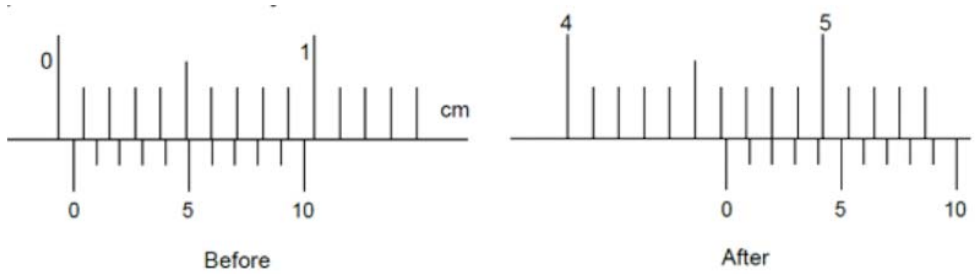
1 The following shows a set of Vernier caliper reading before and after a coin is placed between its jaws.



What is the zero error and the corrected radius of the coin, in cm?

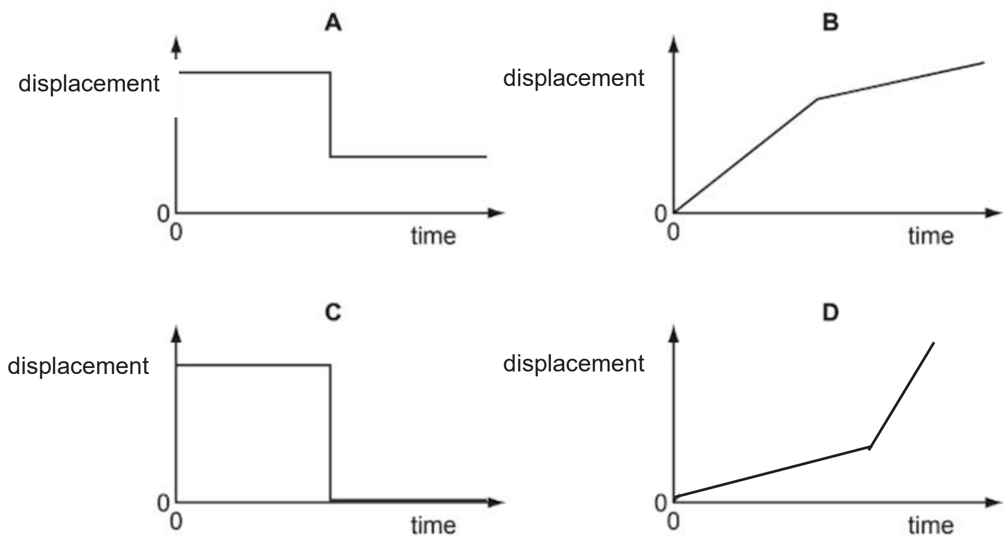
	zero error/cm	corrected radius/cm
A	-0.04	2.33
B	-0.04	2.44
C	0.06	2.28
D	0.06	2.38

2 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

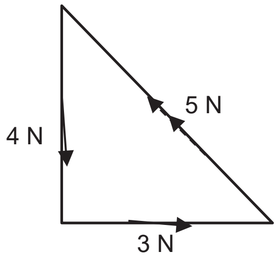
3 A car is traveling at constant speed. Brakes are applied for a short period of time and the car continues at a lower constant speed.

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

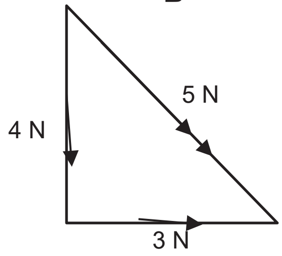


4 Which diagram correctly shows the addition of a 3 N force and a 4 N force at right angles to each other?

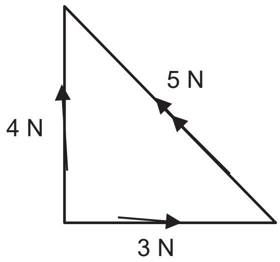
A



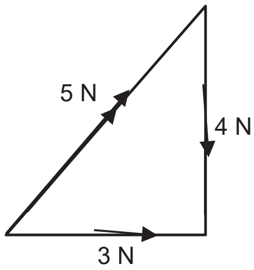
B



C



D



5 Twenty-seven identical small cubes are arranged to form a big cube as shown in the diagram.

The cubes are made from the same material and the density of each cube is ρ. If one small cube is removed from the arrangement, what is the density of the remaining cubes?

A ρ

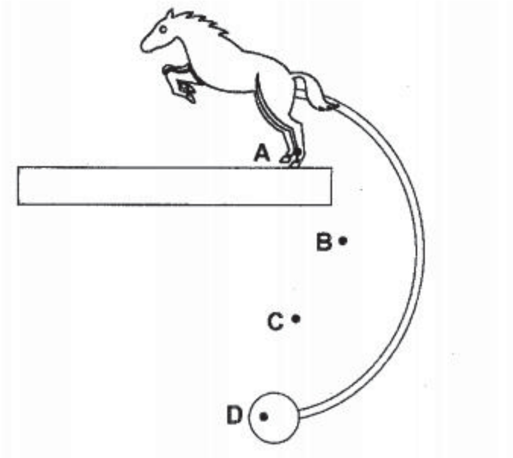
B $\frac{27}{26}$ ρ

C $\frac{26}{27}$ ρ

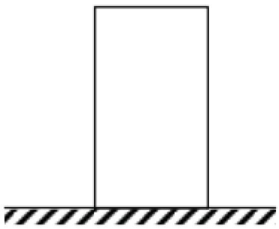
D $\frac{28}{27}$ ρ

6 The diagram shows the rest position of a balancing toy on the edge of a table.

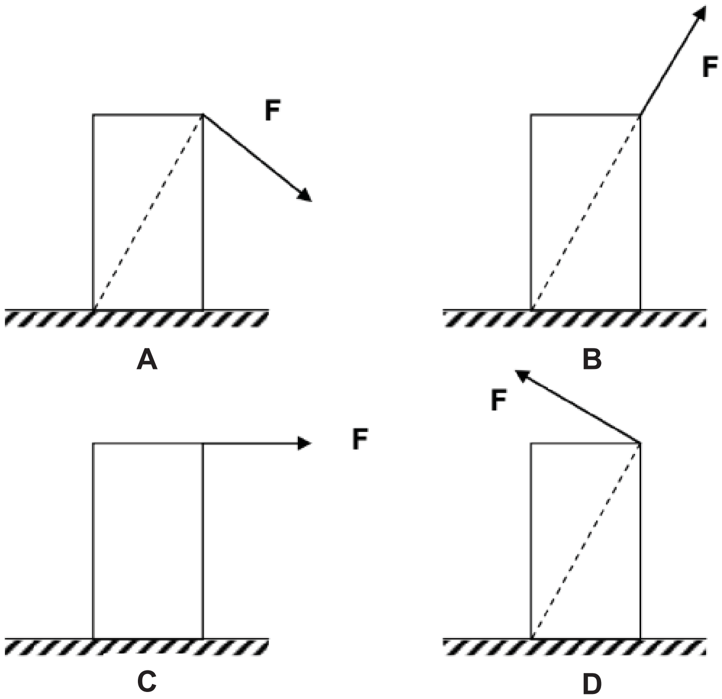
Which position is most likely to be the centre of mass of the toy?



7 A rectangular block of wood rests on the ground as shown in the diagram.



Which of the following is the easiest way for a force F to topple the block?



8 Car X is travelling at half the speed of car Y. Car X has twice the mass of car Y.

Which statement is correct?

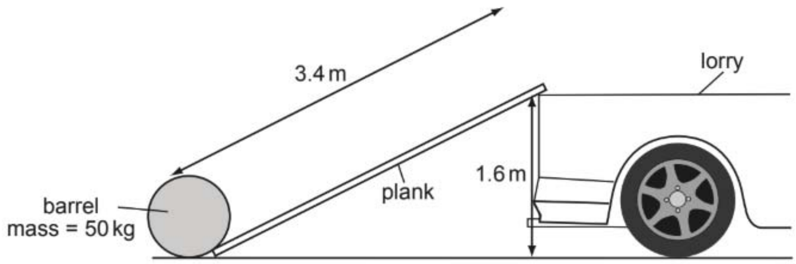
A Car X has half the kinetic energy of car Y.
B Car X has one quarter of the kinetic energy of car Y.
C Car X has twice the kinetic energy of car Y.
D The two cars have the same kinetic energy.

9 A mass is raised vertically. In time *t*, the increase in its gravitational potential energy is E_p and the increase in its kinetic energy is E_k.

What is the average power input to the mass?

A $(E_p - E_k)t$
B $(E_p + E_k)t$
C $\left(\frac{E_p - E_k}{t}\right)$
D $\left(\frac{E_p + E_k}{t}\right)$

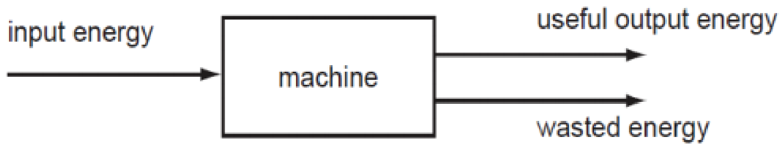
10 A barrel of mass 50 kg is loaded onto the back of a lorry 1.6 m high by pushing it up a smooth plank 3.4 m long. The gravitational field strength, g = 10 N/kg.



What is the minimum work done on the barrel?

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

11 The diagram shows the energy transfer of a machine.



The machine is 50% efficient.

Which of the following statements is correct?

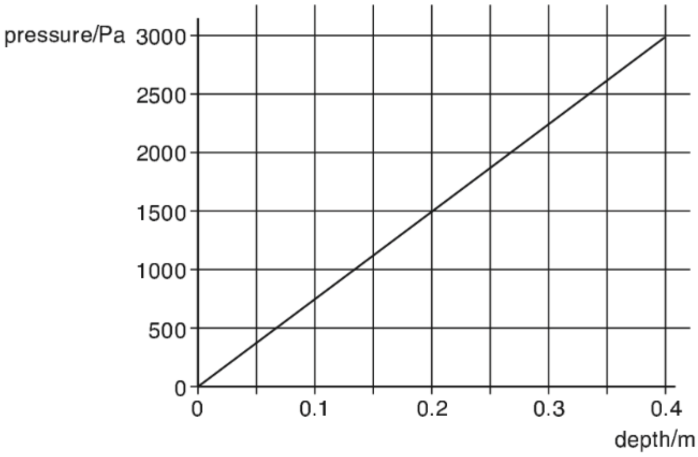
A input energy = useful output energy

B useful output energy = input energy + wasted energy

C wasted energy = input energy + useful output energy

D wasted energy = useful output energy

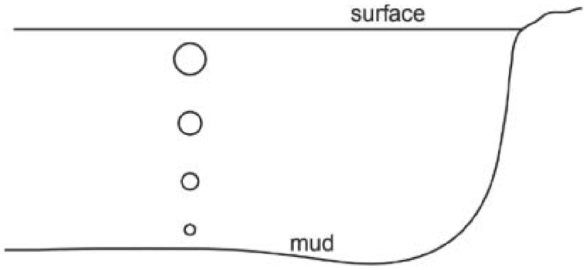
12 The graph shows how the pressure exerted by a liquid varies with depth below the surface. The gravitational field strength, g = 10 N/kg.



