DUNMAN SECONDARY SCHOOL

CANDIDATE NAME			
CLASS		**INDEX NUMBER**	

PRELIMINARY EXAMINATION 2024
SECONDARY 4 EXPRESS

PHYSICS **6091/01**

Paper 1 Multiple Choice **23 August 2024**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

1 Which instrument is most suitable for measuring the internal diameter of a pipe?

A digital calipers

B digital micrometer

C manometer

D measuring cylinder

2 Pendulum X makes 25 complete oscillations in 10 s. Pendulum Y makes 15 complete oscillations in 15 s. Both pendulums were displaced by a small angle before their oscillations.

Which statement must be true?

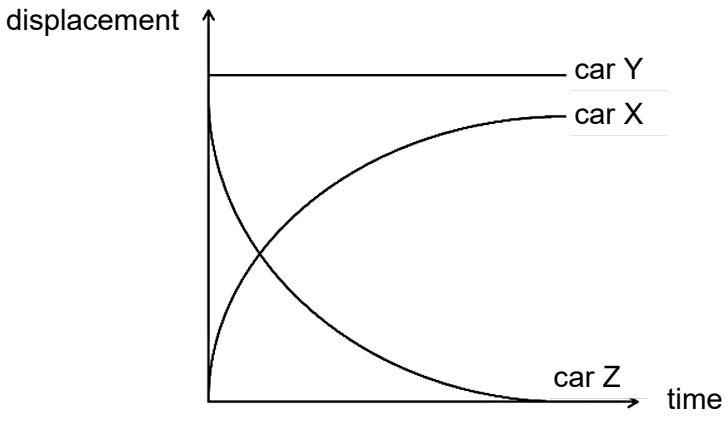
A Pendulum Y has a shorter period than pendulum X.

B The angle of swing of release for pendulum Y is smaller than that of pendulum X.

C The mass of the bob of pendulum Y is smaller than that of pendulum X.

D The string of pendulum Y is longer than that of pendulum X.

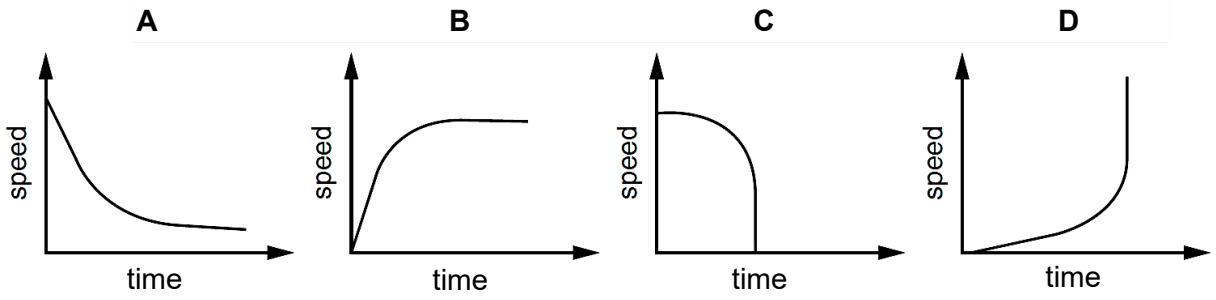
3 The graph shows how displacement varies with time for three cars X, Y and Z.



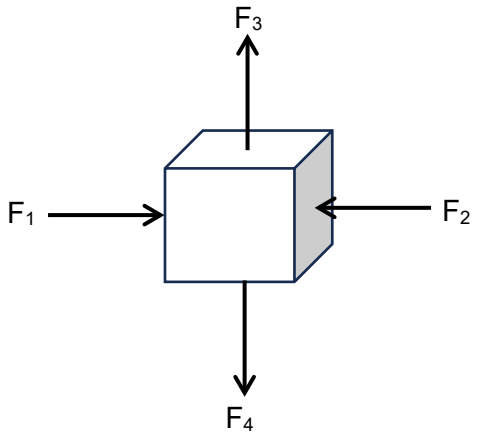
Which row describes the motion of cars X, Y and Z?

	car X	car Y	car Z
A	decreasing speed	constant speed	moving in the same direction as car X
B	decreasing speed	not moving	moving in the opposite direction to car X
C	increasing speed	constant speed	moving in the opposite direction to car X
D	increasing speed	not moving	moving in the same direction as car X

4 Which graph represents the motion of a body falling vertically that reaches a terminal speed?



5 Four forces F_1, F_2, F_3 and F_4 act on an object. The directions of the forces are as shown.



The object moves vertically downwards at a constant speed.

Which statement must be correct?

A All four forces are the same magnitude.

B F_1 and F_2 are equal in magnitude and F_3 and F_4 are equal in magnitude.

C F_1 and F_2 are equal in magnitude but both are smaller than F_3 or F_4.

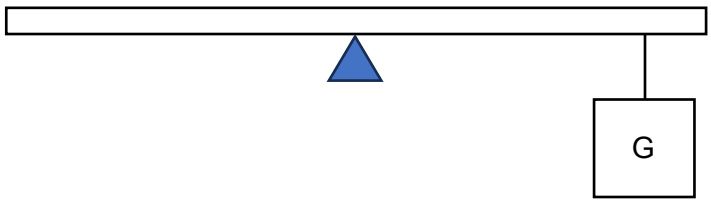
D F_4 is larger than F_3 but F_1 and F_2 are equal in magnitude.

