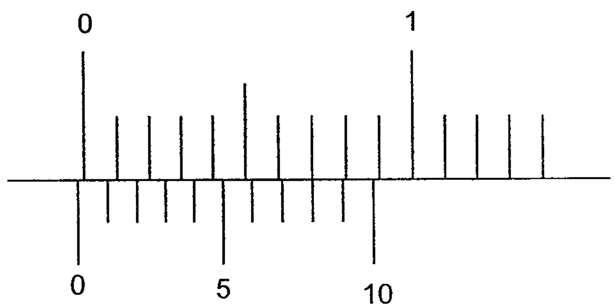
This paper consists of **14 printed pages**, INCLUDING the cover page.

1. Which of the following is an SI base unit?

   A Ampere **B** Joule **C** Newton **D** Watt

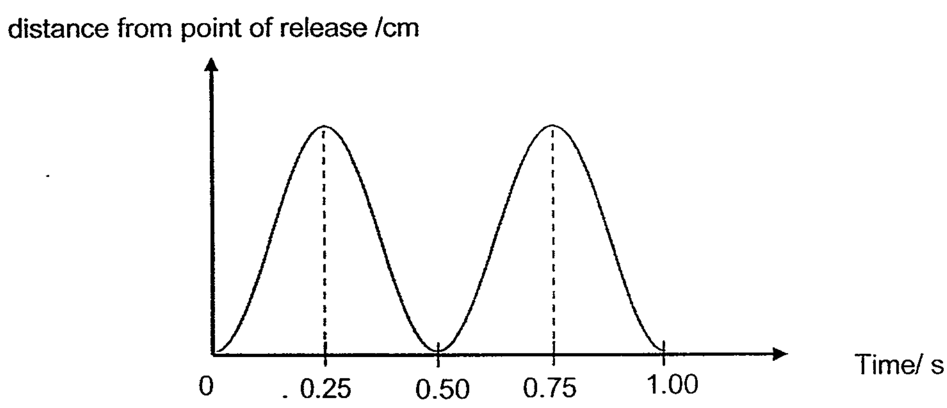
2. The reading on a vernier callipers when an object is between its jaws is 2.55 cm.
   The diagram below shows the reading of the vernier callipers without any object between its jaws.



What is the actual length of the object?

A 2.47 cm **B** 2.53 cm **C** 2.57 cm **D** 2.63 cm

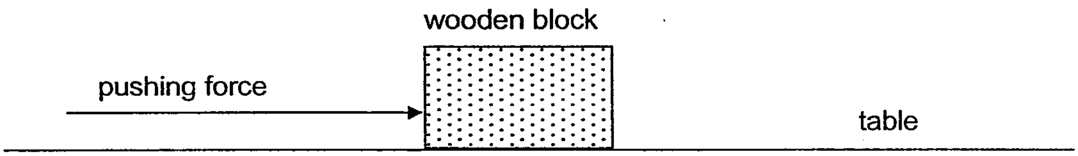
3. The bob of a pendulum is pulled slightly to one side and released. The motion during its swing is shown on the graph below.



Which statement is correct?

A The acceleration of the pendulum bob at time = 0 s is zero.
B The kinetic energy at time = 0 s is the maximum.
C The period of the pendulum is 1.00 s.
D The velocity of the pendulum bob at time = 0.50 s is the minimum.

4. A wooden block is pushed across a table at constant speed.

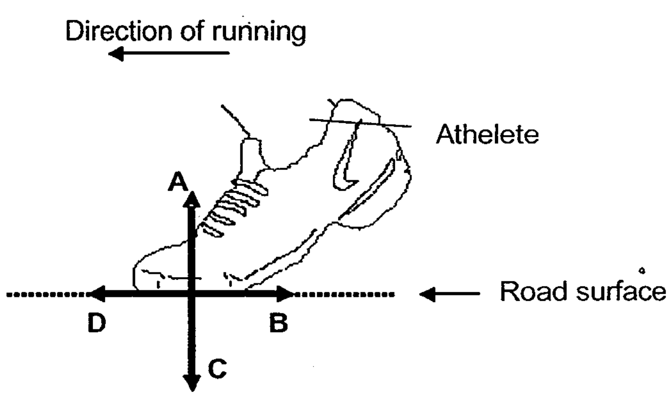


Which statement is correct?

A The frictional force increases as the block moves.
B The frictional force is equal and opposite to the pushing force.
C The frictional force is less than the pushing force.
D The frictional force is more than the pushing force.

5. The figure below shows the foot of an athlete as he is about to start running.

In which direction does the frictional force act on the sole of his shoe?



6. An object weighs 250 N on planet Jupiter where the gravitational field strength is 25 N/kg.

What is the weight of the object on Earth? (Earth's gravitational field strength is 10 N/kg.)

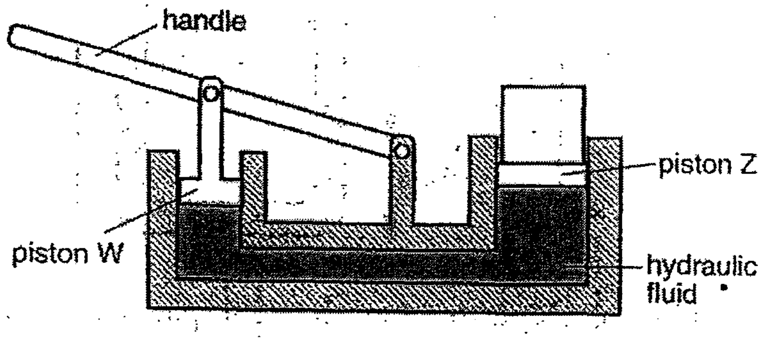
A 10 N **B** 100 N **C** 250 N **D** 2500 N

7. Four objects are each made from a different material. The masses and volumes of the objects are shown below.

Which object has the highest density?

	mass	*volume*
A	50 g	25 cm^3
B	150 kg	20 m^3
C	10 kg	500 cm^3
D	4000 kg	25 m^3

8. The diagram below shows a simple hydraulic jack.



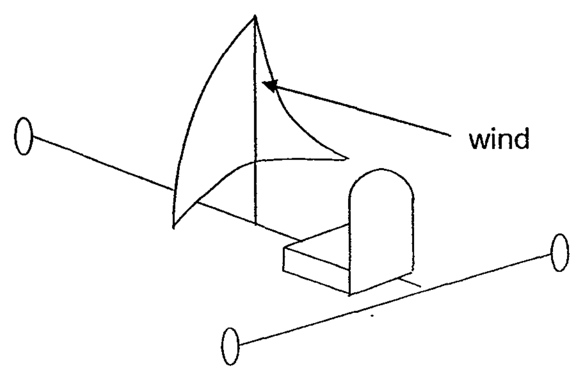
Which of the following alterations will enable heavier loads at piston Z to be lifted?

	diameter of W	diameter of Z
A	doubled	halved
B	doubled	remained the same
C	halved	doubled
D	remained the same	halved

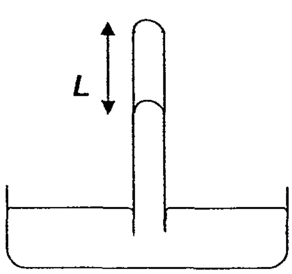
9. A dune buggy at rest has a sail of area 6 m^2. Wind blowing at the sail creates an excess pressure of 5×10^2 Pa on it.

If the mass of the buggy including the driver measures 120 kg, what is the acceleration of the buggy?

A 0.69 ms^{-2}
B 2.5 ms^{-2}
C 5.0 ms^{-2}
D 25 ms^{-2}

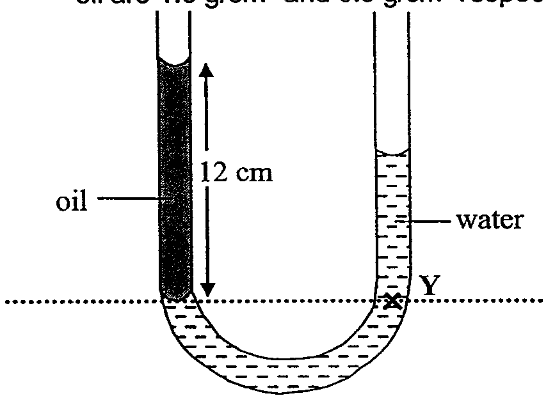


10. The figure shows a simple liquid barometer. Which of the following will **not** cause the length *L* to change?



A Evaporation of some liquid in the reservoir.
B Using a different liquid.
C Bringing the barometer to a different altitude.
D Leakage of air into the tube.

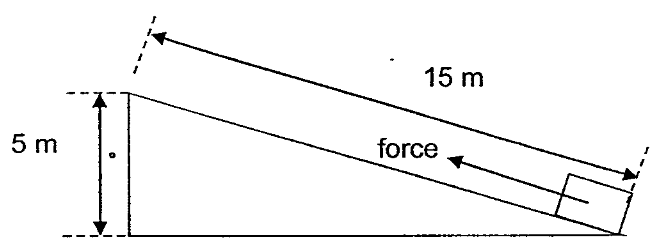
11. A U-tube containing oil and water is shown in the diagram below. The densities of water and oil are 1.0 g/cm³ and 0.9 g/cm³ respectively.



What is the length of the water column above point **Y**?

A 9.0 cm **B** 10.8 cm
C 12.0 cm **D** 13.3 cm

12. An object of mass 20 kg is pulled up a slope of 15 m long. The frictional force between the object and the slope is 30 N.



Calculate the minimum work done by the pulling force. (Take g = 10 N/kg)

A 300 J **B** 450 J **C** 1000 J **D** 1450 J

13. A motor pumps water from a well 10 m deep and projects the water horizontally at a speed of 15 m s^{-1}. If the rate of flow of water from the pipe is 1200 kg min^{-1}. What is the power of the motor?

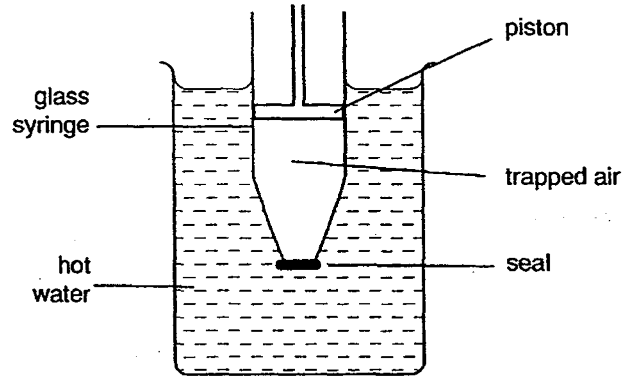
A 4.3 kW **B** 2.6 kW **C** 260 kW **D** 430 kW

14. When a pure substance is being heated, which of the following statements are correct?

I Its internal energy always increases.
II Its kinetic energy and potential energy cannot rise at the same time.
III Its temperature always increases.

A I only **B** I and II only **C** II and III only **D** I, II and III

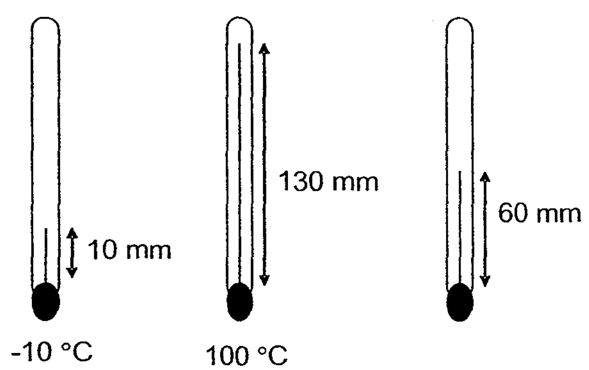
15. The outlet of a glass syringe is sealed so that air is trapped below the piston. The piston begins to rise when the syringe is placed in hot water.



