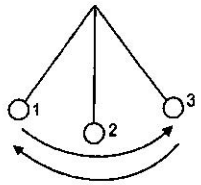
SCGS 16 P1

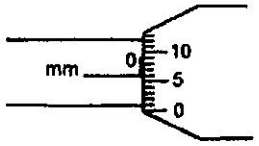
1 The diagram below shows a simple pendulum that swings between positions 1 and 3.



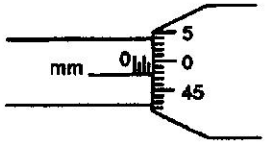
What is the period of the pendulum if it takes T s to swing from positions 2 to 3?

A $\frac{T}{2}$s **B** Ts **C** $2T$s **D** $4T$s

2 The diagram shows an enlargement of the micrometer screw gauge readings.



zero reading

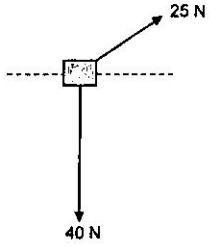


diameter reading

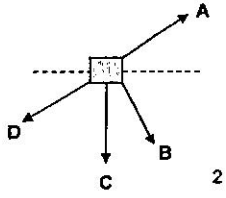
What is the volume of the ball bearing?

A 1.50 mm^3 **B** 3.71 mm^3 **C** 4.06 mm^3 **D** 4.45 mm^3

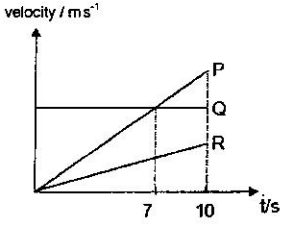
3 Forces of 40 N and 25 N act on an object in the directions shown.



Which arrow shows the direction of the resultant force on the object?



4 Three objects P, Q and R start from the same point and move in the same direction. The diagram shows the v-t graph of the objects in the first 10 s of their motion.



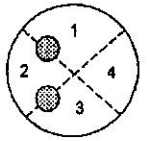
Which of the following statements is correct?

A P has the greatest displacement in the 10 s.
B Q has the greatest average velocity in the 10 s.
C R has the smallest acceleration.
D P overtakes Q at the 7th second.

5 A car is initially travelling along a straight path at 5.0 m s^{-1}. It then accelerates at 2.0 m s^{-2} for 10 s. What is the final speed of the car?

A 5.0 m s^{-1}
B 10.0 m s^{-1}
C 20.0 m s^{-1}
D 25.0 m s^{-1}

6 The figure below represents a uniform lamina with the two shaded portions cut out.



The centre of gravity of the remaining portion is in quadrant .....

A 1 **B** 2 **C** 3 **D** 4

7 Which property of an object resists changes in the state of motion of the object?

A acceleration
B density
C mass
D velocity

8 A uniform metre rule is pivoted at its mid-point. An object of weight 30 N is placed on the metre rule as shown.

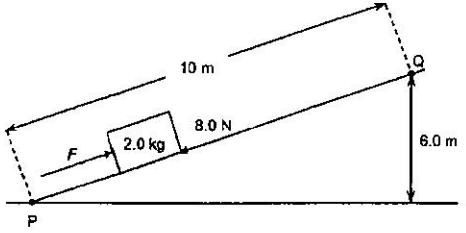
Which of the following forces will rebalance the metre rule?

A 30 N upwards, 10 cm to the left of the pivot.
B 30 N downwards, 40 cm to the left of the pivot.
C 40 N downwards, 10 cm to the right of the pivot.
D 40 N upwards, 40 cm to the right of the pivot.

9 A toy car was pushed steadily from rest to reach a speed of 5.0 m s^{-1} in 10 s. During this time, there was an average air resistance of 3.0 N acting on the car. Calculate the rate of work done against air resistance.

A 7.5 W
B 15 W
C 75 W
D 150 W

10 A box of mass 2.0 kg is pushed upwards with an applied force F along a 10 m ramp from point P to point Q. The average frictional force acting on the box is 8.0 N throughout the motion. The box reaches a vertical height of 6.0 m above ground when it is at point Q.



If the increase in kinetic energy of the box is 45 J as it moves from point P to point Q, what is the work done by the applied force F?

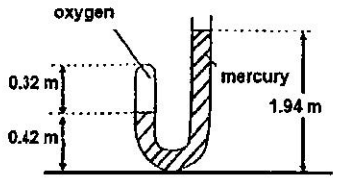
A 80 J B 85 J C 165 J D 245 J

11 A crane lifts a weight of 600 N through a vertical height of 30 m in 25 s. The efficiency of the crane is 40%.

What is the average power of the crane?

A 0.29 kW B 0.72 kW C 1.8 kW D 1800 kW

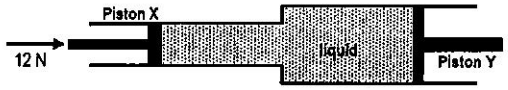
12 Oxygen is compressed in the sealed end of a long J-tube by means of a column of mercury open to the atmosphere as shown.



Given that the atmospheric pressure is 76 cm Hg, what is the approximate ratio of the pressure of the compressed oxygen to that of the atmosphere?

A 1.5 B 2.0 C 2.5 D 3.0

13 A cylinder fitted with two pistons X and Y of diameters 5.0 cm and 10.0 cm respectively. The piston X is pushed by a force of 12 N.

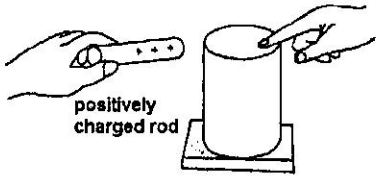


What is the force exerted on piston Y?

A 3.0 N
B 6.0 N
C 24 N
D 48 N

14 A student tries to charge a metal cylinder negatively using a series of steps (not in order):

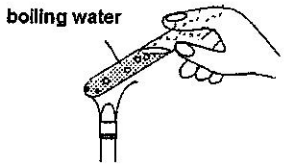
I. touch the cylinder with a finger;
II. bring a positively charged rod near the cylinder;
III. remove the finger;
IV. remove the rod



Which is the correct order to charge the metal cylinder negatively?

A II, I, III, IV
B I, II, IV, III
C I, III, IV, II
D II, I, IV, III

15



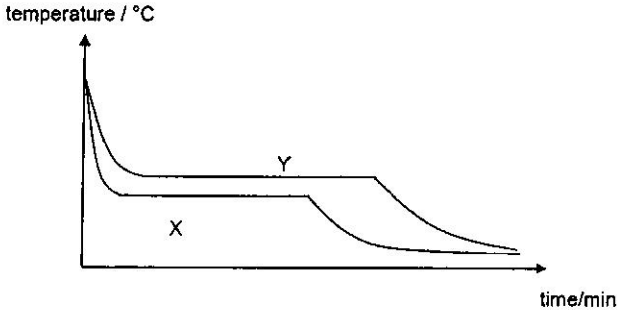
You can still hold a test tube while the water in it is boiling as shown in the diagram because

A glass is a poor conductor of heat
B glass is a poor radiator of heat
C water is a poor conductor of heat
D water is a poor radiator of heat

16 A resistance thermometer has a resistance of 20 Ω when the temperature is 30°C and 60 Ω when the temperature is 100°C. What is the temperature when the resistance is 50 Ω?

A 47.1°C
B 52.5°C
C 82.5°C
D 105°C

17 John performed an experiment to compare the physical properties of two liquids X and Y. He poured equal mass of the liquids, initially at the same temperature, into two identical test tubes and placed them at room temperature. The cooling curves are shown in the graph below.



Which of the following statements is/are correct?

(I) Liquid X has a higher specific latent heat of fusion than liquid Y.
(II) Liquid X has a lower freezing point than liquid Y.
(III) Liquid X has a lower specific heat capacity than liquid Y.

A (I) and (II) only
B (I) and (III) only
C (II) and (III) only
D (I), (II) and (III)

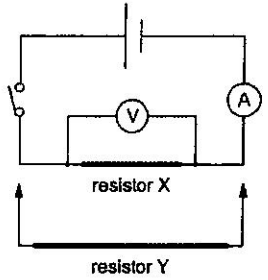
18 The internal energy of a body consists of the

A sum of kinetic energy and potential energy of the body
B sum of kinetic energy and potential energy of atoms in the body
C energy released when the body is completely burnt
D energy released when its body is partially burnt

19 A current of 3.0 A flows through a resistor. What is the total amount of charges passing through it in 2.0 minutes?

A 0.025 C
B 1.5 C
C 6.0 C
D 360 C

20 A resistor X with resistance R is made from a length L of resistance wire with a cross-sectional area A. It is connected to a simple electrical circuit and the voltmeter and the ammeter readings are recorded.



A second resistor Y made from wire of the same material has length $2L$ and cross-sectional A, connected in parallel with wire X.

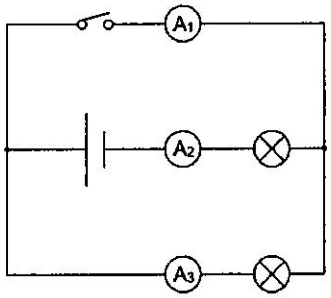
Which of the following correctly describes the readings observed from the voltmeter and ammeter?

	voltmeter reading	*ammeter reading*
A	decrease	decrease
B	decrease	increase
C	no change	decrease
D	no change	increase

21 Which of the following statements about the resistance of a pure metallic conductor is true when its temperature increases? The resistance of the pure metallic conductor

A decreases because the metallic conductor will expand and its particles are less likely to obstruct the flow of charges.
B decreases because the particles in the metallic conductor gain energy and flow around at higher speeds.
C increases because the particles in the metallic conductor will expand and obstruct the flow of charges.
D increases because the particles in the metallic conductor will vibrate more vigorously and obstruct the flow of charges.

22 An electrical circuit with two lamps and three ammeters with negligible resistance is set up as shown below. The switch is initially open.



When the switch is closed, which of the following is correct?

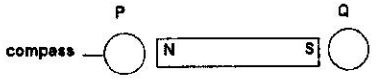
A $A_1 = A_2$
B $A_1 > A_2$
C $A_2 = A_3$
D $A_1 + A_3 = A_2$

23 An electrical fault occurs in a kettle such that the live wire is in touch with the metal casing which is earthed. Under normal condition, a current of 6 A is delivered to the kettle, which has a plug that contains a 7 A fuse.

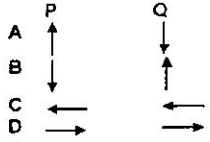
Which of the following occurs after the fault kicks in?

A Current continues to flow along the live wire and earth wire.
B The fuse will melt and cut off the electricity supply.
C The fuse becomes hot but does not blow.
D The metal case will become live and dangerous.

24 Two small plotting compasses P and Q are placed near the ends of a bar magnet as shown in the diagram.



The needles of the compasses point in the directions shown in



25 An electric kettle has a power rating of 2 kW while a bread toaster has a power rating of 1.5kW. On a typical day, both the electric kettle and the toaster are switched on for 30 minutes.

If the cost of electricity is 20 cents per kWh, what is the cost of using the two appliances for 30 days?

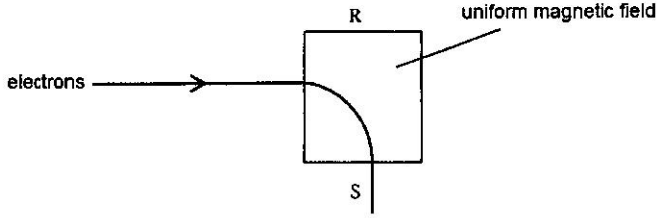
A $10.50
B $11.00
C $12.00
D $12.50

26 The diagram shows a magnetic compass placed below a wire PQ when there is no current flowing through it.

Ignoring the effect of the earth's magnetic field, which of the following correctly states the motion of the compass needle when a strong current flows from Q to P?

A The needle remains at the same position.
B The needle points in the opposite direction.
C The needle points to the left.
D The needle points to the right.

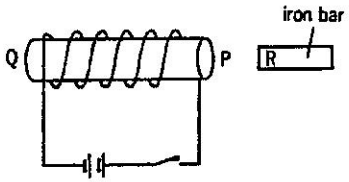
27 A beam of electrons enters a uniform magnetic field, causing the beam to change direction.



What is the direction of the magnetic field?

A perpendicularly out of the page
B perpendicularly into the page
C towards the bottom of the page
D towards the top of the page

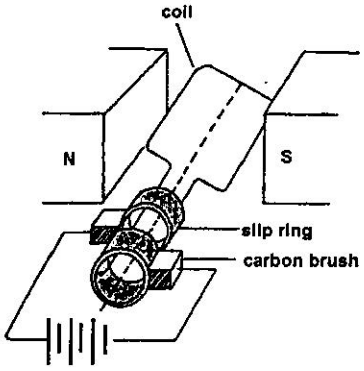
28 The diagram shows an iron bar placed next to a coil of wire connected to a battery and a switch.



Which of the following correctly describes the polarities of P and R when the switch is closed?

	P	R
A	North	South
B	South	North
C	North	North
D	South	South

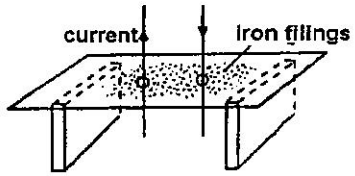
29 The diagram below shows a simple d.c. motor connected to a pair of slip rings instead of split ring.



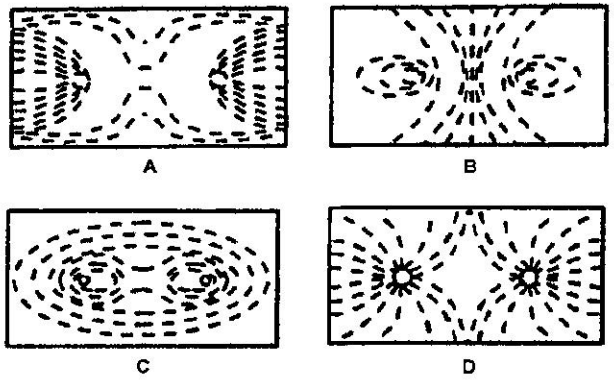
Which of the following is true?

A The coil will rotate continuously back and forth.
B The coil will rotate continuously at a slower rate.
C The coil will rotate in the clockwise direction continuously.
D The coil will rotate in the anti-clockwise direction continuously.

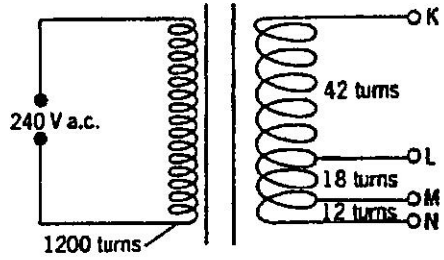
30 The diagram shows two straight and parallel current-carrying wires passing through a horizontal plane. Some iron filings are placed on the horizontal plane.



Which of the following shows the pattern of the magnetic field produced by the current-carrying wires?



31 The diagram shows a multi-tap transformer where different output voltages can be obtained. The primary coil has 1200 turns and the number of turns in the secondary coil between KL, LM and MN are 42, 18 and 12 turns respectively.



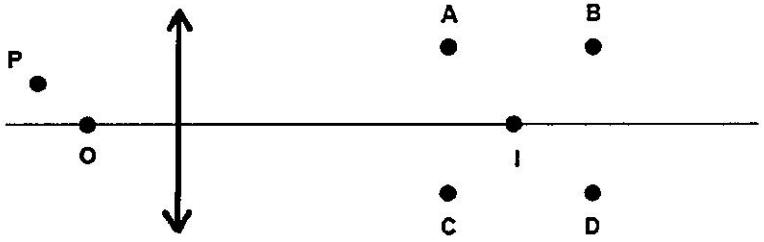
Between which two terminals would the output voltage be 12 V?