What is the density of the liquid?

A 600 kg/m^3 **B** 750 kg/m^3 **C** 6000 kg/m^3 **D** 7500 kg/m^3

13 Bubbles of gas, escaping from the mud at the bottom of a deep lake, rise to the surface.



As the bubbles rise, they get larger.

Why is this?

A Atmospheric pressure on the bubble decreases.

B Atmospheric pressure on the bubble increases.

C Water pressure on the bubbles decreases.

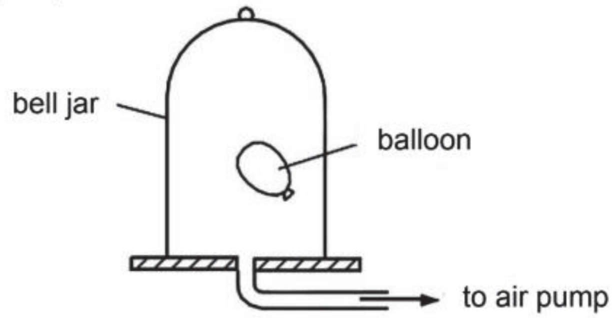
D Water pressure on the bubbles increases.

14 According to the kinetic theory of matter, matter is made up of very small particles in a constant state of motion.

Which of the following best describes the particle behaviour in the liquid state?

	forces between particles	motion of particles
A	strong	move randomly at high speed
B	strong	vibrate and are free to move position
C	weak	vibrate to and fro about a fixed position
D	weak	move randomly at high speed

15 A partially-inflated balloon is placed inside a bell jar. The bell jar is connected to an air pump. The air pump is switched on and air is slowly removed from the bell jar, keeping the temperature of the air constant.



What happens to the pressure and to the volume of the gas inside the balloon?

	pressure	volume
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

16 The lengths of the mercury thread in the stem of a mercury thermometer placed in three conditions are provided below:

- length in melting ice = 10 mm
- length in steam above boiling water = 160 mm
- length in liquid L = 70 mm

What is the temperature of liquid L?

A 37.5 °C

B 40.0 °C

C 43.8 °C

D 46.7 °C

17 Expanded polystyrene is often used to make containers for storing ice-cream. Air is trapped within the expanded polystyrene.

Which process(es) of thermal energy loss does the expanded polystyrene reduce?

A conduction and convection only

B conduction and radiation only

C conduction only

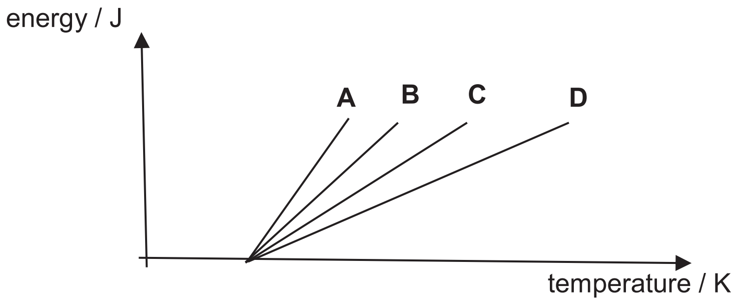
D convection only

18 The table gives the specific heat capacities of four materials.

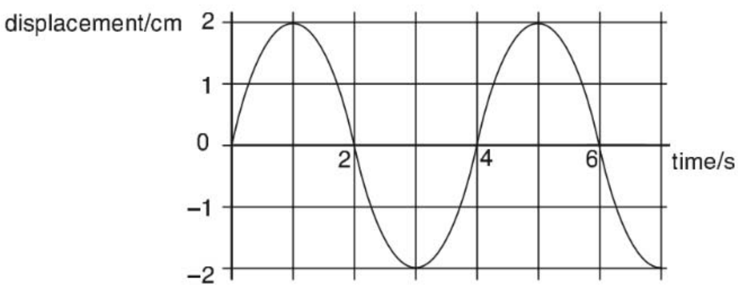
material	specific heat capacity / J/(kgK)
aluminium	913
lead	130
steel	420
water	4200

Four samples of the above materials, of equal masses were heated by an identical heat source. The graph below shows how the energy of the four samples varies with their temperature.

Which graph best represents the energy-temperature graph of aluminium?



19 The graph shows how the displacement of a particle in a wave varies with time.



Which of the following is correct?

A The wave has an amplitude of 2 cm and could be either transverse or longitudinal.

B The wave has an amplitude of 2 cm and must be transverse.

C The wave has an amplitude of 4 cm and could be either transverse or longitudinal.

D The wave has an amplitude of 4 cm and must be transverse.

20 Which list shows electromagnetic waves in order of increasing frequency?

A gamma rays, X rays, visible light

B visible light, X rays, gamma rays

C visible light, gamma rays, X rays

D X rays, gamma rays, visible light

21 The four statements shown are about the uses of electromagnetic radiation.

1. Gamma rays are used in medical treatment.
2. Infra-red waves are used in sunbeds.
3. Microwaves are used in satellite television
4. X rays are used in intruder alarms.

Which of these statements are correct?

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

22 What happens to light as it passes from glass into air?

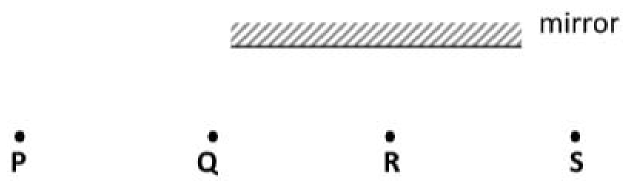
A Its frequency decreases because its speed decreases.

B Its frequency increases because its speed increases.

C Its wavelength decreases because its speed decreases.

D Its wavelength increases because its speed increases.

23 Four people, P, Q, R and S, are standing in front of a plane mirror as shown.



How many people (including herself) can Q see in the mirror?

A 0

B 1

C 2

D 3

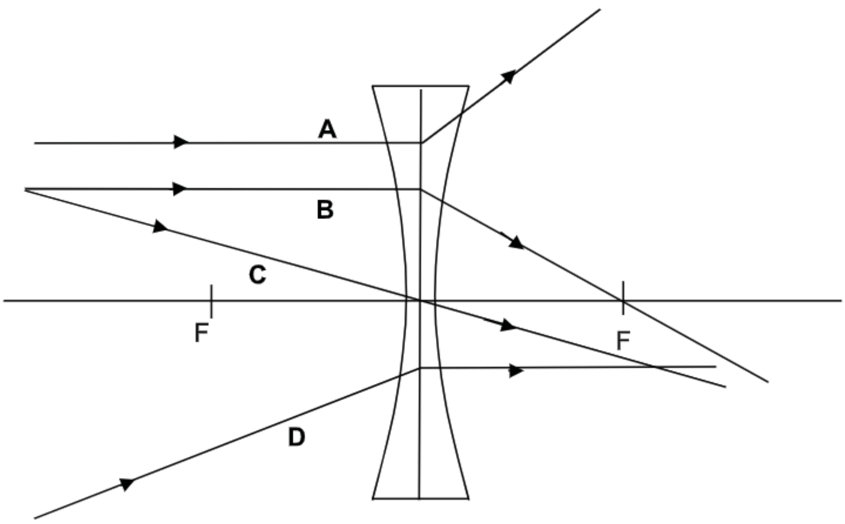
24 An object placed at 28 cm from a thin converging lens produces an image of the same size as the object.

When the object is moved to 12 cm from the same lens, the image produced will be

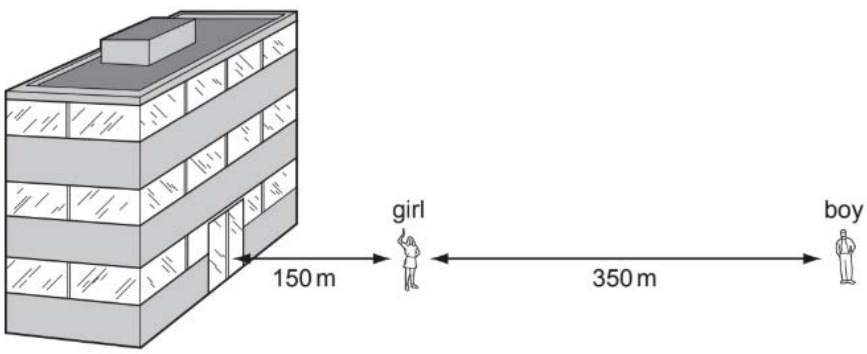
A real, inverted, diminished.
B real, inverted, magnified.
C virtual, upright, magnified.
D virtual, upright, diminished.

25 Four different rays are passing through a diverging lens as shown in the figure.

Which ray does not represent the path after passing through the diverging lens?



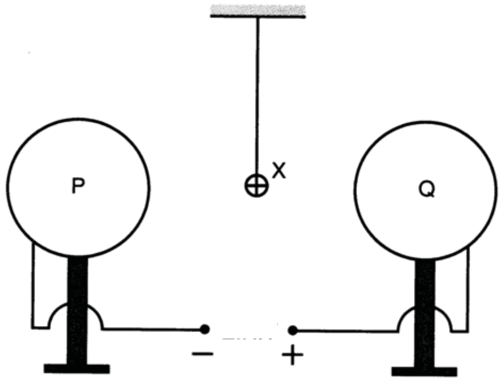
26 A girl, standing 150 m in front of a tall building, fires a shot using a starting pistol. A boy, standing 350 m from the girl, hears two bangs 1 s apart.



From this information, what is the speed of sound in air?

A 300 m/s **B** 350 m/s **C** 500 m/s **D** 650 m/s

27 The diagram shows a light spherical conductor X that is positively charged and suspended in between two insulated copper spheres, P and Q, which are connected to an power supply.



What will happen to conductor X when the switch is closed?