Compare the average speed of the air molecules and their frequency of collision with the piston with the initial values at the lower temperature once the piston stop moving.

	average speed	frequency of collision with walls
A	increases	decreases
B	increases	increases
C	increases	unchanged
D	unchanged	increases

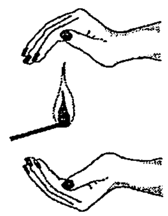
16. The length of mercury thread in a laboratory thermometer is found to be 10 mm and 130 mm at -10 °C and 100 °C respectively.



What is the temperature when the length of the mercury thread is 60 mm?

A 35°C **B** 45°C **C** 55°C **D** 65°C

17. A lighted match is placed between two hands, one at the top and the other at the bottom as shown below.



What is/are the main process(es) for which heat energy reach the hands at the top and bottom?

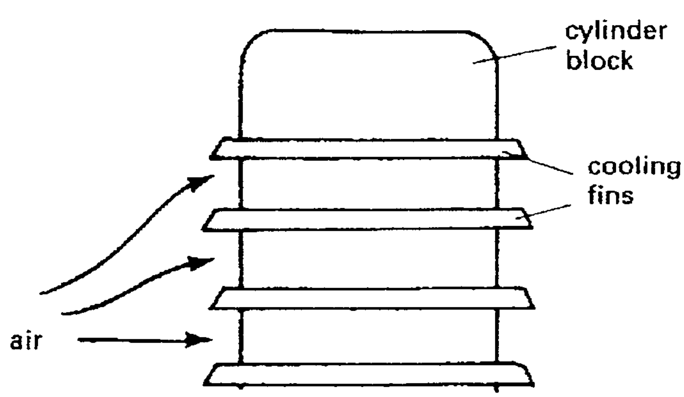
	hand at the top	hand at the bottom
A	conduction and convection	conduction only
B	conduction and convection	radiation only
C	convection and radiation	conduction only
D	convection and radiation	radiation only

18. An object A has a mass of m kg and specific heat capacity c $Jkg^{-1}K^{-1}$ and temperature of 60 °C. An object B has a mass of $2m$ kg and specific heat capacity $2c$ $Jkg^{-1}K^{-1}$ and temperature of 30 °C.

If object A and B are brought into contact, what will be the final temperature reached? Assume no thermal energy is lost to the surroundings.

A 20 °C **B** 36 °C **C** 45 °C **D** 50 °C

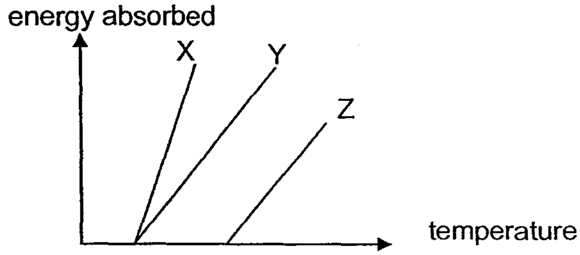
19. The diagram shows an engine block of a motorcycle. The engine block gets very hot.



Which of the following actions would enable the engine block to cool down most quickly?

A decreasing the air flow over the block
B decreasing the surface area of the fins
C painting the fins dull black
D polishing the fins of the block

20. Equal masses of X, Y and Z are separately heated. The graph below shows the variation of the energies absorbed by the liquids with their temperatures. Let c_x, c_y and c_z be the specific heat capacities of X, Y and Z respectively. Which of the following relationship between c_x, c_y and c_z is correct?



A $c_x = c_y > c_z$
B $c_x < c_y = c_z$
C $c_x > c_y > c_z$
D $c_x > c_y = c_z$

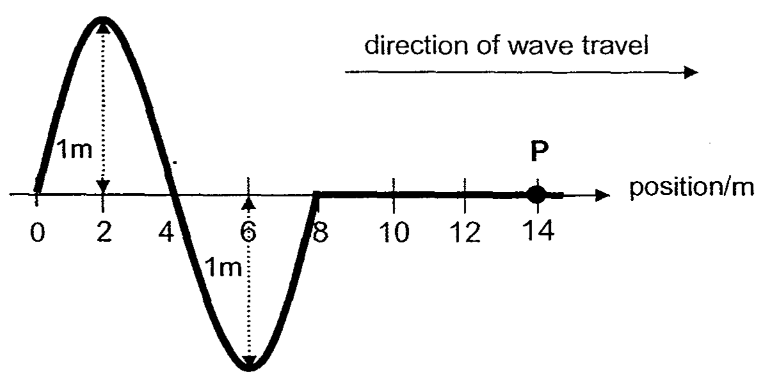
21. When a little ether is spilt on the hand, it feels very cold. In the case of water, it is almost unnoticeable. Explain the observation.

A ether evaporates much more quickly than water
B ether has a greater specific heat capacity
C ether has a higher boiling point
D ether has a lower temperature

22. Which of the following statement is true about a transverse wave?

A It transfers energy.
B It has compressions and rarefactions.
C Its speed is the same in vacuum and any medium.
D Sound is a form of transverse wave.

23. The graph represents a wave pulse travelling along a rope at 2 m/s in the direction shown by the arrow.



From the moment shown, what is the shortest time needed for point **P** on the rope to have an amplitude of 1m?

A 4.0 s B 6.0 s C 8.0 s D 16.0 s

24. Which property applies to γ-rays, ultra-violet light and microwaves?

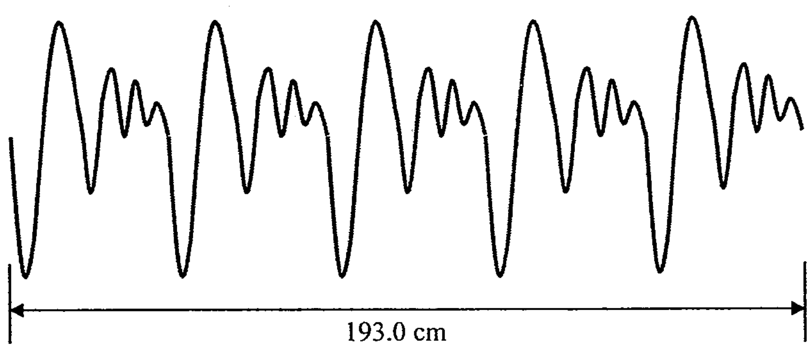
A They are all damaging to health.

B They all have similar wavelengths.

C They are all affected by magnetic fields.

D They all travel with the same speed in vacuum.

25. The waveform of a violin's musical note is shown in the figure below.



What is the frequency of the musical note? (Given that the speed of sound in air is 340 ms^{-1}.)

A 880 Hz B 528 Hz

C 352 Hz D 176 Hz

26. The e.m.f. of a cell is labelled as 1.5 V. This means that that the cell can provide 1.5

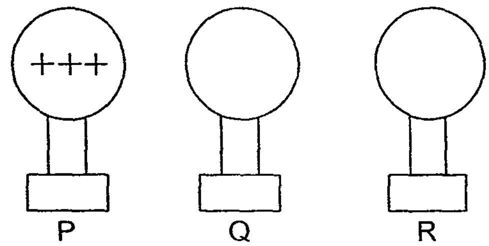
A amperes of current.

B coulombs of charges.

C joules of energy per coulomb of charge it delivers.

D joules of energy per ampere of current it delivers.

27. P, Q and R represent three conducting spheres of copper mounted on insulating stands. At the start of an experiment, P is given some positive charges, but Q and R are left electrically neutral. When R is momentarily earthed, which of the following statements describes the charges on Q and R correctly?



A Q and R both carry excess positive charges.

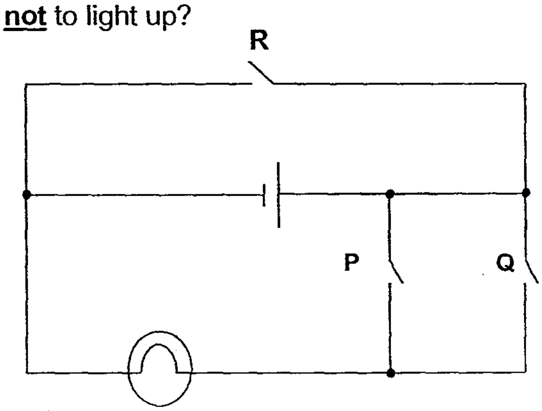
B Q and R both carry excess negative charges.

C Q carries excess negative charges but R carries excess positive charges.

D Q remains neutral but R carries excess negative charges.

28. A light bulb is designed to operate using three switches P, Q and R as shown below. Which of the following conditions will cause the bulb **not** to light up?

	P	Q	R
A	off	on	off
B	off	off	on
C	on	off	off
D	on	on	off

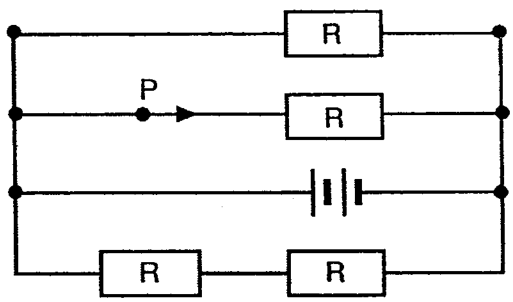


29. Nowadays, fuse wires are usually replaced with circuit breaker.

What is the design of the circuit breaker based on?

A Motor effect of current
B Heating effect of current
C Magnetic effect of current
D Electromagnetic induction

30. In the circuit, all resistors are identical. If the current at P is 0.50 A, the current from the battery is________________.



A 0.50 A

B 1.25 A

C 1.50 A

D 2.00 A

31. A tungsten wire of length L, and cross-sectional area A, has a resistance of R. Henry uses another piece of tungsten wire of the same length with cross sectional area 2A and cuts it into 5 equal pieces. Find the resistance of each piece of wire in terms of R.

A 0.1 **R**

B 2.5 **R**

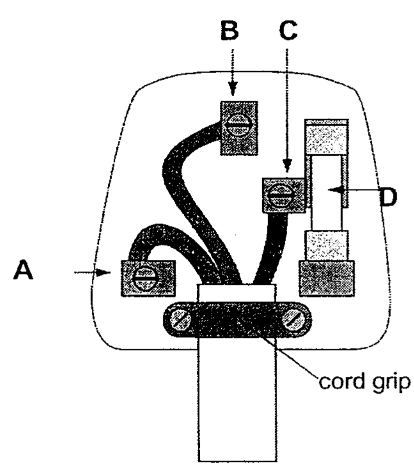
C 5 **R**

D 10 **R**

32. An electrical heater has a resistance of 30 Ω. It is connected to a power supply of 200 V. What is the power of the heater and a suitable rating for the fuse?

	Power	Fuse Rating
A	6000 W	10 A
B	6000 W	5 A
C	1333 W	10 A
D	1333 W	5 A

33. In the diagram shown below, which component is crucial in preventing current in the circuit from getting too large?



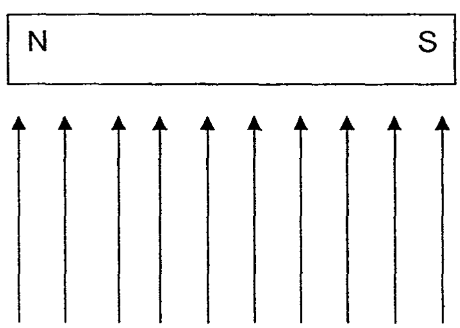
34. Electrical energy is transmitted at high alternating voltages. Which of the following is not a valid reason for doing this?

- **A** At high voltage, a.c is safer than d.c.
- **B** For a given power, there is lower current with a higher voltage.
- **C** There is a smaller energy loss at higher voltage and lower current.
- **D** The transmission lines can be thinner with a lower current.