A K and L
B L and M
C M and N
D K and M

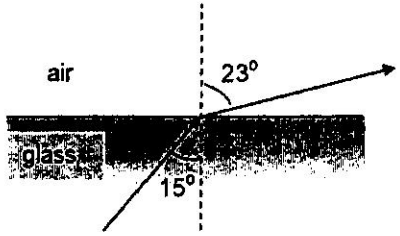
32 An electric current can produce a heating effect and a magnetic effect.
Which option shows the effect used by a relay and its corresponding application?

	effect used by a relay	one application of a relay
A	heating effect	allowing a small current to switch on a large current
B	heating effect	changing the voltage of an alternating current
C	magnetic effect	allowing a small current to switch on a large current
D	magnetic effect	changing the voltage of an alternating current

33 An object is placed in front of a converging lens. The lens forms an image at I. If the object is placed at P, where will the image be formed?



34 The diagram shows the path of light ray as it travels from glass to air.

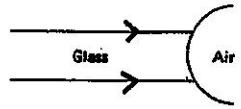


What is the critical angle of glass?

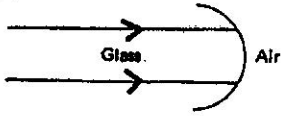
A 40.8°
B 41.5°
C 63.3°
D 72.2°

35 The diagrams show parallel beams of light entering from one medium into another.

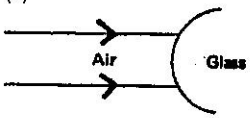
(1)



(2)



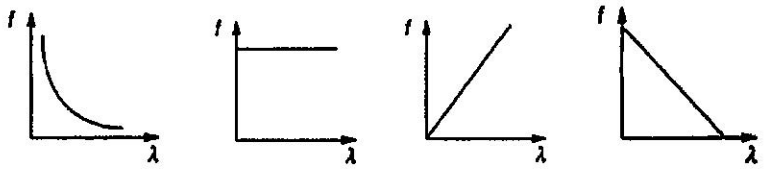
(3)



Which beam will emerge as diverging rays?

A (1) only
B (2) only
C (3) only
D (1) and (2) only

36 Which of the following graphs shows the correct relationship between the frequency *f* of an electromagnetic wave and its wavelength λ?

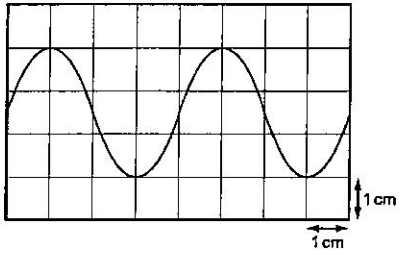


A B C D

37 A crest of a water wave travels 40 cm in 5 s. If the distance between two successive crests is 5 mm, what is the frequency of the wave?

A 0.2 Hz
B 1.6 Hz
C 8.0 Hz
D 16 Hz

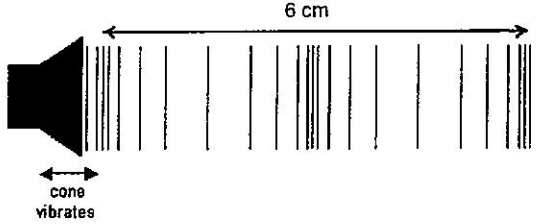
38 The diagram shows a trace of a wave on a cathode-ray oscilloscope.
The vertical and horizontal gridlines have a spacing of 1.0 cm.
The Y-gain is 4 V cm^{-1} and the timebase is 5 ms cm^{-1}.



What is the amplitude and the period of the wave?

	Amplitude/V	Period/ ms
A	3.0	10
B	6.0	10
C	6.0	20
D	12.0	20

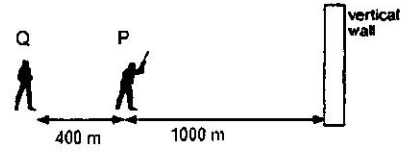
39 The diagram shows a wave set up in front of a vibrating cone.



Which of the statements about the wave is/are true?
(1) It is a travelling wave.
(2) It is a longitudinal wave.
(3) Its wavelength is 3 cm

A (2) only
B (3) only
C (2) and (3) only
D (1), (2) and (3)

40 A man P stands 1000 m from a vertical wall. A second man Q is located 400 m from P and 1400 m from the wall, as shown below.



When P fires a gun into the sky, Q hears two bangs. The first bang is heard when P fired the gun, and the second bang is the echo from the gun. What is the time interval between the two bangs if the velocity of sound in air is 330 ms^{-1}?

A 1.21 s
B 1.81 s
C 6.06 s
D 7.27 s

- END OF PAPER -

SCGS P2 16.

SECTION A

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

1 On a skydiving trip, two parachutists, A and B, jumped out of a plane at the same time. A has a mass of 45.0 kg and B has a mass of 80.0 kg.

After free falling for 2 seconds, both of them stretched out their arms and legs. A then reached a constant speed 56 m s^{-1}, while B continued to accelerate downwards before reaching a constant speed of 78 m s^{-1} several seconds later.

Fig. 1.1 shows the speed-time graph of both A and B for the first 2 s.

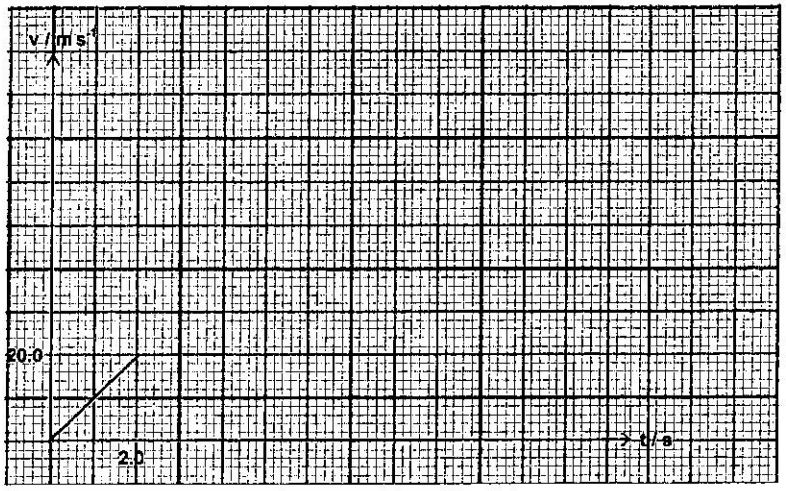


Fig. 1.1

(a) State the acceleration of the parachutist at t = 1.0 s.

Acceleration = ...[1]

(b) On Fig. 1.1, complete the graphs for A and B until they reach constant speed. Label the graphs clearly. [2]

(c) Explain in terms of forces acting on each of them, why B continued to accelerate for a while even though A had started to fall with constant speed.

.....

.....

.....

.....

..... [3]

2 In Fig. 2, the axle A is fixed into the wheel W, so that they rotate together.

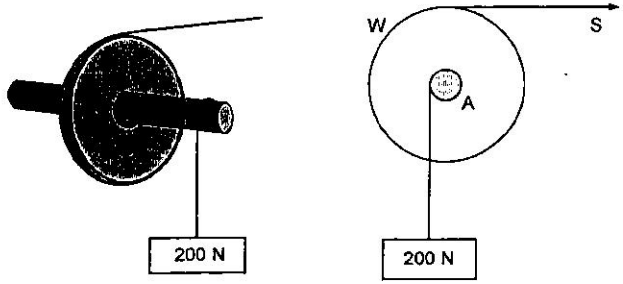


Fig. 2

A load of 200 N hangs on a rope wound around the axle which has a radius of 14 cm. A string S is wound around the wheel of radius 70 cm.

The string is pulled with a 50 N force and the load rises through a vertical distance of 6.0 m at a slow and steady speed.

Calculate

(a) the work done on the load, [2]

(b) the number of rotations of the 'wheel and axle' system when the load rises 6.0 m,

number of rotations = ... [1]

(c) the work done by the force pulling the string.

Work done = ... [2]

(d) Account for the difference in your answers to (a) and (c).

.....

.....

.....[1]

(e) Calculate the efficiency of the wheel and axel system.

Efficiency = ... [1]

3 A uniform rod AB of length 4.0 m weighs 10.0 N. It is suspended by two identical strings at points X and Y as shown in Fig. 3 below.

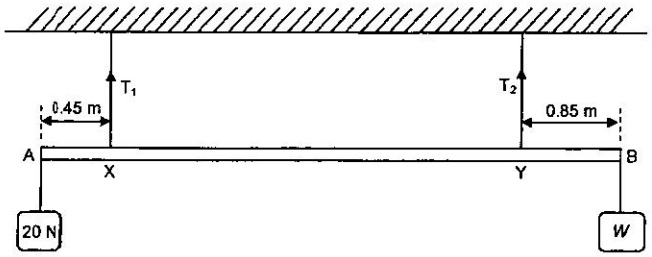


Fig. 3

Two weights 20 N and *W* are hung from the rod at point A and point B respectively.

(a) State the conditions of equilibrium of a body.

.....

.....

.....[2]

(b) When weight *W* is 35 N, calculate the tensions of the strings T_1 and T_2.

T_1 = ... N T_2 = ... N [3]

(c) If the breaking tension of each string is 60 N, what is the maximum weight *W* that can be hung such that one of the strings breaks?

maximum *W* = ... N [2]

4 (a) A copper rod is heated at one end X by a Bunsen flame as shown in Fig. 4.1. An iron nail initially stuck on the other end Y by a piece of wax that falls off after t minutes.

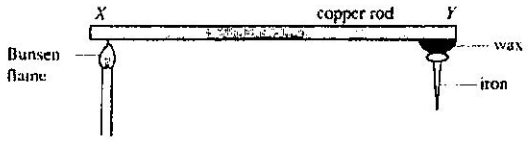


Fig. 4.1

(i) Describe, in terms of the motion of particles, how the temperature of end Y rises.

.....

.....

.....

.....

.....

.....

.....[3]

(ii) If the copper rod is replaced by a metal rod whose heat capacity is larger, state and explain any change in the value of t.

.....

.....

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.....

.....

.....[2]

(b) Fig. 4.2 shows a heater used in homes during winter to keep the room warm.

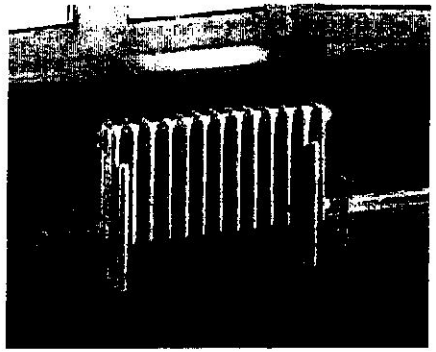


Fig. 4.2

(i) State the main processes of heat transfer by the heater to warm up the whole room.

.....[1]

(ii) The heater is usually placed at the bottom of the bedroom. Explain why the heater is placed at the bottom in terms of density changes.

.....

.....

.....

.....

.....

.....[2]

5 At an airport, fuel is pumped through a pipe from a tanker to an aeroplane, as shown in Fig. 5.

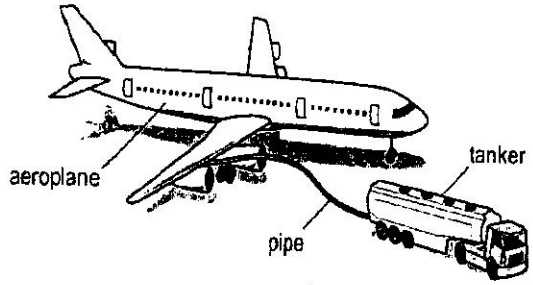


Fig. 5

As the fuel rubs against the pipe, the fuel becomes positively charged and this charges up the aeroplane.

(a) Explain, in terms of the particles involved, how the fuel becomes positively charged.

.....

.....

.....[1]

(b) Explain how the positively charged fuel can charge up the aeroplane.

.....

.....

.....[1]

(c) To prevent an aeroplane from becoming charged, a metal cable connects the aeroplane to the ground.

i) Explain why the cable is made of metal,

.....

.....

.....[1]

ii) Explain how the cable prevents the aeroplane from becoming charged.

.....

.....

.....[1]

(d) Calculate the current that flows through the cable if 2.0 μC of charge on aeroplane flows in a time of 1.2 ms.

Current = ...[2]

6 Fig. 6 shows a step-up transformer. The ends AB of the primary coil are connected to a 1.5 V cell and a switch. The switch is initially closed and the lamp is not lit. The switch is suddenly opened and the lamp illuminates for a short time.

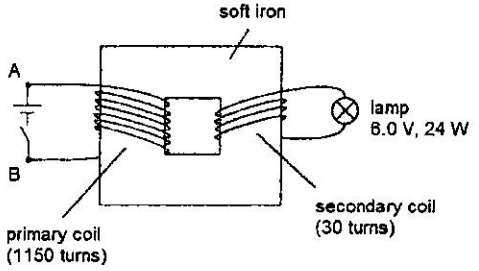


Fig. 6

(a) Explain why the lamp is initially not lit when the switch is closed, but illuminates only for a short period when the switch is opened.

.....

.....

.....

.....

.....

.....

.....[3]

(b) The 1.5 V cell is replaced by an a.c. supply of 230 V. The transformer is 80% efficient. Calculate the power loss in the transformer.

Power loss = ...[2]

(c) Suggest and explain one method to minimize power loss in the transformer.

.....

.....

.....

.....

.....[1]

7. Fig. 7 shows the passage of light beam A through an optical fibre.

Fig. 7

(a) State and explain the process that takes place as the light beam **A** travels through the optical fibre.

.....

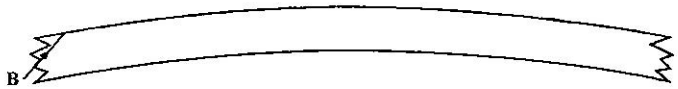
.....

.....

.....

.....[2]

(b) Complete the diagram to show the passage of the light beam **B** through the same optical fibre. [1]



(c) Suggest why beam **B** will take slightly longer to travel through the fibre than beam **A**.

.....

.....

.....

.....

.....[1]

(d) The speed of light in the fibre was found to be 1.2×10^8 m/s. Calculate the maximum angle that Beam B makes with the boundary so that it can travel through the optical fibre.

Maximum angle = ...[2]

8 **(a)** Fig. 8.1 shows a fishing boat far out at sea.

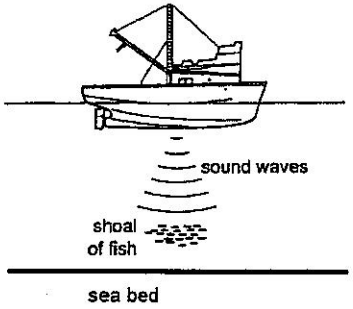


Fig. 8.1

(i) The fishermen on the boat are using ultrasound technology to detect fish.

Suggest why the fishermen cannot hear the ultrasound.

.....

.....

.....[1]

(ii) The fishermen sent a pulse into the sea and they recorded the reflected pulse on a microphone after 0.5 seconds. Calculate the depth of the sea. The speed of sound in water is 1500 m/s.

Depth of sea = ...[2]

(b) Fig. 8.2 is a diagram drawn to scale. It shows a device that the fisherman used to measure the waves in the sea. The waves on the surface of the sea caused a wooden ring to slide up and down a fixed vertical rod as the waves pass. At time t = 0 s, the ring was below P. The wooden ring reaches P every 20 seconds.

