1 Which line in the table correctly indicates the prefixes micro, nano and giga?

	$\times 10^{-6}$	$\times 10^{-9}$	$\times 10^{9}$
A	giga	micro	nano
B	giga	nano	micro
C	nano	micro	giga
D	micro	nano	giga

2 Which equation contains two vector quantities?

A acceleration = $\dfrac{\text{change in velocity}}{\text{time taken}}$

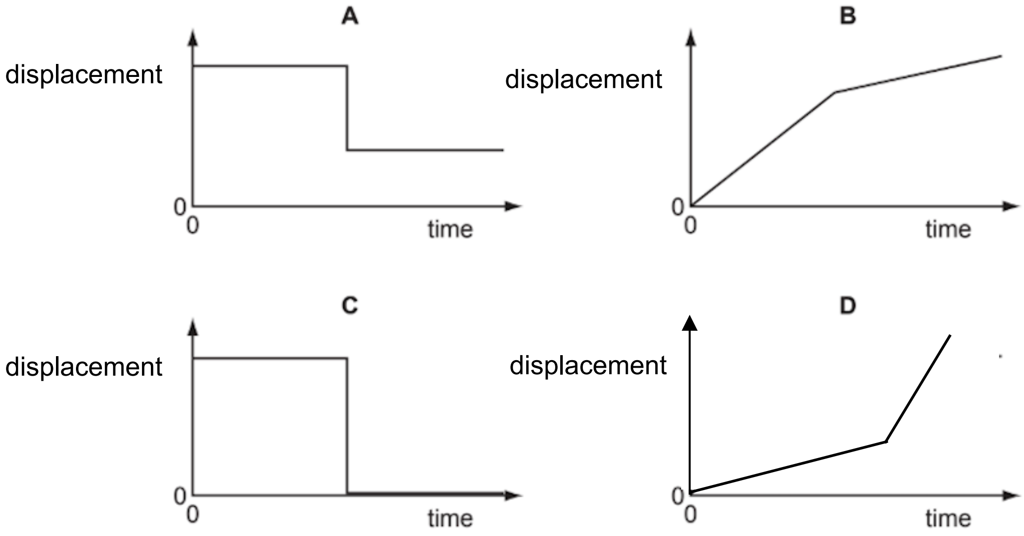
B average speed = $\dfrac{\text{distance travelled}}{\text{time taken}}$

C density = $\dfrac{\text{mass}}{\text{volume}}$

D volume = length × width × height

3 A car is traveling at constant speed. Brakes are applied for a short period of time and the car continues at a lower constant speed.

Which displacement-time graph shows the motion of the car?



4 A box of mass 3.0 kg is initially at rest on a horizontal rough surface.
Three parallel horizontal forces of magnitude 2.0 N, 3.0 N and 4.0 N act on the box in the same direction. Friction acts between the box and the ground is 1.5 N.

What is the minimum acceleration of the box?

A 0.25 m/s^2

B 0.50 m/s^2

C 1.0 m/s^2

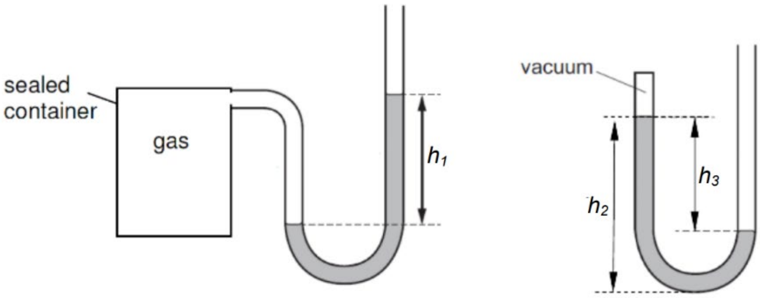
D 2.5 m/s^2

5 The gravitational field strength on the Moon is one-sixth that on the Earth. An astronaut returns from the Moon to the Earth with a specimen of a moon rock.

How would the moon's rock density and mass change?

	density	**mass**
A	higher on Earth	higher on Earth
B	higher on Earth	same on Earth and Moon
C	same on Earth and Moon	higher on Earth
D	same on Earth and Moon	same on Earth and Moon

6 The diagram shows 2 manometers containing mercury. Both are placed in the same room. The manometer on the left is connected to a sealed container filled with gas. The manometer on the right is sealed at one end as shown.
All measurements are in cm.



What is the pressure of gas in cmHg?

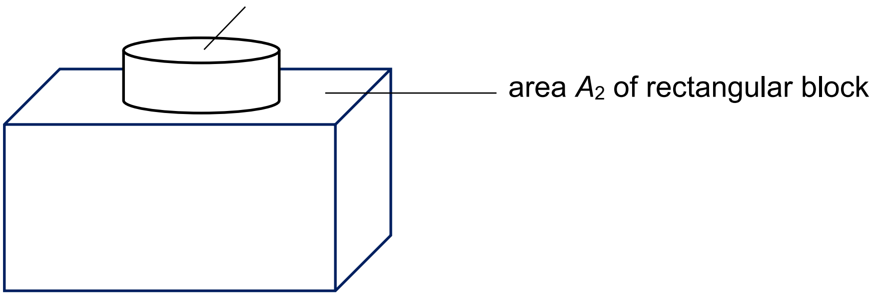
A $(h_1 + h_2)$

B $(h_1 + h_3)$

C $(h_1 + h_2 - h_3)$

D $(h_2 - h_1)$

7 A cylindrical block rests on a rectangular block. The area of the cylindrical block in contact with the rectangular block is A_1 and the area of the rectangular block facing up is A_2.

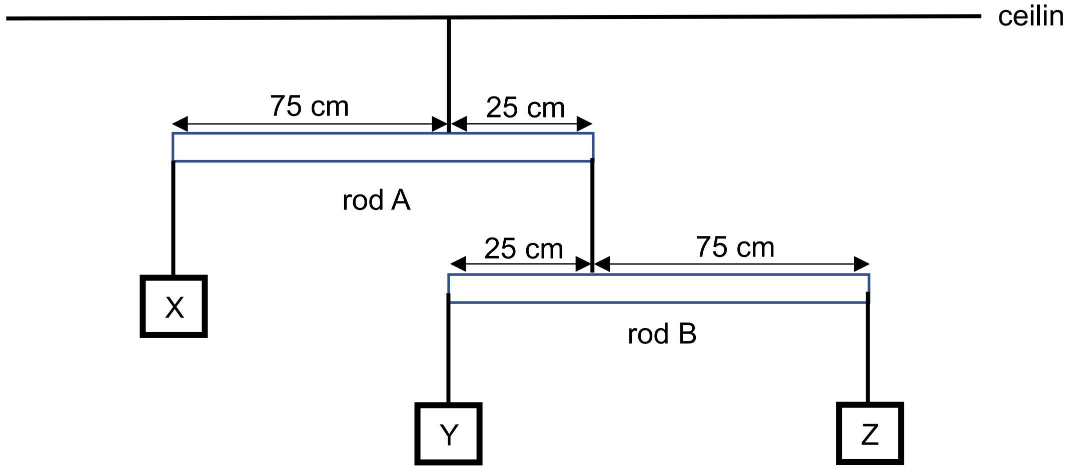


The weight of the cylindrical block is W_1 and the weight of the rectangular block is W_2.

What is the pressure exerted on the cylindrical block by the rectangular block?

A $\frac{W_1}{A_1}$ **B** $\frac{W_1}{A_2}$ **C** $\frac{W_2}{A_1}$ **D** $\frac{W_2}{A_2}$

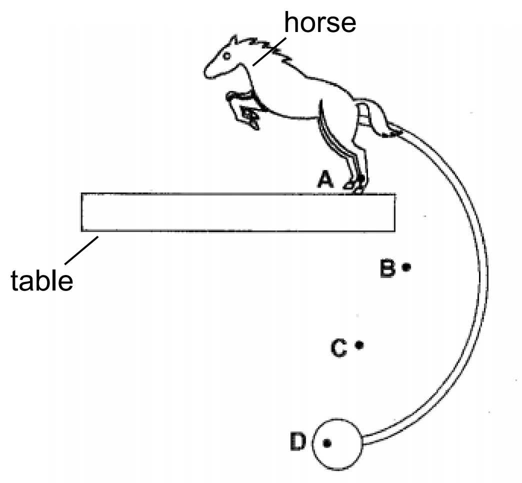
8 The diagram shows an ornament hung from a ceiling. It consists of objects X, Y and Z suspended from light rods A and B. The masses of X, Y and Z are such that the rods are horizontal.



Which row gives a possible combination of the masses X, Y and Z?

	mass of X / g	mass of Y / g	mass of Z / g
A	100	75	25
B	50	75	25
C	48	36	12
D	16	36	12

9 The diagram shows the rest position of a balancing toy near the edge of a table. Which position is most likely to be the center of gravity of the toy?



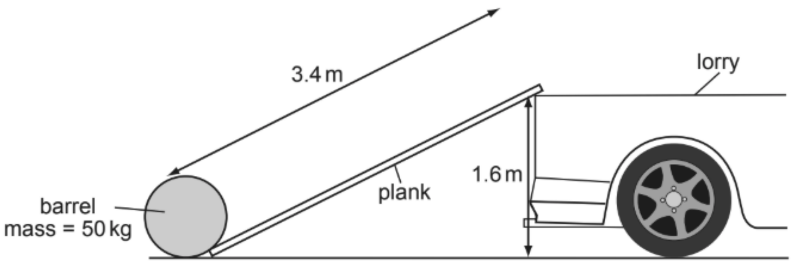
10 Electromagnetic waves from the Sun are absorbed by a solar panel. These waves transfer energy electrically to a portable traffic light system.

A few solar panels with a total area 12 m^2 were used to operate the traffic light system. 1.0 m^2 of a panel receives 0.85 kJ of energy via electromagnetic waves from the Sun in 1.0 s.

If the efficiency of the panels is 16 %, how much power do they transfer electrically?

A 1.6 kW **B** 2.2 kW **C** 64 kW **D** 160 kW

11 A barrel of mass 50 kg is loaded onto the back of a lorry 1.6 m high by pushing it up a smooth plank 3.4 m long. The gravitational field strength, g = 10 N/kg.



What is the minimum work done on the barrel?

A 80 J **B** 170 J **C** 800 J **D** 1700 J

12 A student investigates the changes that take place as molten wax solidifies.

Which of the following correctly describe these changes?

A A transfer of energy and a change in temperature

B A transfer of energy but no change in temperature

C No transfer of energy and no change in temperature

D No transfer of energy but a change in temperature

13 Wiping the body of a patient who has a high fever with a wet towel makes use of the cooling effect of evaporation.
When liquid evaporates, some liquid molecules in the liquid escape.

Which molecules in the liquid escape?

A the molecules at the bottom of the liquid with less energy than others

B the molecules at the bottom of the liquid with more energy than others

C the molecules at the surface of the liquid with less energy than others

D the molecules at the surface of the liquid with more energy than others

14 Water in a glass pot is heated by a gas stove.

Which of the following explains how the energy in the internal store of the glass pot increases?

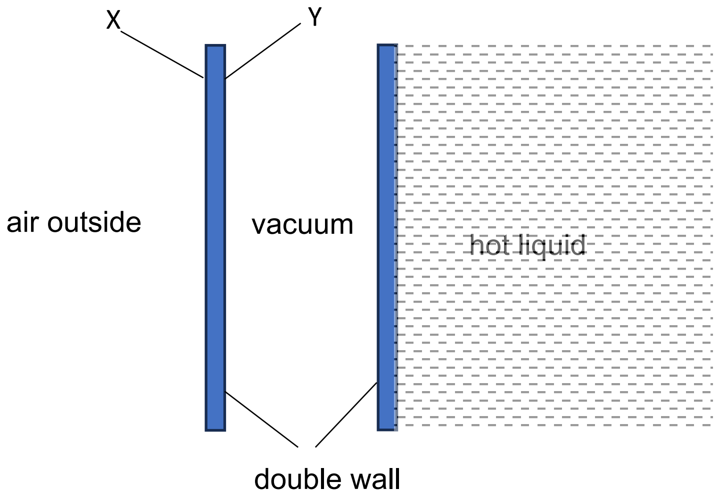
A Glass molecules at the bottom surface of the pot move around and transfer energy to glass molecules on the upper surface by collisions.

B Glass molecules at the bottom surface of the pot move to the upper surface of the pot.

C Glass molecules at the bottom surface of the pot radiate microwaves which pass through the upper surface of the pot.

D Glass molecules at the bottom surface of the pot vibrate more vigorously and transfer energy to the neighbouring glass molecules.

15 A vacuum flask contains a hot liquid. The diagram shows a section of the flask's double wall.



Which colour(s) for surface X and for surface Y will reduce the rate of decrease of energy in the internal store of the liquid?