35. Which of the following is an example of induced magnetism?

- **A** a compass needle pointing north
- **B** a north pole attracting iron filings
- **C** a north pole repelling a north pole
- **D** the coil of a motor turning in a magnetic field

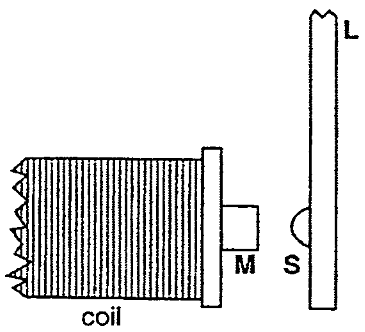
36. The diagram shows a bar magnet being placed in a magnetic field.



What will happen to the bar magnet?

- **A** The bar magnet does not react to the magnetic field.
- **B** The bar magnet moves in the direction of the field.
- **C** The bar magnet moves in the opposite direction of the field.
- **D** The bar magnet rotates clockwise by 90.

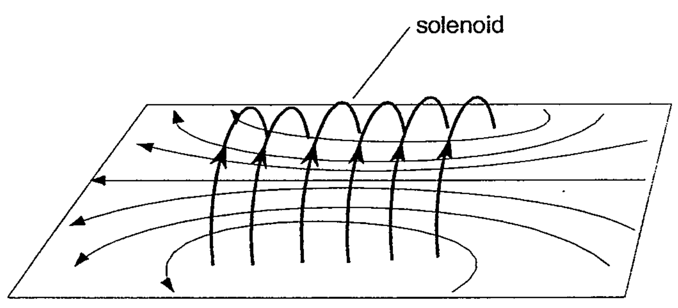
37. The diagram shows part of a magnetic relay. M is part of the core of the magnet. L is part of the armature which is attracted to the core when a current flows through the coil. S is a stud which stops the armature from being attracted too strongly.



Which line of the table gives the best materials for M, L and S?

	M	L	S
A	copper	iron	iron
B	Iron	iron	copper
C	iron	copper	copper
D	copper	copper	copper

38. The magnetic field set up by a solenoid is shown below.



Which of the following actions will cause the field lines to move closer together?

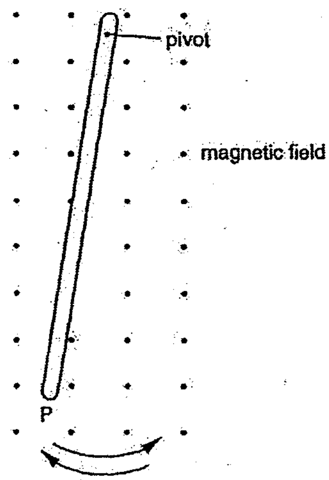
A Placing a piece of copper bar in the solenoid.

B Placing copper bars at the two ends of the solenoid.

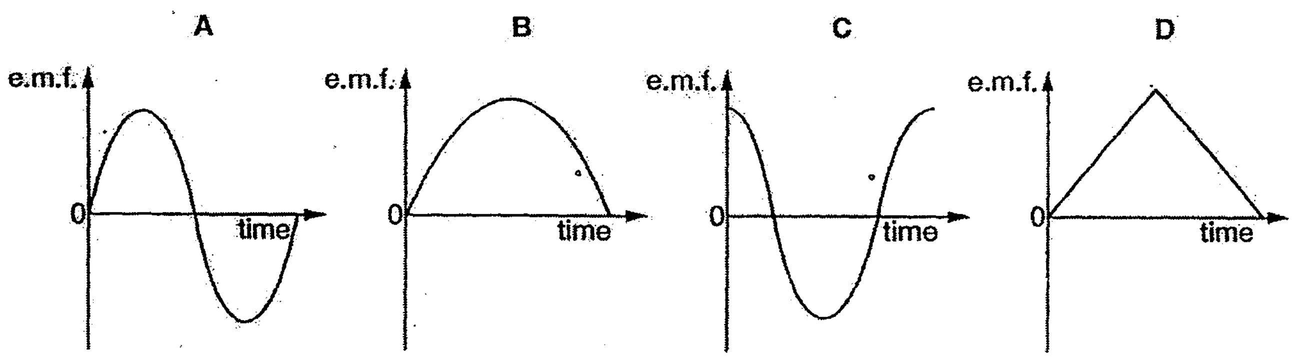
C Using alternating current instead of direct current.

D Adding more turns to the solenoid.

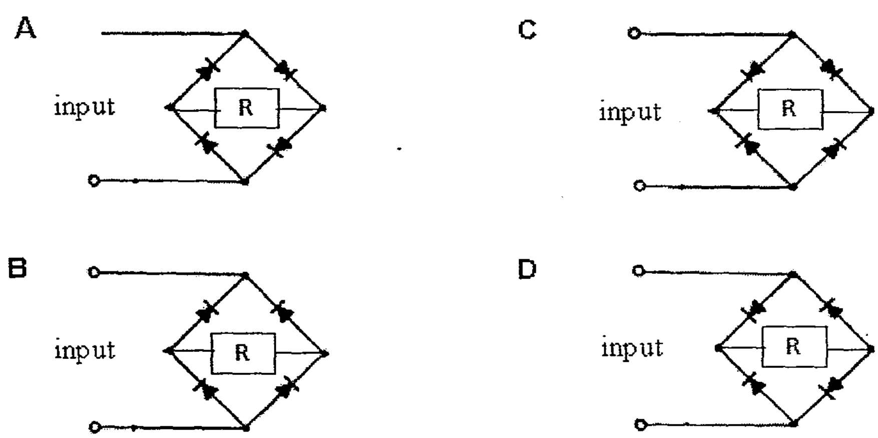
39. The diagram shows a metal bar swinging like a pendulum across a uniform magnetic field. The motion induces an emf between the ends of the bar.



Which graph represents this emf during one complete oscillation of the bar, starting and finishing at P?



40. Which circuit provides full wave rectification of the a.c. input across the resistor R?



Section A

Answer all questions. Show all workings.

For Examiner's Use

1

Fig 1.1

Fig 1.1 shows a lunar landing craft descending vertically towards the Moon surface. There are two stages in the landing process.

During Stage 1, the upward thrust of the rocket engine is 2.4×10^4 N such that the craft moves vertically towards the surface of the moon with a steady speed of 600 m/s. Stage 1 lasts 15 min.

The thrust is increased to 2.6×10^4 N during Stage 2, allowing the craft to land on the surface of the Moon with a speed of 400 m/s.

The acceleration due to gravity on Moon is 1.6 N/kg.

(a) **(i)** On Fig 1.2, draw two forces acting on the craft during Stage 1. Label them clearly. [1]

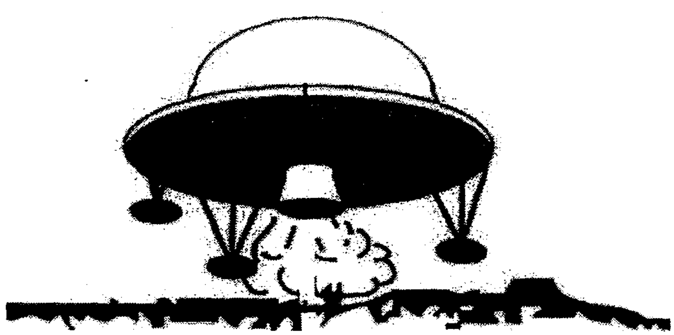


Fig 1.2

(ii) Hence or otherwise, determine the mass of the aircraft.

mass =............ [1]

For Examiner's Use

(b) **(i)** Find the acceleration of the craft during Stage 2.

acceleration =............ [1]

(ii) Determine the time taken for the craft to complete Stage 2.

time taken =............ [1]

(c) **(i)** On Fig. 1.3, sketch the velocity-time graph of the craft, labelling clearly the two stages of its motion during its descent.

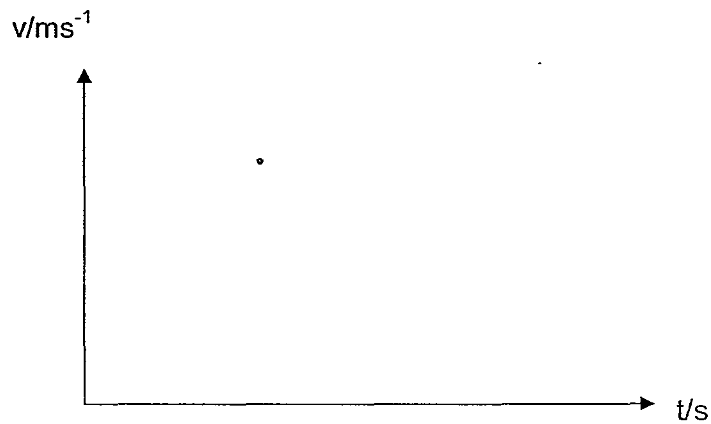


Fig. 1.3

[1]

(ii) Suggest why lunar landing crafts do not use parachutes for their landing process.

....

....[1]

For Examiner's Use

2 Fig 2.1 shows a skier of mass 60.0 kg jumping off a ramp **ABC** in a Winter Olympic Games. In this competition, the ultimate goal for the skier is to cover the maximum possible horizontal distance.

The skier starts rest at **A**, reaches maximum height at **D**, before landing at **E**. The ramp has negligible frictional force.

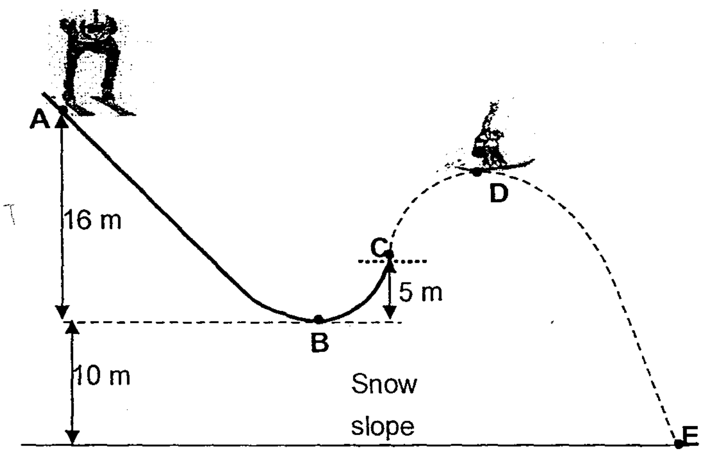


Fig. 2.1

(a) Calculate the speed of the skier at **C**.

speed =............ [2]

(b) Just before landing at **E**, the skier has a speed of 24 m/s. Find the work done against air resistance during his journey from **C** to **E**.

Work done =............ [1]

(c) When the skier is in an equilibrium position, the normal reaction force, **R** exerted by the skis on him, is 400N, at an angle of 40° to the vertical.

Two forces experienced by the skier, **R** and **W**, are indicated in Fig. 2.2.

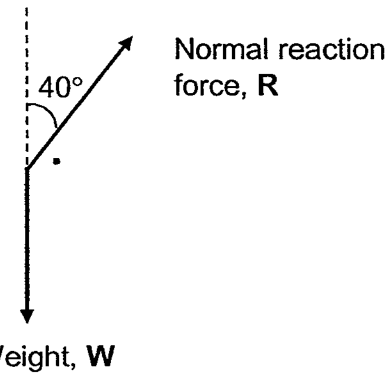


Fig. 2.2

Using a labelled vector diagram, determine the magnitude and direction of the air resistance experienced by the skier.

Your vector diagram should show forces in the same orientation as Fig. 2.2. (i.e. **W** must be vertically downward).

air resistance =............ [4]

For Examiner's Use

3 **(a) (i)** Explain, with the aid of diagram(s), why the centre of gravity of a freely suspended object will always be directly below the point of suspension when the object comes to rest.