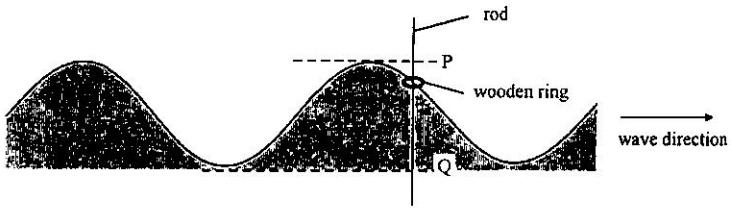


Fig. 8.2

(i) On Fig. 8.2, draw the direction that the ring is moving at t = 0 s.

(ii) How does the motion of the ring show that the waves are transverse?

.....

.....

.....

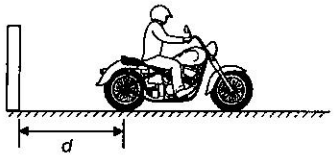
.....

.....[1]

SECTION B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11.**

9 A student is investigating the stopping distance for a motorcycle with high-performance brakes. In an experiment using electronic apparatus, a speeding motorcycle's distance *d* from a reference point is measured at different times *t*.



A mass is then added on the motorcycle and the experiment repeated.
Fig. 9.1 shows the results obtained for both experiments.

	without added mass	with added mass
t / s	*d* / m	*d* / m
0.0	0.0	0.0
0.2	12.0	12.0
0.4	23.0	24.0
0.6	31.2	34.8
0.8	35.8	44.4
1.0	37.6	52.4
1.2	38.0	58.8
1.4	38.0	63.5
1.6	38.0	66.5
1.8	38.0	68.0
2.0	38.0	68.4
2.2	38.0	68.4

Fig. 9.1

(a) Explain how the data in Fig. 9.1 for the motorcycle with the added mass suggests that the speed is constant at $t = 0.2$ s.

.....

..... [1]

(b) **(i)** On Fig. 9.2, draw a graph of *d* against *t* for the heavier motorcycle. [2]

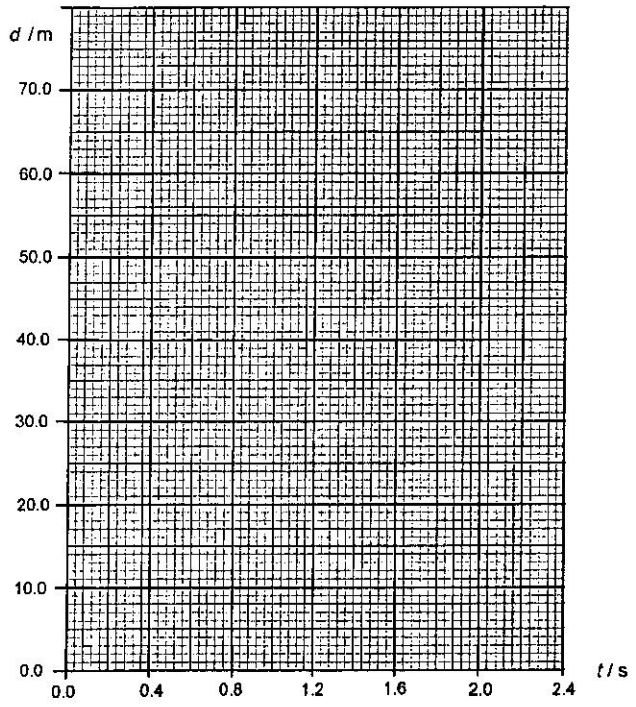


Fig. 9.2

(ii) At what time t does this motorcycle start to decelerate?

time = ... [1]

(iii) Explain how the graph shows that this motorcycle is decelerating at the time indicated in *b*(ii).

.....

..... [1]

(iv) Using the data in Fig. 9.1, determine the speed of the motorcycle with added mass at t =1.0 s.

speed = ... [1]

(v) Hence determine the average deceleration of the motorcycle with added mass between t = 0.2 s and t =1.0 s.

average deceleration = ... [2]

(c) Compare the motion of the original motorcycle with that of the heavier one.

.....

.....

..... [2]

10 (a) A light dependent resistor and a 2 kΩ resistor are connected in series across a 3.0 V d.c. supply as shown in Fig. 10.1.

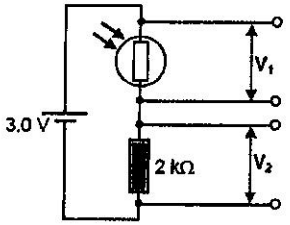


Fig. 10.1

In an experiment the light intensity incident on the LDR is varied during a 60 s period. The voltage V_1/V across the LDR is measured over the 60 s period and a graph was obtained as shown in Fig. 10.2.

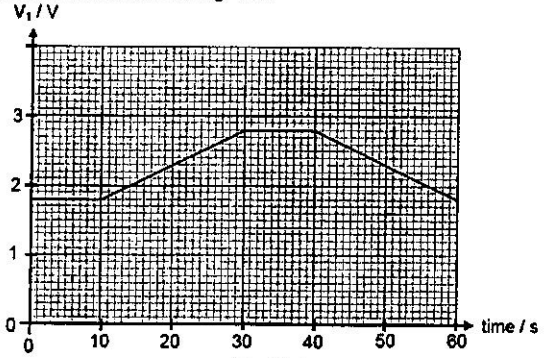
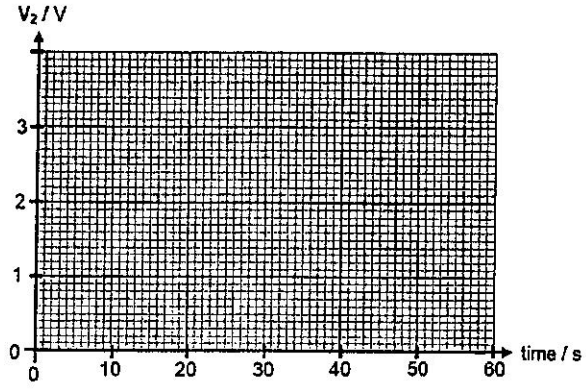


Fig. 10.2

(i) Sketch, in the grid below, the graph of V_2/V against time/s, across the 2 kΩ resistor over the same 60 s period. [2]



(ii) Calculate the resistance of the light dependent resistor at the start of the 60 s period.

Resistance = ...[2]

(iii) Is the light intensity incident on the LDR increasing or decreasing during the time interval between 10 s and 30 s? Explain your answer.

.....

.....

.....

.....

..... [2]

(b) A student was trying out a circuit he assembled using an A.C. source, diodes, switches and light bulbs (12V, 24 W). He wanted to measure the voltage of the input, so he connected a CRO across the supply as shown in Fig 10.3.

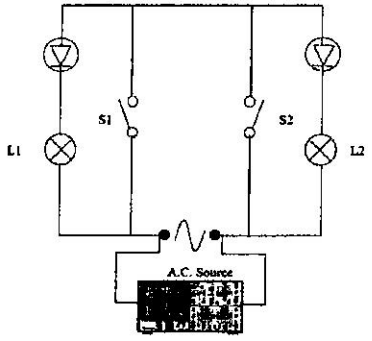
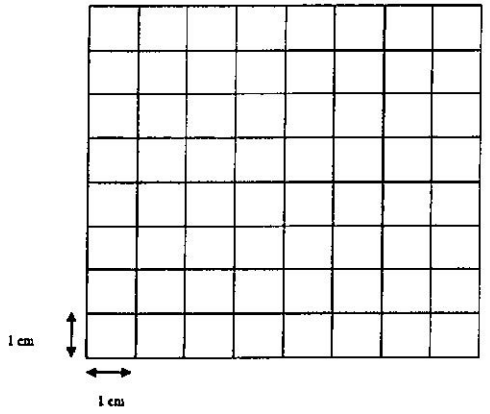


Fig. 10.3

(i) If the supply is a 12 V, 50 Hz A.C, how would the display look like if the gain is set at 3V/cm and the timebase is 5 ms/cm? Draw the probable waveform in the grid provided. [2]



(ii) The CRO is now connected across L2 (Fig 10.4). S1 is closed and S2 is open with the gain set at 4V/cm and the time base setting is 10 ms/cm. Assuming that the bulbs are working normally. The CRO now shows a display as shown in Fig 10.5.

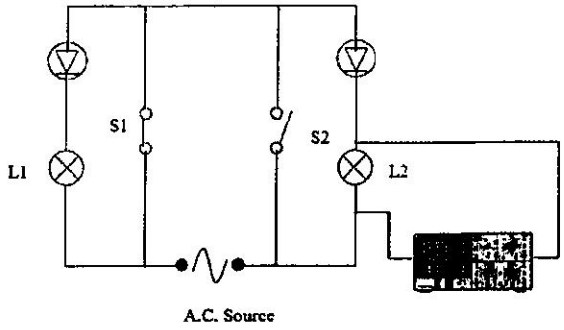


Fig. 10.4

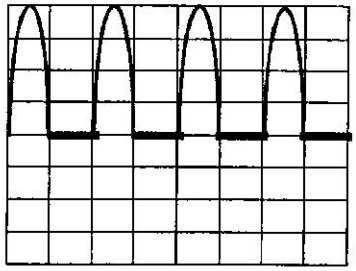


Fig. 10.5

Explain clearly how the graph shown in Fig 10.5 is obtained.

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.....

.....

..... [2]

11 Either

(a) Desktop computers store data on discs coated with a magnetic medium which records the data in a digital form. As a disc spins at very high speeds the magnetic field at each place on the disc can be detected in order to 'read' the data.

Fig. 11.1 shows a school laboratory model set up to demonstrate how such systems work.

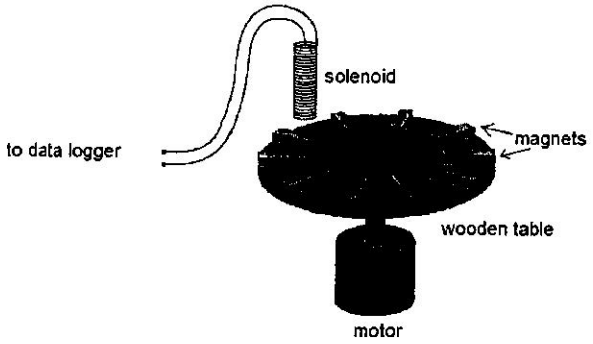

Fig. 11.1

The ten flat magnets on this model disc can be arranged with either the North Pole or South Pole facing upwards. These are detected by the solenoid linked to the datalogger as the wooden table spins.

(i) Fig. 11.2 shows the view of one of the magnets from the side. Sketch its magnetic field. [2]

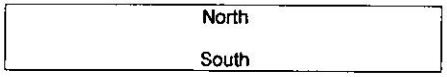

Fig. 11.2

(ii) Fig. 11.3 shows how the magnetic flux varies as an upward-facing north pole moves beneath the coil. Fig. 11.4 shows the corresponding induced emf from the solenoid.

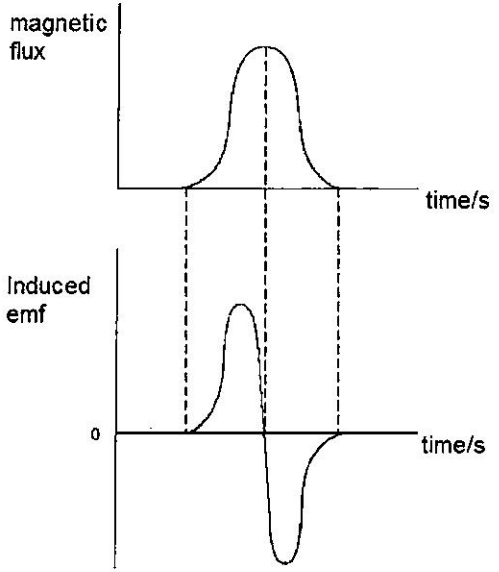

Fig. 11.3

Fig. 11.4

Explain how the output is generated and why it has this shape.

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..... [4]

(b) Fig. 11.5 shows an electric toothbrush that contains rechargeable batteries. The electric toothbrush charges its batteries despite there being no metal contacts between the toothbrush and the base.

The base, which is connected to an a.c. supply, contains a coil around a metal bar (coil X). The toothbrush contains a second coil (coil Y). When the toothbrush is placed on to the base, coil Y goes around the bar and coil X. The two coils do not make physical contact.

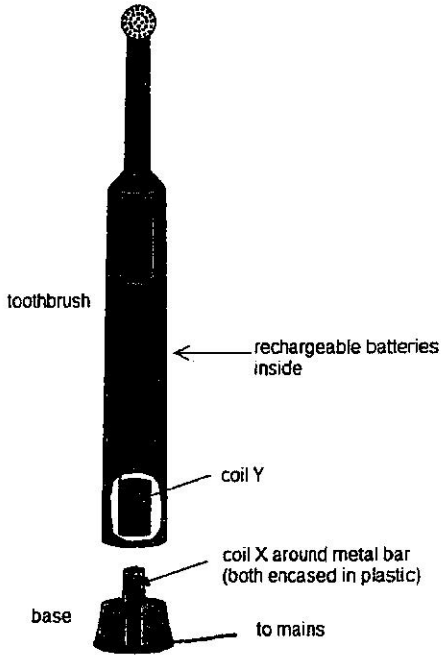

Fig. 11.5

(i) State a reason for the design of the electric toothbrush not having metal contacts between the toothbrush and the base.

.....

..... [1]

(ii) Explain how, without the two coils making contact, this arrangement is able to charge the battery in the toothbrush.

.....

.....

.....

.....

.....

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..... [3]

11 Or

(a) In Fig. 11.6, the device inside the plastic box can be used to measure current. T_1 and T_2 are the terminals to which the external circuit is connected.

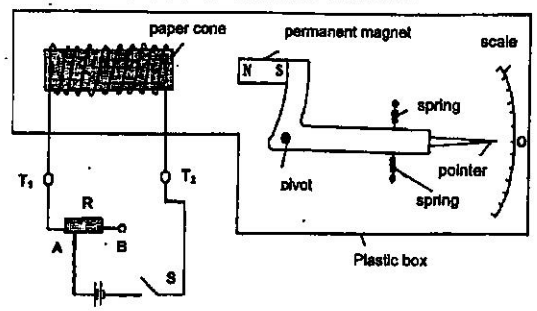

Fig. 11.6

(i) State and explain which direction the pointer would deflect when the switch S is closed.

.....

.....

.....

.....

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.....

..... [2]

(ii) State the effect on the deflection of the pointer if the slide contact of the rheostat R is moved from A to B.

.....

.....

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.....

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.....

.....

..... [1]

(iii) The polarities of the cells are reversed. Briefly explain how the device can be used to show the direction of current.

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.....

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.....

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.....

..... [2]

(iv) The permanent magnet is replaced by a piece of soft iron. Explain whether the device can be used to detect the direction of current.

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.....

..... [1]

(v) Suggest one modification to the above device to produce a greater deflection for the same magnitude of current.

.....

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..... [1]

(b) Fig. 11.7 shows a current-carrying wire, **AB**, placed between two magnets.

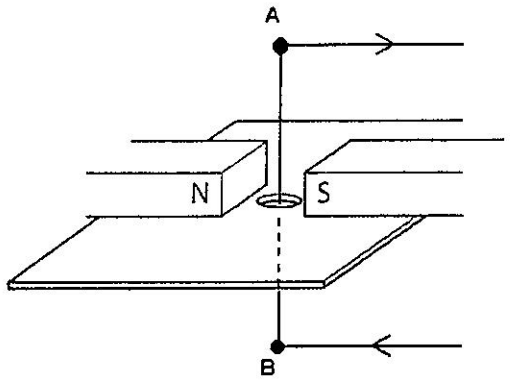


Fig. 11.7

(i) Indicate in Fig. 11.7, the direction of the force acting on the current-carrying wire **AB**. [1]

(ii) Explain why the wire in (i) moved in the direction you have indicated.

.....

.....

.....