	X	Y
A	black	black
B	black	silver
C	silver	black
D	silver	silver

16 Different amounts of energy are transferred to the internal store of the iron blocks of different masses.

Which block experiences the greatest temperature change?

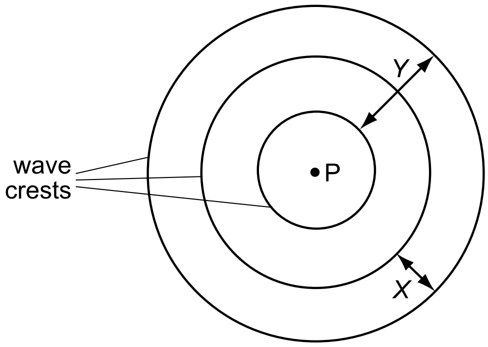
	mass of block / kg	energy supplied / J
A	1.0	120
B	1.5	150
C	2.0	180
D	2.5	210

17 Water from two identical containers is mixed. One container contains 2.0 kg of water at 25°C and the other contains 3.0 kg of water at 90°C.

What is the final temperature of the mixture?
(Assume there is no change to the energy in the internal store of the surroundings)

A 32°C **B** 46°C **C** 64°C **D** 78°C

18 A vertical stick is dipped up and down in the water at point P.



In two seconds, three wave crests are produced on the surface of the water.

Which statement is correct?

A Distance X is the amplitude of the waves.
B Distance Y is the wavelength of the waves.
C Each circle represents a wavefront.
D The frequency of the waves is 3 Hz.

19 An observer hears a clap of thunder 3.0 s after seeing the flash of lightning.
The speed of sound in air is 330 m/s.

How far from the observer was the lightning?

A 110 m **B** 330 m **C** 990 m **D** 1980 m

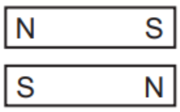
20 Bar magnets and various non-magnetic and demagnetised metal bars are placed in the different arrangements shown.

In which arrangement do the bars repel?

A

B

C



D

21 Which type of electromagnetic radiation has the lowest frequency while travelling through a vacuum?

A gamma rays
B infra red waves
C light waves
D microwaves

22 Ultrasound is high pitched and cannot be heard by human ears. However, ultrasound has many uses.

Which of the following is/are correct use/s of ultrasound?

(1) Checking for cracks or damages in materials.

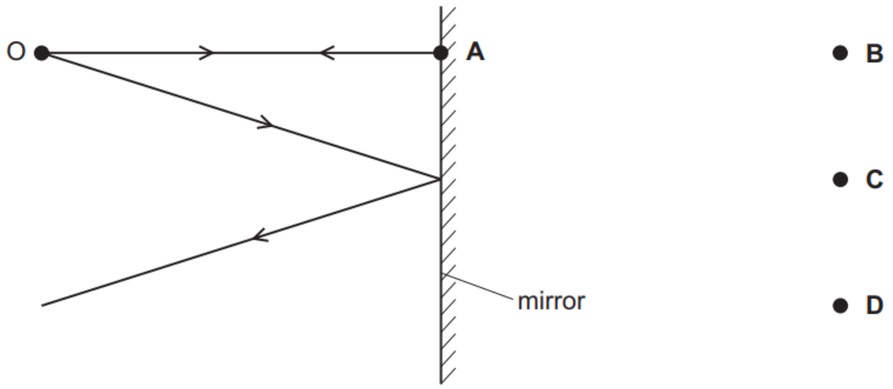
(2) Medical scanning of organs and tissues.

(3) Radar systems used by air traffic controllers to detect location of an aeroplane.

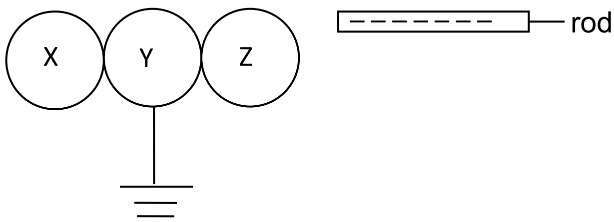
A (1) only
B (2) only
C (1) and (2) only
D (1) and (3) only

23 The diagram shows two divergent rays of light from an object O being reflected from a plane mirror.

At which position is the image formed?



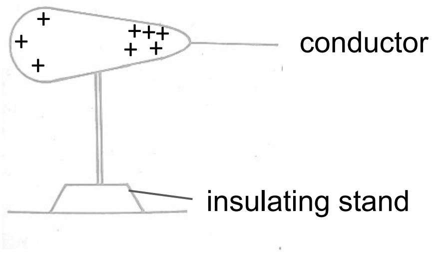
24 Three metal spheres X, Y and Z are placed in contact as shown in the diagram. A negatively charged rod is brought near to Z. With the rod near to Z, sphere Y is then earthed.



What is the net charge on X, Y and Z?

	X	Y	Z
A	negative	zero	positive
B	positive	positive	negative
C	zero	negative	positive
D	zero	zero	positive

25 A positively charged hollow conductor is mounted on an insulator.



Which of the following statement(s) about the conductor is correct?

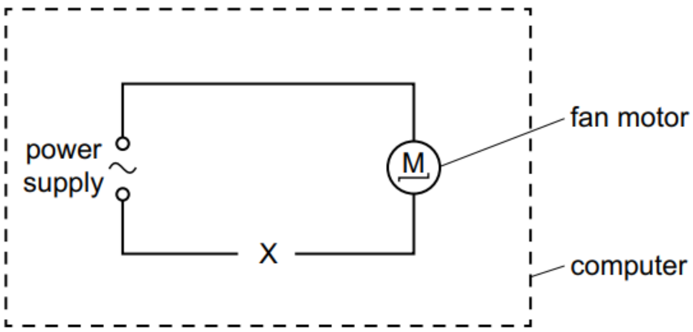
(1) The inner wall of the conductor must be negatively charged.

(2) The charge density is higher on the part of the surface with a smaller radius of curvature.

(3) There is a constant motion of positive charge on the surface.

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

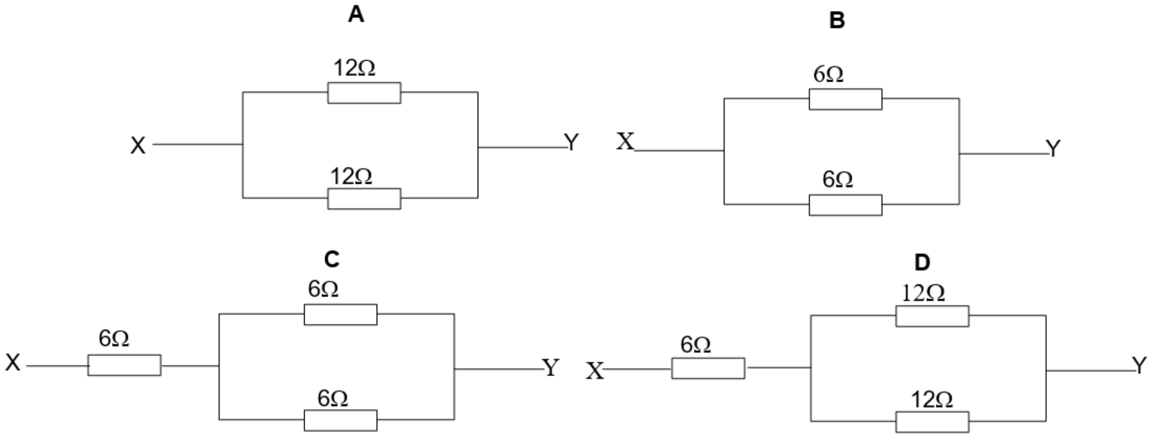
26 A computer engineer wants the speed of a fan to increase when the temperature inside a computer increases. The engineer knows that a larger current causes the fan to turn more quickly.



Which component should be placed at X to make this happen?

A a relay
B a thermistor
C a transformer
D a variable resistor

27 Which arrangement gives a total resistance of 12 Ω between X and Y?

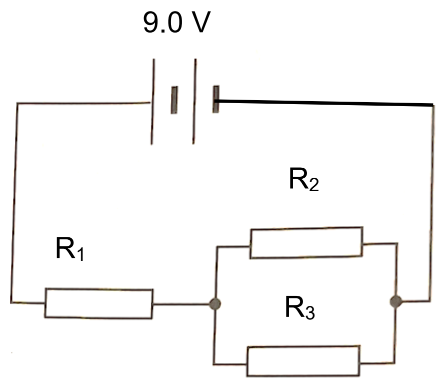


28 A wire has a resistance of 8.0 Ω. A second wire, made of the same material, has double the length and half the thickness.

What is the resistance of the second wire?

A 8.0 Ω **B** 16.0 Ω **C** 32.0 Ω **D** 64.0 Ω

29 In the circuit shown, the resistance of R_1 R_2 and R_3 are all equal to 3.0 Ω.



What is the power dissipated by R_2?

A 3.0 W **B** 6.0 W **C** 9.0 W **D** 12 W

30 A combined bathroom unit of a heater and a lamp is controlled by one switch. The unit contains a 2 kW heater and a 100 W lamp. In one week, the lamp uses 1 kWh of electrical energy.

How much electrical energy is used by the heater alone?

A 2 kWh **B** 4 kWh **C** 10 kWh **D** 20 kWh

31 Ten light bulbs, each labelled '200 V, 60 W', are connected in parallel to a 200 V supply.

Which one of the following fuses should be used in the main circuit?

A 1.0 A **B** 2.0 A **C** 3.0 A **D** 4.0 A

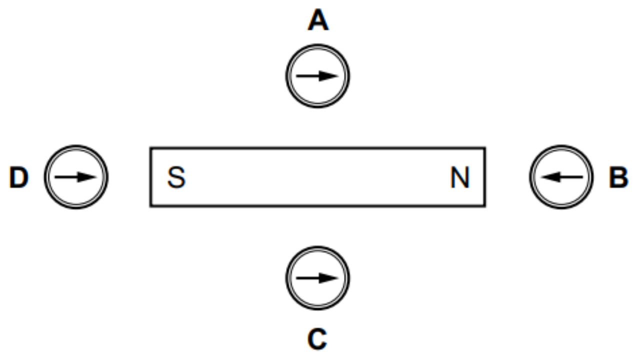
32 An electric kettle has a metal casing. The cable for the kettle contains a wire that is connected to the earth pin of the plug.

How does this protect the user from electric shock?

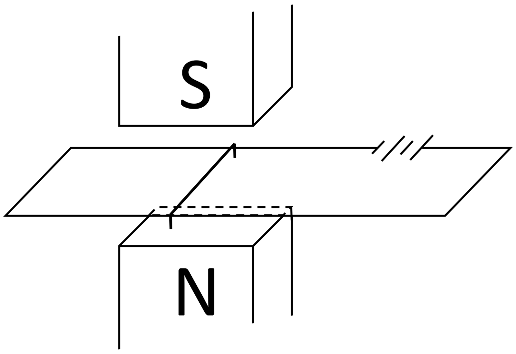
A It prevents the cable to the kettle becoming too hot.
B It prevents the casing of the kettle becoming live.
C It prevents the casing of the kettle becoming wet on the outside.
D It prevents the casing of the kettle from overheating.

33 The diagram shows a bar magnet and four plotting compasses.

Which compass correctly shows the direction of the magnetic field due to the magnet?



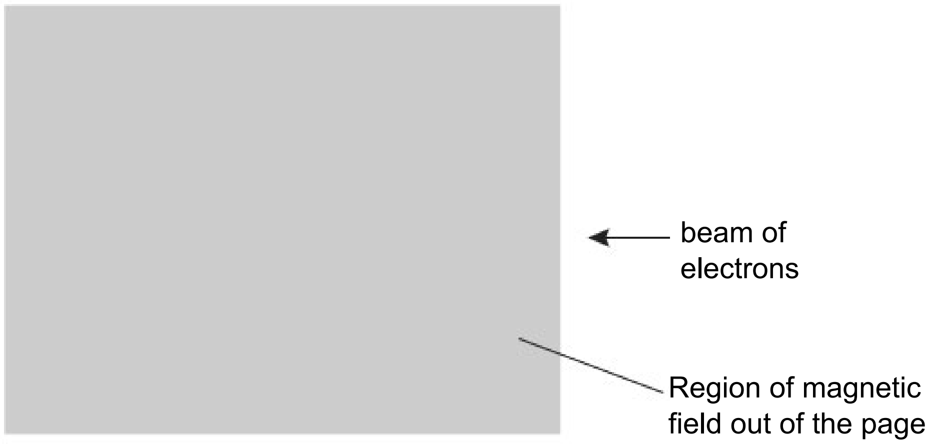
34 In the diagram shown, a current passes through wire X which is placed between the poles of a magnet.



In what direction will wire X move when current pass through it?