....

....

....

....[2]

(ii) Baby Emily is learning to roll on the ground. Fig. 3.1 shows a simplified version of Emily, with her tummy and both hands on the ground. Fig. 3.2 shows Emily moving into a new position, such that her body is pivoted about one side of her body. The positions of her center of gravity are as shown.

State and explain if baby Emily is in a stable equilibrium in Fig. 3.2.

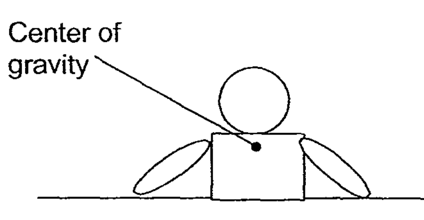


Fig. 3.1

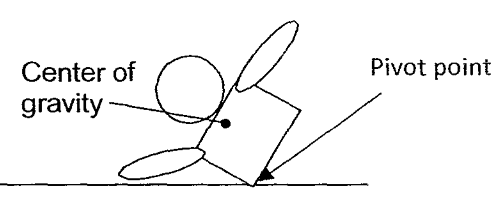


Fig. 3.2

....

....

....

....

....[2]

For Examiner's Use

(b) Define *moment exerted by a force.*

....

....

....[1]

(c) A water wheel has eight buckets equally spaced around its circumference, as illustrated in Fig 3.3. The distance between the centre of each bucket and the centre of the wheel is 1.6 m.

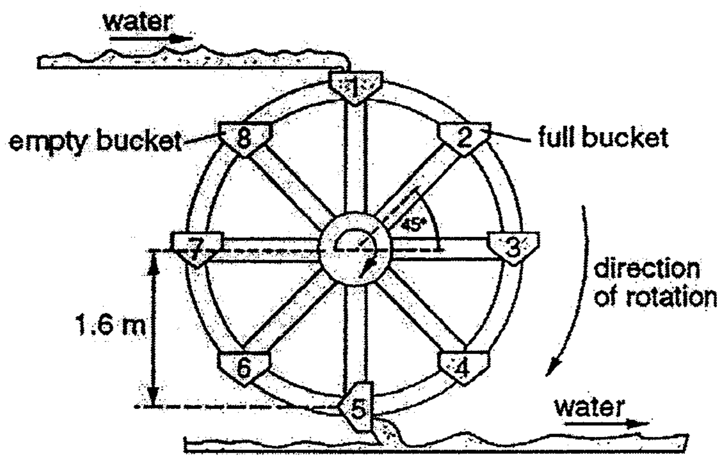


Fig 3.3

When a bucket is at its highest point, it is filled with 40 kg of water. The mass of each bucket is negligible. The wheel rotates in a clockwise manner and the bucket is emptied at its lowest point.

(i) Calculate, for the wheel in the position shown in Fig 3.3, the moment due to the water in bucket 3 about the centre of the wheel.

moment =............ [1]

(ii) State if the moment due to water in bucket 2 about the centre of the wheel is bigger or smaller than your answer in **(i)**.

....

....[1]

For Examiner's Use

4 (a) Fig. 4.1 shows a section of an optical fibre with the refractive index of n = 1.46. A ray of light from air is incident on the fibre at an angle of 30°.

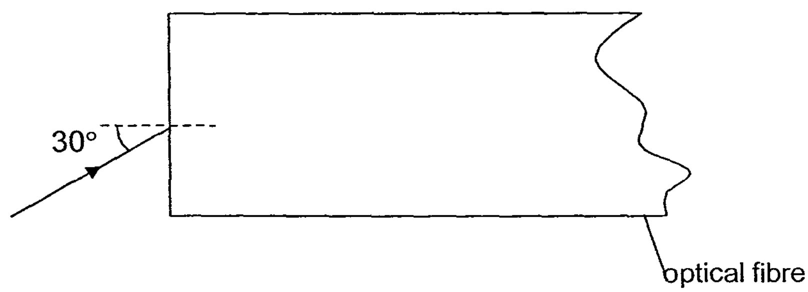


Fig. 4.1

On Fig. 4.1, complete the path of light ray until it emerges from the fibre. Label clearly the normal and angles of incidence and refraction each time the ray meets a boundary. Show all calculations in the space below. [3]

(b) Fig. 4.2 shows the side view of a gold disc of mass 300 kg that just fits within a container. Some gas is trapped by the disc. The cross-sectional area of the bottom end of the gold disc exposed to the gas is 50 cm^2.

Atmospheric pressure is 76 cmHg. The density of gold and mercury is 19.3 g/cm^3 and 13.6 g/cm^3 respectively.

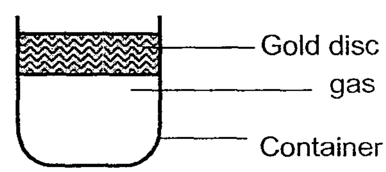


Fig. 4.2

(i) On Fig. 4.2, show the force exerted by the gas on the gold disc. [1]

(ii) Find the pressure exerted by the gas that is trapped in the container.

pressure =............ [1]

For Examiner's Use

5 **(a)** The tuning dial on a radio displays three different bands which are labelled frequency modulation (FM), medium wave (MW) and long wave (LW) respectively. The frequency range for each band is shown below.

Band	**Frequency Range**
FM	88 -108 MHz
MW	540- 1600 kHz
LW	150 - 270 kHz

(i) The radio receives a signal with a wavelength of 1200 m. To which of the above bands is the radio tuned?

band =............ [2]

(ii) What kind of wave is used in satellite TV programmes broadcast?

....

....[1]

(b) Fig. 5.1 shows a ship emitting ultrasonic waves to measure the sea depth.

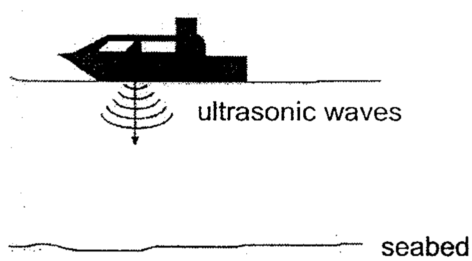


Fig. 5.1

Explain why the ultrasonic waves but not the audible sound is used in this detecting method.

....

....

....[1]

(c) Fig. 5.2 shows a longitudinal wave in a slinky spring is travelling to the right. The period of the wave is 40 s.

For Examiner's Use

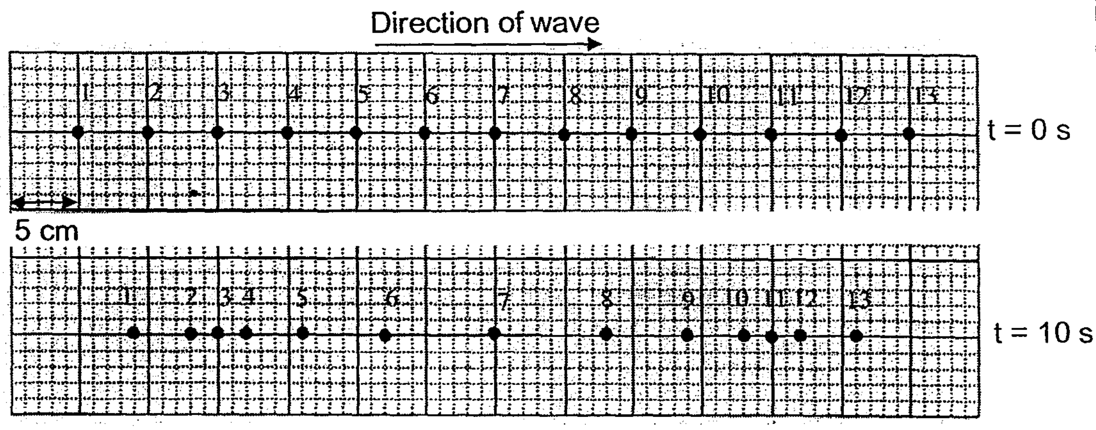


Fig. 5.2

(i) Sketch the displacement-distance graph of the wave at t = 10s. Take the direction to the right as positive. Label clearly all values on the graph. [2]

(ii) Hence state the amplitude and wavelength of the wave.

amplitude = ...

wavelength = ... [1]

6 **(a)** Fig. 6.1 shows a positively charged metal sphere **A** on an insulating stand d an uncharged metal sphere B on an insulating stand.

For Examiner's Use

Discuss how sphere **A** induces a charge on sphere **B**. Include additional apparatus necessary to achieve this. State the final charge on sphere **B**.

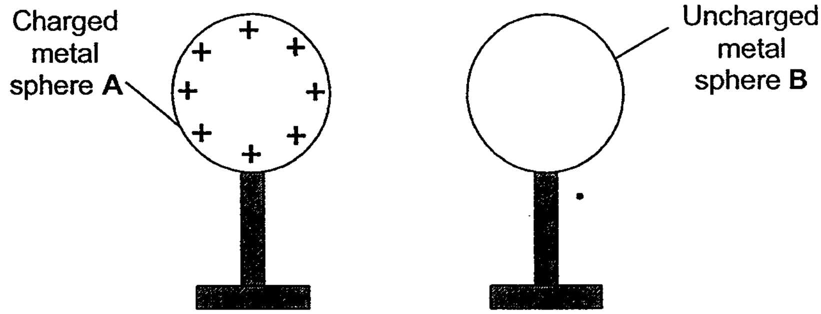


Fig. 6.1

....

....

....

....

.... [2]

(b) **(i)** Briefly explain what is meant by *double insulation*.

....

....

....[1]

(ii) On Fig. 6.2, sketch the wiring in the mains plug of an electrical component. Label the earth, live, neutral wires and the fuse. [1]

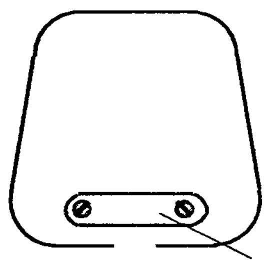


Fig. 6.2

7 Fig. 7.1 shows a circuit with two cells of emf 1.5V each, four identical resistors, two switches and an ammeter. Switch 1 is open and switch 2 is closed. The current I_1 is observed to be 5.0 mA.

For Examiner's Use

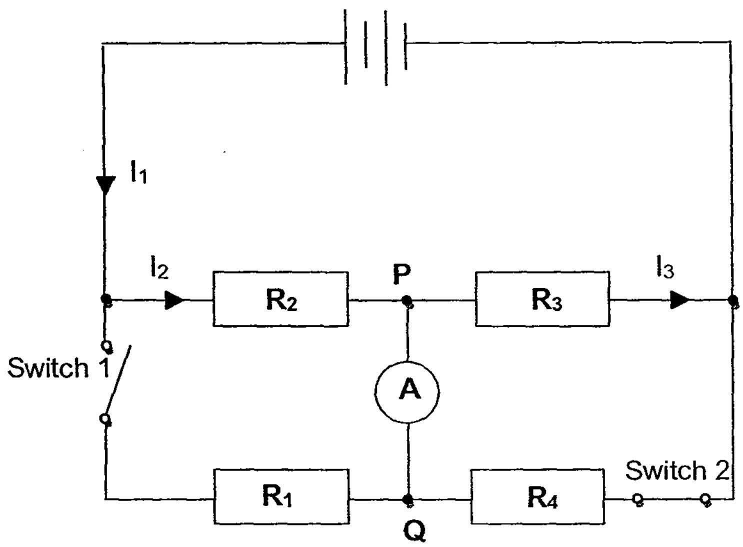


Fig. 7.1

(a) (i) Find the total amount of charge flowing through the circuit in 2.0 min.

charge =............ [1]

(ii) Determine the current I_3 through R_3.

current, I_3 =............ [1]

(iii) Find the resistance of R_3.

resistance =............ [1]

(b) Switch 1 is now closed.