.....

.....

..... [2]

End of Paper

Answers for SCGS 2016 Prelim Physics Paper 1				
1	D		21	D
2	B		22	A
3	B		23	B
4	B		24	C
5	D		25	A
6	D		26	B
7	C		27	B
8	B		28	A
9	A		29	A
10	D		30	B
11	C		31	D
12	D		32	C
13	D		33	C
14	A		34	B
15	A		35	A
16	C		36	A
17	C		37	D
18	B		38	C
19	D		39	D
20	D		40	C

SCGS 2016 Prelim Physics Paper 2 Mark Scheme

1 (a) State the acceleration of the parachutist at t = 1.0 s. [1]

taking gradient , a = 10.0 m s^{-2}

(b) On fig. 1.1, complete the graph for A and B until they reach constant speed. [2]

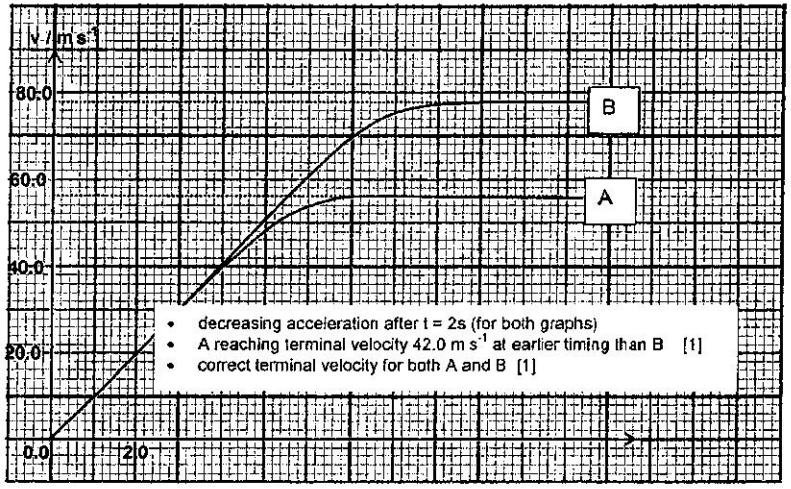


Fig. 1.1

(c) Explain in terms of forces acting on each of them, why B continues to accelerate for a while even though A has started to fall with constant speed.

- As weight of A < weight of B
- A will reach terminal velocity earlier than B
- A will have a smaller magnitude of air resistance when terminal velocity is reached [1]
- Amount of air resistance depends on the speed of falling, so A will have a lower falling speed (terminal velocity). [1]
- Conversely, B must continue to accelerate to a higher speed until the air resistance is as large as its weight [1]

2 Find

(a) the work done on the load, [2]

Work done on load = force applied against gravity x vertical distance moved [1]
= 200 x 6.0 = 1200 J [1]

(b) the number of rotation of the 'wheel and axle' system when the load rises 6.0 m

circumference of axle = 2π r = 0.8796 m
number of wheel & axle rotation = 6.0 / 0.8796 = 6.82 [1]

(c) the work done by the force pulling the string. [2]

distance pulled by 50 N force = 6.82 x circumference of wheel = 6.82 x 4.40 = 30.0 m [1]
Work done by 50 N force = 50 N x distance pulled = 50 x 30.0
= 1500 J [1]

(d) Account for the difference in your answers to (a) and (b). [1]

Energy is loss as work done against frictional forces [1]

(e) the efficiency of the wheel and axel system. [1]

efficiency = useful energy output / total energy input x 100%
= 1200 / 1500 x 100% = 80 % [1]

3 a) State the conditions of equilibrium of a body.

No resultant force [1] and No resultant moment acting on a body [1]

b) When weight W is 35 N, calculate the tensions of the strings T_1 and T_2. [3]

taking moment about point X. At equilibrium,
clockwise moment about X = anticlockwise moment about X
(10 N x 1.55 m) + (35 N x 3.55 m) = (T_2 x 2.70 m) + (20 N x 0.45 m) ----- [1]
T_2 = 48.4 N ---------- [1]

$T_1 + T_2$ = 20 N + 10 N + 35 N
T_1 = 16.6 N ---------- [1]

c) If the breaking tension of each string is 60 N, what is the maximum weight W that can be hung such that one of the strings just breaks?

Since T_2 is greater, it will break first. Let T_2 = 60 N when it breaks.
taking moment about point X.

At equilibrium,
clockwise moment about X = anticlockwise moment about X
(10 N x 1.55 m) + (W x 3.55 m) = (T_2 x 2.70 m) + (20 N x 0.45 m) ----- [1]
15.5 + 3.55 W = 162 + 9.0
W = 43.8 N ---------- [1]

4 (a)

(i) Describe, in terms of the motion of particles, how the temperature of end Y rises. [2]

The particles at X gain thermal energy from the Bunsen Burner flame. Their average kinetic energy increases. The thermal energy is transferred to the neighouring particles through molecular vibration and also through free electron diffusion.[1] Hence the particles at Y are driven into more vigorous vibration. Since temperature is directly proportional to the average kinetic energy of the particles, the temperature increases. [1]

(ii) If the copper rod is replaced by a metal rod whose heat capacity is larger, describe and explain any change in the value of t. [2]

The value of t will increase. [1]
A longer time is required for the Bunsen flame to supply a larger amount of energy so as to result in the same increase in temperature of the metal rod. [1]

(b)

(i) State the main processes of heat transfer by the heater to warm up the whole room. [1]

Radiation and convection [1]

(ii) The heater is usually placed at the bottom of the bedroom. Explain why the heater is placed at the bottom in terms of density changes. [2]

When the fan is placed at the bottom of the bedroom, it will heat up the air there. When temperature of the air increases, its volume expands and its density decreases. [1]
This causes it to rise and the cooler air at the top of the room, being denser will sink. [1] Convection currents are set up to effectively heat up the room.

5

(a) Explain, in terms of the particles involved, how the fuel becomes positively charged. [1]

Electrons move from fuel to the pipe. The fuel loses electrons and becomes positively charged and pipe gains electron and becomes negatively charged. [1]

(b) Suggest and explain how the positively charged fuel can charge up the aeroplane. [1]

Electrostatic induction occurs. Positively charged fuel induces positive charges on the plane. [1]

(c) To prevent an aeroplane from becoming charged, a metal cable connects the aeroplane to the ground.

i) Explain why the cable is made of metal, [1]

Metal is an electrical conductor that allows electrons to flow through it [1]

ii) Explain how the cable prevents the aeroplane from becoming charged. [1]

Electrons flow from plane along the cable to earth and plane is neutralised/earthed. [1]

(d) Calculate the current that flows through the cable if 2.0 μC of charge on aeroplane flows in a time of 1.2 ms. [2]

$I = Q/t = (2.0 \times 10^{-6}) / (1.2 \times 10^{-3})$ [1]
$= 1.7 \times 10^{-3}$ A [1]

6

a) Explain why the lamp illuminates only for a short period. [3]

There is a current in the primary coil when the switch is closed. This current creates a magnetic flux in the primary coil. Due to the soft iron ring, the magnetic flux created by the primary coil also links the secondary coil. With the switch closed, there is no change in the magnetic flux linkage at the secondary and hence the lamp is not lit. [1]

When the switch is opened, the magnetic flux decreases to zero in a short period. The rapid change in magnetic flux at the secondary coil creates an e.m.f. and the lamp illuminates for a short period.[1]

Eventually there is no magnetic flux at either the primary or the secondary coil and hence there is no e.m.f. induced – the lamp stays off. [1]

b) The 1.5 V cell is replaced by an a.c. supply of 230 V. The transformer is 80% efficient. Calculate the power loss in the transformer.

Power in primary coil = [24/80%] = 30W [1] **(P_s/P_p) x 100% = Efficiency**
Power loss = 30 – 24 = 6W [1]

c) Suggest and explain one method to minimize power loss in the transformer. [1]

Laminate the soft iron core to prevent eddy current [1]

7. (a) State and explain the process that takes place as the light **A** beam travels down the optical fibre. [2]

total internal reflection[1]; when the incident angle of the ray of light that travels from the optical fibre into the external exceeds the critical angle, light is internally reflected. [1]

(b) Complete the diagram to show the passage of the light beam **B** down the same optical fibre. [1]

should show more reflections; [1]

(c) Suggest why beam **B** will take slightly longer to travel down the fibre than beam **A**. [1]

There are more reflections/hits side more often: A. so greater distance to travel [1]

(d) The speed of light in the fibre was found to be 1.2×10^8 m/s. Calculate

critical angle = $\sin^{-1}$ [1.2/ 3.0] = 23.6^0
Max angle B can make with boundary = $90^0 - 23.6^0 = 66.4^0$

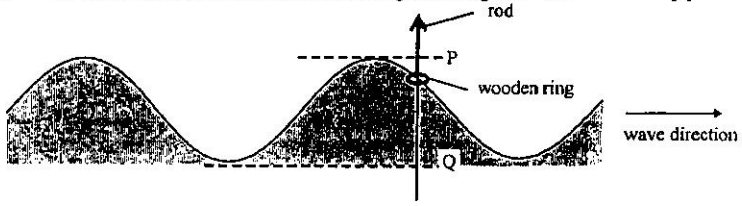
8 (a)(i) Suggest why the fishermen cannot hear the ultrasound. [1]

frequency/ pitch; OR above normal hearing /too high;

(ii) The fisher men sent a pulse into the sea and they recorded the reflected pulse on a microphone after 0.5 seconds. Calculate the depth of the sea. The speed of sound in water is 1500 m/s. [2]

distance = [1500 x 0.5] / 2 [1] = 375 m [1]

8 (b)(i) On Fig. 8.2, draw the direction that the ring is moving at t = 0 s. [1]



(ii) How does the motion of the ring show that the waves are transverse? [1]

ripples are at 90 degrees / vertical displacement (up / down) perpendicular to wave travel

[not forward and back]

Data Question (10 marks)

9 (a) Explain how the data in Fig. 9.1 for the motorcycle suggests that the speed is constant at t = 0.2 s.

the motorcycle moves equal distance of 12.0 m for both intervals from t = 0 to t =0.2 s and t= 0.2 s to t=0.4 s.

(b) (i) On Fig. 10.2, draw a graph of d against t for the heavier motorcycle. [2]

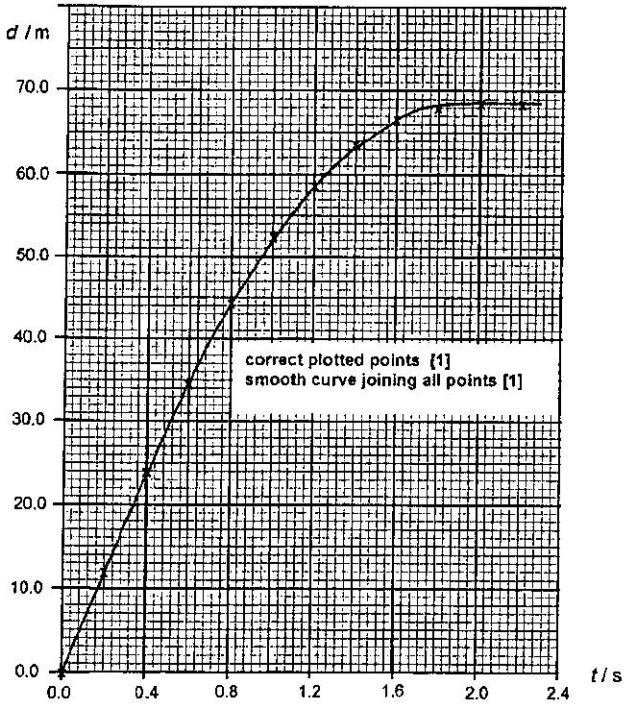


Fig. 10.2

(ii) At what time does this motorcycle starts to decelerate?

t = 0.6 s – 0.8 s [1]

(iii) Explain how the graph shows that this motorcycle is decelerating at the time indicated in b(ii).

the gradient of the graph represents speed and it starts to decrease from t = 0.6 s/ 0.8 s [1]

(iv) Using the data in Fig. 9.1, determine the speed of the heavier motorcycle at t =1.0 s.

the gradient (at t = 1.0 s) = (58.8 – 44.4) / (1.2 – 0.8) = 36 m/s [1]

(v) Hence determine the average deceleration of the heavier motorcycle between t = 0.2 s and t =1.0 s.

deceleration = change in speed / time (between t = 1.0 s and t = 0.2 s)
speed at t = 0.2 s is 60 m s^{-1} [1]

ave deceleration = (60 – 36) / 0.8 = 30 m s^{-2} [1]

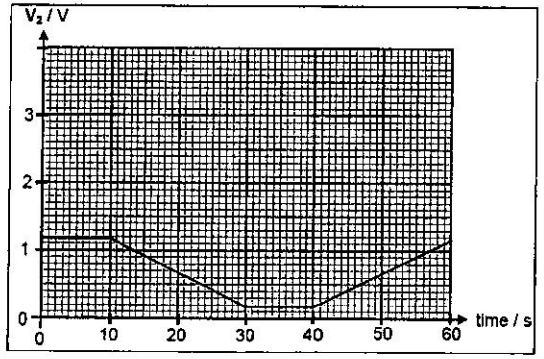
(c) Compare the motion of the original motorcycle with that of the heavier one.

the heavier motorcycle has a larger braking distance [1]

the lighter motorcycle has a greater deceleration
the lighter motorcycle took a shorter amount of time to come to a stop } [1]
same point

10 (a)

(I) Sketch in the graph of V_2/V against time/s below, the voltage across the 2 kΩ resistor over the same 60 s period. [2]



(II) Calculate the resistance of the light dependent resistor at the start of the 60 s period. [2]

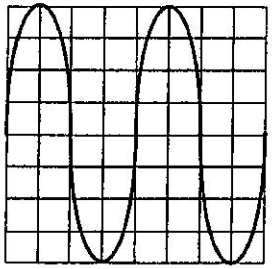
2000 Ω /R = 1.2 V/ 1.8 V [1]
R = 3000 Ω [1]

(iii) Is the light intensity incident on the LDR increasing or decreasing during the ti [2]
Interval between 10 s and 30 s? Explain your answer.

Light intensity is decreasing. [1]
V_1 is increasing. Resistance of LDR is increasing. [1]

(b)

(i) If the supply is a 12 V, 50 Hz A.C, how would the display look like if the gain is [2]
set at 3V/cm and the timebase is 5 ms/cm? Draw the probable waveform in
the grids provided.



(ii) Explain clearly how the graph shown in Fig 10.5. is obtained. [2]

When S2 is opened, the current will flow through the CRO when it flows out of the a.c. source from the left hand side.[1] This is will be captured on the CRO. When the a.c. source changes direction, no current flows.[1]

11 Either

(a) (i) Fig. 11.2 shows one of the magnets on this model. Sketch its magnetic field. [2]

Shape [lines not crossing] [1] arrow(s) [1]

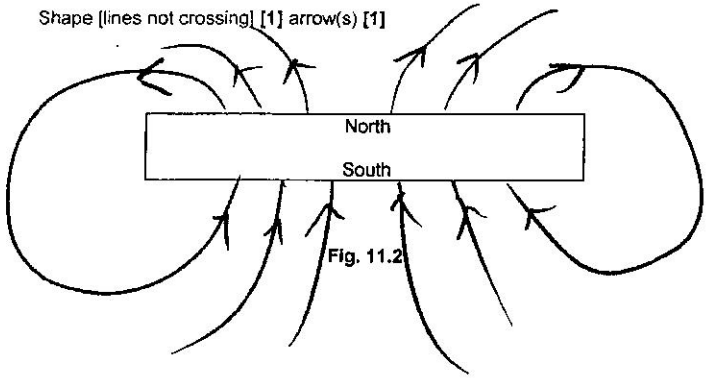


Fig. 11.2

(ii) Explain how the output is generated and why it has this shape. [4]

- There is a changing magnetic flux(linkage) and hence induces emf or current [1]
- emf is proportional to rate of change / Faraday's law stated [1]
- output is gradient of flux graph, max emf for max rate of change of magnetic flux / steepest gradient , Emf = 0 when gradient = 0 [1]
- signal +ve while the rate of change of magnetic flux increases / –ve while rate of change of magnetic flux decreases [1]

(b) (i) State a reason for avoiding metal contacts between the toothbrush and the base.