A move to P and stay attached to P

B move to P and then oscillate between P and Q

C move to Q and stay attached to Q

D move to Q and then oscillate between P and Q

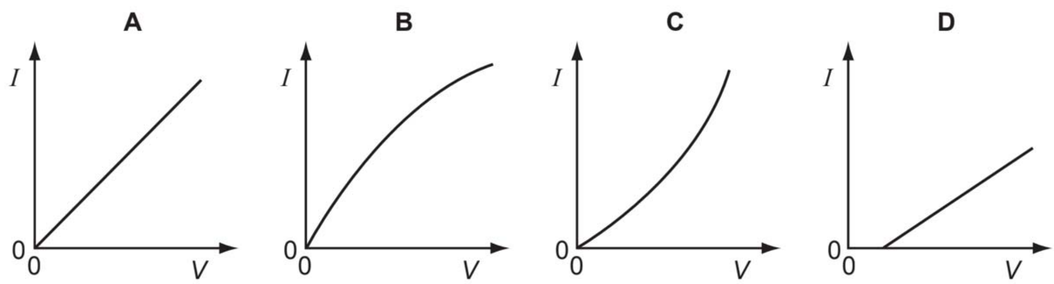
28 Two resistance wires made of the same material and of the same length are connected in parallel to the same voltage supply. Wire P has a diameter of 2 mm. Wire Q has a diameter of 1 mm.

What is the ratio of current in P to current in Q?

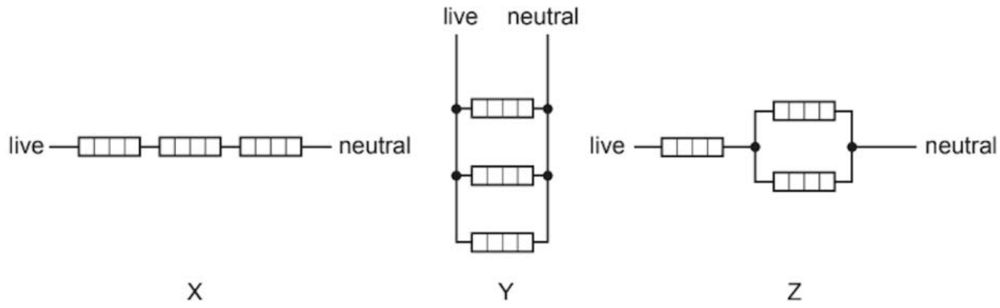
A 0.25 **B** 0.50 **C** 2.0 **D** 4.0

29 The resistance of a component in a circuit increases as the current through the component increases.

Which of the following graphs best represent the *I-V* characteristics of the component?



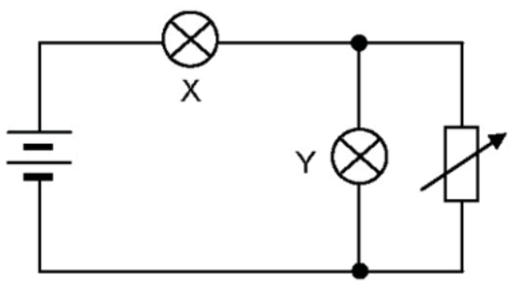
30 Three identical heating elements are wired up to the mains supply in the three arrangements shown.



In which arrangement is the current through the supply lowest and in which is the highest?

	lowest current	highest current
A	X	Z
B	X	Y
C	Y	X
D	Y	Z

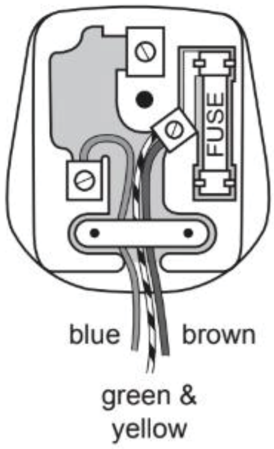
31 Two lamps, X and Y are connected to a battery and a rheostat as shown in the diagram.



What will happen to the brightness of the lamps if the resistance of the rheostat is decreased?

	X	Y
A	dimmer	dimmer
B	dimmer	brighter
C	brighter	dimmer
D	brighter	brighter

32 A plug is wrongly wired as shown. It is connected to an old vacuum cleaner, which has a metal case.



What is the effect of using the plug wired in this way?

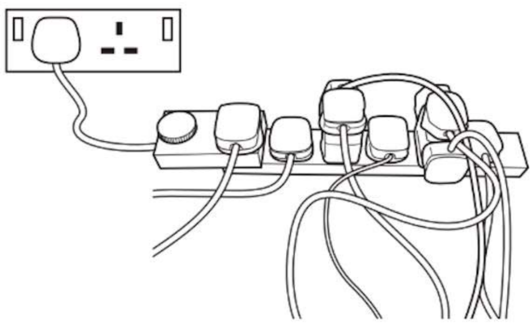
A The fuse in the plug blows.

B The metal case is live.

C The neutral wire melts.

D The vacuum cleaner catches fire.

33 The diagram shows an unsafe use of an extension cable.



What is the electrical hazard?

A the danger of burning out the appliances

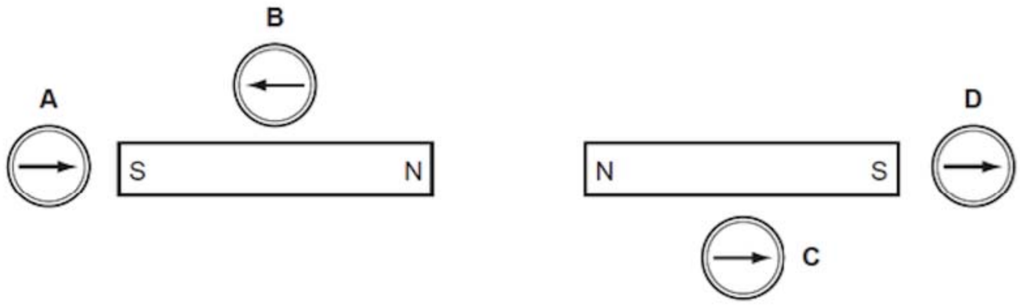
B the danger of melting the fuse

C the danger of overheating the cable

D the danger of the appliances not being earthed.

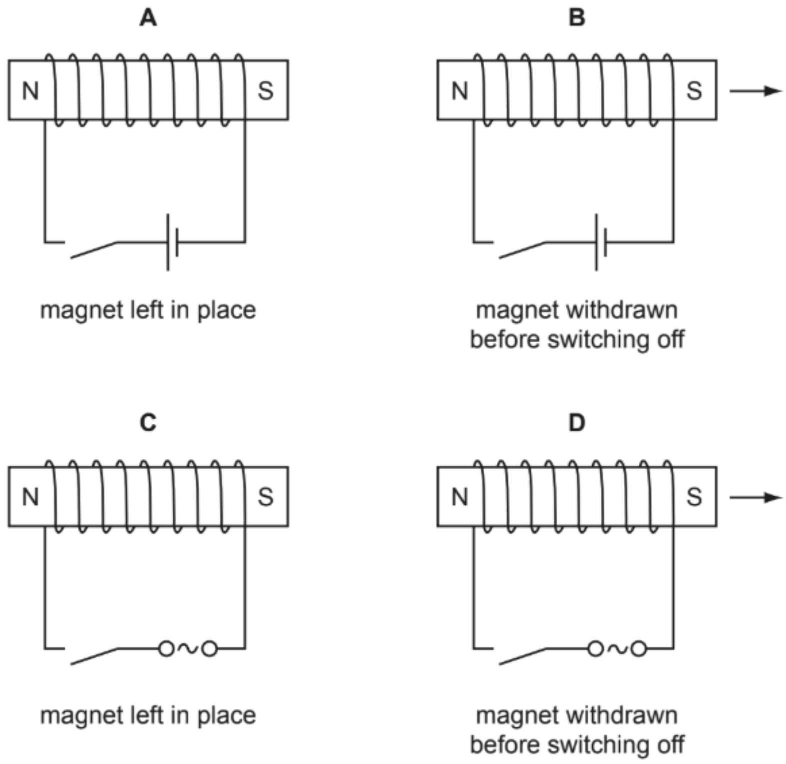
34 Four plotting compasses are placed in the magnetic field of two identical bar magnets as shown in the diagram.

Which compass is shown pointing in the wrong direction?



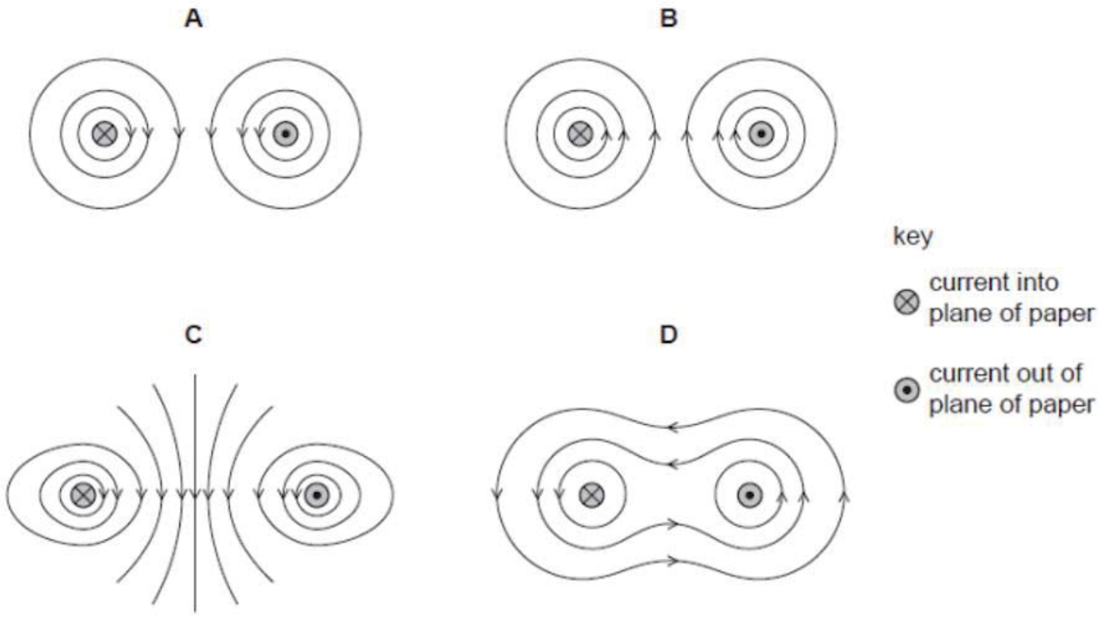
35 A permanent magnet can be demagnetised by using a solenoid and switching the current on then off.

Which diagram shows the most effective method of producing demagnetisation?

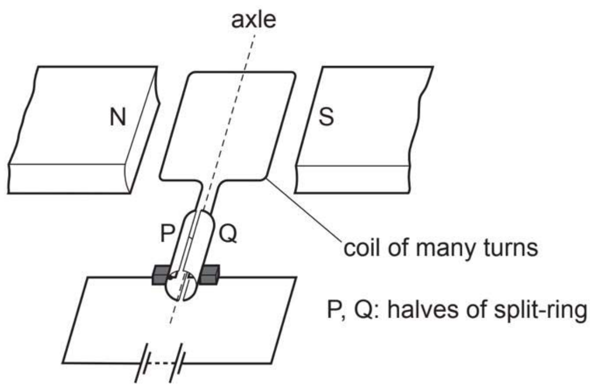


36 Two straight electrical conductors are parallel to one another. Each carries a current, one into the plane of the paper and one out of the plane of the paper.