(i) Determine the new value for the total current in the circuit, I_1'.

current I_1' =............ [1]

(ii) Without calculation, explain its impact on current I_2 through R_2.

....

....

....[1]

(iii) State and explain the ammeter reading across **PQ**.

....

....

....[1]

(c) Fig. 7.2 shows high voltage cables transmitting electrical energy from the power station to office towers.

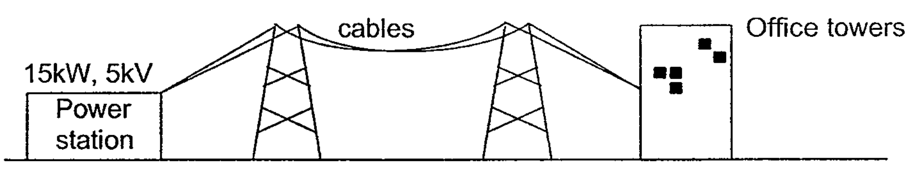


Fig. 7.2

The power station generates 15kW of electricity that is transmitted at a voltage of 5kV across the cables. The net resistance of the cables is 200Ω. Calculate the power loss in the cables.

power loss =............ [2]

For Examiner's Use

8 Fig. 8.1 shows a set up consisting of two similar metal rods, **AB** and **CD**. Both rods are equal in length but of masses 2m and m respectively. The rods are connected by wires of negligible masses and hung over a smooth wooden support.

The set up is initially at rest. You may assume that air resistance and friction in the system are negligible.

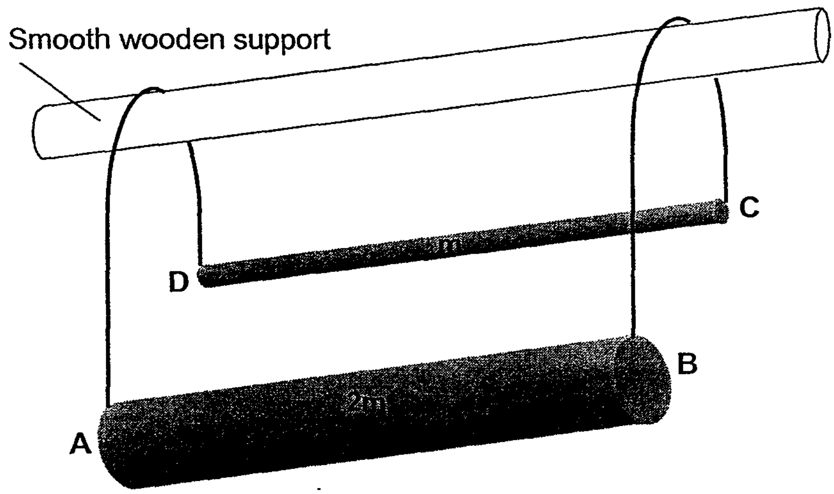


Fig. 8.1

(a) The set up is now placed between two magnetic poles. Fig. 8.2 shows the side view of the set up and the magnets. On Fig. 8.2, draw the magnetic field lines between the magnets.

[1]

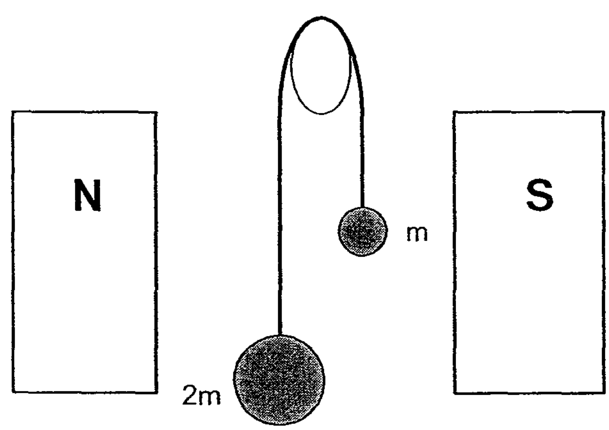


Fig. 8.2

(b) **(i)** The system is now released from rest. State and explain which will slide down first.

....

....[1]

For Examiner's Use

(ii) Using laws of electromagnetic induction (EMI), account for the current flowing in rods **AB** and **CD**. Draw arrows on Fig. 8.1 to indicate the direction of flow of current.

....

....

....

....

....

....

....

....

....

....

....[3]

(c) Rod **CD** is replaced with another rod of mass 8m. State the effect of this change on the magnitude and direction of the current in rod **CD**.

....

....[1]

Class	Index Number	Name

For Examiner's Use

Section B

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

9 A pupil wants to investigate the variation of the magnitude of the force on a wire with the current flowing through it under the action of a magnetic field. He sets up the apparatus as shown in Fig. 9.1. One end of the wire is pivoted at the joint while its other end is placed in contact with a small tank of mercury.

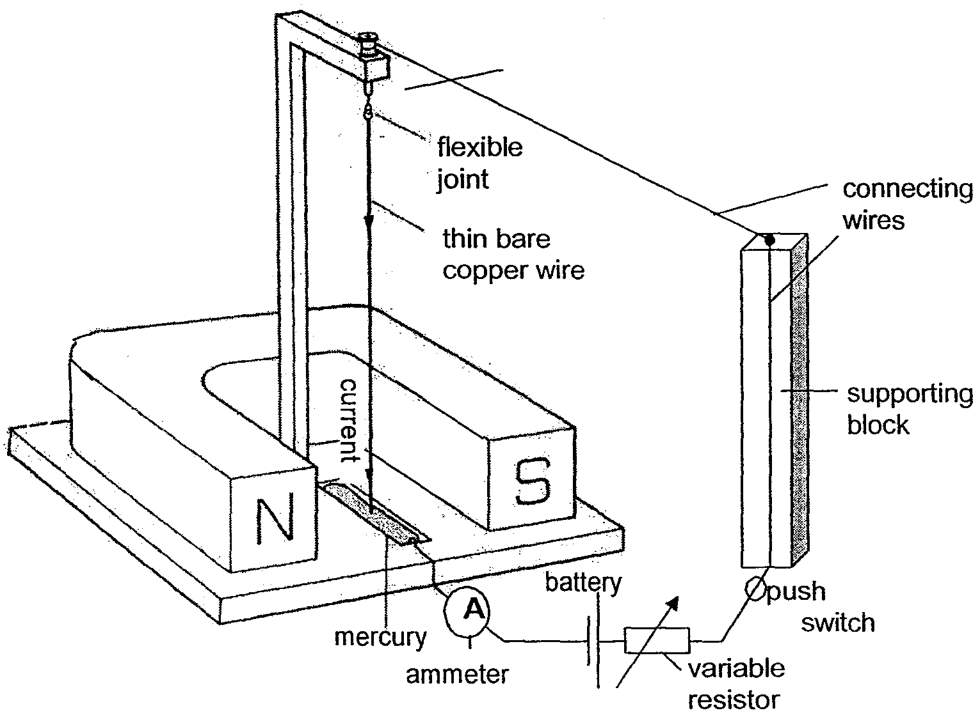


Fig. 9.1

When the switch is closed, the thin bare copper wire appears to move. The maximum angle of deflection θ of the deflection is noted using the protractor.

(a) **(i)** Explain the purpose of using mercury in the set-up.

....

....[1]

(ii) State and explain the direction in which the thin wire will move.

....

....

....[2]

For Examiner's Use

(iii) Given that the length of the bare wire is 80.0 cm long, measured from the joint to the mercury surface and the force exerted on the wire is 1.5 N, calculate the moment of this force at the surface about the joint.

moment =............ [2]

(b) The pupil varies the current by adjusting the resistance of the variable resistor. Fig. 9.2 shows the variation of the maximum angular displacement of the wire, θ, from the vertical with the current in the thin wire, I.

I/A	θ / °
0.10	1
0.20	3
0.30	5
0.50	9
0.70	15

Fig. 9.2

(i) Describe briefly how the pupil can use the data from Fig. 9.2 to check the relationship between I and θ.

....

....

....[1]

(ii) Suggest one other modification in Fig. 9.1 to increase the size of the angular displacement.

....

....[1]

(c) The power circuit is removed and the ends **PQ** are connected to a cathode ray oscilloscope (C.R.O.), as shown in Fig. 9.3. Initially, the bare wire is at the highest point and not in contact with the mercury in the tank. It only makes contact with the mercury when it is at the bottom of the swing.

Fig. 9.3 shows two possible positions of the wire at its highest point.
The trace in Fig. 9.4 shows one complete swing.

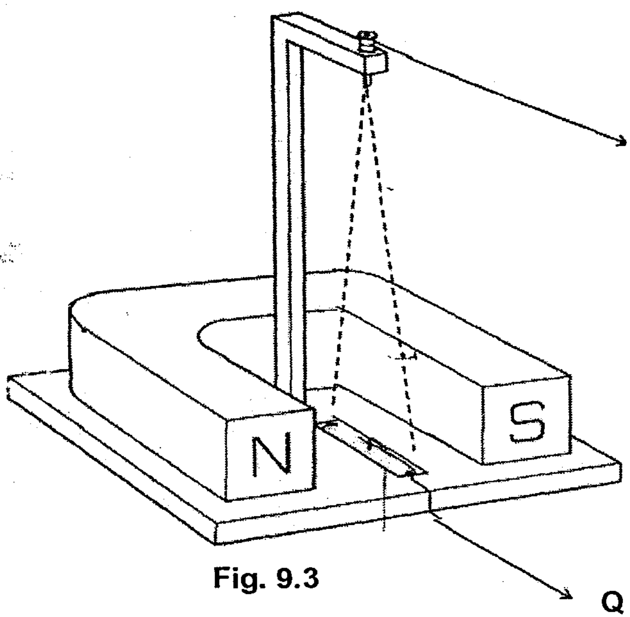


Fig. 9.3

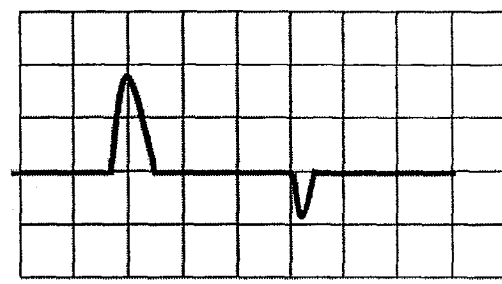


Fig. 9.4

(i) State and explain the shape of the trace shown in the CRO in Fig. 9.4

....

....

....

....[2]

(ii) Suggest why the wire ceases to swing after a short while.

....

....

....[1]

Electricity in the kitchen

10 The microwave oven is now commonly used in kitchens to quickly heat up fresh or pre-prepared food. It produces microwave radiation of frequency 2500 MHz that is absorbed by water molecules.

The water molecules have charge distributions which are not symmetric and when the electric field in the microwave radiation is incident on them, the water molecules increase in vibration. The microwaves can only penetrate a short distance inside the food. The typical power in the microwave beam is 750 W. Over each distance of 3 mm, the power available from the microwave decreases by 60%.

Thicker food can, however, be cooked in the microwave oven using other processes than the absorption of microwave energy.

(a) **(i)** Using information in the passage, sketch on Fig. 10.1 a graph to show how the power available from the microwave radiation varies with the depth within the food.

Include points at depths of 0, 3, 6, 9 mm in your sketch.