Advantage of avoiding metal contacts
Any one from:
- makes possible a sealed unit to prevent water from entering
- avoids electrocution
- prevents corrosion (by water)
- so that water cannot enter and cause short circuit

(ii) Explain how, without the two coils making contact, this arrangement is able to charge the battery in the toothbrush.

The a.c. in X produces a changing magnetic field and this produces a magnetic flux linkage between X and Y. [1]
This induced an emf and a current in Y which charges the batteries. [1]

11 Or

(a) (i) State and explain which direction would the pointer deflect when the switch S is closed.

Up [1]. The current flowing into the solenoid will **magnetize** the solenoid with a N pole on the left and a S pole on the right of the solenoid. This **attracts** the magnet and cause the pointer to move anticlockwise.[1]

(ii) State the effect on the deflection of the pointer if the slide contact of the rheostat R is moved from A to B. [1]

Resistance increase and smaller current flows and thus produces weaker magnetic force to attract the magnet. This produces a **smaller deflection**.

(iii) The polarities of the cells are reversed. Briefly explain how the device can be used to show the direction of current.

This produces a S pole on the left and a N pole on the right.[1] Like poles repel so the magnet will move to the right, producing an unbalanced clockwise moment which turns the pointer down/clockwise.[1]

(iv) The permanent magnet is replaced by a piece of soft iron. Explain whether the device can be used to detect the direction of current.

No. The soft iron will always have an induced magnetic pole that is opposite to the magnetic pole at the right end of the solenoid (as iron magnetises and demagnetises easily). Hence there will **always be an attraction** regardless of the direction of current flow.[1]

(v) Suggest one modification to the above device to produce a greater deflection for the same magnitude of current. [1]

Reduce the distance between the solenoid and permanent magnet / use a stronger permanent magnet / more turns[1]

(b) (i) Indicate in Fig. 11.7, the direction of the force acting on the current-carrying wire AB. [1]

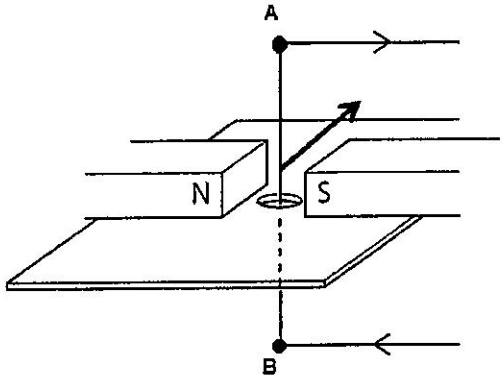


Fig. 11.7

(ii) Explain why the wire in (i) moved in the direction you have indicated.

When current flows through AB, there is a magnetic field produced around AB. [1] This magnetic field interacts with the external magnetic field and thus a force is exerted. According to Fleming's Left Hand Rule[1], the direction of the force is as shown.

End of Paper

1 What is the correct order of magnitude for the diameter of an atom and for the diameter of the Earth?

	diameter of atom	diameter of Earth
A	0.1 nm	10 Mm
B	0.1 nm	10 Gm
C	0.1 μm	10 Mm
D	0.1 μm	10 Gm

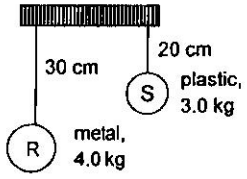
2 A student measures the diameter of a cylindrical wooden pencil with a ruler. How could he increase the precision of the measurement?

A	take the average value of several measurements of the diameter along different parts of the pencil using the ruler
B	take the average value of several measurements of the diameter along different parts of the pencil using vernier calipers with zero error
C	take the average value of several measurements of the diameter along different parts of the pencil using vernier calipers without zero error
D	use a micrometer with zero error and take one value of the diameter

3 The diagram shows two different pendulums R and S hung from a horizontal rod.

Which of the following statements is true?

A R will swing faster as it has a greater density.
B R will swing faster as it is larger in size.
C S will swing faster as it has a smaller mass.
D S will swing faster as it is shorter.



4 Two forces act at a point.

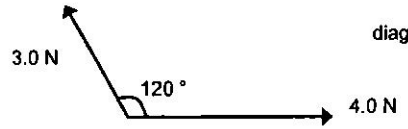


diagram not drawn to scale

What is the resultant of the two forces?

A 1.0 N B 3.6 N C 5.0 N D 7.0 N

5

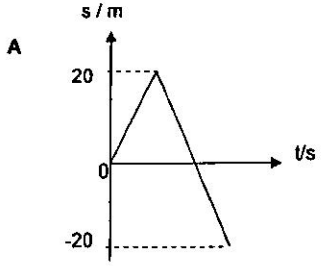
Once upon a time (300 B.C.) there was a very wealthy king, Hiero of Syracuse (Sicily) suspected that the goldsmith has cheated him by using a gold and silver mix instead of pure gold to make a crown. King Hiero asked Archimedes to determine the truth without destroying the crown. (In modern terms, he was to perform nondestructive testing).

Given that the mass of crown = 1000 g, volume of crown = 64.8 cm^3 and density of gold, silver and water are:19.3g/cm^3;10.49 g/cm^3 and 1g/cm^3 respectively, find the percentage of gold and silver.

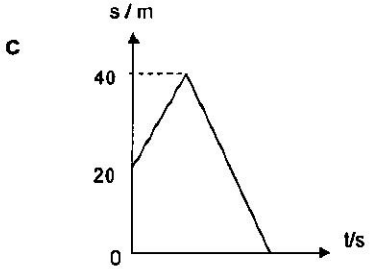
	% of Gold	% of Silver
A	29.8	70.2
B	35.2	64.8
C	64.8	35.2
D	70.2	29.8

6 A ball is thrown vertically up from the top of a building 20 m high with an initial velocity of 20 m s^{-1}. If the displacement of the balls is measured from the point of projection of the ball, which of the following graphs best represents the displacement of the ball with time t?

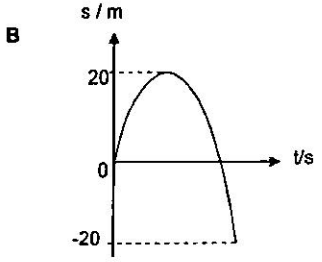
A



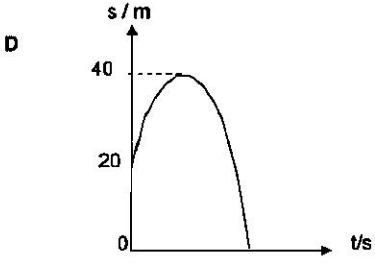
C



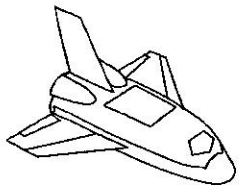
B



D



7 If the engine of a space craft travelling in empty space is turned off, the space craft will



A continue to move with constant acceleration.
B continue to move with constant deceleration.
C continue to move with constant velocity.
D stop moving.

8 A non-uniform object is placed on an inclined plane as shown in **Fig 8.1**. If the object is just about to topple, which position will be its centre of gravity?

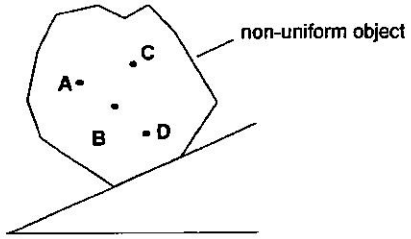
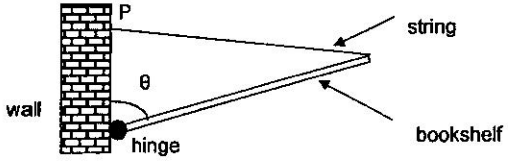


Fig 8.1

9 A string is tied to the wall at a fixed point P to help to secure a bookshelf.

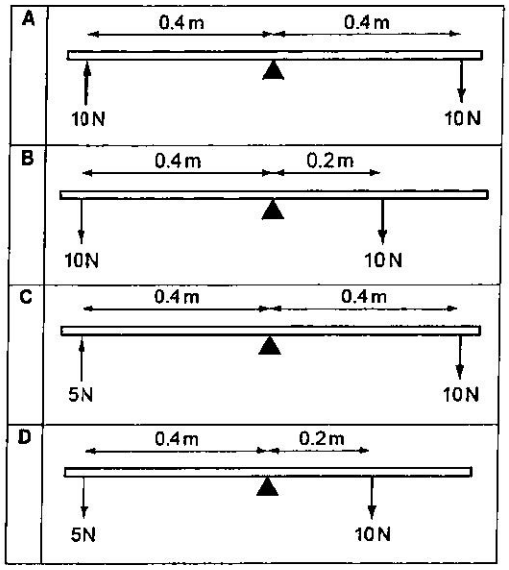


Which of the following will help to minimize the tension in the string in order to help it last longer?

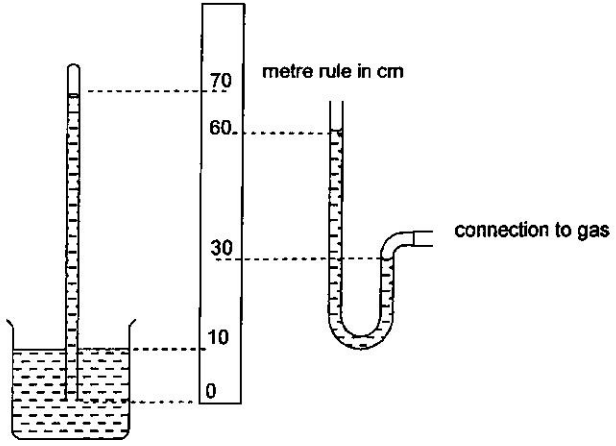
A a smaller θ
B have a longer bookshelf
C less friction at hinge
D use steel bookshelf instead of light wooden one

10 Forces are applied to a uniform beam pivoted at its centre.

Which beam is balanced?



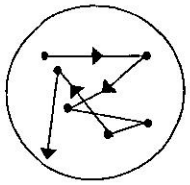
11 A mercury barometer and a mercury manometer are placed in the same room which is on a hill top. The manometer is connected to a gas container.



What is the pressure of the gas?

A 15 cm Hg B 40 cm Hg C 75 cm Hg D 90 cm Hg

12 Smoke particles in a transparent box are observed using a microscope. A small point of light is seen to move around as shown.



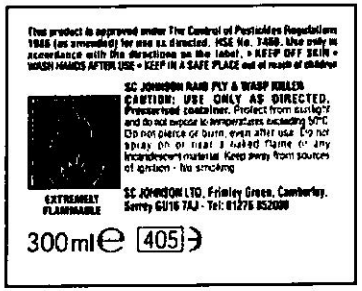
What does this experiment demonstrate about air molecules?

A They are in continuous random motion.
B They can be seen through a microscope.
C They move because of collisions with smoke particles.
D They move more slowly when they are heated.

13 When a solid is melting how do the potential energy and kinetic energy of the particles in the solid change?

	Potential Energy	Kinetic Energy
A	decreases	increases
B	increases	increases
C	increases	no change
D	no change	increases

14 On the spray containers of insecticide, there is a warning label stating that it is dangerous to dispose of the container, even when empty, in fire.



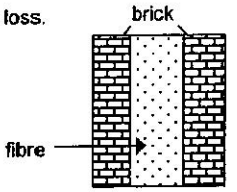
Why is it dangerous to throw empty insecticide containers into fire?

A	The can is not fire-proof and will catch fire easily.
B	When the can is heated, the gas molecules within the can will absorb the heat quickly from the fire and catch fire.
C	When the can is heated, the gas molecules inside the empty can will expand and the pressure within the container will build up until the can explodes.
D	When the can is heated, the gas molecules inside the empty can will move faster and the pressure within the container will build up until the can explodes.

15 The resistance of a piece of platinum wire in melting ice and boiling water are 800 Ω and 910 Ω respectively. What is the temperature reading in Kelvin when the resistance has a value of 1000 Ω?

A 328 K B 383 K C 455 K D 495 K

16 A brick wall in a cold country is filled with fibre to prevent heat loss.



Heat cannot easily escape through the wall because the fibre

A heats up the wall.
B is tightly packed.
C is warm.
D traps air.

17 A liquid placed inside an insulated container is kept boiling by a heater immersed in it. When the power supplied to the coil is 84 W, the liquid boils away at a rate of 10^{-3} kg/min.

Calculate the specific latent heat of vaporization of the liquid in J/kg.

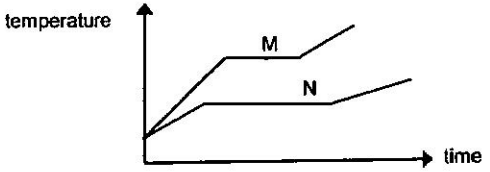
A 8.4×10^2 B 5.05×10^4 C 8.4×10^4 D 5.04×10^6

18 Two cars, one painted dull black and the other a shiny white, were left in the sun. When the two cars had reached the same temperature they were driven into the shade.

Which car will be heated up faster and which car will cool down faster?

	In the Sun	*In the shade*
A	Black car heats up faster	Black car cools down faster
B	Black car heats up faster	White car cools down faster
C	White car heats up faster	Black car cools down faster
D	White car heats up faster	White car cools down faster

19 Two solids M and N are heated separately by identical heaters under identical conditions. The changes in temperature with time for the two solids are shown below.



If M and N are of the same mass, which of these statements is/are correct?

1 Freezing point of N is lower than that of M.
2 Solid N has a higher specific heat capacity than solid M.
3 The specific latent heat of fusion of N is higher than that of M.

A 1 only B 1 and 2 only C 1 and 3 only D 1, 2 and 3

20 It is observed that the crest of a water wave takes 10 s to travel 20 cm. Given that the frequency of the wave is 5 Hz, calculate the wavelength of the water wave.

A 0.040 cm **B** 0.40 cm **C** 4.0 cm **D** 40 cm

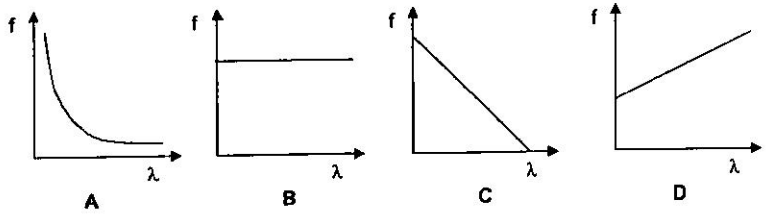
21 Which one of the following values can possibly be the wavelength of X-rays given that the wavelength of red light is 700 nm?

A 5×10^{-2} m **B** 5×10^{-5} m **C** 5×10^{-7} m **D** 5×10^{-10} m

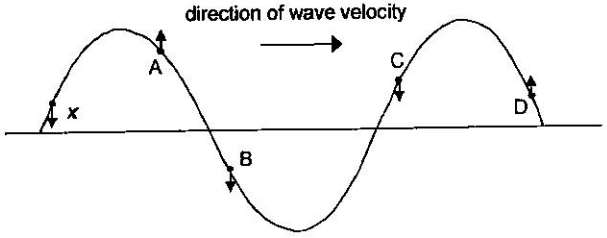
22 Which one of the following statements is **NOT** correct?