Which diagram shows the magnetic field around the two wires?



37 A d.c. motor consists of a coil of many turns rotating in a fixed magnetic field. The coil is connected to a d.c. supply through a split-ring commutator.



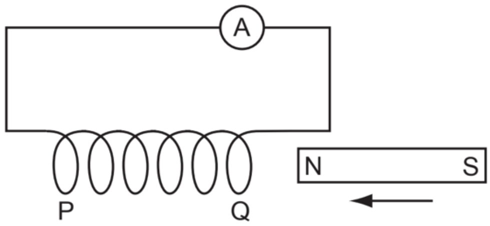
Each of these changes are made, one at a time and then compared to the above arrangement.

- The d.c. supply is reversed.
- The coil is rotated before switching on, so that P starts on the right and Q on the left.
- The poles of the magnet are reversed
- The turns on the coil are increased in number.

How many of these changes make the coil rotate in the opposite direction?

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

38 A student pushes the N-pole of a bar magnet into the end Q of a long solenoid and observes a deflection to the right on the sensitive ammeter.



What will produce a deflection in the same direction?

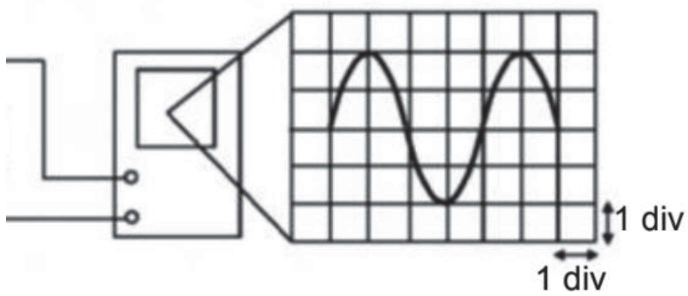
A pulling the N-pole out of end Q

B pulling the S-pole out of end P

C pushing the N-pole into end P

D pushing the S-pole into end P

39 A signal generator is connected to an oscilloscope (c.r.o) as shown the in the diagram.

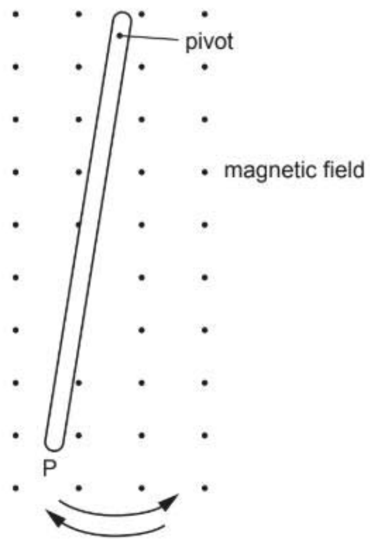


The Y-gain setting is 20 mV/div and time base setting is 5 ms/div.

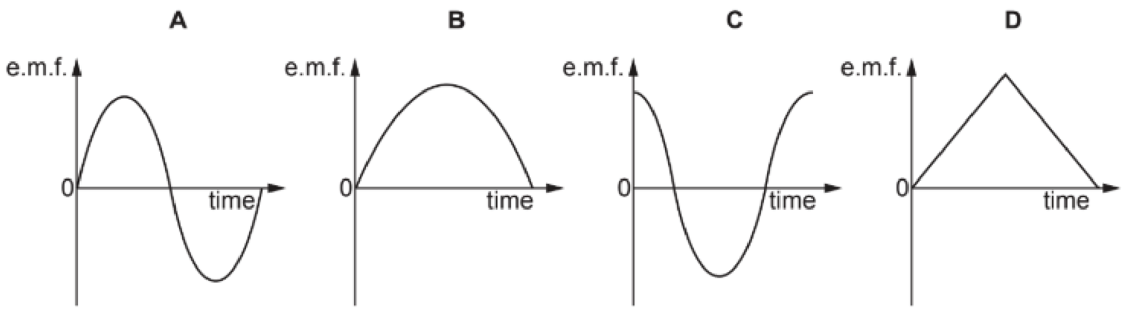
Which of the following indicates the correct amplitude and frequency of the actual signal?

	Amplitude / mV	frequency / Hz
A	40	50
B	40	100
C	400	50
D	400	100

40 The diagram shows a metal bar swinging like a pendulum across a uniform magnetic field. The motion induces an e.m.f. between the ends of the bar.



Which graph represents this e.m.f. during one complete oscillation of the bar, starting and finishing at P?



End of Paper

Section A [50 marks]

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

1 Fig. 1.1 shows a large tank containing water. The tank leaks and drops of water fall from the tank at A to the ground at B.

The drops hit the ground at a regular rate.

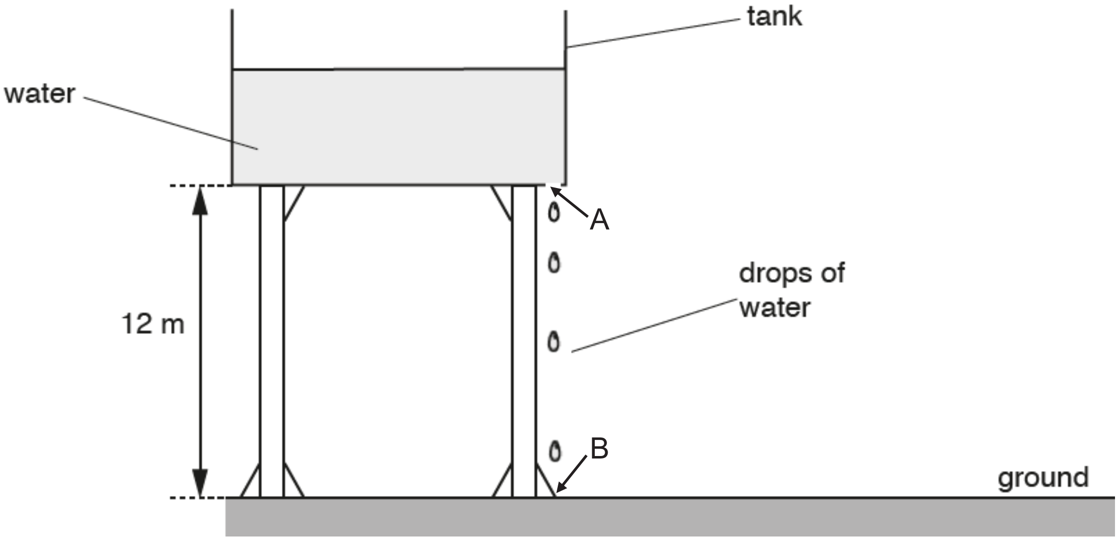


Fig. 1.1

(a) A student measures the time interval between two drops of water hitting the ground. She uses a stopwatch and repeats the procedure three times. She recorded the readings as shown.

1.24 s 1.14 s 1.16 s

(i) Calculate the average time interval between two drops of water hitting the ground.

average time = ... [1]

(ii) The average time interval calculated in **(a)(i)** is not accurate due to human reaction time error.

Describe a modification to the above procedure to obtain a more accurate value of the average time interval.

....

....

....

.... [2]

(b) The mass of one drop of water is 1.0×10^{-3} kg.

The gravitational field strength *g* is 10 N/kg.

(i) Calculate the change in gravitational potential energy of one drop of water as it falls from the tank at A to the ground at B.

change in gravitational potential energy = ... [2]

(ii) Determine the velocity of the drop of water just before it hits the ground at B. The effects of air resistance is negligible.

velocity = ... [2]

(iii) When the hole on the tank at A is enlarged, every drop of water falling from the tank will be of a much greater mass.

State and explain how the velocity of the drop of water will differ from that calculated in **(b)(ii).**

……………………………………………………………………………………………..…..

……………………………………………………………………………………………..…..

……………………………………………………………………………………………..…..

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

2 A car accelerates from rest in a straight line. During the first 14 s, the acceleration is uniform and the car reaches a velocity of 25 m/s.

(a) **(i)** Calculate the acceleration of the car.

acceleration = ... [2]

(ii) After the first 14 s, the velocity of the car continues to increase but the acceleration decreases gradually. From 70 s to 80 s after the start, the car moves at a constant velocity of 55 m/s.

On Fig. 2.1, sketch a possible velocity-time graph for the car.

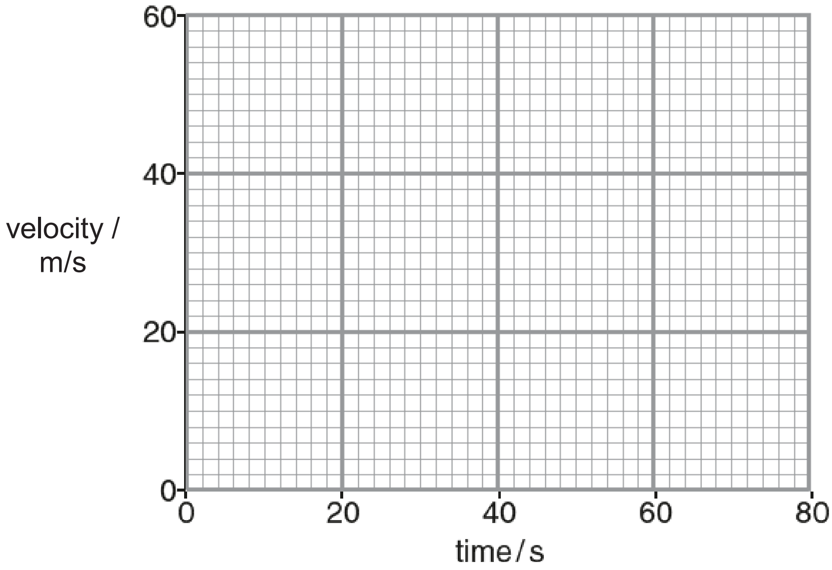


Fig. 2.1

[2]

(b) At a later time, the driver applies the brakes to stop. As he is wearing a seat belt, his body slows down in his seat. However, a bag on the seat next to him slides forwards, across the seat towards the front of the car.

Using ideas about the forces acting, explain why

(i) the driver slows down,

………………………………………………………………………………………………

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

(ii) the bag slides forwards.

………………………………………………………………………………………………

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

3 Fig. 3.1 shows a rocket as it takes off with an initial acceleration of 1.25 m/s^2. The total mass of the rocket and fuel is 40 000 kg. The gravitational field strength g is 10 N/kg.