A to the left
B to the right
C towards the South pole of the magnet
D towards the North pole of the magnet

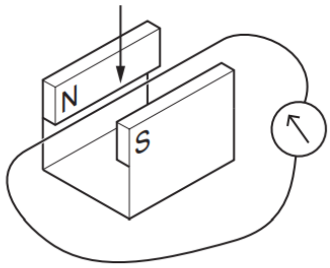
35 The diagram shows a beam of electrons entering a magnetic field. The direction of the field is out of the page.



In which direction does the beam of electrons deflect?

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

36 A wire is moved down in a direction perpendicular to the magnetic field.



Three changes are suggested.

1 The speed of the movement of the wire is increased.

2 The strength of magnetic field is decreased.

3 The direction of the magnetic field is reversed.

Which changes increase the electromotive force (e.m.f.) induced in the wire?

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

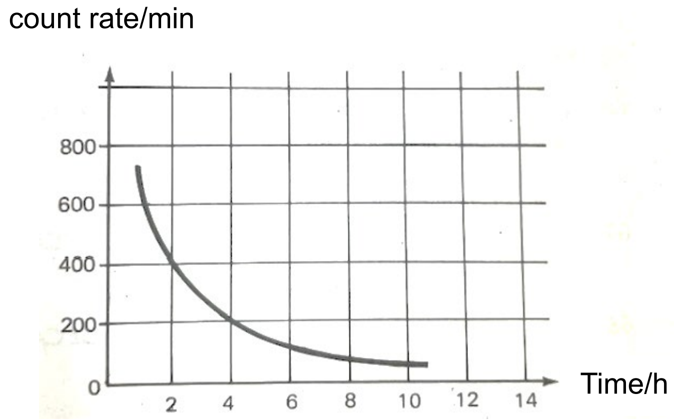
37 A nucleus consists of 90 protons and 144 neutrons.

This nucleus emits two beta particles followed by an alpha particle.

Which of the following shows the number pf protons and nucleus in the new nuclide formed?

A 86 protons and 140 neutrons.
B 86 protons and 142 neutrons.
C 90 protons and 140 neutrons.
D 90 protons and 142 neutrons.

38 The graph represents the decay of a radioactive element.



What is the half-life of this element?

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

39 The background count rate is 40 counts per minute. A radioactive source gives a count rate of 360 counts per minute.

If the half-life of the source is 1 hour what is the count rate after 2 hours?

A 40 counts per min
B 80 counts per min
C 160 counts per min
D 180 counts per min

40 Which statement about nuclear fusion is correct?

A Nuclear fusion occurs at low temperatures.
B Nuclear fusion occurs between heavy nuclei.
C Nuclear fusion occurs in the formation of many stars.
D Nuclear fusion powers most electricity generating power stations.

End of Paper

Section A
Answer **all** questions.

1 Fig. 1.1 shows the velocity-time graph of a vehicle accelerating from rest.

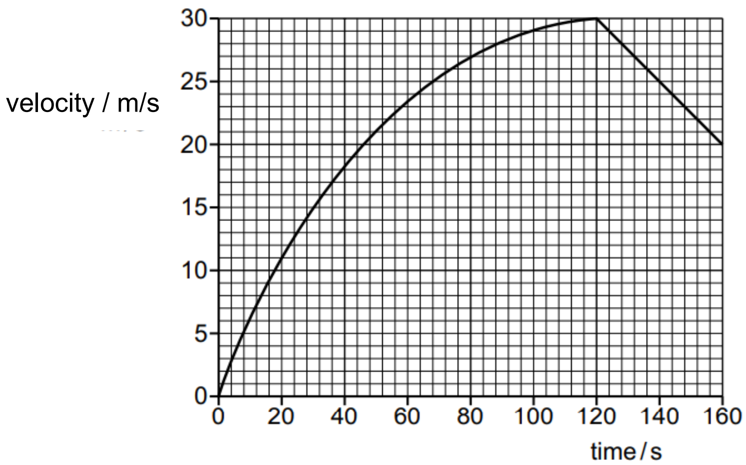


Fig. 1.1

(a) State what is meant by *acceleration*.

....

.... [1]

(b) State how the acceleration at time t = 100 s compares to the acceleration at time t = 20 s. Using ideas about forces, explain why any change in the acceleration has occurred.

....

.... [2]

(c) Calculate the acceleration of the vehicle at time t = 140 s.

acceleration = ... [2]

(d) Determine the distance travelled by the vehicle between t = 120 s and t = 160 s.

distance = ... [2]

[Total: 7]

2 Pole-vaulting is a sport in which the athlete uses a long flexible pole as an aid to clear a crossbar.

Fig. 2.1 shows the athlete going through the initial stages in his attempt to clear the crossbar.

In stage 1, he sprints down a runway towards the crossbar. At the end of stage 1, he plants his pole in a box on the ground. As the athlete leaves the ground at the beginning of stage 2, the pole bends under the athlete's motion and begins to rise and invert as the pole starts to straighten. The athlete reaches his maximum height when the pole straightens vertically at the end of stage 3, just before clearing the crossbar.

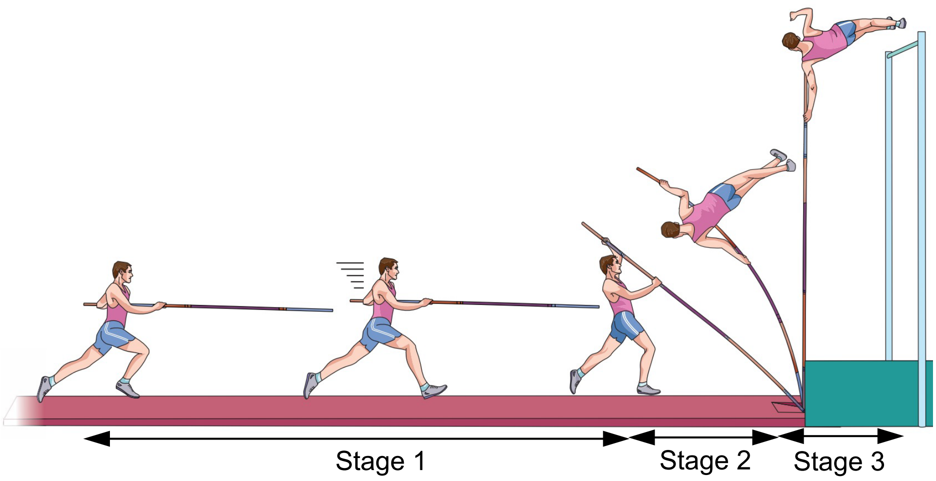


Fig. 2.1

(a) The transfer of energy between energy stores of the athlete and the long pole at each stage of the motion is shown in Table 2.1.

Stage 1 in Table 2.1 has been completed for you. Complete the energy transfer for stages 2 and 3.

Table 2.1

Stage	Energy transfers from
1	chemical potential store of athlete to kinetic store of athlete
2	
3	

[2]

(b) When the athlete is at the end of stage 1, just before he plants his pole in the box, his energy in the kinetic store is 1800 J.

The mass of the athlete is 50 kg. The height of the cross bar from the ground is 4.0 m. The gravitational field strength is 10 N/kg.

You may assume that air resistance has negligible effect on the athlete throughout the 3 stages.

Explain, with appropriate calculations, why the athlete will **not** be successful in clearing the bar.

....

.... [2]

(c) Determine the minimum speed that the athlete must have at the end of stage 1 to effectively clear the crossbar at the end of stage 3.

minimum speed = ... [2]

[Total: 6]

3 **(a)** Brownian motion provides indirect evidence that a gas consists of particles in motion.

The apparatus shown in Fig. 3.1 is used to study Brownian motion of smoke particles. Smoke from a burnt paper is let into the glass smoke cell. The smoke cell is illuminated and seen through a microscope.

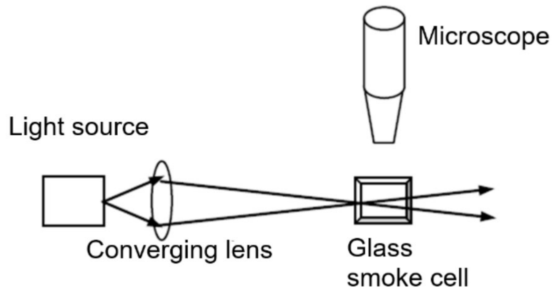


Fig. 3.1

Through the microscope, tiny bright specks are seen moving randomly.

Explain how this observation provides indirect evidence of the gas particles in motion.

....

....

.... [2]

(b) Fig. 3.2 shows a device with a piston supported by a gas trapped in a cylinder.

The cross-sectional area, *A* of the piston is 5.0×10^{-3} m^2. The pressure of the gas in the cylinder is 2.0×10^5 Pa. The atmospheric pressure is 1.0×10^5 Pa. The acceleration of free fall is 10 m/s^2.

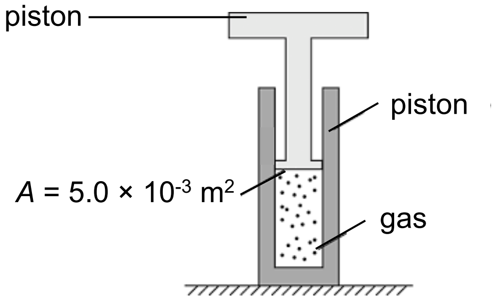


Fig. 3.2

(i) Determine the mass of the piston.

mass = ………………………….. [2]

(ii) The gas in the cylinder is now heated to a much higher temperature.

Explain, in terms of particle motion, why the piston rises to a higher position as the gas is heated.

....

....

[2]

....

[Total: 6]

4 One type of renewable energy source is shown in Fig. 4.1.

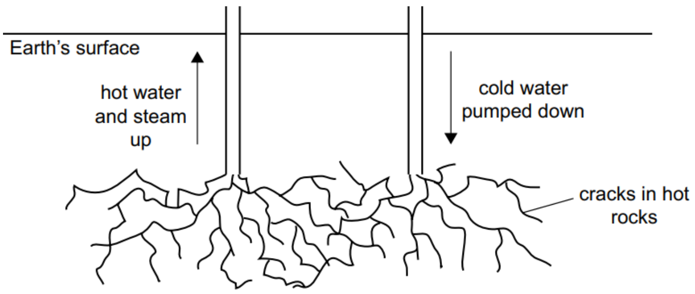


Fig. 4.1

(a) State the name of the renewable energy source shown in Fig. 4.1.

.... [1]

(b) 1.0×10^3 kg of cold water at a temperature of 20°C is pumped down to the hot rocks. The water returns partly as steam and partly as hot water. The steam and the hot water are both at a temperature of 100°C.

The specific heat capacity of water is 4200 J / (kg °C).

(i) Calculate the energy needed to heat 1.0×10^3 kg of water from 20°C to 100°C.

energy = ... [2]

(ii) An accident occurred while a worker was pumping out the steam and hot water. He has some steam burns some hot water burns.

Using the concept of energy, explain why the steam burns caused more injury than burns from hot water.

....

....

....

.... [3]

[Total: 6]

5 **(a)** Fig. 5.1 shows a converging lens and its principal axis. The points F_1 and F_2 are the principal focus of the lens.

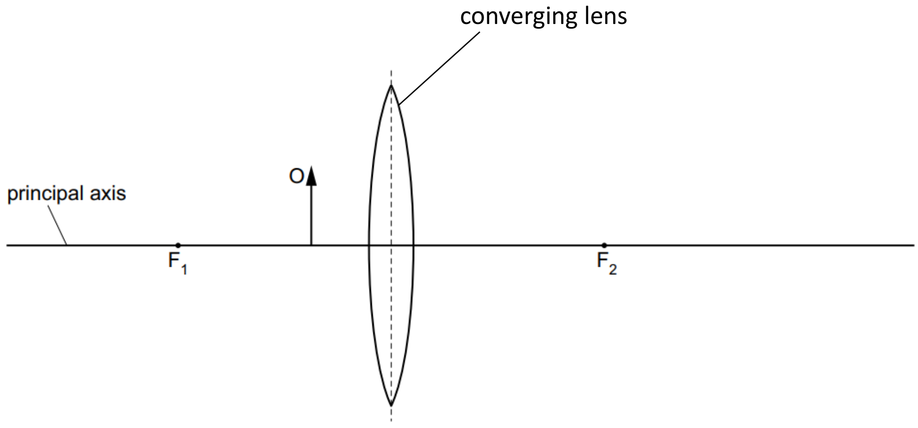


Fig. 5.1

An object O is placed between F_1 and the centre of the lens.

(i) On Fig. 5.1, draw two light rays from the top of object O to locate the image. Label the image I. [3]

(ii) Object O is moved to the left along the principal axis so that it is further from the lens than F_1.

Fig. 5.2 shows the new position of object O.