A	Gamma rays have wavelengths shorter than visible light and may be used to find faults in metal casting.
B	Infrared rays are given off by hot objects, and can pass through fog and glass.
C	Radiowaves have wavelengths longer than visible light and can be reflected by layers in the upper atmospheres.
D	Ultraviolet rays may produce sunburn, are absorbed by glass and can produce fluorescence.

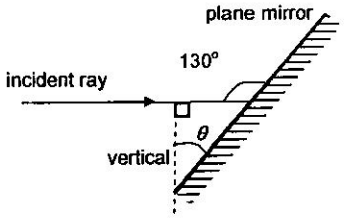
23 Which one of the following graphs shows the correct relationship between the frequency, f of an electromagnetic wave and its wavelength, λ?



24 The diagram shows a section of a wave motion. The particle at position *x* moves in the direction of the arrow shown. Which of the following particles at the labelled positions, **A**, **B**, **C** and **D** is ***incorrect***?



25 A plane mirror is tilted at an angle of θ to the vertical. When an incident ray of light strikes the mirror it makes an angle of 130° to the surface of the mirror as shown below.



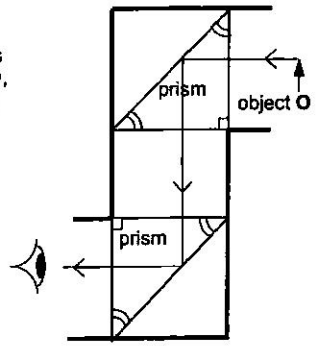
Find the angle of reflection and the angle θ.

	angle of reflection / °	angle θ / °
A	40	40
B	40	50
C	50	40
D	65	50

26 A periscope is used to look over the top of obstacles. One type consists of two triangular prisms that are fitted at end of a tube as shown. Each prism has angles of 90° and 45°. A ray of light from the top of an object **O**, passes through the periscope. The image of the object is viewed by an eye **E**.

What type of image is formed is seen by the eye **E**?

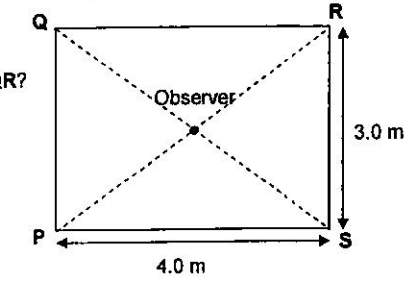
A	inverted and same size as object
B	inverted and smaller size than the object
C	upright and same size as object
D	upright and smaller size than the object



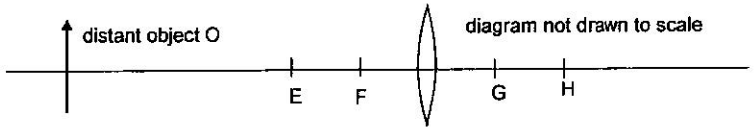
27 The diagram represents, the top view of a room **PQRS** which measures 3.0 m by 4.0 m. An observer stands at the centre of the room with his back to **PS**.

In order for the observer to see the full width of the wall **PS**, what is the minimum length of a plane mirror placed at eye level on the wall **QR**?

A	1.0 m
B	1.3 m
C	2.0 m
D	2.5 m



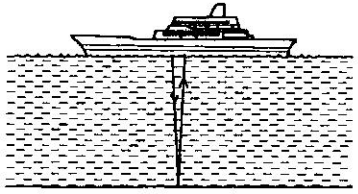
28 In the diagram below, a self-luminous object is located at O and is assumed to be faraway from the converging lens. Point E, F, G and H are points equally spaced along the axis of the lens. A real, inverted image of the object O is found at point G.



When the object is moved between E and F, what will happen to the image?

A It moves away from point G towards a point between G and H.
B It moves away from point G towards a point beyond H.
C It remains inverted at point G but becomes bigger.
D It remains inverted at point G but becomes smaller.

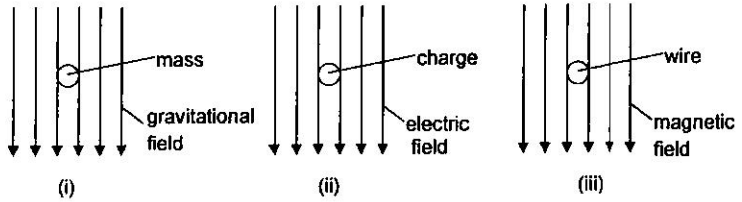
29 The diagram below shows a ship measuring the depth of the sea. The ship sends down an ultrasonic pulse and receives an echo from the sea bed 0.6 s later.



Calculate the depth of the sea if the speed of sound in water is 1400 m/s.

A 210 m **B** 420 m **C** 630 m **D** 840 m

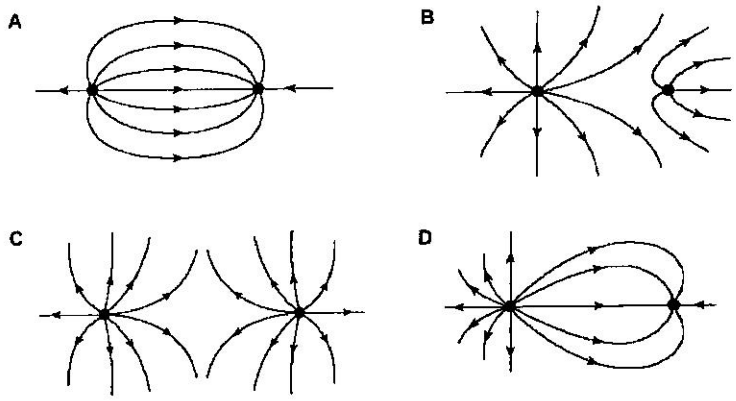
30 The diagrams show (i) a mass in a gravitational field, (ii) an unknown charge in an electric field and (iii) a current-carrying wire at right angles to a magnetic field.



Which are the possible direction(s) the forces act on the mass, unknown charge and the current-carrying conductor?

	Gravitational field	Electric field	Magnetic field
A	Force down	Force down	Force down
B	Force down	Force up or down	Force left or right
C	Force down	Force up or down	Force right
D	Force up or down	Force up or down	Force up or down

31 Which of the following shows two opposite electric charges of different magnitude?

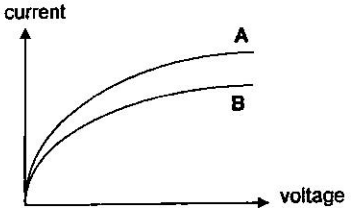


32 A battery moves a charge of 20 C round a circuit in a time of 5.0 s.

What is the current in the circuit?

A 0.25 A **B** 4.0 A **C** 80 A **D** 100 A

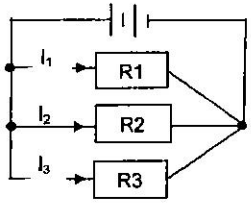
33 The graph shows the current and voltage relationship of two filament lamps made of the same type of metal.



Which of the following statements is **true**?

A Both filament A and filament B obey Ohm's law.
B Filament A is longer and thinner than filament B.
C The resistance of A is smaller than the resistance of B.
D The resistance of both filaments decreases with temperature rise.

34 The circuit below shows three resistors, R1, R2 and R3, connected to batteries and their resistances of the three resistors is $R_1<R_2<R_3$.



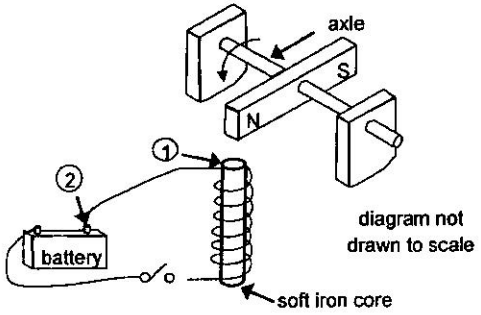
Which of the following shows correctly, in increasing order, the currents I_1, I_2 and I_3?

A $I_1 < I_2 < I_3$ **B** $I_1 < I_3 < I_2$ **C** $I_2 < I_3 < I_1$ **D** $I_3 < I_2 < I_1$

35 Which of the following is correct for domestic lighting circuits?

	Circuits connected in	Fuse placed in	Switch placed in
A	parallel	live lead	live lead
B	parallel	neutral lead	Neutral lead
C	series	live lead	live lead
D	series	neutral lead	Neutral lead

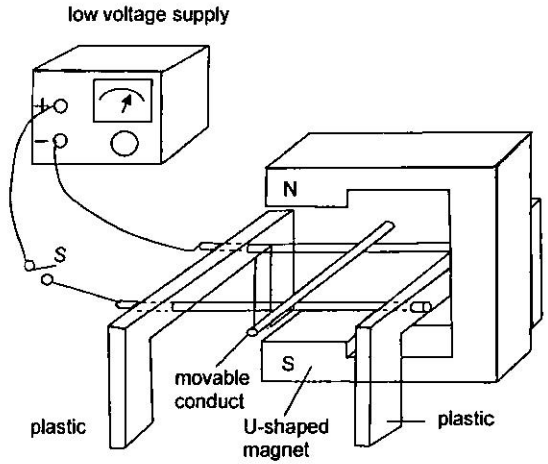
36 A magnet is free to spin. When the switch is closed, the magnet spins in the direction shown.



What is the magnetic polarity of the end of the soft iron core marked as (1) and the polarity of the battery terminal marked as (2)?

	Polarity of Magnet (1)	Polarity of Battery (2)
A	North	Negative
B	North	Positive
C	South	Negative
D	South	Positive

37 A movable conductor is placed on two parallel conductors and in the magnetic field of a U-shaped magnet. The two parallel connectors are connected to a low voltage supply.

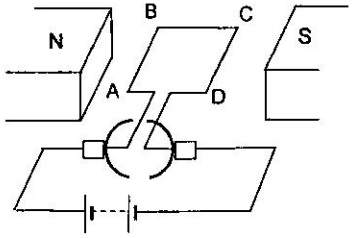


Which of the following can increase the magnetic force acting on the movable conductor when the switch is closed?

(1) Increasing the current
(2) Increasing the strength of the magnetic field
(3) Increasing the length of the movable conductor

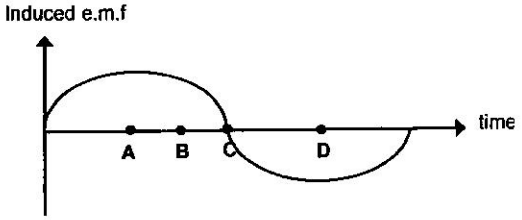
A (1) and (2) **B** (1) and (3) **C** (2) and (3) **D** (1), (2) and (3)

38 Why is a commutator used in a d.c. motor?



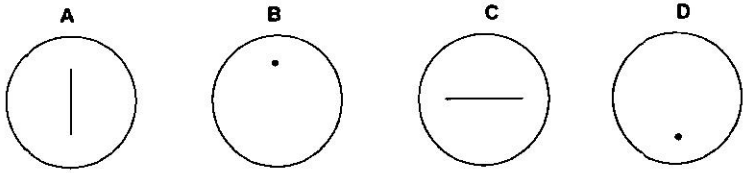
A	It allows the coil to rotate by allowing the wires to be entangled.
B	It allows the coil to rotate by reversing the current through the coil every half-turn.
C	It produces a greater turning effect by becoming magnetically induced.
D	It produces a greater turning effect by increasing the current through the coil

39 When an a.c. generator is rotating in a magnetic field, the induced e.m.f changes due to position of the coil.



Which point of the following graph shows that the area of the coil is at an oblique angle to the magnetic field?

40 Which of the following would be observed on the screen of the CRO if an alternating voltage supply is applied to the Y-input and the time-base is turned off?



The END

Section A (50 marks)
Answer **all** the questions in the section.

1 A student carries out an experiment to measure the power he produces. He runs up from floor of a hall to the top of the raised platform as shown in Fig. 1.1

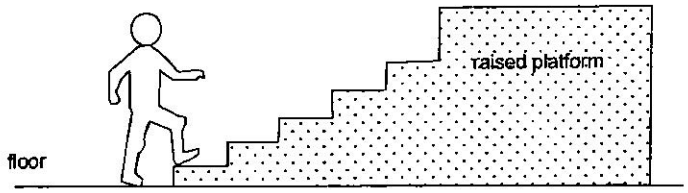


Fig. 1.1

(a) The student takes readings to calculate his power.

(i) List all the readings he must take. [2]

(ii) State one step he should take to make sure one of his readings is accurate. [1]

(iii) State one limitation in the way he determines his power. [1]

(b) Write down all of the equations he must use to calculate his power from the readings. You may use SI symbols or words in your equations. [1]

2 **Fig. 2.1** shows a 500 kg hovercraft accelerating from right to left while maintaining a constant height above the land. The four forces acting on it are Drag, Lift, Weight and Thrust.

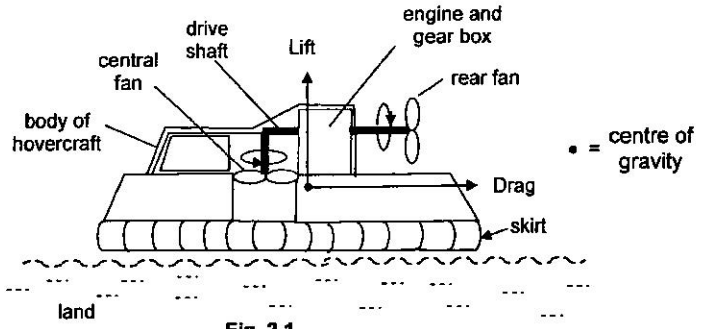


Fig. 2.1

(a) Draw and label the other two forces. [1]

(b) The hovercraft is travelling at constant acceleration.

State and explain the relationship between the four forces. In the relationship state whether the forces is less or equal or more than each other. [2]

(c) Calculate the Thrust needed if the acceleration of the hovercraft is 2.4 m/s^2 and the Drag is 200 N. [2]

(d) From **Fig. 2.1**, suggest how the Lift force is produced. [1]

3 **Fig. 3.1** shows a type of weighing machine. The two sliding weights can be moved independently along the rod. With no load on the hook and the sliding weights at the zero mark on the metal rod, the metal rod is horizontal. The hook is 4.8 cm from the pivot.

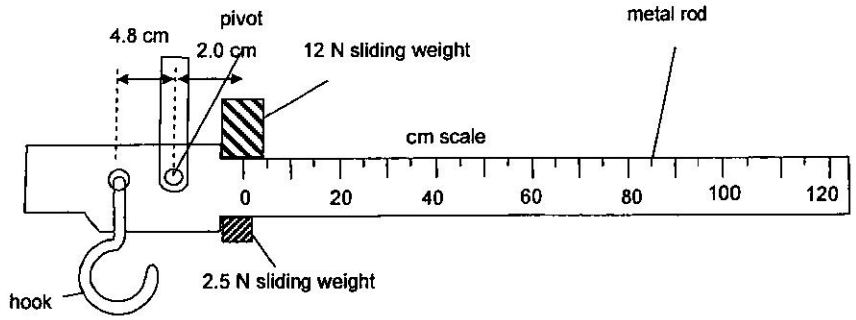


Fig. 3.1

(a) Explain what is meant by the moment of a force. [1]

(b) A sack of flour is suspended from the hook. In order to return the metal rod to the horizontal position, the 12 N sliding weight is moved 84 cm along the rod and the 2.5 N weight is moved 72 cm.

(i) Calculate the weight of the sack of flour. [2]

(ii) Suggest why this weighing machine would be imprecise when weighing objects with a weight of about 2.5 N and how would you overcome this limitation. [2]

4 **Fig. 4.1** shows a narrow beam of light, **AB** from a ray box directed towards the surface **ST** of an irregular shaped glass block **PQRSTU**. The glass block is fixed to a table.