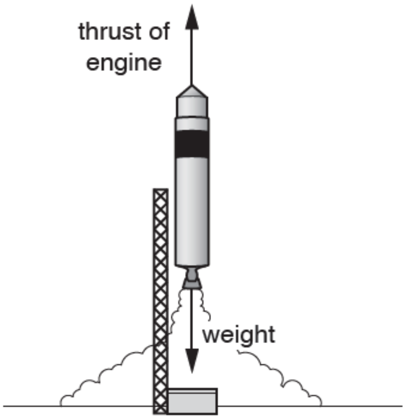


Fig. 3.1

(a) Determine the total weight of the rocket and fuel.

weight = ………………………….. [1]

(b) Calculate the magnitude of

(i) the resultant force acting on the rocket as it rises,

magnitude of resultant force = ………………………….. [2]

(ii) the upward thrust of the engine on the rocket as it rises.

magnitude of thrust = ………………………….. [2]

(c) As the rocket rises, the fuel will be used up.

Explain how this affects the acceleration of the rocket as it rises.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...

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

4 Fig. 4.1 shows a Galilean thermometer. This thermometer is used to measure the approximate temperature of the surrounding air in an air-conditioned room.

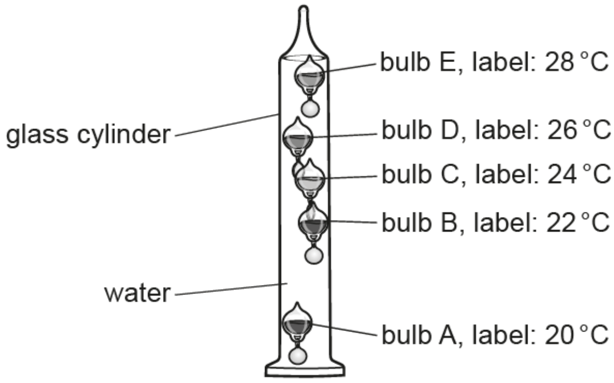


Fig. 4.1

The glass cylinder contains water. When the temperature of the water changes, so does its density.

Each bulb has a label printed with a temperature, as shown in Fig. 4.1. The bulbs have different densities. At 22 °C, only bulb A is at the bottom of the cylinder.

(a) Explain, in terms of density, why bulb A is at the bottom of the cylinder while bulb E is at the top.

……………………………………………………………………………………………...

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

(b) The temperature of the surrounding air increases to a temperature above 23°C.

(i) Suggest **one** reason why there is a delay before the temperature of the water increases to 23 °C.

……………………………………………………………………………………..…..

…………………………………………………………..…………………… [1]

(ii) Explain why, after this delay, bulb B sinks. Assume that the density of the bulbs remains the same.

……………………………………………………………………………………..…..

……………………………………………………………………………………..…..

……………………………………………………………………………………..…..

…………………………………………………………..…………………… [2]

5 **(a)** State the principle of moments.

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

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

(b) Fig. 5.1 shows a device for punching holes in a piece of paper. A person applies a force *F* at the end of the arm. Just before the hole is made in the paper, the arm is at rest.

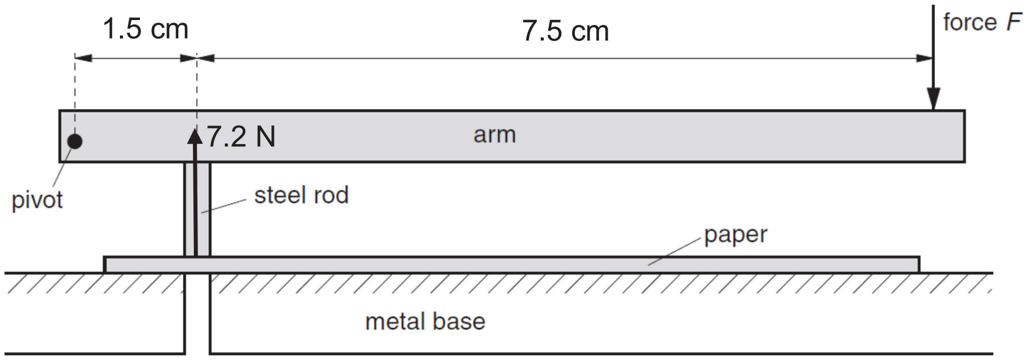


Fig. 5.1

Just before the hole is made, the upward force acting on the steel rod by the paper is 7.2 N.

Calculate

(i) the moment of the upward force acting on the steel rod by the paper about the pivot,

moment = ………………………….. [2]

(ii) the magnitude of the applied force *F*.

F = ………………………….. [2]

6 Fig. 6.1 shows part of a hydraulic jack used to lift the front of a car.

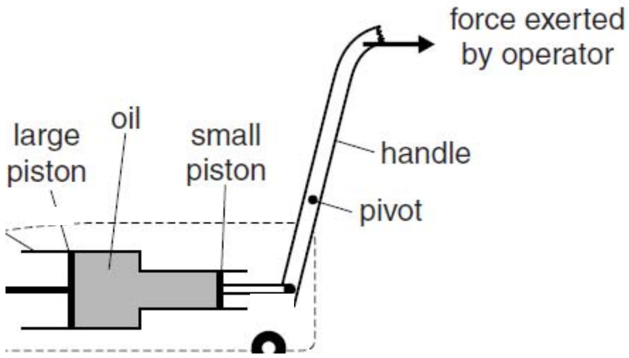


Fig. 6.1

The operator pulls the handle and causes a force of 50 N to act on the small piston. A force F is then exerted by the oil on the large piston.

The cross-sectional area of the small piston is 1.5 cm^2.
The cross-sectional area of the large piston is 5.0 cm^2.

(a) Calculate

(i) the pressure in the oil caused by the force on the small piston,

pressure = ………………………….. [2]

(ii) the magnitude of F.

F = ………………………….. [2]

(b) Explain why the large piston moves through a shorter distance than the small piston.

……………………………………………………………………………………………...

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

7 Fig. 7.1 shows the relay connected in a circuit to a 12 V battery. A relay is an electrical circuit used to open and close contacts in another circuit.

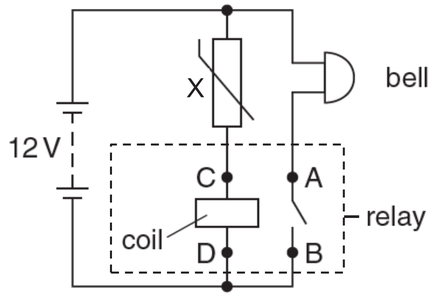


Fig. 7.1

(a) Explain why the bell rings when the temperature of X rises.

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

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

(b) At a particular temperature, the resistance of X is 2000 Ω and the current in the coil is 1.5 mA. This causes the switch AB in the relay to close. The resistance of the bell is 200 Ω.

Calculate

(i) the potential difference across X,

potential difference = ………………………….. [2]

(ii) the potential difference across the coil,

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

(iii) the current through the battery.

current = ………………………….. [2]

8 Fig. 8.1 shows an electrical cooker hood used in some kitchens. The hood removes cooking fumes from the kitchen.

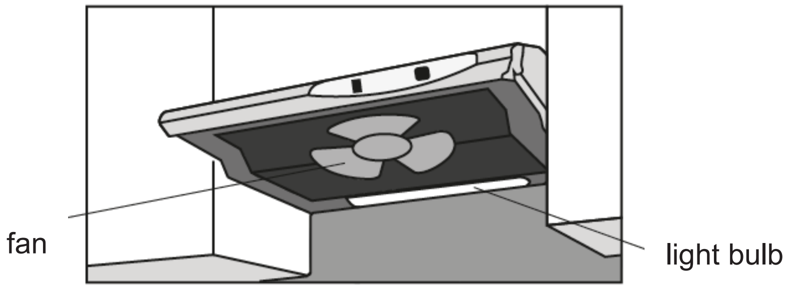


Fig. 8.1

The hood has a fan and a light bulb. Fig. 8.2 shows a simplified circuit diagram for the cooker hood.

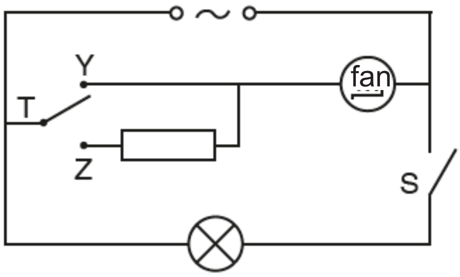


Fig. 8.2

(a) Switch S is closed. Switch T is moved to position Y.
State all the components that are switched on.

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

(b) Switch T is moved from position Y to position Z.
Suggest how this change affects the fan.

………………………………………………………………………………………………...

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

(c) Electrical appliances with metal cases can become dangerous if there is a fault.
Suggest a hazard and describe a safety feature to reduce the danger due to this hazard.

hazard ..……………………………………………………………………………………...

………………………………………………………………………………………………...

safety feature ………………………………..…………………………………………...

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

9 When a magnet is placed near a small cardboard box, paper clips on the other side of the box are picked up as shown in Fig. 9.1.

When a small piece of soft iron is placed inside the box as shown in Fig. 9.2 the paper clips fall off.

Magnetic field lines in each diagram are shown as thin lines.

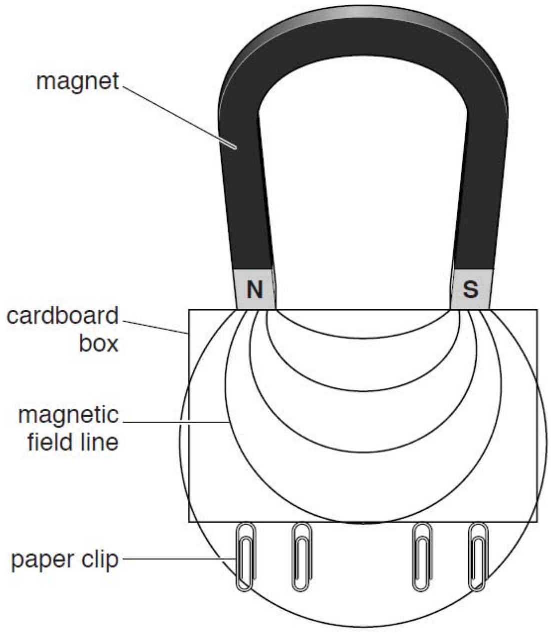


Fig. 9.1

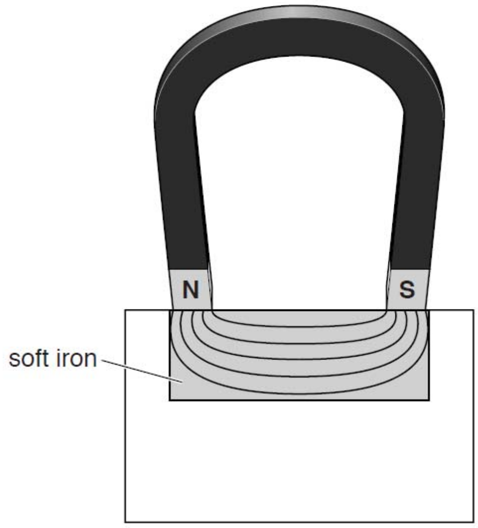


Fig. 9.2

(a) The lines in Fig. 9.1 are further apart compared to the lines in Fig.9.2.