[3]

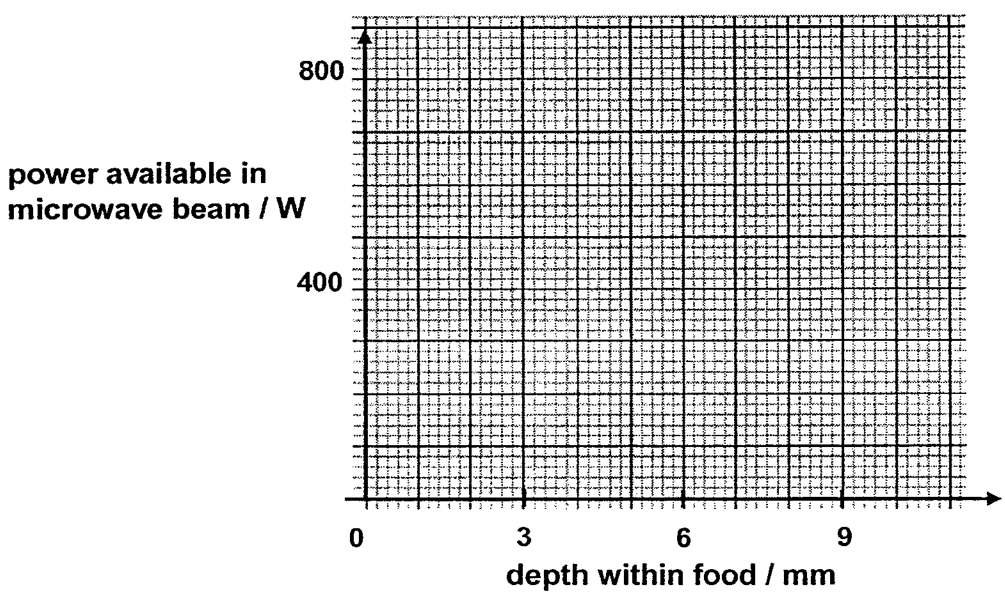


Fig. 10.1

(ii) Using Fig. 10.1, estimate the power at a distance of 5 mm.

power =............ [1]

For Examiner's Use

(a) **(iii)** Suggest a method of cooking food thicker than 9 mm thoroughly in the microwave oven.

....

....

....[1]

(b) Explain what is meant by an electric field and how the electric field of the microwave radiation causes a water molecule to vibrate.

....

....

....

....

....[2]

(c) Estimate the minimum time taken by a 750W microwave oven to thaw 0.25 kg of frozen soup. The soup, initially at -18°C, is to be just turned into liquid at 0°C.

The soup can be assumed to be made entirely of water. The specific heat capacity of ice as 2100 J/(kg °C) and the specific latent heat of fusion of water is 334 0000 J/kg.

time =............ [3]

For Examiner's Use

EITHER

11(a) In Fig. 11.1, the device inside the plastic box can be used to measure current. $\mathbf{T_1}$ and $\mathbf{T_2}$ are terminals to which the external circuit is connected.

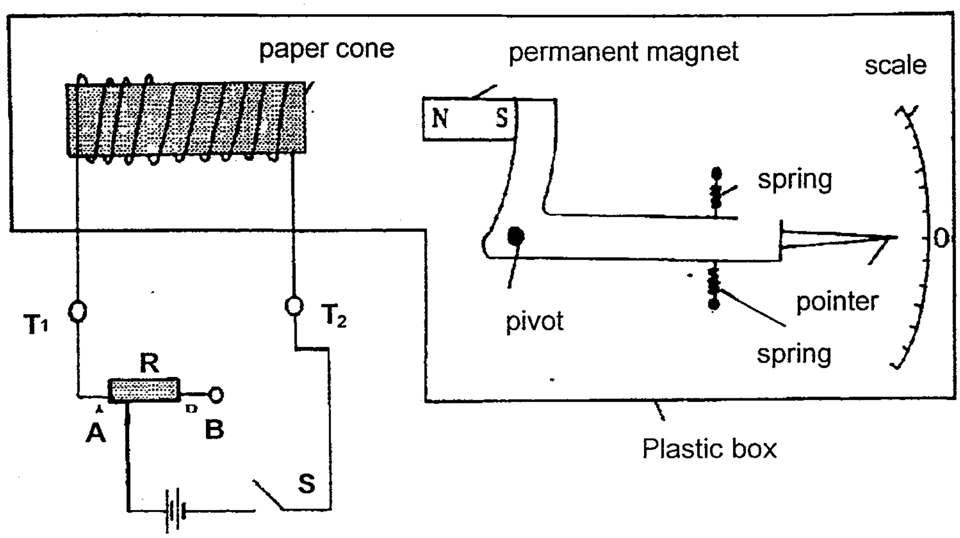


Fig. 11.1

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

....

....

....

.... [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**.

....

.... [1]

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

....

....

....

.... [2]

For Examiner's Use

(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?

....

.... [1]

(v) Suggest **one** modification to the above device to allow it to measure a small current.

.... [1]

(b) A thermistor switches on a fan in the engine compartment of the car when the temperature changes. Fig. 11.2 shows the thermistor, 12 V battery, a rheostat and a 3000 Ω resistor in part of the control circuit for the device.

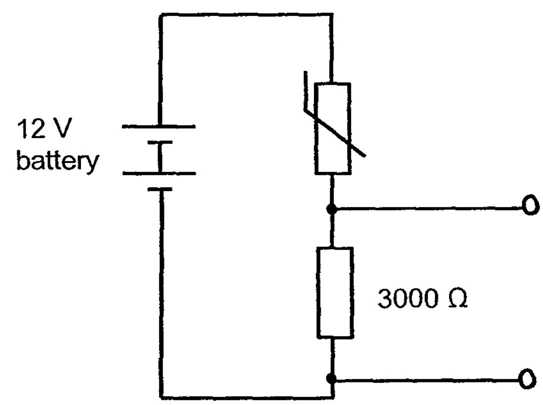


Fig. 11.2

(i) At a particular temperature, the resistance of the thermistor is 500 Ω. Calculate the potential difference (p.d.) across the resistor.

potential difference =............ [1]

(ii) State and explain how the current in the circuit and p.d across the thermistor will change when the temperature inside the engine compartment rises.

....

....

....

.... [2]

For Examiner's

OR

11 Figure 11.3 shows two coils of wire wound on a soft iron ring.

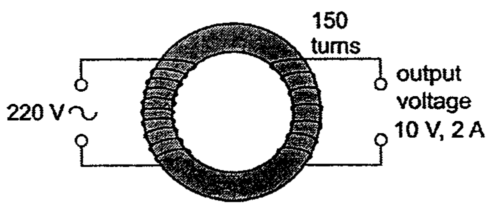


Fig 11.3

(a) Calculate the number of turns, Np, of the primary coil.

Np = ... [2]

(b) If the efficiency of the transformer is 80%, calculate the current, Ip, in the primary coil.

Ip = ... [3]

For Examiner's Use

(c) In which wire should a thicker wire be used? Explain briefly.

....

....

....

....

....

....

....

....[3]

(d) Figure 11.4 below shows an output voltage-time graph of the transformer. Sketch on the same Figure, the new output voltage-time graph if the number of turns of the primary coil is halved. [2]

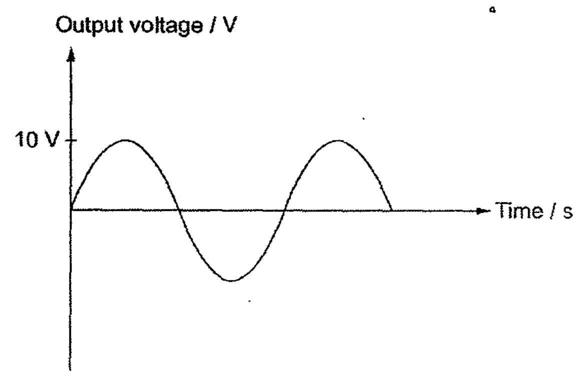


Fig 11.4

End of Paper

(c) Fig. 11.4 shows the positions of an object, **O**, and a thin converging lens **LL'**. Two rays of light from the top of the object are directed to the lens. The path of the ray **OA** is shown after passing through the lens.

For Examiner's Use

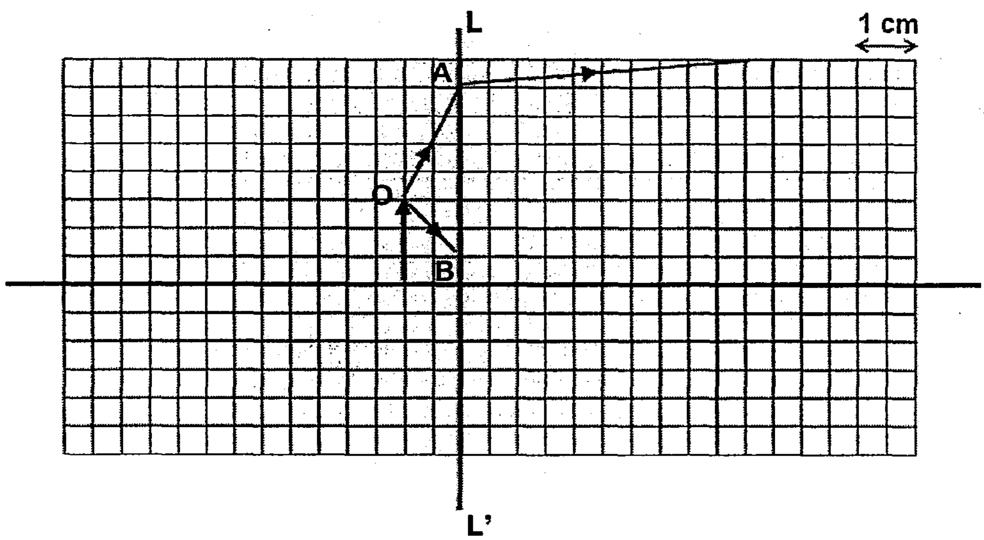


Fig. 11.4

(i) On Fig. 11.4, locate the image of the object. Label it *I*. [1]

(ii) Hence, determine the focal length of the lens.

focal length =............ [1]

(iii) Draw the path of OB after passing through the lens. Label it BB'. [1]

END OF PAPER

SEC 4 EXPRESS PHYSICS PRELIMINARY EXAMINATION 2016

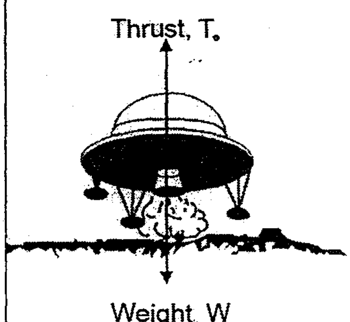
5059 / 01, 5059 /02 PHYSICS THEORY

MARKING SCHEME

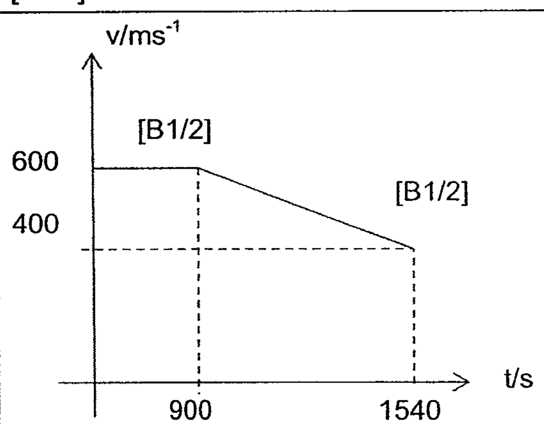
Paper 1

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

5059/02/Section A

Question no.	Marking Scheme
1(a)(i)	Thrust or F_{thrust}[Label & Arrow B1/2]  Weight or **W**[Label & Arrow B1/2]
1(a)(ii)	For v = constant, F_{net} = ma = 0. So,

5059/02/Section A

Question no.	Marking Scheme
	W - T = 0 (Take downward direction as positive.) $mg_{moon} = T$ $m = (T/g_{moon})$ [M1/2] $= (2.4 \times 10^4\ N)/(1.6\ Nkg^{-1})$ $= 1.5 \times 10^4$ kg (2 s.f.) [A1/2]
1(b)(i)	The increase in thrust results in a net force of magnitude $(2.6 - 2.4) \times 10^4$ N in the upward direction. Using $F_{net} = ma$, this causes the space craft to decelerate. F_{net} is negative since it is directed upwards. Therefore, the acceleration of the space craft, which is also negative is given by $a = F_{net}/m$ $a = -1.2 \times 10^4\ N/1.5 \times 10^4\ kg$ [M1/2] $a = -0.13\ ms^{-2}$ (2 s.f.) [A1/2].
1(b)(ii)	The speed of the space craft is given by $v = u + at$, which gives the duration of stage 2 $t = (v - u)/a = (400\ ms^{-1} - 600\ ms^{-1}) / -0.13\ ms^{-2}$ [M1/2] $= 1.5 \times 10^3$ s (2 .s.f.) or 26 min [A1/2]
1(c)(i)	
1(c)(ii)	There is little / no air on the Moon to provide the air resistance that a parachute depends upon to reduce the landing speed of the spacecraft
2(a)	By conservation of energy, E_k at C = loss of GPE at C. So, $\frac{1}{2} mv_C^2 = mg(h_A - h_C)$, which gives $v_C = (2g(h_A - h_C))^{1/2}$ [M1/2] $= 14.8\ ms^{-1}$ (3 s.f.) [A1/2]
2(b)	Since the ramp is frictionless, the skier has a total energy of $E = mgh_C + 1/2mv_c^2 =$

Question no.	Marking Scheme

mgh_A by the law of conservation of energy.