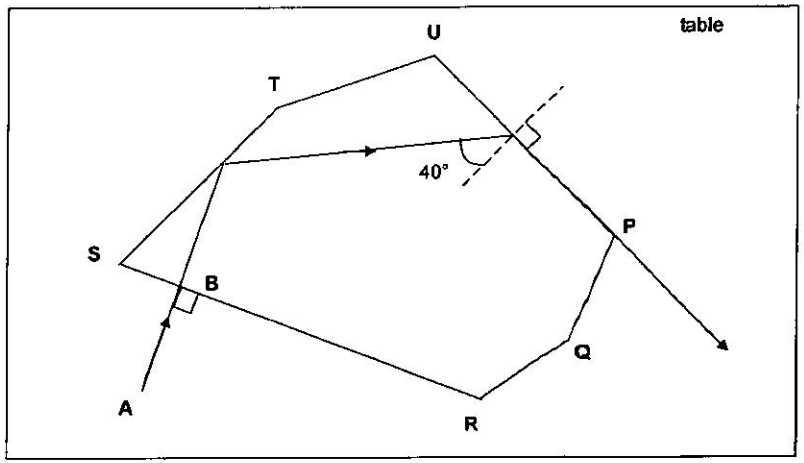


Fig. 4.1

(a) Calculate the refractive index of the glass. [2]

[b) Explain why the beam of light **AB** does not refract when it enters the glass block. [1]

(c) The ray from A is rotated in anti-clockwise direction while maintaining the **same** point of incidence B. At a new direction, it is found that the ray emerges along the surface **ST** of the glass block.

(i) On **Fig. 4.1**, sketch the new path and label the essential angles for this new emergent ray. [1]

(ii) Calculate the new angle of incidence if the angle at corner S is 65°. [2]

5 **Fig. 5.1** shows a diver working below the surface of a lake. The density of the water in the lake is 1000 kg/m^3, the atmospheric pressure at the surface is 1.0 x 10^5 Pa and the gravitational field strength is 10 N / kg. The diver inflates a balloon with air at a depth of 15 m and attaches the balloon to a tray of object.

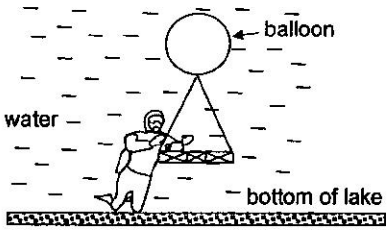


Fig. 5.1

(a) Calculate

(i) the pressure due to 15 m of water in Pa, [2]

(ii) the total pressure at 15 m below the surface of the lake. [1]

(b) The pressure of the air inside the balloon is less at the surface of the lake than at a depth of 15 m. Explain, in terms of the air molecules inside the balloon, why the pressure is less. State any assumption(s) made. [2]

(c) State one difference between the arrangement of the molecules of water in the lake and the molecules of air in the balloon. [1]

6 A collector views a postage stamp of height 1.5 cm through a lens. The lens is 2.0 cm from the stamp and the ratio of height of image to height of object is 3.0.

(a) In **Fig. 6.1**, complete the full scale ray diagram to determine the image of the stamp. [3]

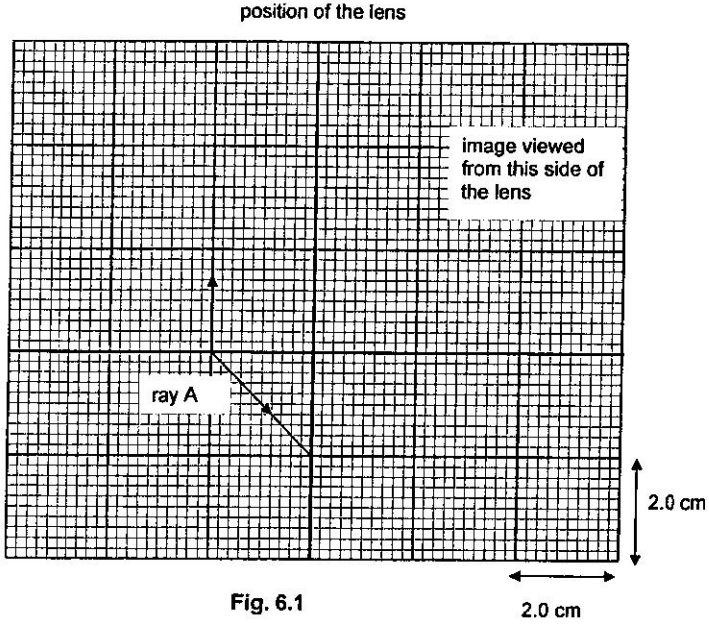


Fig. 6.1

(b) State what is meant by a virtual image. [1]

(c) Use your drawing to determine the focal length of the lens. [1]

(d) On **Fig. 6.1**, complete the path of ray A after passing through the lens. [1]

7 **Fig. 7.1** shows the position after a negatively charged sphere **C** on an insulating stand is brought close to a small, uncharged metal sphere **U** which is suspended from an insulating thread.

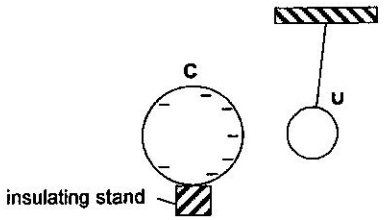


Fig. 7.1

(a) On **Fig. 7.1**, draw the induced charges on sphere **U**. [1]

(b) Sphere **C** is moved towards sphere **U** until the spheres touched. Sphere **U** is then repelled by sphere **C**, as shown in **Fig. 7.2**. The charges on **C** and **U** are not shown.

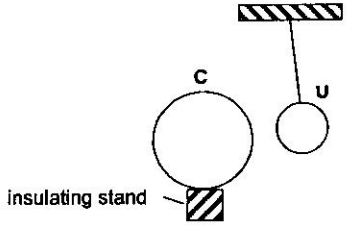


Fig. 7.2

(i) On **Fig. 7.2**, draw the resultant charges on spheres C and U after the spheres made contact. [2]

(ii) Explain what happens to the charges on the two spheres **C** and **U** as they touch. [2]

8 **Fig. 8.1** shows a circuit containing a variable resistor and two identical lamps each of resistance 10.0 Ω.

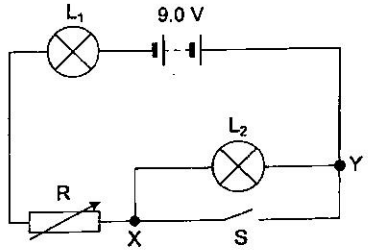


Fig. 8.1

(a) The switch S is open and the resistance of the variable resistor is gradually reduced to the minimum setting.

State and explain what happens to the brightness of both lamps. [2]

(b) Switch S is now closed with the variable resistor at its minimum setting.

(i) State the value of the potential difference across XY. [1]

(ii) State what happens to the brightness of lamp L_1. [1]

(c) Explain what happen to the brightness of L_1 at night when the rheostat is replaced by a light dependent resistor and the switch is open. [1]

9 **Fig. 9.1** shows a long flexible copper wire coil suspended vertically from a fixed clamp at A so that its lower end just dips into mercury in a container at B.

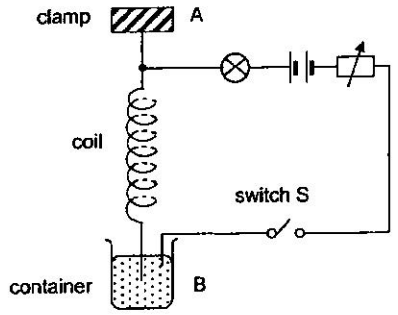


Fig. 9.1

Switch S is closed and when the current in the coil is gradually increased until the coil contracts such that the lower end loses contact with the mercury and the lamp goes out.

(a) Explain the above observation why the current need to be adjusted to a certain value for the lamp to be not lit. [2]

(b) State and explain what will take place after breaking contact with the mercury when switch S is still closed. [2]

(c) If the current in the coil is further increased, describe and explain what will happen to the lamp. [2]

Section B [30 marks]

Answer **all** questions in this sections.

Answer only one of the alternative questions in **Question 12.**

10 **Fig. 10.1** shows a graph of pressure against distance of a travelling wave at time $t = 0$ s. The speed of sound in air can be taken as 340 m/s.

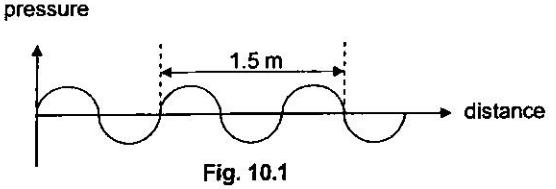


Fig. 10.1

(a) Determine the following characteristics by completing the table below. [4]

(i) Wavelength	
(ii) Frequency	
(iii) periodic time	

(b) As the wave travels to the right, sketch on **Fig. 10.1**, the pressure variation at half a period later. [2]

(c) An oscillator is used to set up water waves in a ripple tank which is slightly inclined. **Fig. 10.2** shows the top view and the wavelength in region X and wavelength in region Y is 2.5 cm and 3.5 cm respectively.

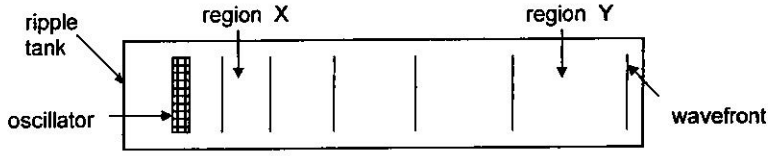


Fig. 10.2

(i) Which region X or Y is the shallower region? Explain your answer. [2]

(ii) State what is meant by a wavefront. [1]

(iii) Explain the formation of the above pattern of wavefront. [1]

11 In an experiment using a datalogger, a ball M is released from rest at a certain height *h* above the ground and the speed *v* is measured at a frequency of 10 Hz.

Some air is then released from the ball M and the altered ball is renamed ball L.
The same setting for the data logger is then repeated when ball L is released from rest and the height *h*.

Fig. 11.1 shows the results obtained with the ball M (with more air) and ball L (with less air).

time t / s	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80
Ball 1 v / m/s	0.0	1.0	2.0	3.0	4.0	0.0	-1.5	-0.5	0.0
Ball 2 v / m/s	0.0	1.0	2.0	3.0	4.0	2.0	0.0	-0.5	0.0

Fig. 11.1

(a) Plot the above data for balls 1 and 2 and label correctly the two graphs as ball M and ball L in **Fig. 11.2**. [3]

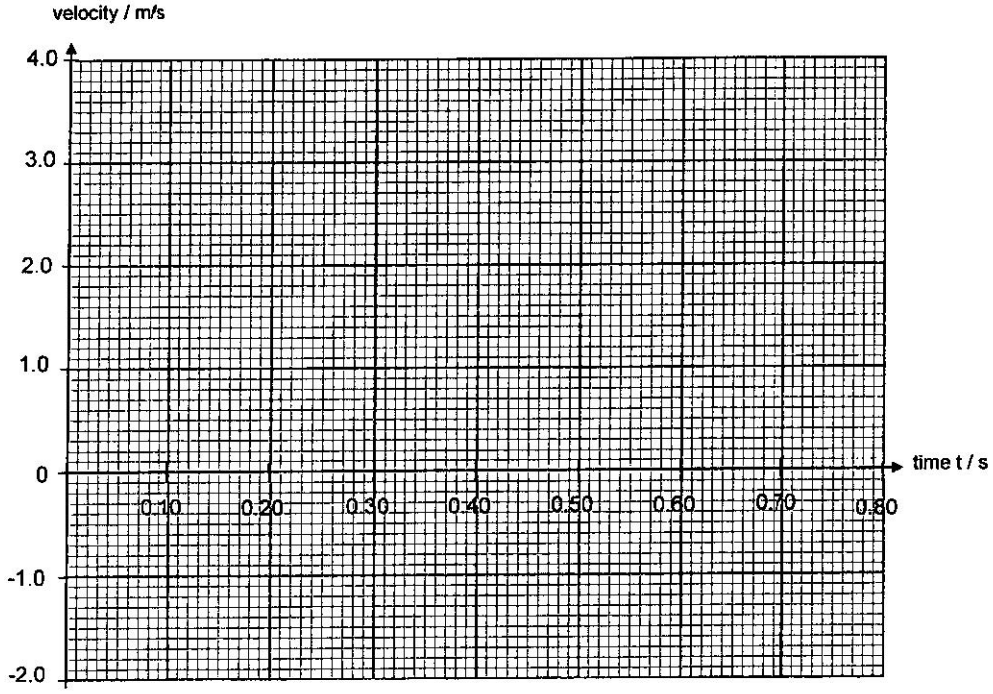


Fig. 11.2

(b) Explain your labelling of the graph as ball M. [1]

(c) Determine from the graph, *h*, the height from the ground at which the ball was initially released. [2]

(d) Explain how the graph shows that the ball in both instances was released from the same height. [1]

(e) From the data or graph, state the velocity of ball L when it first rebound from the ground. [1]

(f) Using the answer to **(e)** and the *Principle of Conservation of Energy*, explain why "more energy was lost to the ground" for the ball (with less air). [2]

12 **EITHER**

Fig. 12.1 shows the circuit diagram of a hairdryer. A motor-driven fan and a heating element are used to generate warm air. The hairdryer is connected to a 240 V a.c. supply. Switch S can be connected to either contact X or Y.

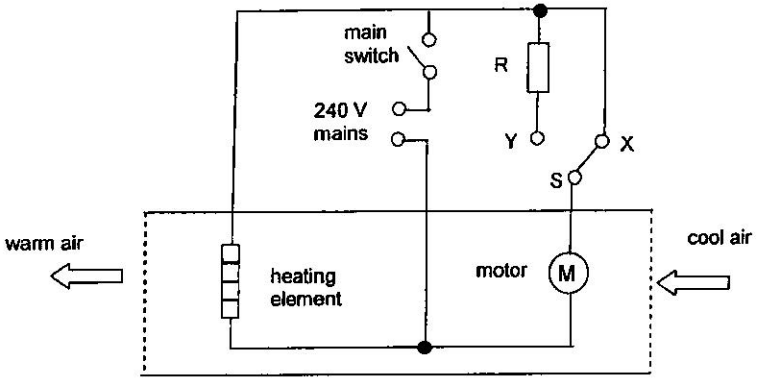


Fig. 12.1

(a) The hairdryer is used to dry wet hair.

Explain, using kinetic theory of particles, how the hairdryer can increase the rate of evaporation of water from the wet hair. [3]

(b) During quality control tests of the hairdryer in the factory, switch S is first connected to contact X. Some measurements are made to obtain the data shown in **Fig. 12.2**.

resistance of the heating element	30 Ω
resistance of resistor R	20 Ω
temperature of air entering the hairdryer	25 °C
rate of air flow through the hairdryer	0.055 kg/s
specific heat capacity of air	1 000 J/kg.°C

Fig. 12.2

(i) Estimate the temperature of the air flowing out of the hairdryer. [2]

(ii) State one assumption in your calculation. [1]

(c) Switch S is then connected to contact Y. State and explain whether there is any change in the temperature of the air flowing out of the hairdryer, as compared to when switch S is connected to contact X. [2]

(d) Calculate the cost of using the hair dryer for 10 minutes if the hair dryer is set to the lower heating setting and the cost of electricity is 20 cents per kWh. [2]

12 **OR**

Two coils, A and B, are placed one on top of the other, as shown in **Fig. 12.3**. Coil A is connected in series with a battery and a switch. A millivoltmeter is connected across the terminals of coil B

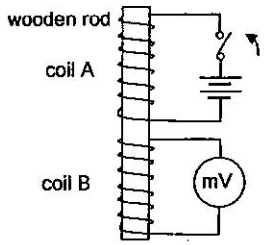


Fig. 12.3

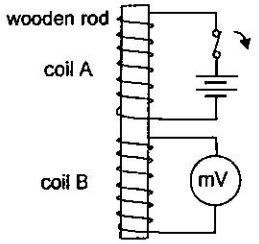


Fig. 12.4

(a) Explain why, when the current in coil A is switched on, the millivoltmeter indicates an induced e.m.f. for a short period of time and then reduces to zero rapidly in **Fig. 12.3**. [2]

(b) **(i)** On **Fig. 12.4**, draw an arrow on coil B to show the direction of the induced current in coil B when the switch was just opened. [1]

(ii) Explain the direction drawn in **(b)(i)**. [2]

Fig. 12.5 shows two coils of insulated wire wound on an iron core to make a transformer. One coil is connected to a 16 V a.c. supply. The other coil is connected to a lamp, which is rated 12 V, 24 W.