State what this shows about the magnetic field in Fig. 9.1 compared to that in Fig. 9.2.

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

(b) Explain why placing the soft iron inside the box causes the paper clips to fall off.

…………………………………………………………………………………………………...

…………………………………………………………………………………………………...

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

Section B [30 marks]

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

10 An explosion is triggered on the surface of the earth to investigate a layer of rock underground.

Fig 10.1 shows the paths of how the sound waves propagate after an explosion.

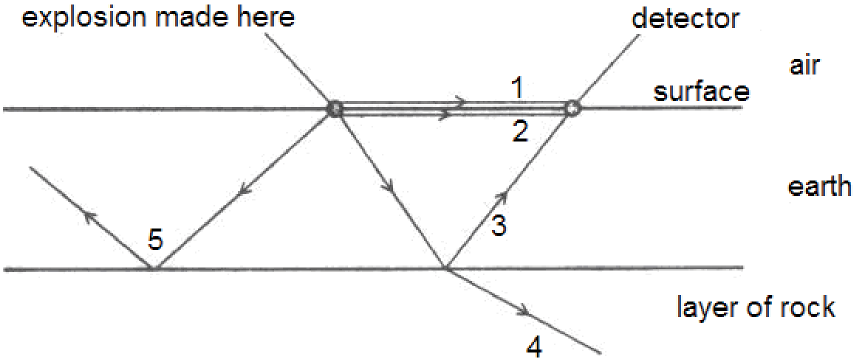


Fig. 10.1

Sound waves from the explosion travel to the detector through air (path 1) and through earth (path 2).

Some waves are transmitted through earth into the layer of rock by path 4 with part of wave being reflected at the boundary between the earth and the layer of rock as indicated by path 3.

Some waves also travelled along path 5 undergoing total internal reflection.

The time taken for the sound to reach the detector is shown in Fig. 10.2.

	path 1	**path 2**	**path 3**
Time taken (in seconds) for sound to travel from the source to the detector	0.10	0.02	0.30

Fig. 10.2

(a) Sound is a longitudinal wave.
Describe how the particles in earth move as the sound passes.

…………………………………………………………………………………………………...

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

(b) Suggest a reason why sound wave takes the shortest time to reach the detector along path 2.

…………………………………………………………………………………………………...

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

(c) **(i)** Given that the speed of sound in air is 330 m/s, calculate the distance between the source of sound and the detector.

distance = ………………………….. [2]

(ii) Using your answer in part **(c)(i)**, calculate the speed of sound in earth.

speed = ………………………….. [1]

(d) State and explain how the speed of sound changes when it travels from earth to the layer of rock along path 4.

…………………………………………………………………………………………...

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

(e) State two conditions that allows total internal reflection to occur along path 5.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………...

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

(f) There are small bubbles of gas in the earth.

Explain why the volume of the bubbles fluctuates as the sound passes through the earth and the bubbles.

…………………………………………………………………………………………...

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

11 **(a)** Fig. 11.1 shows an open tray for storing water.

It is noticed that the level of water inside the tray slowly decreases as water evaporates.

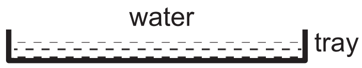


Fig. 11.1

(i) Using ideas about molecules, explain how the temperature of the water is affected when it evaporates.

....

....

....

.... [3]

(ii) Fig 11.2 shows a sheet of plastic used to cover half the surface of the water.

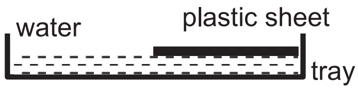


Fig. 11.2

State how this affects the rate of evaporation.

....

.... [1]

(b) Liquid air contains a mixture of oxygen and nitrogen. The boiling point of nitrogen is lower than oxygen. A sample of liquid air in a beaker is allowed to warm up slowly.

Fig. 11.2 shows how the reading of a thermometer in the beaker varies with time *t*.

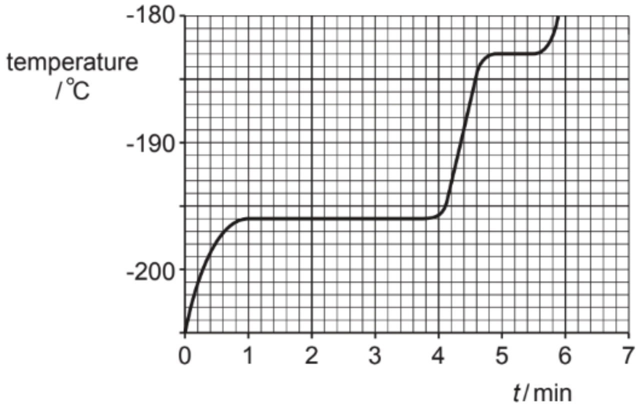


Fig. 11.2

(i) On Fig 11.2, label the boiling point of nitrogen, N on the temperature axis. [1]

(ii) The liquid air contains 200 g of liquid oxygen and 800 g of liquid nitrogen. Table 11.3 shows the table of specific heat capacity and specific latent heat of both gases.

	specific heat capacity J/(g°C)	specific latent heat of vaporisation J/g
oxygen	1.7	213
nitrogen	2.0	199

Table 11.3

Determine

(1) the thermal energy absorbed by the combined liquid air to reach the temperature at the 1 min mark.

thermal energy = ……………………..[2]

(2) the total thermal energy absorbed by the combined liquid air to reach the 4 min mark.

thermal energy = …………………...[3]

EITHER

12 Fig. 12.1 shows an electrical "wind-up" torchlight that operates through cranking a mechanical handle. The crank is turned in one direction and energy is stored in the spring internally. The torchlight then uses the energy stored in the wound-up spring to light the light bulb.

Fig 12.2 shows the simplified diagram of the mechanism within the torchlight. The spring is unwinding and N pole is moving away from the solenoid.

Fig. 12.1

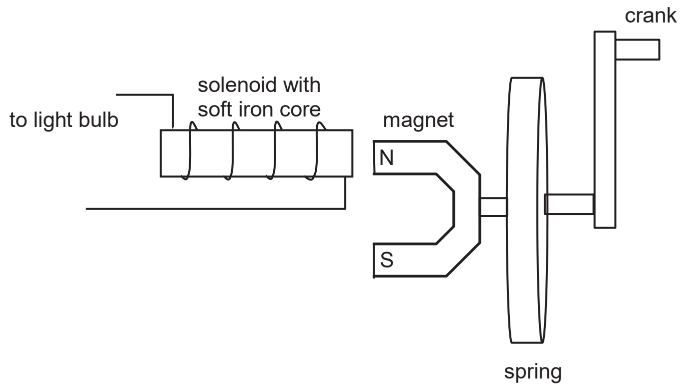


Fig. 12.2

(a) **(i)** On Fig 12.2, draw the current induced on the solenoid. [1]

(ii) Explain how the direction of the induced current in **(a)(i)** is determined.

....

....[1]

(b) As the spring is unwound, the magnet rotates together with the spring.

(i) Explain why electromotive force is induced in the solenoid.

....

....

....[2]

(ii) Describe the various stages of how energy is converted when the spring is unwound to the light bulb.

....

....

....[1]

(iii) Explain why the induced current is an alternating current (A.C.).

....

....

.... [1]

(c) When the spring is tightly wound, the electrical signal from the wires is applied to the input terminals of an oscilloscope. Fig 12.3 shows the trace obtained on the screen of an oscilloscope of e.m.f. vs time.

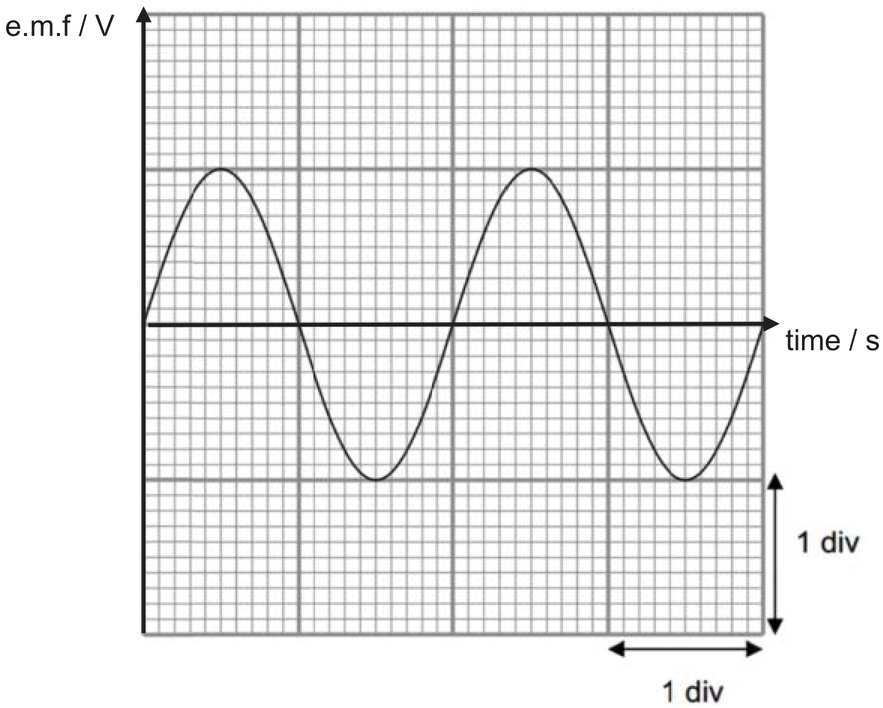


Fig 12.3

(i) The position between the magnet and the solenoid affects the strength of the e.m.f. induced in the coil.

On Fig. 12.3, indicate the position of the magnet poles by labelling N and S to the corresponding trace on the oscilloscope.

[2]

(ii) After a period of time, the rotation of the unwinding spring slows down to half.

On Fig. 12.3, sketch the new electrical signal trace produced by the spring.

[2]

OR

12 **(a)** Fig 12.1 shows a simple transformer.

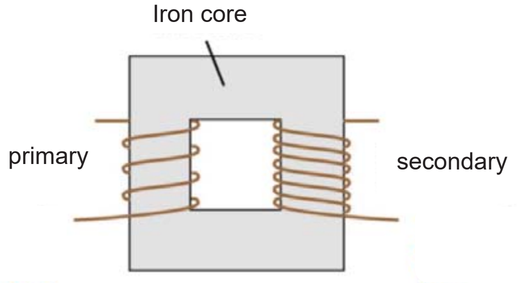


Fig. 12.1

(i) Explain how an alternating e.m.f. in the primary coil induces an e.m.f. in the secondary coil.