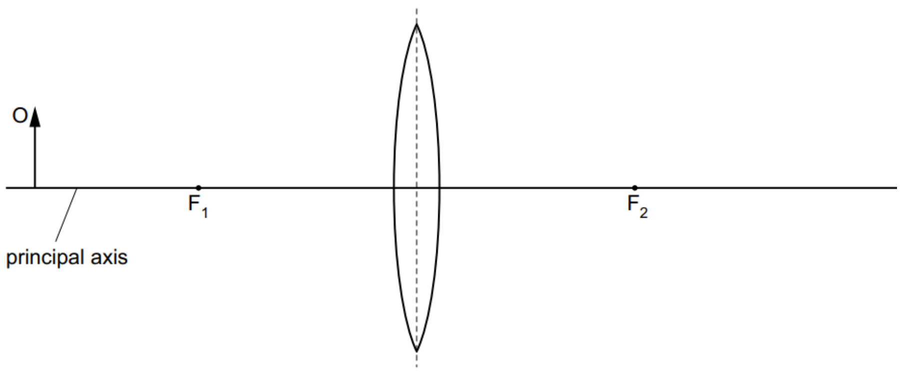


Fig. 5.2

State two differences between the image formed in Fig. 5.1 and in Fig. 5.2.

....

.... [2]

(b) The lens is now used to form an image of a distant object.

Draw two rays on Fig. 5.3 to locate the image formed. Mark the image as I. [2]

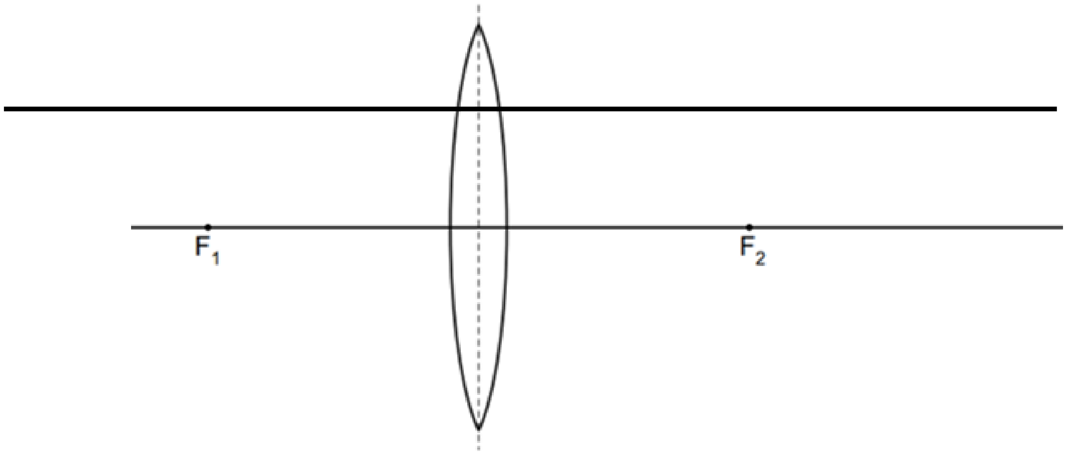


Fig. 5.3

[Total: 7]

6 Fig. 6.1 shows a light ray in air, incident on the side of a rectangular glass block at an angle of 60°.

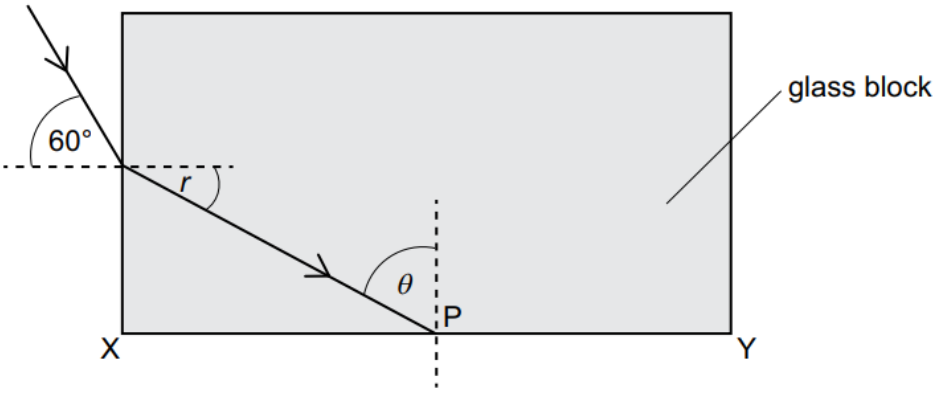


Fig. 6.1

The refractive index of the glass is 1.6. The light travels in the glass and is incident on side XY at P as shown in Fig. 6.1.

(a) At the point where the light enters the glass, the angle of refraction is *r*.
Calculate angle *r.*

angle *r* = ………………………….. [2]

(b) **(i)** Calculate the critical angle *c* for light travelling in the block.

critical angle = ………………………….. [2]

(ii) State and explain what happens to the light when it is incident at P.

....

....

....

.... [2]

[Total: 6]

7 **(a)** An insulated rod is rubbed with a cloth and becomes negatively charged.

Explain, in terms of the movement of charges, how the rod becomes negatively charged.

....

.... [1]

(b) Two stages in the production of a photocopy are shown in Fig. 7.1.

In stage 1, reflected light from the white parts of the original paper hits the positively charged surface of the insulated plate made from photosensitive material, leaving it as shown in stage 2. Neutral black powder (toner) is then sprayed onto the plate. One neutral powder particle is shown enlarged in stage 2.

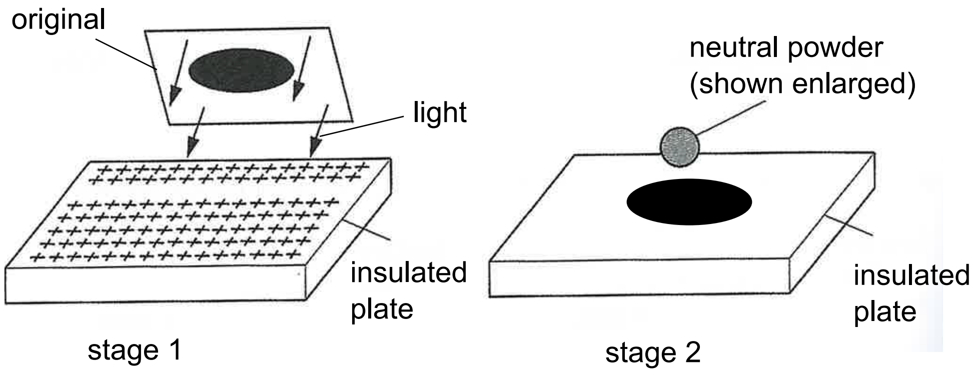


Fig. 7.1

(i) Explain what happens to the charges on the surface of insulated plate in the region that the light strikes.

....

.... [1]

(ii) On Fig.7.1, draw the charge distribution on the neutral powder particle. [1]

(iii) Explain why the neutral powder particle is attracted to the insulated plate as shown in stage 2 of Fig. 7.1.

....

....

.... [2]

[Total: 5]

8 Fig. 8.1 shows a radioactive source stored in a safe way.

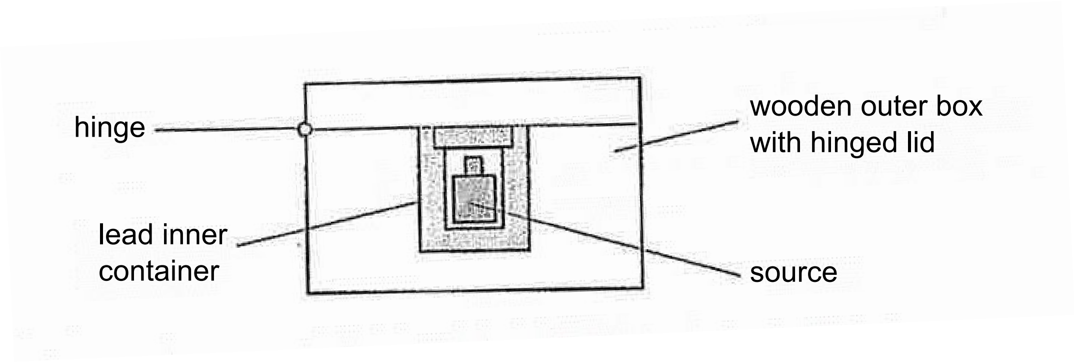


Fig. 8.1

(a) **(i)** State which type of radiation produces the strongest ionising effect.

.... [1]

(ii) State which type of radiation is deflected most by a magnetic field.

.... [1]

(b) Fig. 8.2 shows a Geiger-Müller (G.M.) tube and counter.

When the G.M. tube was first turned on without the presence of a radioactive source, the counter reads 200 units.

When the radioactive source from Fig. 8.1 is placed 10 cm from the G.M. tube, the counter now reads 800 units, as shown in Fig. 8.2.

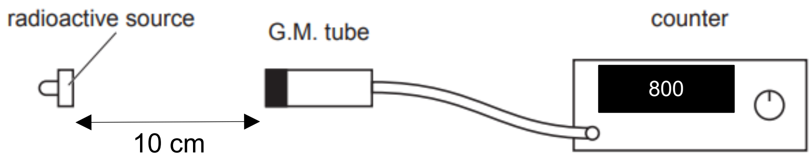


Fig. 8.2

A piece of paper is placed between the radioactive source and the G.M. tube as shown in Fig. 8.3. The counter reads 800 units.

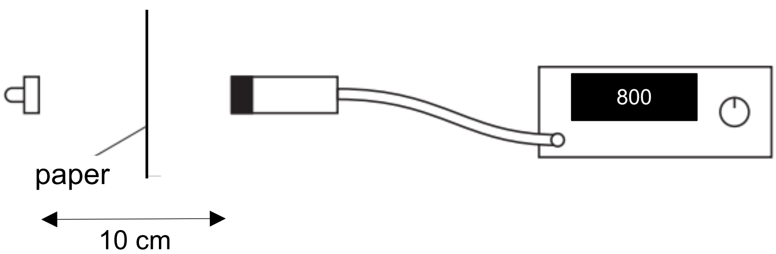


Fig. 8.3

The piece of paper is removed, and a piece of 5 mm thick metal plate (aluminium) is then placed between the source and the G.M. tube as shown in Fig. 8.4. The counter now reads 600 units.

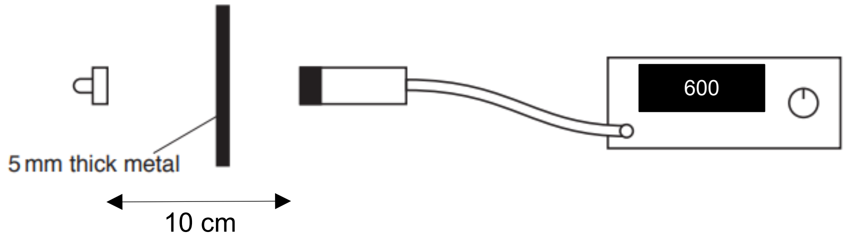


Fig. 8.4

With reference to Fig. 8.3 and Fig. 8.4, explain how the readings show that the radioactive source emits both β-particles and γ-radiation, but **not** α-particles.

....

....

....

....

....

.... [3]

(c) A teacher handles the box shown in Fig. 8.1.

Explain why the design of the box can protect the teacher completely from α and β particles but can only partially protect from γ rays.

....

....

.... [2]

[Total: 7]

9 A thermistor X is connected to the circuit shown in Fig. 9.1.

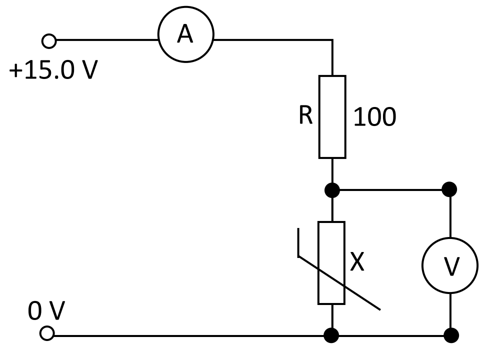


Fig. 9.1

The resistance of R is 100 Ω.

The temperature of the thermistor is varied, and the resistance of the thermistor is measured.

The graph of resistance against temperature for the thermistor is shown in Fig. 9.2.