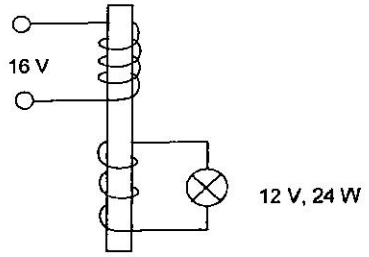


Fig. 12.5

(c) The lamp is operating at its correct rating.

Calculate the minimum current drawn from the 16 V supply. [2]

(d) However the current drawn from the supply is found to be 1.7 A.

(i) Calculate the input power to the transformer. [1]

(ii) How much electrical energy is lost by the transformer each second? [1]

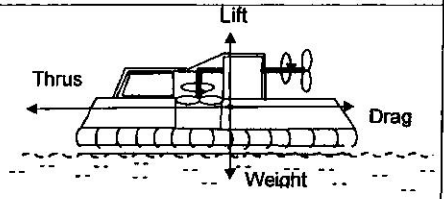
(iii) State one reason why a transformer is not 100% efficient. [1]

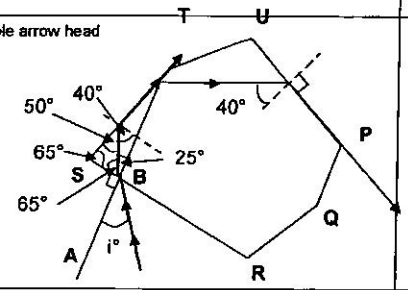
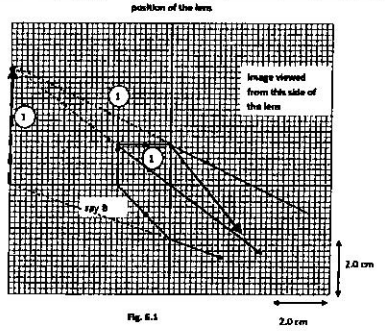
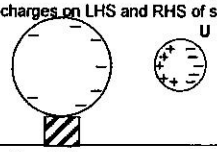
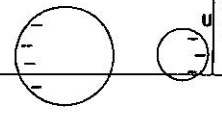
THE END

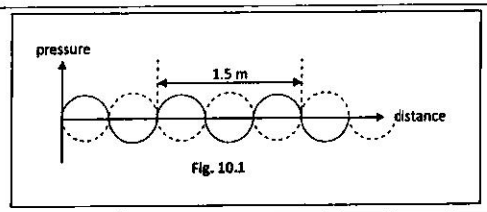
NCHS 2016

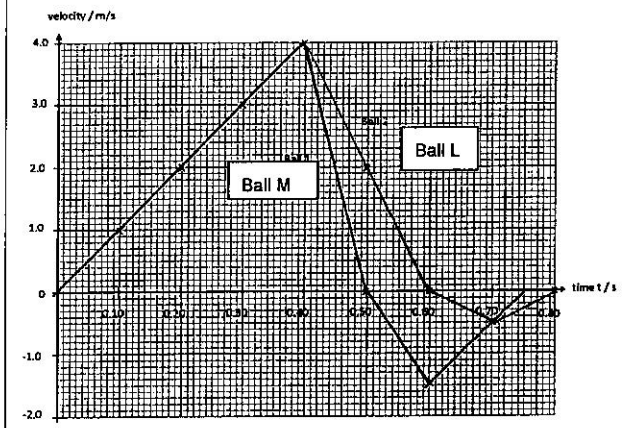
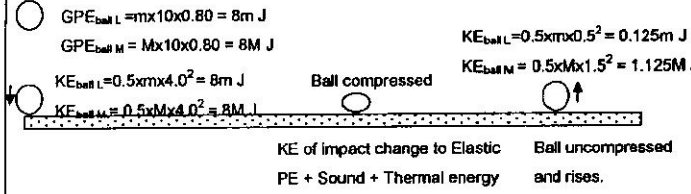
Paper 1 (40 marks)

1	2	3	4	5	6	7	8	9	10
A	C	D	B	D	B	C	B	A	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
D	A	C	D	C	D	D	A	D	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	A	A	B	A	C	B	B	B	B
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
D	B	C	D	A	D	A	B	B	A

Paper 2 Section A (60 marks)			
1	(ai)	>m, mass and g=10m/s^2 or W, weight >t, time he takes to reach the top and h, height of platform	[A1] [A1]
	(aii)	>Repeat or take several readings to find the average of h or t	[A1]
	(aiii)	>% error in timing t is significant in comparison for the time taken to complete his run. Or reaction time is not negligible in comparison to time of run.	[A1]
	(b)	P= mgh / t where P is Power or Wh/t	[A1]
2	(a)	>Horizontal line drawn longer than Drag line and opposite direction to Drag and Weight line drawn equal to Lift line but opposite direction 	[A1[]
	(b)	>Thrust > Drag >Lift = Weight	[A1] [A1
	(c)	>F=ma, or Thrust – 200 = 500 (2.4) >Thrust = 1,400 N	[B1] [A1]
	(d)	>Lift force is produced when the force of air from the central fan or boat hits the land and the lands reacts by exerting an upward force back to the hovercraft.	[A1]
3	(a)	>Moment is the turning effect and the magnitude is given by Force x perpendicular distance between line of action of force and pivot	[B1]
	(bi)	> sum of clockwise moments = sum of anti-clockwise moments W × 4.8 = (12 × (84) + (2.5 × (72) > W = 247.5 N = 248 N (3sf) or 250 N (2sf)	[M1] [A1]
	(bii)	> Imprecise due to either friction at the pivot or pivot is not a sharp point or small movement of weights The 2.5 N sliding weight has to move 4.8 cm away which is not measurable on the existing scale. >Improve by using smaller weights less than 2.5 N eg 0.50 N or oiling the pivot.	[M1] [A1]
4	(a)	>n = 1 / sin c = 1 / sin 40 >n = 1.5557 = 1.6 (2sf) or 1.56 (3sf)	[B1] [A1]
	(b)	>The angle of incidence is 0° and from sin i / sin r = n, r = 0° No mark if restate question or mention that beam is striking the surface at right angle or	[A1]

		angle i = 0° as answer is incomplete.	
	(ci)	>Correct drawing for new ray with double arrow head	
	(cii)	>sin i / sin 25 = 1.5557 > i = 41.1° (3sf) OR i = 41° (2sf) 	
5	(ai)	>P=hρg = 15 x 1000 x 10 >P = 150,000 Pa or 1.5 x 10^5 Pa	[B1] [A1]
	(aii)	>Total P = 100,000 + 150,000 = 250,000 Pa or 2.5 x 10^5 Pa	[A1]
	(b)	>Assume temperature remains the same when it is near the surface or at depth of 15 m. >At depth of 15 m, the volume is smaller so the air molecules are moving a shorter distance before it impacts on the balloon or the **frequency of collisions is higher although its speed of impact and KE remains unchanged.**	[A1] [B1]
	(c)	>The molecules of air are arranged in a random manner whereas the water molecules are loosely packed formation. The difference is no fixed arrangement for air versus regular arrangement for water or air molecules are further space apart than water molecules.	[A1]
6	(a)	>correct position (6 cm) or height for image (4.5cm) >drawing of ray passing through centre of lens and extending backwards to meet image. >correct drawing of second ray  Fig. 6.1	[A1] [A1] [A1]
	(b)	>A virtual image is an image that cannot be formed on a screen.	[B1]
	(c)	>f = 3.0 cm	[B1]
	(d)	>correct drawing using concept ray from of bottom of object originate from bottom of image	[B1]
7	(a)	>equal number of positive and negative charges on LHS and RHS of sphere U 	[B1]
	(b)(i)	>Unequal number of negative charges on C and U Note the total number of negative charges must be Equal to above diagram (Eg 5 and 2 neg charges for C and U) 	[B1] [B1]

		>Both negative charges	
	(bii)	>During contact electrons from RHS of sphere C flow to neutralise the positive charges on LHS of sphere U due to the potential difference or unlike charges attract. >Redistribution of electron charges occur and since like charges repel, the movable sphere U moves away.	[B1] [A1]
8	(a)	>The brightness of both lamps increases >because the potential of each lamp increases due to the drop in potential across R as V_{L1} + V_{L2} + $V_{rheostat}$ = 9.0 V	[B1] [A1]
	(bi)	>0 V	[B1]
	(bii)	>Increase in brightness	[B1]
	(c)	>The brightness of L_1 in the night is not lit because the resistance of LDR is very large compared to resistance of L_1.	[B1]
9	(a)	> The adjacent coils have current flowing in the same direction. This results in the adjacent coils attracting each other as combined magnetic field of all the various concentric fields produces an attractive forces in the upwards direction. > When the current reaches a certain value, this upwards force is greater than the weight of the coil which is acting downwards.	[B1] [B1]
	(b)	>On losing contact, the compressed coil extends itself and touches the mercury again[1]. > It will oscillate up and down and the lamp blinks at regular intervals[1].	[A1] [A1]
	(c)	>The coil will compress more/becomes shorter and the lamp will blink at a slower rate [1]. >The coil will rise higher and fall through a bigger distance. This results in a bigger time interval between the lamp switching off and lighting up [1].	[A1] [A1]
Section B			
10	(ai)	>wavelength = 1.0 m	[B1]
	(aii)	>f = v / λ = 340 / 1.0 >f = 340 Hz	[B1] [A1]
	(aiii)	>T=1/f = 1/340 = 2.94 x 10^{-3} s	[B1]
	(b)	>correct shape >correct amplitude and position  Fig. 10.1	[B1] [B1]
	(ci)	>Region X is shallower >smaller wavelength for X compared to Y	[B1] [B1]
	(cii)	>A wavefront is an imaginary line on a wave that joins all adjacent points that are in phase.	[B1]
	(ciii)	The wavefront is the bright line formed by the converging action of the adjacent wave crest of an advancing wave. The darkest region which is at the centre of the wavelength is formed by the diverging action of the trough.	[A1]

11	(a)	>Points plotting >Label Ball 1 as ball M and ball 2 as ball L correctly >Shape. Most student loses this mark as they will draw line joining 0.70 s to 0.80 s directly instead to 0.75s and then a horizontal line.  	[B1] [B1] [A1]
	(b)	>Ball M has more air/mass and a higher pressure results in a larger force of impact on the ground. From N3L, the Reaction Force from ground to ball pushes the ball to rebound..	[B1]
	(c)	>Distance = area = 0.5 x 0.40 x 4.0 >Distance = 0.80 m	[B1] [A1]
	(d)	>Both balls travels the same distance before it hits the ground at 0.40 s. Or on the graph both line coincides for 0 to 0.40 s.	[B1]
	(d)	>Rebound velocity of ball L = -0.50 m/s	[B1]
	(e)	 >From POCOE, energy before impact = energy after impact. >As speed of rebound of ball L(=0.50 m/s) < speed of rebound of ball M (=1.50 m/s), KE of rebound of ball L during rebound < KE of rebound of ball M during rebound, implies energy lost for ball L during impact > energy lost for ball M during impact Assume mass of ball L = 0.9 kg, mass of ball M=1.0 kg Energy lost during impact = KE before impact – KE after impact Ball L:=0.5 x 0.9 x(4.0^2 – 0.5^2) = 7.0875 J Ball M = 0.5 x 1.0 x (4.0^2 – 1.5^2) = 6.875 J Hence more energy is lost for ball L. as 7.0875 J> 6.875 J OR a smaller KE of the first rebound implies more energy is lost to the ground as sound and thermal energy	[B1] [B1]

12E	(a)	>Hair dryer produces fast moving hot air molecules which collide with the water molecules on the hair and transfer thermal energy to it. >More water molecules increase its KE and they move more vigorously. >The larger number of fast moving surface water molecules successfully breaks the bonds of attraction between the remaining molecules and doing work to overcome atmospheric force. OR combine with >The water molecules once evaporated from the hair are removed away by the movement of the air molecules from the motor thus freeing up the space for the remaining water molecules to escape. > The water molecules can evaporated at a greater rate at a lower humidity level as the hot air from the motor reduces the water moisture level in the air	[B1] [B1] [B1]
	(bi)	>Heat lost by heater in 1 s = heat gained by air in 1 s $V^2/R = mc(\Delta\theta)$ or $2402/30 = 0.055 \times 1000 \times \Delta\theta$ $\Delta\theta = 34.9$ >Temperature of air flowing out = 34.9 + 25 = 59.9 °C or 60 °C	[B1] [A1]
	(bii)	>Assume room temperature is constant or >Assume no heat is lost by the heating circuit to other parts of the circuit or >All the heat energy is transferred to the cold air and not lost to the surrounding eg by radiation Or >Assume resistance of motor is zero ohm.	[B1]
	(c)	>No change in temperature >because pd across the heater is unchanged in a parallel circuit OR the addition of resistor R only reduces current flow to the motor and speed of rotation of the motor produces moving cool air at a slower rate.or OR temperature of air will be hotter <u>after a while</u> because the incoming air later has smaller mass of air per second (=flow rate) and will be heated up.	[B1] [B1]
	(d)	>Total Power of heating element and motor $= 240^2/30 + 240^2/20 = 1920 + 2880 = 4,800$ W >Cost = (4,800/1000) x (10/60) x 20 = 16.6 cents	[B1] [A1]
12 OR	(e)	>The induced e.m.f in coil B is due to a change in the magnetic flux linkage created by coil A on coil B when current flows in coil A making it an electromagnet. >When the current is steady, there is no change in magnetic flux linkage between the two coils although there is magnetic flux linkage between the 2 coils. Zero change results in no emf induced according to Faraday's law of electromagnetic induction.	[B1] [B1]
	(fi)	>Direction of current in the outer coil of B is to the right in Fig.12.4	[B1]
	(fii)	>By Lenz's Law, the induced current must be in such a direction as to oppose the decreasing magnetic flux linkage from A to coil Bwhen the switch is off. >The induced current thus produces a North pole at the end of coil B that is facing coil A to oppose the weakening or moving away south pole at the bottom of coil A. >From Fleming's Right Hand Grip rule, the thumb indicates the direction of North pole and the direction of the curled fingers indicate the direction of the convection current.	[B1] [B1]
	(g)	>P=VI, I=P/V = I_S = 24/12 = 2.0 A	[B1]

		>$I_P/I_S = V_S/V_P$ I_P =(12/16) x 2.0 = 1.5 A	[B1]
	(hi)	>Input Power = IV = 1.7 x 16 = 27.2 W	[B1]
	(hii)	>Lost power = 27.2 – 24 = 3.2 W	[B1]
	(hiii)	>Copper loses ie. Work done against the resistance of the copper wire OR Eddy Current loses OR Leakage of Magnetic flux OR Hysteresis Loses	[B1]

The END