....

....

....

.... [2]

(ii) State and explain one method to improve the efficiency of the transformer.

....

....

.... [2]

(b) Fig. 12.2 shows a consumer connected to a main electrical supply some distance away. The electrical supplier generates electrical supply at 25 kV and transmits it to the consumer that uses 20 kV. Transformer X steps up the output voltage to 275 kV.

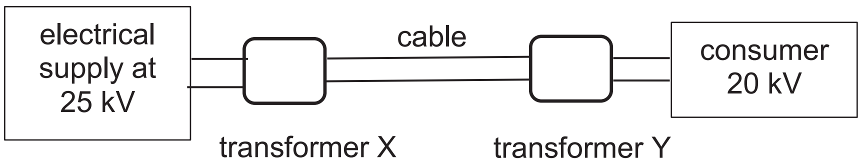


Fig. 12.2

(i) Explain why voltage is stepped up from the electrical supply and transmitted at high voltage.

....

....

....[1]

(ii) Determine the turns ratio for transformer X.

turns ratio = …………………[2]

(iii) 10 MW of power is transmitted through the cable of resistance 1 Ω/km at 275 kV.

Determine the power loss per kilometre as internal energy in the cable.

power loss per km = …………………[3]

End of Paper

Answers:

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

Methodist Girls' School
Physics Sec 4 Preliminary Examination 2019
Marking Scheme

Section A

1(a)(i) (1.24 + 1.14 + 1.16) ÷ 3 = **1.18 s** A1

1(a)(ii) - find time interval between 21 (appropriate no.) drops of water hitting the ground, t B1
- find the average timing for the time interval between two drops using T_1 = t/20 = t / (no.of drops - 1) B1

1(b)(i) GPE = mgh = 0.001 x 10 x 12 C1
= **0.12 J** A1

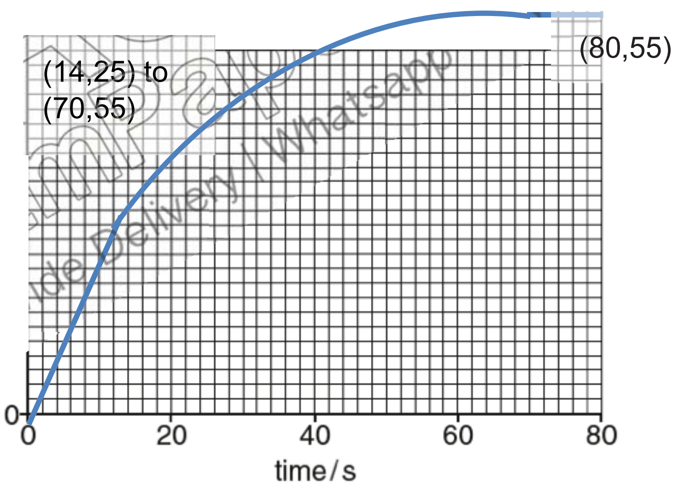
1(b)(ii) KE = GPE
½ mv² = 0.12
½ (0.001) v² = 0.12 C1
v = **15.5 m/s** OR **15 m/s** e.c.f. A1

1(b)(iii) Velocity will **remain unchanged.** B1

As ½ mv² = mgh, m will be cancelled in this equation. As, height and g remain unchanged, v calculated will be the same. B1
OR Acceleration due to free fall is constant, therefore, all masses falls with the same velocity.

2(a)(i) a = v–u / t = 25 / 14 C1
= **1.79 m/s²** OR **1.8 m/s²** A1

2(a)(ii) B1 – shape from 14 to 80 s
B1 – correct coordinates



2(b)(i) force backwards on driver / car B1
OR force produced by seat belt

2(b)(ii) mass of bag resists change from state of motion B1
OR bag has inertia

3(a) weight = mg = 40 000 x 10 = **400 000 N** A1

3(b)(i) F = ma = 40 000 x 1.25 C1
= **50 000 N** A1

3(b)(ii) resultant F = Thrust – weight
50 000 = Thrust – 400 000 C1
Thrust = **450 000 N** e.c.f. A1

3(c) As the fuel is used up, the **total mass (weight) of the rocket and fuel decreases**,

	thrust remains the same, resulting in an **increase in resultant force**.		B1
	Hence, **resultant force and acceleration will increase**.		B1
4(a)	Density of bulb A greater than the density of the water (and sinks) AND Density of bulb E less than the density of water (and float)		B1
4(b)(i)	Water / Glass is a poor conductor of heat OR water / glass conducts heat at a slow rate OR water / glass has a high (specific) heat capacity		B1
4(b)(ii)	The **water expands and becomes less dense** when temp increase.		B1
	Bulb B now has a greater density than the water (and sinks) OR Weight of bulb B more than buoyancy forces / upthrust		B1
5(a)	The principle of moment states that **for an object in equilibrium**,		B1
	the **sum of clockwise moments about a point** is equal to the **sum of anti-clockwise moments about the same point**.		B1
5(b)(i)	Moment = 7.2 x 1.5		C1
	= **10.8 Ncm (0.108 Nm)**		A1
5(b)(ii)	*F* = 10.8 / 9.0	e.c.f.	C1
	= **1.2 N**		A1
6(a)(i)	Pressure = Force / Area		
	= 50 / 1.5		C1
	= **33.3 N/cm^2** OR **3.33 x 10^5 N/m^2 (Pa)** OR **333 kPa**		A1
6(a)(ii)	*F* = Pressure x area		
	= 33.3 x 5.0	e.c.f.	C1
	= **167 N** OR **170 N**		A1
6(b)	the displaced volume of oil remains the same, as the larger piston with larger cross-sectional area results in a smaller d		B1
	OR Work done = Fd and when work done is constant, distance is small when force is large		
7(a)	resistance (of X) decreases		B1
	current (in coil) increases or more voltage across coil and either relay switch closes or circuit (to bell) complete		B1
7(b)(i)	V = $1.5 \times 10^{-3} \times 2000$		C1
	= **3.0 V**		A1
7(b)(ii)	12 – 3 = **9.0 V**	e.c.f.	B1
7(b)(iii)	I flowing through bell = 12 / 200 = 0.06 A or 60 mA		C1
	I in battery = 1.5 + 60 mA or 0.0015 +0.06 A = **61.5 mA or 62 mA** = **0.0615 A or 0.062 A**		A1
8(a)	motor / fan AND lamp		B1
8(b)	motor / fan speed decreases / slows down		B1
8(c)	hazard: live wire touching case **AND** user gets electric shock / burns OR electrical fire due overheating / wire gets hot		B1
	safety feature: case is earthed OR connect earth wire to the metal case		B1
9(a)	lines that are further apart shows **weaker** magnetic field strength OR lines that are closer shows **stronger** magnetic field strength		B1
9(b)	magnetic field goes through soft iron OR no field through paper clips **paper clips lose their (induced) magnetism / cannot be magnetised**		B1

Section B

10(a)	vibrate / oscillate in the same direction or parallel to transfer of energy or wave		B1
10(b)	sound travels faster in solid (earth) compared to air		B1
10(c)(i)	Distance	= 330 x 0.10	C1
		= **33 m**	A1
10(c)(ii)	Speed	= 33/0.02	
		=**1650 m/s**	A1
10(d)	As the sound wave bends away from the normal as it travels from earth to rock,		B1
	its speed in rock is **faster** than earth.		B1
10(e)	Wave must travel from a region of lower speed to a region of higher speed.		B1
	Angle of incidence is larger than critical angle from a region of lower speed to a region of higher speed. B1		
10(f)	pressure increases and decreases		B1

11 **(a)** Fig. 11.1 shows an open tray for storing water.

It is noticed that the level of water inside the tray slowly decreases as water evaporates.

Fig. 11.1

(i) Using ideas about molecules, explain how the temperature of the water is affected when it evaporates.

11	**a**	**i**	Faster moving molecules escape from the attraction of their neighbours and leave <u>surface</u> of the liq. Leaving behind slower moving molecules Avg KE dec and temp dec	**B1** **B1** **B1**

....

....

....

.... [3]

(ii) Fig 11.2 shows a sheet of plastic used to cover half the surface of the water.

Fig. 11.2

State how this affects the rate of evaporation.

....

.... [1]

		ii	Rate of evaporation dec	**B1**

(b) Liquid air contains a mixture of oxygen and nitrogen. The boiling point of nitrogen is lower than oxygen. A sample of liquid air in a beaker is allowed to warm up slowly.

Fig. 11.2 shows how the reading of a thermometer in the beaker varies with time *t*.

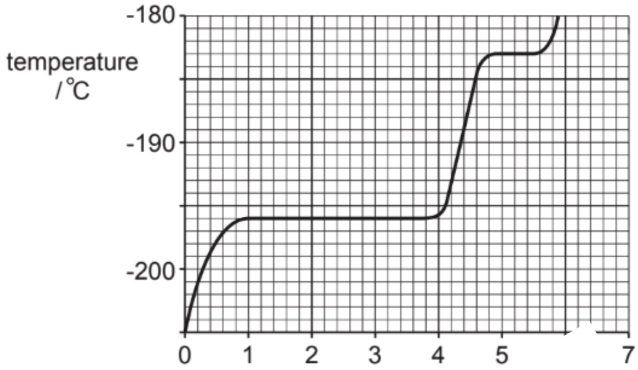
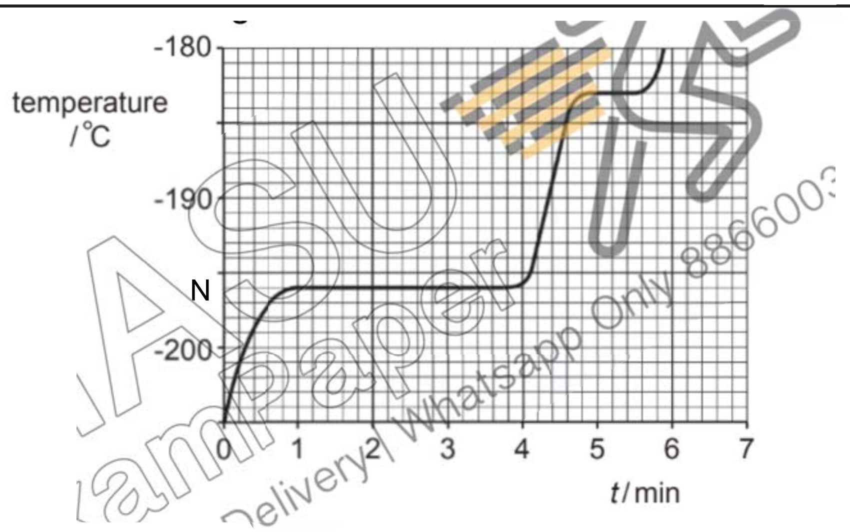


Fig. 11.2

	b	i		B1

(i) On Fig 11.2, label the boiling point of nitrogen, N on the temperature axis. [1]

(ii) The liquid air contains 200 g of liquid oxygen and 800 g of liquid nitrogen. Table 11.3 shows the table of specific heat capacity and specific latent heat of both gases.

	specific heat capacity J/(g°C)	specific latent heat of vaporisation J/g
oxygen	1.7	213
nitrogen	2.0	199

Table 11.3

Determine

(1) the thermal energy absorbed by the combined liquid air to reach the temperature at the 1 min mark.

thermal energy = ……………………..[2]

(2) the total thermal energy absorbed by the combined liquid air to reach the 4 min mark.

thermal energy = …………………...[3]

		ii	(1)Q=mc x theta =200 x 1.7 x 9 + 800 x 2 x 9 =17.5 x 10^3 J (2) Q=ml = 800 x 199 = 159 x 10^3 J Total Q = 159 + 17.5 = 177 x 10^3 J (ecf)	 **C1** **A1** **B1** **A1** **A1**

EITHER

12 Fig. 12.1 shows an electrical "wind-up" torchlight that operates through cranking a mechanical handle. The crank is turned in one direction and energy is stored in the spring internally. The torchlight then uses the energy stored in the wound-up spring to light the light bulb.