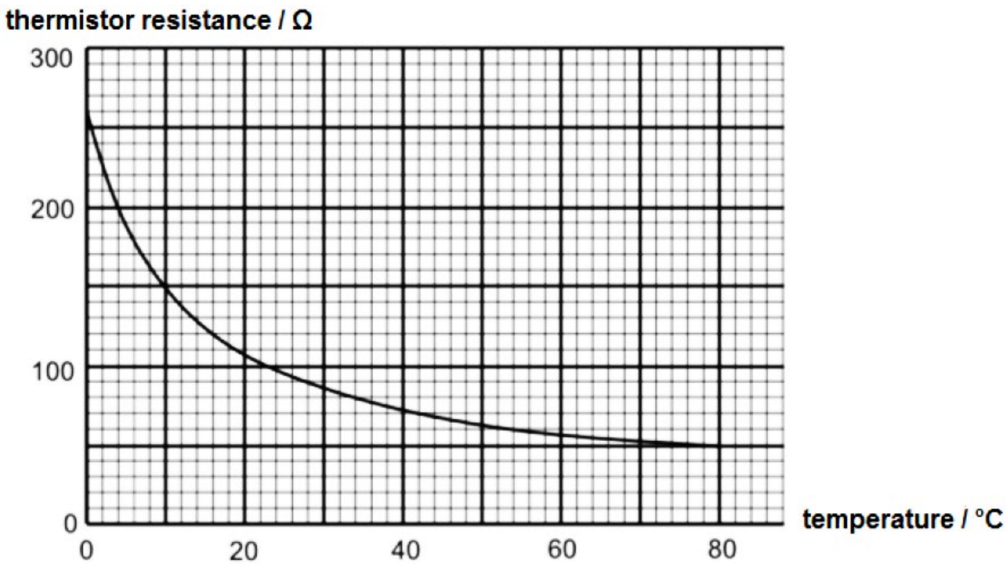


Fig. 9.2

(a) When the temperature of the thermistor is at 28°C, determine the

(i) total resistance of the circuit,

total resistance = ………………………….. [1]

(ii) ammeter reading

ammeter reading = ………………………….. [1]

(iii) voltmeter reading.

voltmeter reading = ………………………….. [2]

(b) Explain how the potential difference across resistor R changes as the temperature of the thermistor increases.

....

....

....

....

.... [2]

(c) Component K is connected across resistor R as shown in Fig. 9.3.

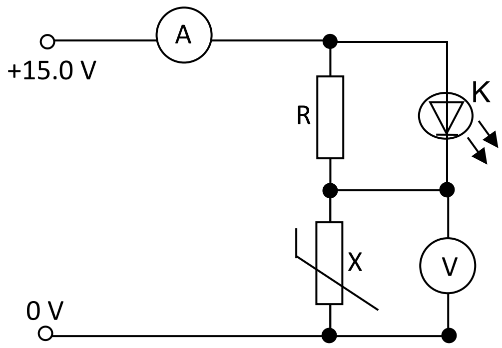


Fig. 9.3

Component K will only switch on when the potential difference across it is larger than 4.5 V.

Some readings of the ammeter and voltmeter are shown in Table 9.4.

Temperature of thermistor / °C	Ammeter reading / A	Voltmeter reading / V
0	0.056	14.4
20	0.098	10.2
30	0.108	9.2
40	0.118	8.2
45	0.125	7.9
60	0.129	7.1

Table 9.4

(i) Identify component K.

.... [1]

(ii) Based on Table 9.4, determine the temperature range that component K will switch on.

....

.... [1]

(iii) Determine the voltage across component K when the temperature of the thermistor is 45°C.

voltage = ………………………….. [2]

[Total: 10]

10 The Earth's weather system creates waves on the surface of the ocean.

Fig. 10.1 shows data on the speed and wavelength of some ocean waves. The waves travel in deep water of depth 3500 m or in shallow water of depth 10 m.

Depth									
3500 m	Wavelength / m	10	40	100	200	300	400	500	600
	Speed / m/s	4.0	7.9	12.5	17.7	21.6	25.0	27.9	30.6

Depth									
10 m	Wavelength / m	10	40	100	200	300	400	500	600
	Speed / m/s	4.0	7.6	9.3	9.7	9.8	9.9	9.9	9.9

Fig. 10.1

A yacht can sail in either shallow water or deep water.

(a) Describe what is a wave motion.

....

.... [1]

(b) Describe the motion of the yacht as water waves arrive at the yacht.

....

.... [1]

(c) **(i)** Determine, using Fig. 10.1 for wavelength of 400 m, the frequency of motion of the yacht in shallow water.

frequency = ………………………….. [2]

(ii) Using suitable calculations, compare the frequency of motion of the yacht in shallow water, for wavelengths from 400 m to 600 m.

....

....

....

.... [2]

(d) **(i)** Tsunamis are giant waves caused by earthquakes or volcanic eruptions under the sea. The speed of tsunami waves depends on ocean depth rather than the distance from the source of the wave.

A tsunami is produced at a location 1.0×10^3 km away from a yacht. The waves generated have wavelengths varying between 10 m and 600 m and travel across the ocean of average depth 3500 m to the yacht.

Using data from Fig. 10.1, determine the time taken (in hours) for the first wave to reach the yacht.

time taken = ………………………….. [2]

(ii) After the first wave arrives at the yacht, describe the effect on the yacht of the subsequent waves that arrive.

....

....

....

....

....[2]

[Total: 10]

Section B

Answer **one** question from this section.

11 Fig.11.1 shows a coil in a magnetic field.

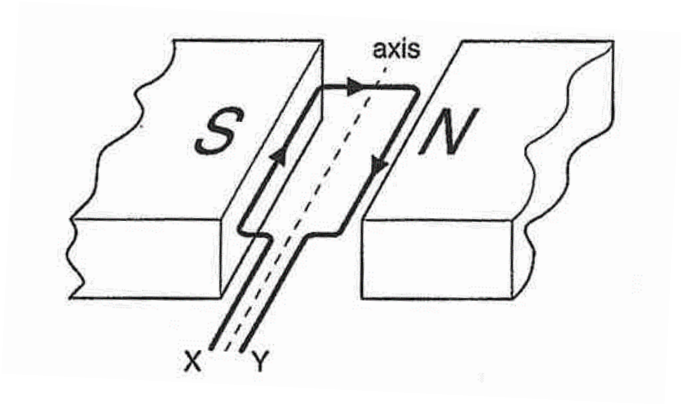


Fig. 11.1

The ends X and Y of the coil are connected directly to a battery (not shown in Fig. 11.1). The arrows on the coil show the direction of the current in the coil.

The coil can rotate about the axis, but not continuously.

(a) On Fig.11.1, draw arrows to show the direction of the forces acting on the sides of the coil. [1]

(b) Describe the motion of the coil until it comes to rest.

....

....

.... [2]

(c) In order for the coil to rotate continuously, a commutator is required to be connected to the coil.

(i) On Fig.11.1, draw a commutator connected to X and Y that will allow the coil to rotate continuously. Include a battery that gives the direction of current shown in Fig.11.1. [2]

(ii) Explain how connecting the commutator to X and Y of the coil will allow the coil to rotate continuously.

....

....

....

[2]
....

(d) Fig.11.3 shows how the moment acting on the coil about the axis depends on time.

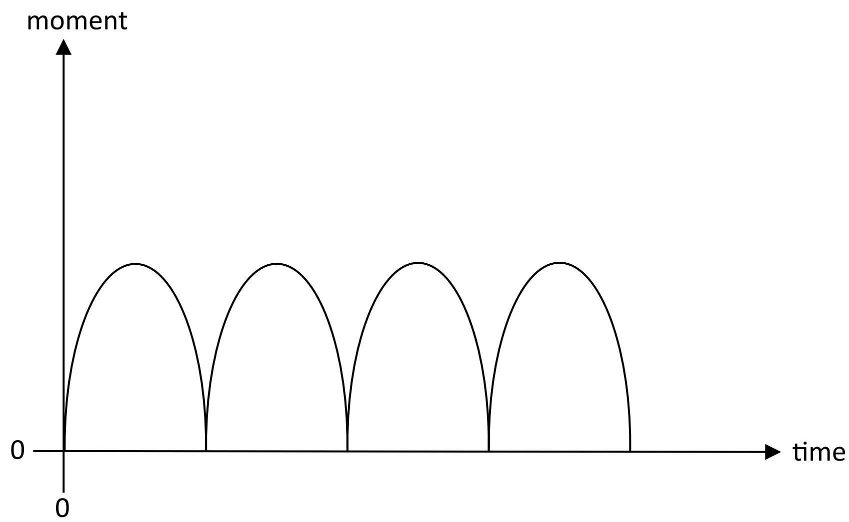


Fig. 11.3

(i) On Fig. 11.3, mark with a letter H when the coil is horizontal. [1]

(ii) Sketch on Fig 11.3, the changes to the graph when the e.m.f. of the battery is doubled. [2]

[Total: 10]

12 Fig.12.1 shows a shaver socket. Fig. 12.2 is a diagram of the transformer inside the socket.

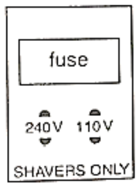


Fig. 12.1

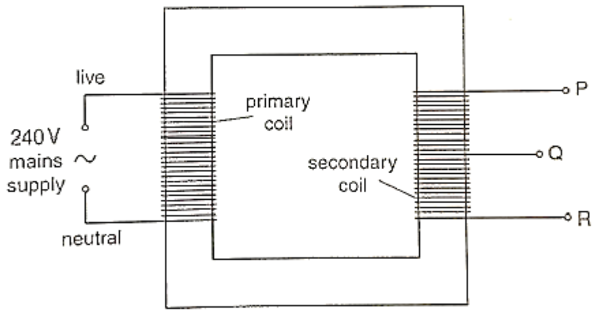


Fig. 12.2

The 6000 turns primary coil of the transformer is connected to the 240 V mains supply.

There is an output of 240 V between P and R and an output of 110 V between P and Q.

(a) Calculate the number of turns in the secondary coil between Q and R.

number of turns = ……………………………..[2]

(b) For safety reasons there must be a mains fuse in the transformer.

(i) On Fig.12.2, mark with a letter X to show the position of the fuse. [1]

(ii) Explain the purpose of the fuse and why it must be in the position marked.

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

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

(c) Transformers are also used in transferring electrical power from power plants to homes of consumers. Fig.12.3 shows high voltage cables used to transfer electrical power.

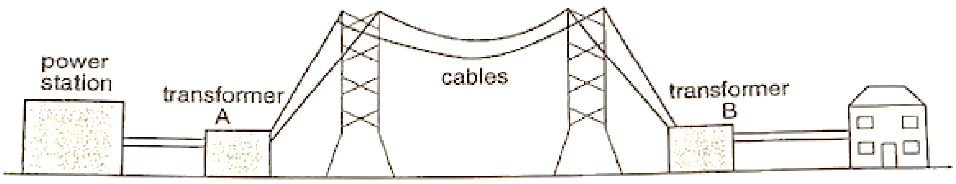


Fig. 12.3

(i) State the purpose of transformer A.

....

.... [1]

(ii) Explain why high voltages and thick cables are used to transfer electrical power.

....

....

....

....

.... [3]

[Total: 10]

End of Paper

Section A

Answer **all** questions.

1 Fig. 1.1 shows the velocity-time graph of a vehicle accelerating from rest.

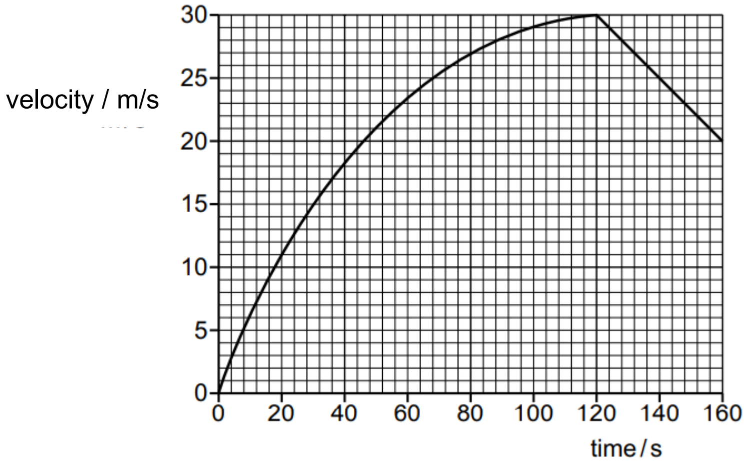


Fig. 1.1

Strictly not allowed to write

Rate of change of velocity per unit time or

Change of velocity over a period of time

(a) State what is meant by *acceleration*.

Acceleration is the rate of change of velocity / change of velocity per unit time

.... [1]

....

Strictly not allowed to write

Acceleration is slower

(b) State how the acceleration at time t = 100 s compares 20 s. Using ideas about forces, explain why any ch occurred.

Acceleration at t = 100 s is smaller/lower than acceleration at t = 10 s.

For the same mass of object, acceleration is proportional to the resultant force on the object. The resultant / net force on the object decreases from t = 20 s to t = 100 s.

(c) Calculate the acceleration of the vehicle at time t = 140 s.

Acceleration = (30 - 20)/(120 - 160)
= - 0.25 m/s^2 (- 1 if missing negative sign)

acceleration = ... [2]

(d) Determine the distance travelled by the vehicle between t = 120 s and t = 160 s.

Distance= 1/2 (20 + 30)(40)
= 1000 m

distance = ... [2]

[Total: 7]

2 Pole-vaulting is a sport in which the athlete uses a long flexible pole as an aid to clear a crossbar.

Fig. 2.1 shows the athlete going through the initial stages in his attempt to clear the crossbar.