At E, the skier's speed v_E is less than v_C. As the law of conservation of energy requires his total energy at E to be equal to his total energy at A, E at location E = $1/2mv_E^2$ + work done. So,

work done against air resistance

$= mgh_A - 1/2mv_E^2$

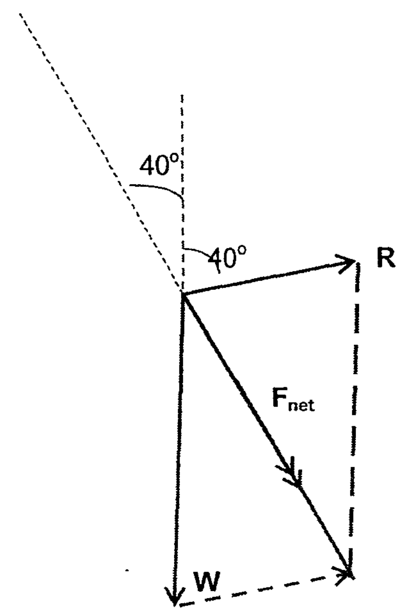
$= (60\ kg)[(10 Nkg^{-1})(26\ m) - ½(20\ ms^{-1})^2]$ [M1/2]

= 3600 J [A1/2]

2(c)

Method 1: Parallelogram of forces (not drawn to scale)

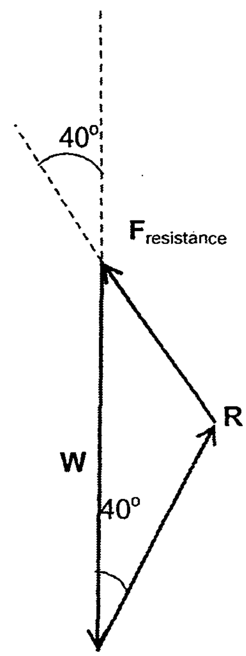
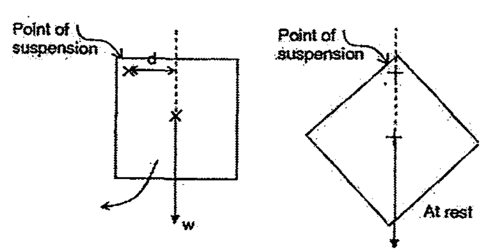
Suggested scale is 1 cm: 100 N (or smaller)



- suitable scale [B1]
- appropriate labels for given forces and the resultant force [B1]
- Inference from the parallelogram of forces that the magnitude of air resistance = magnitude of resultant force = 390 N, together with appropriate label for the force; reasoning in words is expected [A1].

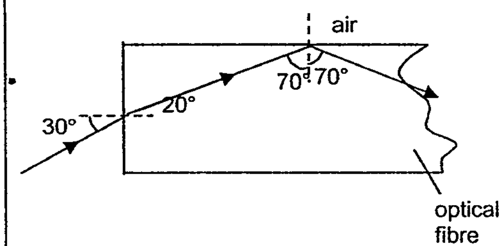
Remark: As the skier is in equilibrium, a vector that has the magnitude of the resultant force but is directed in the opposite direction. *A parallelogram can be used to find the resultant force*

- The direction of air resistance is 40° from the vertical/N40°W [A1].
- No mark is awarded for giving the direction of air resistance without a reference direction.
- Deduct ½ mark for missing arrows to show vectors or vector **W** not directed vertically.

5059/02/Section A	
Question no.	**Marking Scheme**
	<u>Method 2</u>: Triangle of forces (not drawn to scale)  **Remark** A triangle of forces modelling the skier in equilibrium must show vectors that are directed in such a way that the tip of one vector touches the tail of the next vector sequentially as shown above.
3(a)(i)	When the centre of gravity (CG) of an object is *not* directly under the point of suspension (see diagram A), its weight will produce a moment (Wd) about the point of suspension, thus causing the object to oscillate. [B1] When object finally comes to rest (see diagram B), the CG of the object must lie directly below the point of suspension (the pivot). At this position, the line of action of the weight passes through the pivot and hence produces no net moment. [B1]  Net Moment = Wd Diagram A Net moment = 0 Diagram B

(a)(ii)	No, the baby is not in stable equilibrium. [1] It is in an unstable equilibrium because the anti-clockwise moment of CG created will cause it to continue to rotate and not be able to return to her original position.[1]
3(b)	Moment is defined as the product of the force and the perpendicular distance from the line of action of force to the pivot. [B1]
3(c)(i)	Moment = 40 x10 x 1.6 = 640 Nm [M1/2, A1/2]

5059/02/Section A

Question no.	Marking Scheme
3(c)(ii)	<u>Smaller</u> [B1]
4(a)	Drawing of light rays must be complete with arrows.  *<u>Diagram</u>*: At least 1 internal reflection should be shown. Angles should be accurate. *<u>Computation</u>*: n = sin i/sin r 1.46 = sin 30 °/sin r r = 20.5° Let **critical angle** be c sin c = 1/n, c = 44° Angle of incidance at the fibre-air boundary should be computed (90° – r) Since the angle of incidence is higher than the critical angle, **total internal reflection** occurs.
4(b)(i) (ii)	<u>Method 1</u>: As lid is in equilibrium, Pressure due to gas = atmospheric pressure + pressue exerted by lid $P_{gas} = h\rho g + \frac{W}{A}$ $= (0.76\times13.6\times10^3\times10) + \frac{300\times10}{50\times10^{-4}}$ $= 703$ kPa or 7.03×10^5 Pa [M1/2, M1/2] <u>Method 2</u>: First compute the force due to atmosphere. Since lid is in equilibrium, Sum of upward forces = sum of downward forces $F_{gas} = F_{atmosphere} + W_{lid}$ = 516.8 N + 3000 N = 3516.8 N Pressure due to gas = 3516.8 / (50x 10^{-4}) = 703 kPa

5059/02/Section A

<table>
<tr><th>Question no.</th><th>Marking Scheme</th></tr>
<tr><td>5(a)</td><td>

$v = f\lambda$ [M1/2]

$3 \times 10^8 = f \times 1200$ [M1/2]

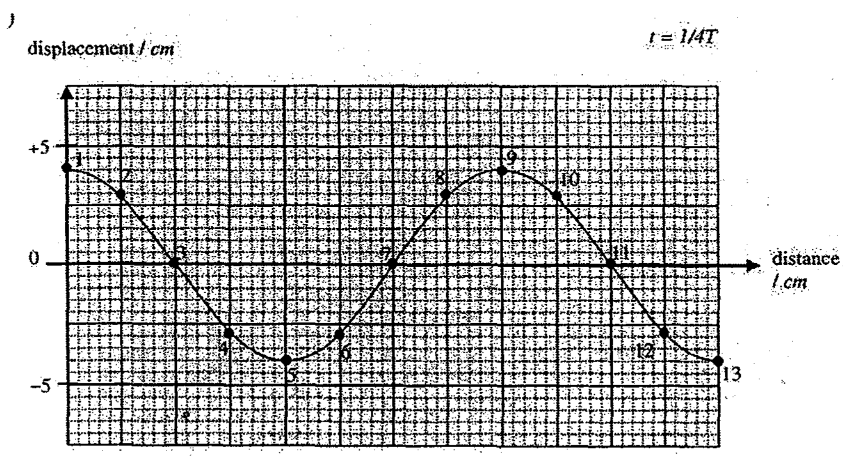
$f = 2.5 \times 10^5$ Hz [A1/2]

Band: LW [A1/2]

</td></tr>
<tr><td>5(b)</td><td>

Ultrasonic waves are not affected by the background sound, e.g. Sounds from ships and waves, which is of much lower frequency. [B1]

</td></tr>
<tr><td>5(c)
(i), (ii)</td><td>



</td></tr>
<tr><td>6(a)</td><td>

For this question, it is possible to either:

(i) charge by induction, making B negatively charged.

(ii) to charge by contact, making B positively charged.

<u>e.g. Charing by induction</u>:

- Bring A near to B without them being in contact with each other.
- Earth B (so that electrons flow from earth)
- With A still in place, remove the earth connection.
- Separate A and B. This will cause a B will become negatively charged.

B½ each

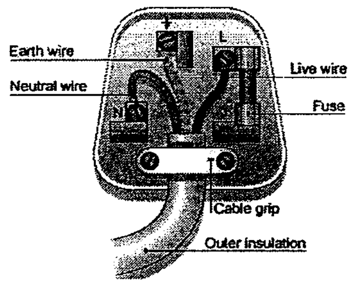
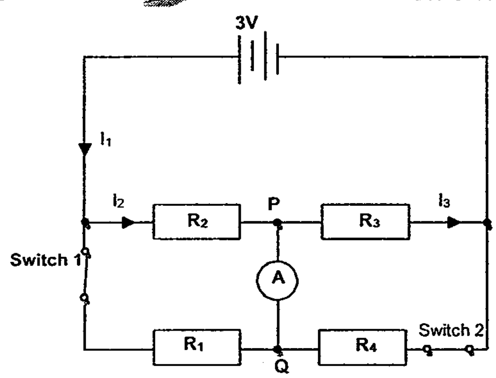
</td></tr>
<tr><td>6(b)(i)</td><td>

- double insulation is a safety feature in an electrical appliance that can substitute the earth wire
- Devices with double insulation usually use a two-pin plug
- There are two levels of insulation in this safety feature
- The electric cable is insulated from the internal components of the appliance
- The internal components of the appliance are also insulated from the external casing.
- Appliances with double insulation normally have non-metallic/ non-conductors casing (e.g. plastics).