Fig 12.2 shows the simplified diagram of the mechanism within the torchlight. The spring is unwinding and N pole is moving away from the solenoid.

Fig. 12.1

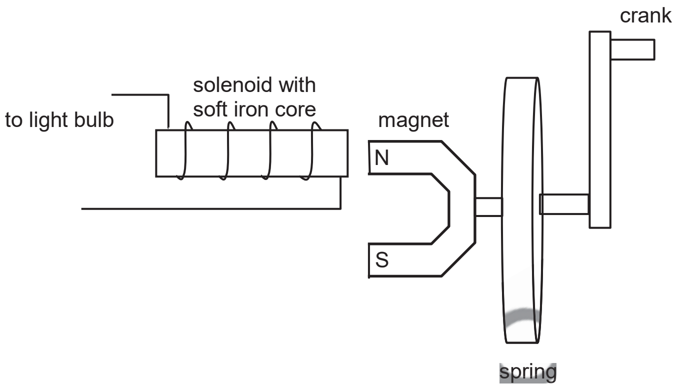
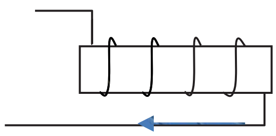


Fig. 12.2

(a) **(i)** On Fig 12.2, draw the current induced on the solenoid.

[1]

	a	**i**		**B1**

(ii) Explain how the direction of the induced current in **(a)(i)** is determined.

....

.... [1]

		ii	Induced current is in direction to oppose the change causing it. OR S polarity induced in coil facing N pole of magnet to attract it.	**B1**

(b) As the spring is unwound, the magnet rotates together with the spring.

(i) Explain why electromotive force is induced in the solenoid.

....

....

.... [2]

	b	i	When magnet rotates, there is a changing magnetic field. This induces an emf when magnetic field lines are "cut" by coil/magnetic flux linkage	**B1** **B1**

(ii) Describe the various stages of how energy is converted when the spring is unwound to the light bulb.

....

....

....[1]

		ii	KE of unwinding spring to electrical energy to light energy (bulb)	**B1**

(iii) Explain why the induced current is an alternating current (A.C.).

....

....

....[1]

		iii	Everytime the magnet rotates 180 deg, the current induced reverses its direction to the light bulb OR magnet moves away then moves towards coil, the current reverses its direction	**B1**

(c) When the spring is tightly wound, the electrical signal from the wires is applied to the input terminals of an oscilloscope. Fig 12.3 shows the trace obtained on the screen of an oscilloscope of e.m.f. vs time.

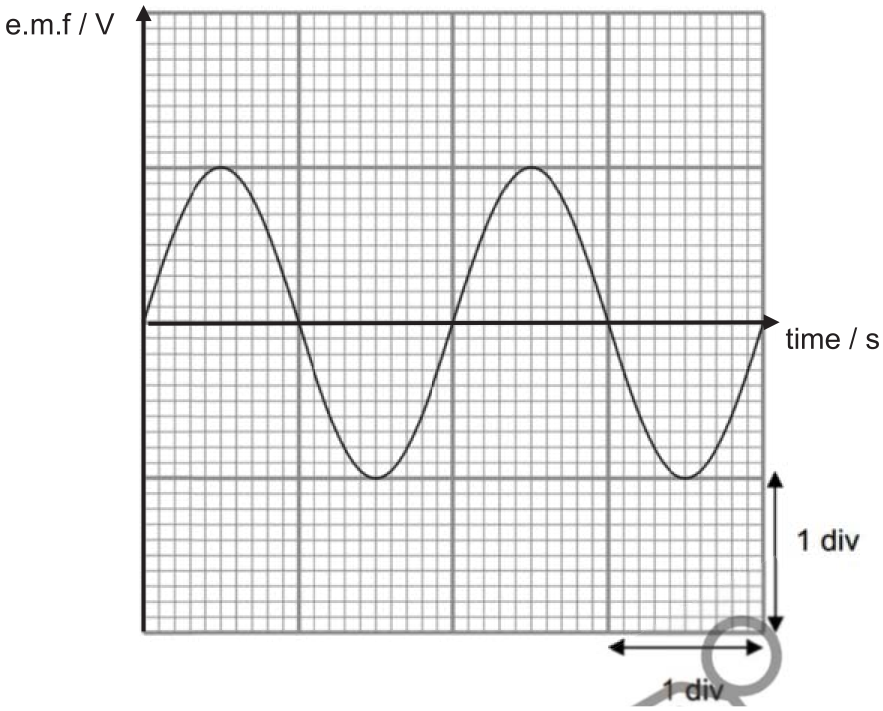


Fig 12.3

(i) The position between the magnet and the solenoid affects the strength of the e.m.f. induced in the coil.

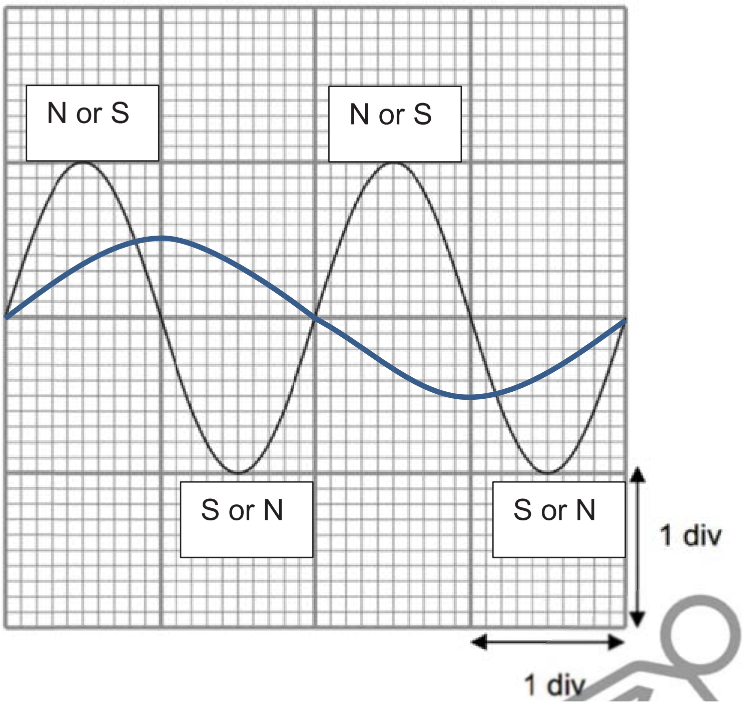
On Fig. 12.3, indicate the position of the magnet poles by labelling N and S to the corresponding trace on the oscilloscope.

[2]

(ii) After a period of time, the rotation of the unwinding spring slows down to half.

On Fig. 12.3, sketch the new electrical signal trace produced by the spring.

[2]

	b	I & ii	 B1 correct location of N B1 correct location of S B1 correct amplitude of graph B1 correct freq/shape of graph	

OR

12 **(a)** Fig 12.1 shows a simple transformer.

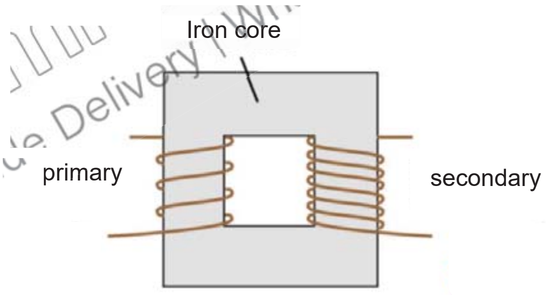


Fig. 12.1

(i) Explain how an alternating e.m.f. in the primary coil induces an e.m.f. in the secondary coil.

....

....

....

....

....

.... [2]

	a	i	AC in pri coil produces a changing magnetic field in the soft iron core magnetic field line “cut” at sec coil induces a changing emf in sec coil	 **B1** **B1**

(ii) State and explain one method to improve the efficiency of the transformer.

....

....

.... [2]

		ii	Laminated core - reduce eddy currents, reduce thermal energy loss OR Methods described in textbook and substantiated with correct effects.	**B1** **B1**

(b) Fig. 12.2 shows a consumer connected to a main electrical supply some distance away. The electrical supplier generates electrical supply at 25 kV and transmits it to the consumer that uses 20 kV. Transformer X steps up the output voltage to 275 kV.

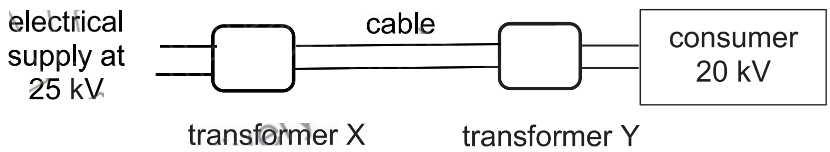


Fig. 12.2

(i) Explain why voltage is stepped up from the electrical supply and transmitted at high voltage.

....

....

.... [1]

	b	i	To reduce <u>power loss</u> as thermal energy	**B1**

(ii) Determine the turns ratio for transformer X.

turns ratio = …………………[2]

		ii	Ns/Np = Vs/Vp =275k/25k =11	 **B1** **A1**

(iii) 10 MW of power is transmitted through the cable of resistance 1 Ω/km at 275 kV.

Determine the power loss per kilometre as internal energy in the cable.

power loss per km = …………………[3]

		iii	P loss = I^2R = (P/V)^2 x R = (10 x 10^6/275x10^3)^2 x 1 = 1320 W/km	 **B1** **B1** **A1**

End of Paper