In stage 1, he sprints down a runway towards the crossbar. At the end of stage 1, he plants his pole in a box on the ground. As the athlete leaves the ground at the beginning of stage 2, the pole bends under the athlete's motion and begins to rise and invert as the pole starts to straighten. The athlete reaches his maximum height when the pole straightens vertically at the end of stage 3, just before clearing the crossbar.

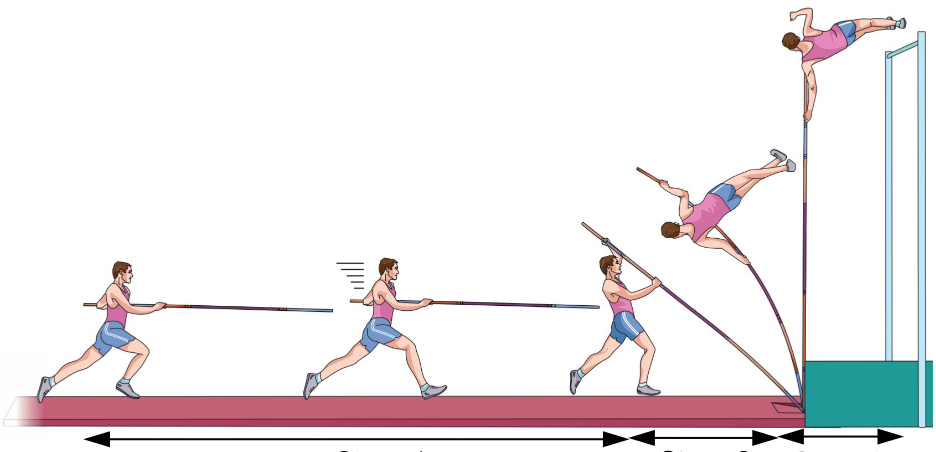


Fig. 2.1

(a) The transfer of energy between energy stores of the athlete and the long pole at each stage of the motion is shown in Table 2.1.

Stage 1 in Table 2.1 has been completed for you. Complete the energy transfer for stages 2 and 3.

Good to include where the energy store is

Table 2.1

Stage	Energy transfers from
1	chemical potential store of athlete to kinetic store of athlete
2	kinetic store of athlete to elastic potential store of pole
3	elastic potential store of pole to gravitational potential energy of man

[2]

(b) When the athlete is at the end of stage 1, just before he plants his pole in the box, his energy in the kinetic store is 1800 J.

The mass of the athlete is 50 kg. The height of the cross bar from the ground is 4.0 m. The gravitational field strength is 10 N/kg.

You may assume that air resistance has negligible effect on the athlete throughout the 3 stages.

Explain, with appropriate calculations, why the athlete will **not** be successful in clearing the bar.

Energy from KE store is transferred to energy in GPE store $mgh = 1800$

$(50)(10)(h) = 1800$

$h = 3.6 < 4.0$

Thus, the athlete will not be successful in jumping over the bar.

Energy from KE store is transferred to energy in GPE store is 1800 J

To clear 4m energy required is 2000 J

Thus, the athlete will not be successful in jumping over the bar.

(c) Determine the minimum speed that the athlete must have at the end of stage 1 to effectively clear the crossbar at the end of stage 3.

$(50)(10)(4.0) = 2000$

$1/2\ (50)v^2 = 2000$

$v = 8.9$ m/s

minimum speed = ... [2]

[Total: 6]

3 **(a)** Brownian motion provides indirect evidence that a gas consists of particles in motion.

The apparatus shown in Fig. 3.1 is used to study Brownian motion of smoke particles. Smoke from a burnt paper is let into the glass smoke cell. The smoke cell is illuminated and seen through a microscope.

Answers for question is weak. You are required to explain why the bright specks (reflection of light from the smoke particles)are moving randomly

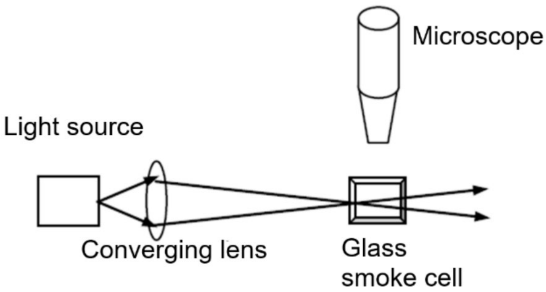


Fig. 3.1

Through the microscope, tiny bright specks are seen moving randomly.

Explain how this observation provides indirect evidence of the gas particles in motion.

The bright specks are moving because the smoke particles are bombarded by unseen air molecules which are moving about at high speeds .The bright specks have random motion which infer that the unseen molecules is moving in different directions.

....

....

.... [2]

(b) Fig. 3.2 shows a device with a piston supported by a gas trapped in a cylinder.

The cross-sectional area, A of the piston is 5.0×10^{-3} m^2. The pressure of the gas in the cylinder is 2.0×10^5 Pa. The atmospheric pressure is 1.0×10^5 Pa. The acceleration of free fall is 10 m/s^2.

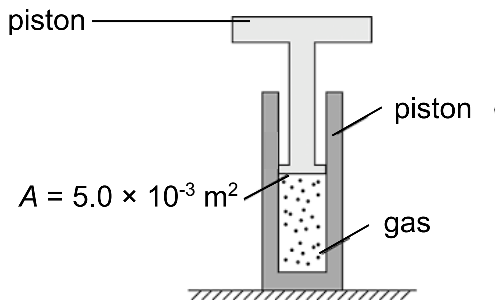


Fig. 3.2

Note

The total force acting on the gas due to piston and atmospheric pressure.

The force due to the gas acting on the inside of the piston

(i) Determine the mass of the piston.

Let the mass be m kg

m (10) + (100 000) (0.0050) = (200 000) (0.0050)

m = 50 kg

mass = ... [2]

For molecules do not write that they gain thermal energy

The gas in the cylinder is now heated to a much higher temperature.

Explain, in terms of particle motion, why the piston rises to a higher position as the gas is heated.

(When the gas is heated), the gas molecules gain kinetic energy (and move faster).

They collide with the walls (of the piston) harder / with greater force / more frequency.

OR

Average KE (of gas particles) increases as temperature increases / gas particles move faster, rate of collision increases / number of collisions per unit time increases and / or more frequently.

Net upward force greater than the downward force (of weight / atmospheric pressure).

OR

Gas pressure greater than downward pressure due to piston and atmospheric pressure.

4 One type of renewable energy source is shown in Fig. 4.1.

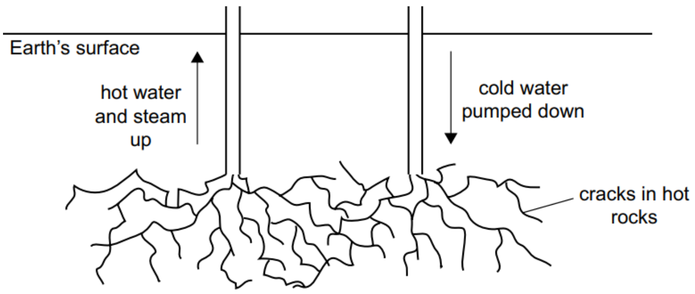


Fig. 4.1

(a) State the name of the renewable energy source shown in Fig. 4.1.

Geothermal energy

.... [1]

(b) 1.0×10^3 kg of cold water at a temperature of 20°C is pumped down to the hot rocks. The water returns partly as steam and partly as hot water. The steam and the hot water are both at a temperature of 100°C.

The specific heat capacity of water is 4200 J / (kg °C).

(i) Calculate the energy needed to heat 1.0×10^3 kg of water from 20°C to 100°C.

Q = (1000)(4200)(100 - 20)
= 336 000 000 J

energy = ... [2]

(ii) An accident occurred while a worker was pumping out the steam and hot water. He has some steam burns some hot water burns.

Using the concept of energy, explain why the steam burns caused more injury than burns from hot water.

You need to explain

What causes the injury and why more injury for steam burns

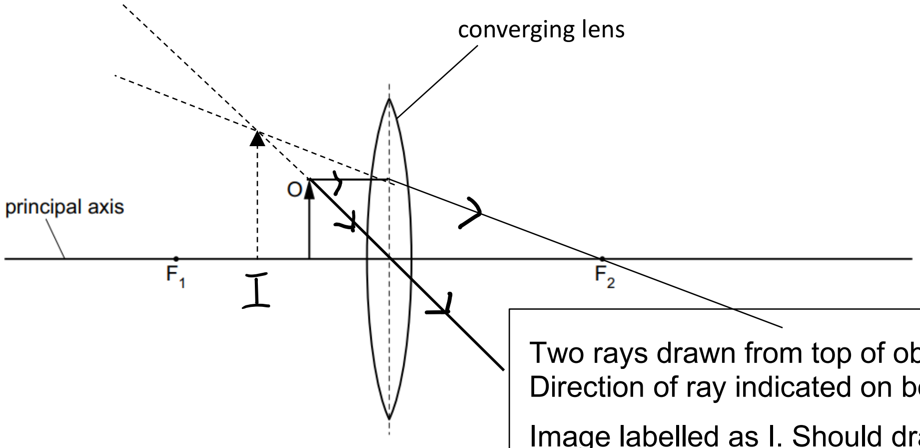
Transfer of thermal energy from hot water and steam to the ~~steam~~ skin result in burn.

More energy is transferred by steam as latent heat is given to the skin when steam condenses

.... [3]

[Total: 6]

5 **(a)** Fig. 5.1 shows a converging lens and its principal axis. The points F_1 and F_2 are the principal focus of the lens.



Two rays drawn from top of object O.
Direction of ray indicated on both rays.

Image labelled as I. Should draw the full arrow. Virtual, magnified and upright image formed to the left of object O

Fig. 5.1

An object O is placed between F_1 and the centre of the lens.

(i) On Fig. 5.1, draw two light rays from the top of object O to locate the image. Label the image I. [3]

(ii) Object O is moved to the left along the principal axis so that it is further from the lens than F_1.

Fig. 5.2 shows the new position of object O.

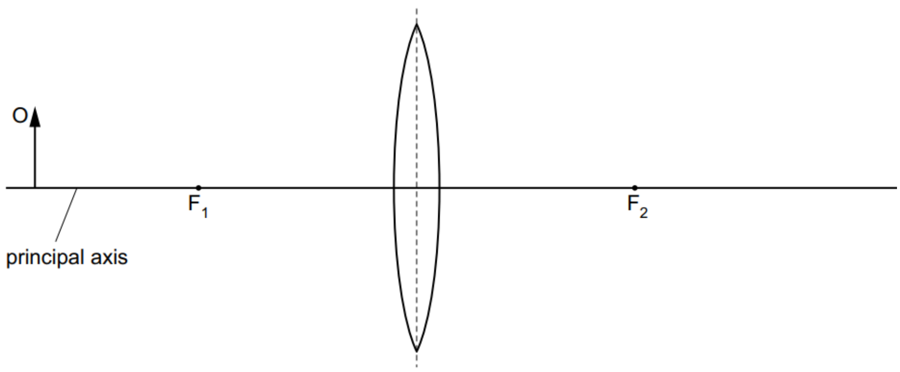


Fig. 5.2

State two differences between the image formed in Fig. 5.1 and in Fig. 5.2.

Virtual, magnified and upright image formed to the left of object O

Image formed is now real and inverted. Image is now formed on the other side of the lens (from the object)

[2]

(b) The lens is now used to form an image of a distant object.