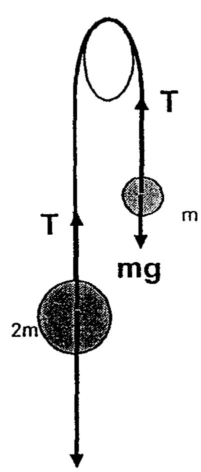
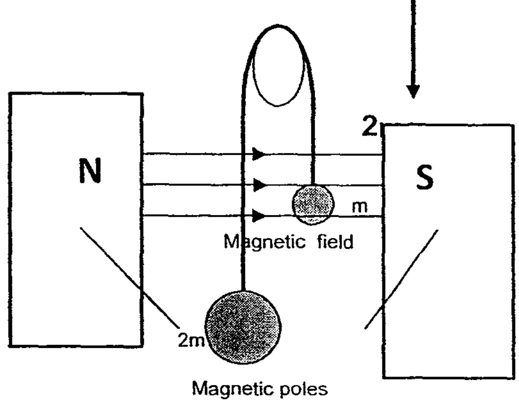
B½ each, max 2 marks

</td></tr>
</table>

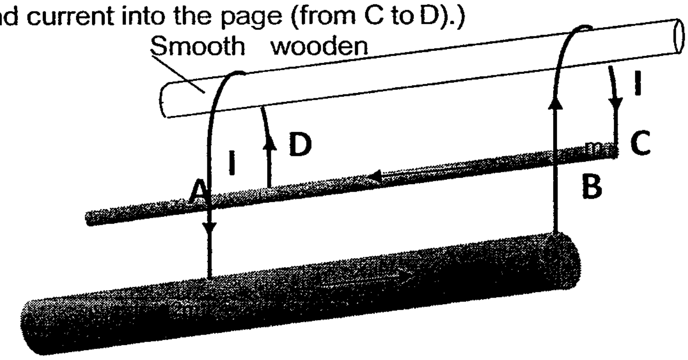
5059/02/Section A

Question no.	Marking Scheme
6(b)(ii)	Diagram should show wiring of NEL wires, as well as fuse attached to live wire. 
	
7(a)(i)	Charge = $5\times10^{-3}\times2\times60 = 0.6$ C
7(a)(ii)	$I_3 = 2.5\times10^{-3} A \text{ or } 2.5\ mA$
7(a)(iii)	Method 1: Find overall p.d. and current $R_{eff} = \frac{3}{5\times10^{-3}}$ $R_{eff} = 600\Omega$ $R_3 + \frac{R_3}{2} = 600$ $R_3 = 400\Omega$ Method 2: Find p.d. and current across R_3. By potential divider rule, pd across R_3 is 1V. $R_3 = \frac{V_3}{I_3}$ $R_3 = \frac{1}{2.5\times10^{-3}}$ $R_3 = 400\Omega$

5059/02/Section A

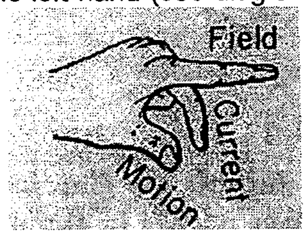
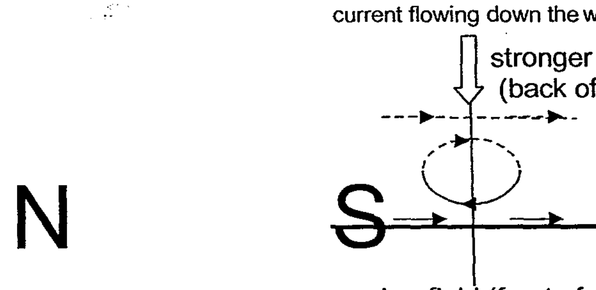
Question no.	Marking Scheme
7(b)(i)	When the switch is closed, the resistance due to R3 and R4 is 200 ∧ . This allows us to apply Ohm's Law. $I_3' = \frac{V_3'}{R_{34}}$ $I_3' = \frac{1.5}{200}$ $I_3' = 7.5 \times 10^{-3}\ A\ or\ 7.5mA$
7(b)(ii)	I_2 decreases. While the effective resistance decreases, the overall current in the circuit increases (less than doubles). However, the current still splits at the junction where R_1 and R_2 are parallel to each other and hence is decreased.
7(b)(iii)	The ammeter reading is zero since there is no p.d. across PQ.
7(c)	$P_{loss} = I^2R$ $P_{loss} = \left(\frac{P_{gen}}{V_{gen}}\right)^2 R$ $P_{loss} = \left(\frac{15000}{5000}\right)^2 200$ $P_{loss} = 1800W\ or\ 1.8kW$
8(a)	**W** : weight of rod CD **2W**: weight of rod AB T : tension in wire (same magnitude acting on either rod)  

5059/02/Section A

Question no.	Marking Scheme
8(b)(i)	AB will slide down first. The net force exerted on rod AB is larger in magnitude than that on rod CD and is in the downward direction. OR the system experiences a net downward force.
8(b)(ii)	As rod AB moves downward and rod CD moves upward, the motion **of the rods** cause them to experience a <u>changing magnetic field</u>. By **Faraday's Law** of EMI, the change in magnetic field in the rods causes an **emf** to be **induced** in the rods. Since the rods form a closed loop with the connecting wires, this drives an **induced current** around the loop. *[no marks awarded if student failed to state induced emf <u>before</u> induced current]* Based on (a)(i), the net force acting on the rod AB **is** downward while (a)(ii) shows that the magnetic field acting on rod AB is to the right. By **<u>Fleming's right hand rule</u>**, the direction of induced current in rod AB will be <u>out of the page (from A to B)</u>. (Accept answer if argument is made wrt rod CD; net upward force, B-field to the right and current into the page (from C to D).) 
8(c)	The current in rod CD increases in magnitude and reverses its direction.

5059/02/Section B/Question 9

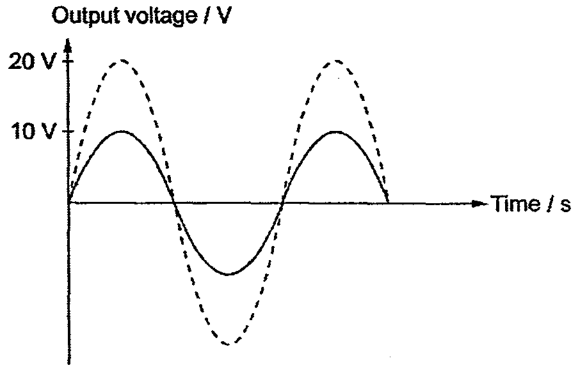
Question no.	Marking Scheme
9(a)(i)	to <u>maintain electrical contact</u> between the swinging wire and the external circuit. [B1]
9(a)(ii)	The wire will move <u>out</u> of the magnet / mercury tank. [B1] **EITHER** Using Fleming's Left Hand Rule, where the index finger representing the direction of magnetic field which is pointing from left to right and the middle finger representing current that is flowing down, then the thumb representing motion of wire will point OUT of the paper. B1

Question no.	Marking Scheme
	OR draw the three fingers of the left hand (see diagram below) to show the motion of wire out of page.  **OR** using the interaction of the magnetic fields between the permanent magnet and the current in the wire (see diagram below), the magnetic field is stronger behind the bare wire than the front. The magnetic field lines behind the wire add up producing a stronger magnetic field whereas the magnetic field lines subtracts off (attraction) to give a weaker field strength in front of wire. This net resultant field produces a net force pushing wire out. 
9(a)(iii)	Moment = F x $s_{perpendicular}$ = 1.5 N x 80 cm = **120 N cm** (or 1.2 Nm) [M1, A1]
9(b)(i)	Plot a graph of θ / ^{0} against I / A to check their relationship.
9(b)(ii)	Use stronger magnets / increase the current / reduce distance between the magnetic poles [B1 for any one] increase voltage of power source [B½]
9(c)(i)	As the bare wire cuts through the magnetic field lines / change of magnetic flux linkage with wire / changing magnetic field in wire, an emf is induced in the wire and which is displayed on the CRO. [B1] The induced emf increases to the maximum when the bare wire is moving at the fastest at the bottom of swing and decreases to zero as the wire leaves the mercury, breaking the electrical contact. [B1] As the direction of swing changes, the direction of induced emf reverses. The strength of the induced emf decreases as there is a decrease in rate of change of flux linkage due to a lesser speed. [B1] Max 2
9(c)(ii)	Energy has been lost due to work done against mercury /air resistance and **also due to** opposing force arising from electromagnetic induction / Lenz's Law

5059/02/Section B/Question 10	
Question no.	**Marking Scheme**
10(a)(i)	At 0 mm , P= **750 W.** At 3 mm , P = 40/100 x 750 = **300 W** At 6 mm , P = 40/100 x 300 = **120 W** At 9 mm, P = 40/100 x 120 = **48 W** [B1] (If working is not shown, but reflect correctly in the graph-award full credit.) **Graph work** Points correctly plotted (ecf from (i)) [B1] Best fit curve [B1]
10(a)(ii)	Evidence of value as shown in graph ½ 150 – 180 W ½
10(a)(iii)	Make holes / reduce thickness / make it less dense by soaking it / equiv [B1]
10(b)	The electric field is a region in which where an electric force act**s on a charged object.** [B1] The electric field exerts an electric force of attraction or repulsion on the charged ions of water molecules/bipolar nature of water, hence causing the vibration of H^+ and O^{2-} [B1]
10(c)	latent heat **of fusion of ice should have been** 334 000 J / kg instead. Let the minimum time be t. Thermal energy released (or loss) by microwave oven = Pt = 750t [M1[Thermal energy absorbed by frozen soup $= mc\otimes\theta + ml_f$ = (0.25 x 2100 x 18) + (0.25 x 334000) = 92950 J [M1] Using Principle of Heat Exchange, 750 t = 92950 t = **124 s** [A1] (Award full credit if answer is 1130 s as l_{ice} is given a wrong value)
5059/02/Section B/Question 11 EITHER	
11(a)(i)	Up [B1/2]. The current flowing into the solenoid will magnetize the solenoid with an N-pole on the left and a South pole at the right of the solenoid.[B1/2] Attraction between unlike poles at near ends of solenoid and permanent magnet causes permanent magnet to move to the left. [B1/2] This produces a net anticlockwise moment. Pointer moves up. [B1/2]
11(a)(ii)	Resistance increases as V = IR and V is constant, hence current decreases. A weaker electromagnet produces a weaker attraction force which produces a smaller unbalanced moment and a smaller deflection. [B1]
11(a)(iii)	Reversing the polarities of power source will produce an electromagnet with an S-pole

5059/02/Section B/Question 10	
Question no.	**Marking Scheme**
	on the left and an N-pole on the right of the solenoid. Like poles repel, hence the permanent magnet will move to the right, producing an unbalanced clockwise moment which turns the pointer down. [1/2 × 4 =B2]
11(a)(iv)	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.
11(a)(v)	Reduce the distance between the solenoid and permanent magnet / use a weaker permanent magnet / less turns in coil
11(b)(i)	p.d. = 3000 / (3000 + 500) × 12 V = 10.3 V [B1]
11(b)(ii)	When temperature rises, the resistance of thermistor decreases. V = IR, and V is constant, thus current I in the circuit will increase. [1/2 × 3 = $B1\frac{1}{2}$] Using potential divider principle, as I is constant along both thermistor and resistor (both are in series), p.d. ∝ R. [B1] As resistance of thermistor decreases, the p.d. across it will decrease. [B1/2]

5059/02/Section B/Question 11 OR	
11(a)	By $\frac{V_s}{V_p}=\frac{N_s}{N_p}$, [1] the number of turns of the primary coil $N_p = (\frac{220}{10}) \times 150 = 3\ 300$ turns [1]
11(b)	The output electrical power = VI = 10 × 2 = 20 W [1] As the efficiency is 80 %, the input power = $\frac{20}{80\%}$ = 25 W [1] Hence, the current in the primary coil = $\frac{P}{V} = \frac{25}{220}$ = 0.11 A [1]
11(c)	The thicker wire should be used in the secondary coil. [1] This is because the current in the secondary coil is greater [1] than that in the primary coil, so the thicker wire can prevent overheating. [1]

11(d)	 Label 20 V – [1] Correct shape of graph with higher amplitude - [1]