Draw two rays on Fig. 5.3 to locate the image formed. Mark the image as I. [2]

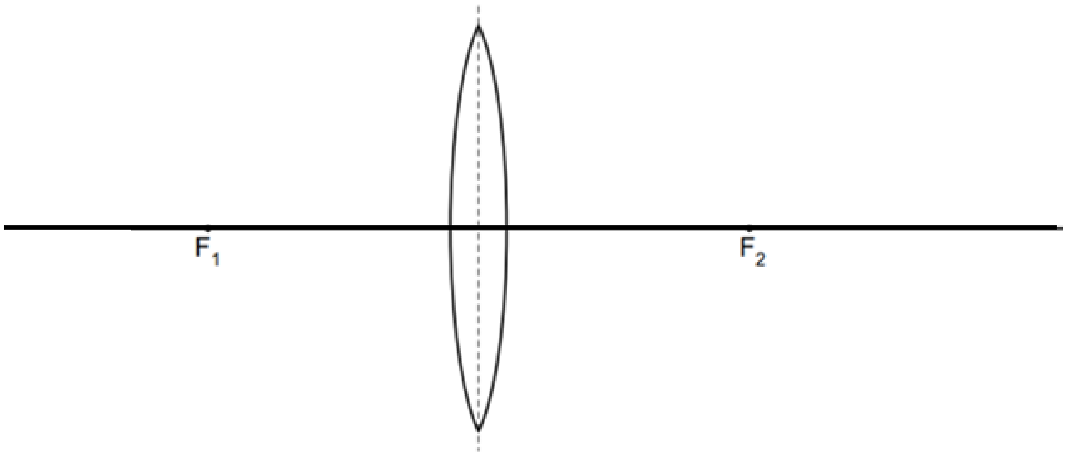
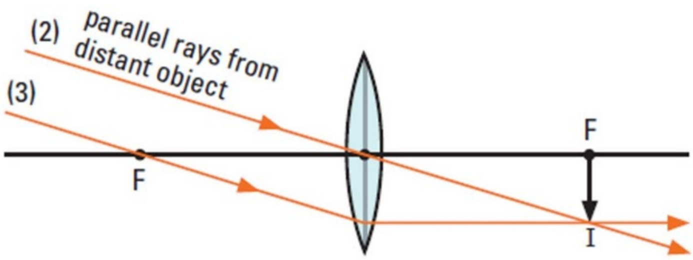


Fig. 5.3

[Total: 7]



6 Fig. 6.1 shows a light ray in air, incident on the side of a rectangular glass block at an angle of 60°.

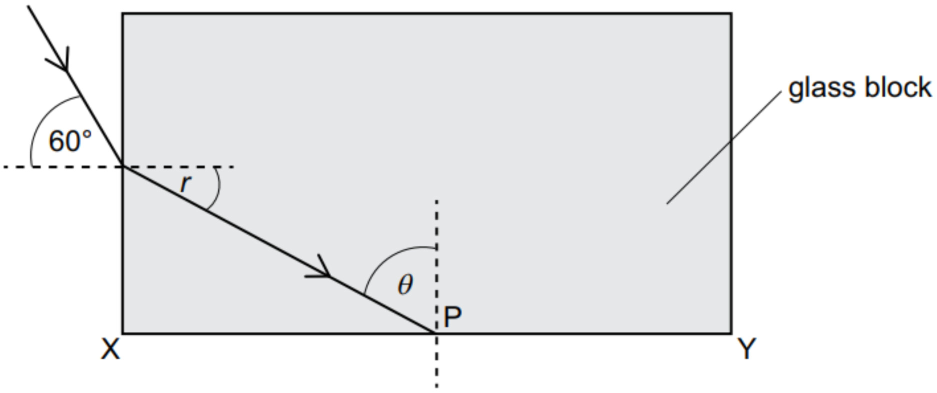


Fig. 6.1

The refractive index of the glass is 1.6. The light travels in the glass and is incident on side XY at P as shown in Fig. 6.1.

(a) At the point where the light enters the glass, the angle of refraction is *r*. Calculate angle *r*.

sin 60 / sin r = 1.6
r = 33°

angle *r* = ... [2]

(b) **(i)** Calculate the critical angle *c* for light travelling in the block.

sin c = 1/1.6
c = 39°

critical angle = ... [2]

(ii) State and explain what happens to the light when it is incident at P.

The light ray will undergo total internal reflection at P because the angle of incidence at P (57°) is greater than the critical angle.

[2]

[Total: 6]

7 **(a)** An insulated rod is rubbed with a cloth and becomes negatively charged.

Explain, in terms of the movement of charges, how the rod becomes negatively charged.

Negative charge is transferred from the cloth to the rod.

[1]

(b) Two stages in the production of a photocopy are shown in Fig. 7.1.

In stage 1, reflected light from the white parts of the original paper hits the positively charged surface of the insulated plate made from photosensitive material, leaving it as shown in stage 2. Neutral black powder (toner) is then sprayed onto the plate. One neutral powder particle is shown enlarged in stage 2.

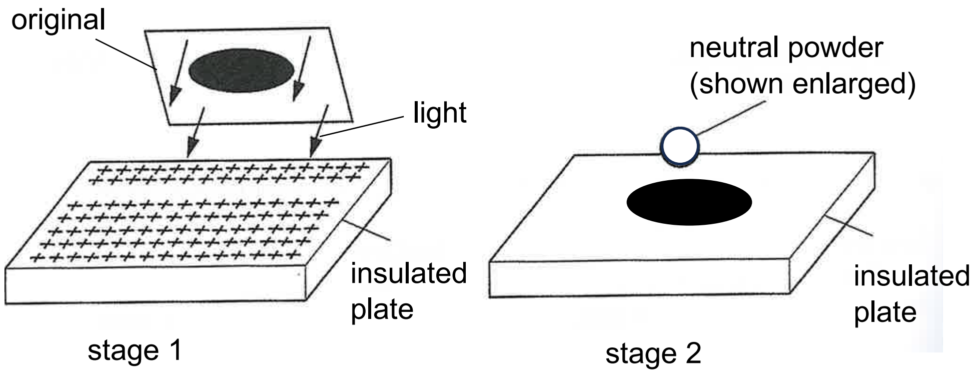
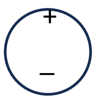


Fig. 7.1

(i) Explain what happens to the charges on the surface of insulated plate in the region that the light strikes.

The (positive) charges on the insulated plate are discharged / neutralised when the light strikes.

[1]



(ii) On Fig.7.1, draw the charge distribution on the neutral powder particle. [1]

(iii) Explain why the neutral powder particle is attracted to the insulated plate as shown in stage 2 of Fig. 7.1.

Negative charge induced at the bottom; positive charge induced at the top.
Unlike charges are closer together than like charges. Since unlike charges attract, there is a net attractive force between the particle and the plate for attraction to charged plate.

[2]

[Total: 5]

8 Fig. 8.1 shows a radioactive source stored in a safe way.

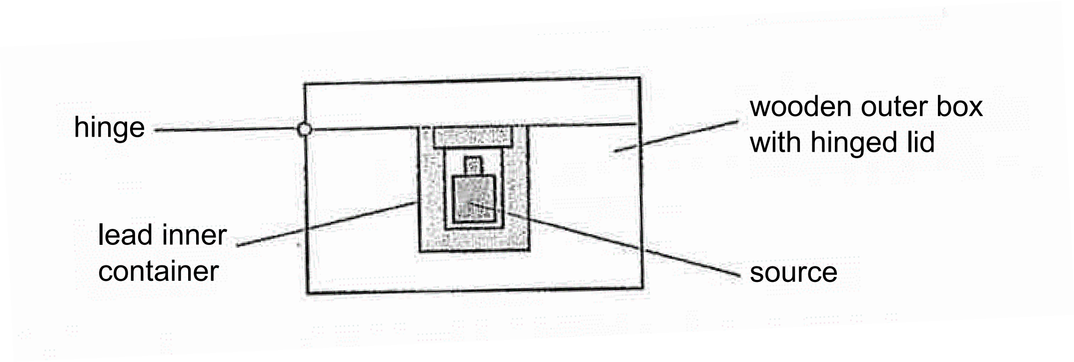


Fig. 8.1

(a) **(i)** State which type of radiation produces the strongest ionising effect.

Alpha radiation/ particles [1]

(ii) State which type of radiation is deflected most by a magnetic field.

beta radiation/particles [1]

(b) Fig. 8.2 shows a Geiger-Müller (G.M.) tube and counter.

When the G.M. tube was first turned on without the presence of a radioactive source, the counter reads 200 units.

When the radioactive source from Fig. 8.1 is placed 10 cm from the G.M. tube, the counter now reads 800 units, as shown in Fig. 8.2.

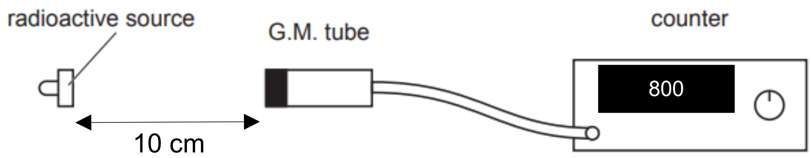


Fig. 8.2

A piece of paper is placed between the radioactive source and the G.M. tube as shown in Fig. 8.3. The counter reads 800 units.

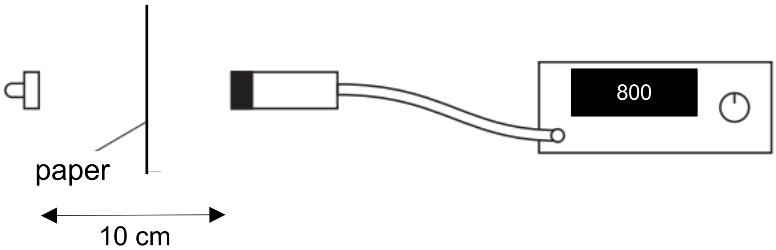


Fig. 8.3

The piece of paper is removed, and a piece of 5 mm thick metal plate (aluminium) is then placed between the source and the G.M. tube as shown in Fig. 8.4. The counter now reads 600 units.

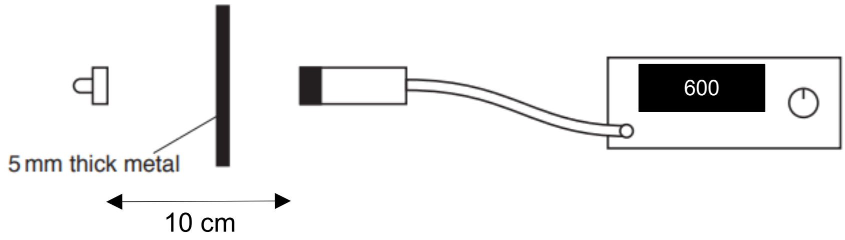


Fig. 8.4

With reference to Fig. 8.3 and Fig. 8.4, explain how the readings show that the radioactive source emits both β-particles and γ-radiation, but **not** α-particles.

The reading with or without the paper indicate 800. This shows that alpha particles are not present as alpha cannot pass through paper

The reading of 600 when a piece of metal is placed in front of the source indicating some radiation is stopped by the metal. This indicate that beta particles are present as beta will be stopped by a few mm of aluminium

The count rate 600 also indicate the presence of gamma radiation because if gamma was not present the rate should drop to 200.

[3]

(c) A teacher handles the box shown in Fig. 8.1.

Explain why the design of the box can protect the teacher completely from α and β particles but can only partially protect from γ rays.

The box is made of lead which can block alpha and beta radiation totally, but can only block gamma radiation partially.

[2]

[Total: 7]

9 A thermistor X is connected to the circuit shown in Fig. 9.1.

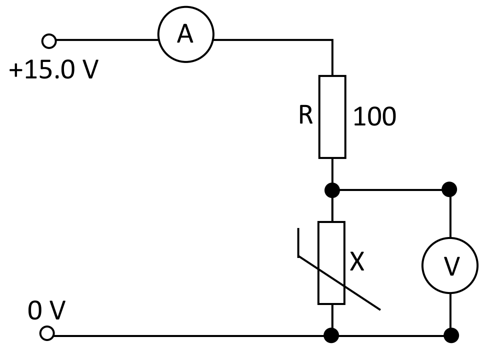


Fig. 9.1

The resistance of R is 100 Ω.

The temperature of the thermistor is varied, and the resistance of the thermistor is measured.

The graph of resistance against temperature for the thermistor is shown in Fig. 9.2.

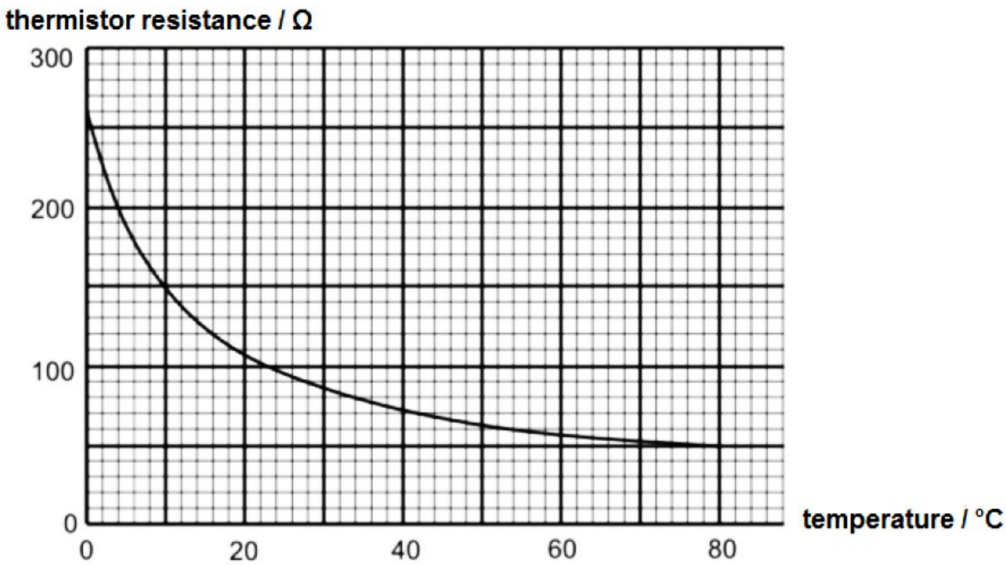


Fig. 9.2

(a) When the temperature of the thermistor is at 28°C, determine the

(i) total resistance of the circuit,

190 Ω

total resistance = ………………………….. [1]

(ii) ammeter reading

15/ 190

= 0.079A

ammeter reading = ………………………….. [1]

(iii) voltmeter reading.

0.079 x 90 =7.1 V

OR

(90/190) x 15 = 7.1V

ıeter reading = ………………………….. [2]

(b) Explain how the potential difference across resistor R changes as the temperature of the thermistor increases.

As the temperature of the thermistor increases, its <u>resistance decreases</u>.

Since connection is in series, the <u>ratio of p.d. is equal to the ratio of resistance</u>.

Thus the p.d. across the thermistor increases while <u>p.d. across the resistor R increases</u>.

[2]

(c) Component K is connected across resistor R as shown in Fig. 9.3.

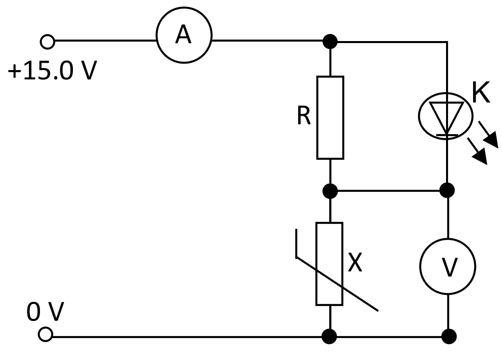


Fig. 9.3

Component K will only switch on when the potential difference across it is larger than 4.5 V.

Some readings of the ammeter and voltmeter are shown in Table 9.4.

Temperature of thermistor / °C	Ammeter reading / A	Voltmeter reading / V
0	0.056	14.4
20	0.098	10.2
30	0.108	9.2
40	0.118	8.2
45	0.125	7.9
60	0.129	7.1

Table 9.4

(i) Identify component K.

Light emitting diode (LED)

.... [1]

(ii) Based on Table 9.4, determine the temperature range that component K will switch on.

Higher than 20°C OR

Between 20^0 C to 60^0 C

.... [1]

(iii) Determine the voltage across component K when the temperature of the thermistor is 45°C.

Voltage across thermistor = 7.9 V
Voltage across R = 15.0 – 7.9 = 7.1 V
Voltage across K = voltage across R = 7.1 V

voltage = ………………………….. [2]

[Total: 10]

10 The Earth's weather system creates waves on the surface of the ocean.

Fig. 10.1 shows data on the speed and wavelength of some ocean waves. The waves travel in deep water of depth 3500 m or in shallow water of depth 10 m.

Depth									
3500 m	Wavelength / m	10	40	100	200	300	400	500	600
	Speed / m/s	4.0	7.9	12.5	17.7	21.6	25.0	27.9	30.6

Depth									
10 m	Wavelength / m	10	40	100	200	300	400	500	600
	Speed / m/s	4.0	7.6	9.3	9.7	9.8	9.9	9.9	9.9

Fig. 10.1

A yacht can sail in either shallow water or deep water.

(a) Describe what is a wave motion.

A wave motion is caused by a disturbance that transfers energy through vibrations from one place to another without transferring matter.

.... [1]

(b) Des

The yacht moves up and down about the same location on the water.

Accept rise and fall

.... [1]

(c) **(i)** Determine, using Fig. 10.1 for wavelength of 400 m, the frequency of motion of the yacht in shallow water.

9.9 / 400 = 0.025 Hz

frequency = ... [2]

(ii) Using suitable calculations, compare the frequency of motion of the yacht in shallow water, for wavelengths from 400 m to 600 m.

f = 9.9 /400 = 0.025 Hz, f = 9.9/600 = 0.017 Hz

Frequency of wave in shallow water decreases as wavelength increases from 400m to 600m as speed is a constant

.... [2]

(d) **(i)** Tsunamis are giant waves caused by earthquakes or volcanic eruptions under the sea. The speed of tsunami waves depends on ocean depth rather than the distance from the source of the wave.

A tsunami is produced at a location 1.0×10^3 km away from a yacht. The waves generated have wavelengths varying between 10 m and 600 m and travel across the ocean of average depth 3500 m to the yacht.

Using data from Fig. 10.1, determine the time taken (in hours) for the first wave to reach the yacht.

The first wave to arrive is the fastest wave with a speed of 30.6 m/s.
Time taken = $(1000 \times 10^3) / 30.6 = 32\,700$ s = 9.1 h

time taken = ………………………….. [2]

(ii) After the first wave arrives at the yacht, describe the effect on the yacht of the subsequent waves that arrive.

With increase in frequency,
the yacht will move up and down more frequently) or
the wave becomes becomes smaller / gentler.

[2]

[Total: 10]

Section B
Answer **one** question from this section.

11 Fig.11.1 shows a coil in a magnetic field.

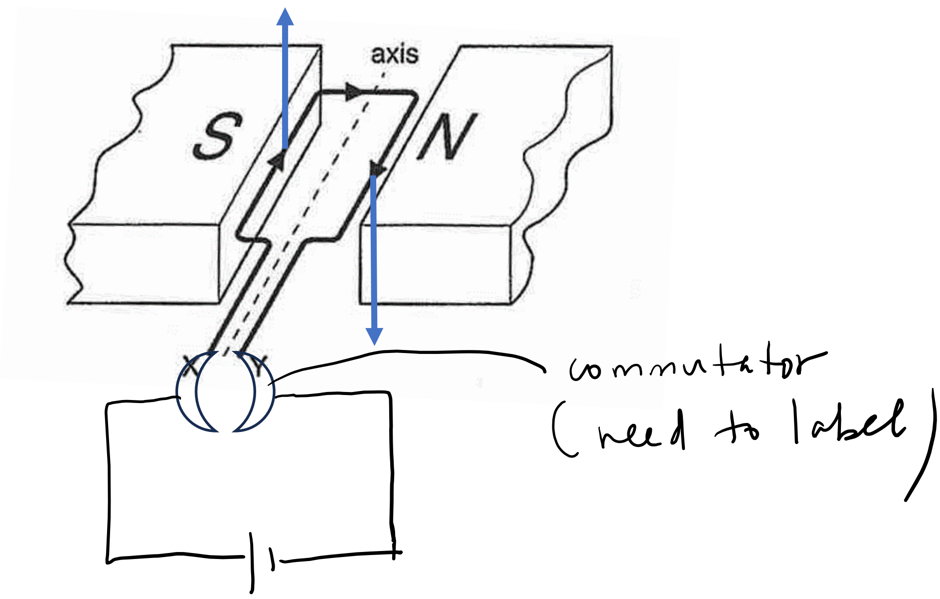


Fig. 11.1

The ends X and Y of the coil are connected directly to a battery (not shown in Fig. 11.1). The arrows on the coil show the direction of the current in the coil.

The coil can rotate about the axis, but not continuously.

(a) On Fig.11.1, draw arrows to show the direction of the forces acting on the sides of the coil. [1]

(b) Describe the motion of the coil until it comes to rest.

Rotate clockwise.

Oscillate vertically about axis / vibrate about the axis before coming to stop.

[2]

(c) In order for the coil to rotate continuously, a commutator is required to be connected to the coil.

(i) On Fig.11.1, draw a commutator connected to X and Y that will allow the coil to rotate continuously. Include a battery that gives the direction of current shown in Fig.11.1. [2]

(ii) Explain how connecting the commutator to X and Y of the coil will allow the coil to rotate continuously.

As the coil becomes vertical and the current is cut off as the commutator is not in contact with the coil.

The inertia of the coil enables the coil to continue turning beyond the vertical position.

A clockwise moment will continue to act on the coil to keep it turning as the commutator enable the current in the coil to reverse directions every half a turn / 180° turn, allowing the coil to turn continuously.

[2]

(d) Fig.11.3 shows how the moment acting on the coil about the axis depends on time.

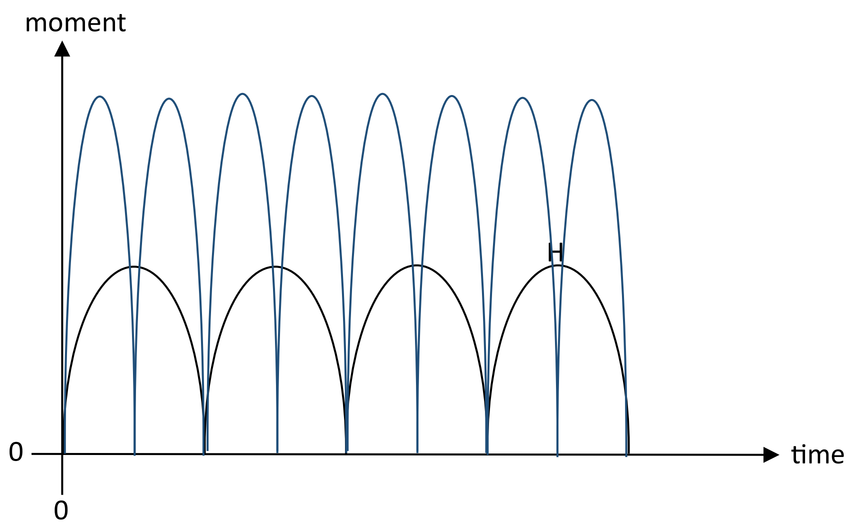


Fig. 11.3

(i) On Fig. 11.3, mark with a letter H when the coil is horizontal. [1]

(ii) Sketch on Fig 11.3, the changes to the graph when the e.m.f. of the battery is doubled. [2]

[Total: 10]

12 Fig.12.1 shows a shaver socket. Fig. 12.2 is a diagram of the transformer inside the socket.

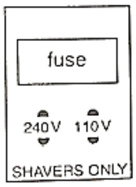


Fig. 12.1

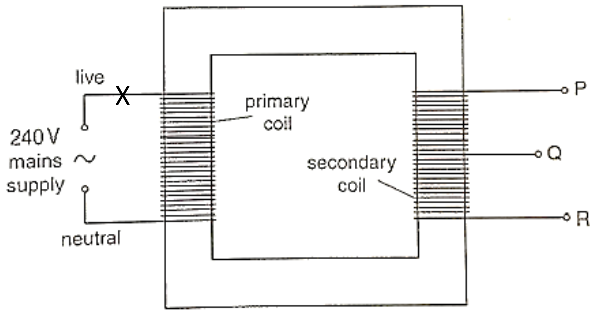


Fig. 12.2

The 6000 turns primary coil of the transformer is connected to the 240 V mains supply.

There is an output of 240 V between P and R and an output of 110 V between P and Q.

(a) Calculate the number of turns in the secondary coil between Q and R.

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

N_s = (240 - 110)/240 x (6000)
= 3250

Common mistake

Vs = 110 V

f turns = ...[2]

(b) For safety reasons there must be a mains fuse in the transformer.

(i) On Fig.12.2, mark with a letter X to show the position of the fuse. [1]

(ii) Explain the purpose of the fuse and why it must be in the position marked.

The fuse will melt and disconnect the circuit when the current flowing exceeds its current rating.

It must be on the live wire so that

the transformer will not become 'live' after the fuse melts.

OR the transformer will be isolated from the live wire and not be at high potential.

(c) Transformers are also used in transferring electrical power from power plants to homes of consumers. Fig.12.3 shows high voltage cables used to transfer electrical power.

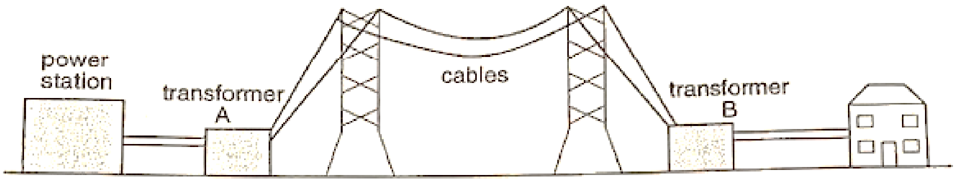


Fig. 12.3

(i) State the purpose of transformer A.

Step up transformer to step up / increase the voltage before transmission.

[1]

(ii) Explain why high voltages and thick cables are used to transfer electrical power.

For a fixed power

a high voltage will result in a smaller current flow through the cable. $I = P/V$

A thick cable will reduce the resistance of the cable as current flows through it. As Power loss = I^2R

This will result in minimal power loss during the transmission.

[3]

[Total: 10]

End of Paper

1) D
2) A
3) B
4) B
5) D
6) B
7) A
8) D
9) D
10) A
11) C
12) B
13) D
14) D
15) D

16) A
17) C
18) C
19) C
20) D
21) D
22) C
23) B
24) ignore
25) B ?
26) B
27) D
28) C
29) B
30) D

31) D
32) B
33) D
34) B
35) C
36) B
37) C
38) B
39) ???
ignore
40) ignore