6 The gravitational field strength on the moon is about one-sixth of that on the Earth. An astronaut returns from the Moon to the Earth.

What effect does this have on the astronaut's weight and inertia?

	weight	inertia
A	decreases	higher on Earth
B	decreases	same on Earth and Moon
C	increases	higher on Earth
D	increases	same on Earth and Moon

7 A load G is attached to a beam. This beam is balanced on a pivot at its mid-point, and the system is at rest in the position as shown.



Which statement must be true?

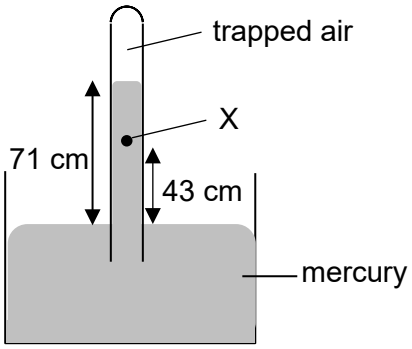
A Decreasing the magnitude of load G will cause the beam to rotate clockwise about the pivot

B If the load G is shifted nearer to the pivot, the beam would rotate anti-clockwise about the pivot.

C The centre of gravity of the beam is to the right of the pivot.

D The load G is equal to the weight of the beam.

8 The barometer shown is faulty and contains trapped air.



If the atmospheric pressure is 76 cmHg and the density of mercury is 13 600 kg/m^3, what is the pressure at X?

A 33 cmHg

B 48 cmHg

C 71 cmHg

D 81 cmHg

9 An alloy is made from two metals X and Y.

The mass of metals X and Y are 14 g and 23.5 g respectively.
The volume of metal X is 1.1 cm^3 and the alloy has a density of 15 g/cm^3.

What is the volume of metal Y?

A 0.8 cm^3

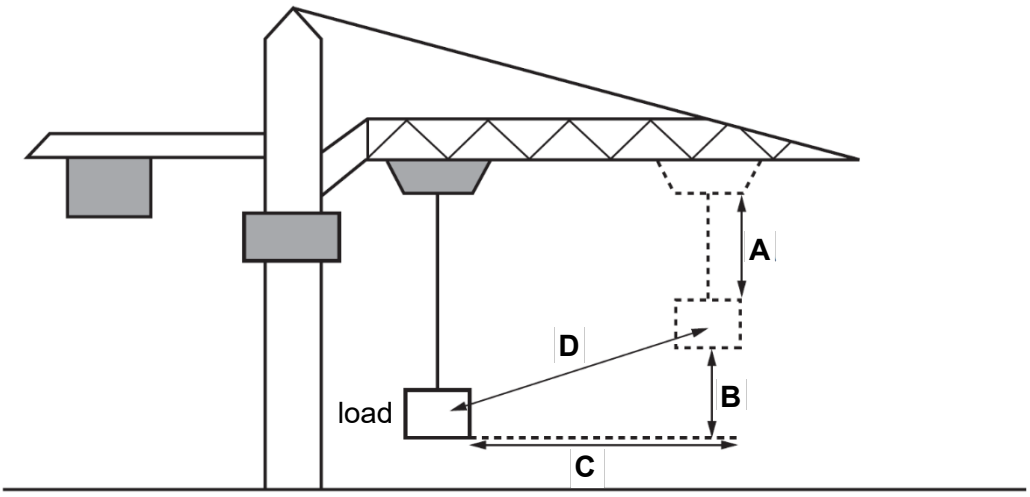
B 1.4 cm^3

C 2.2 cm^3

D 2.5 cm^3

10 A crane moves its load diagonally, as shown.

By which distance must the weight of the load be multiplied in order to find the increase in gravitational potential store of the load?



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

What is the power input to the crane's motor?

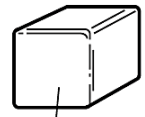
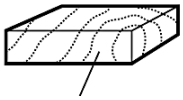
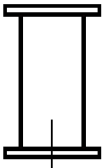
A 0.29 kW

B 0.72 kW

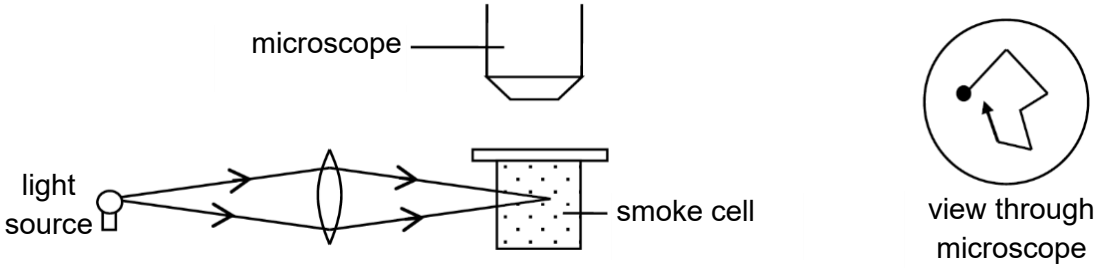
C 1.8 kW

D 1800 kW

12 Which object contains the molecules with the highest kinetic energy?

A	B	C	D
			
ice cube at -10 °C	water at room temperature	wood at room temperature	steam at 110 °C

13 The diagram shows a light source illuminating smoke particles in air. When observed under a microscope, moving points of light are seen.



What are these moving points of light?

A Reflected light from air particles, colliding with smoke particles.

B Reflected light from smoke and air particles that move randomly.

C Reflected light from smoke particles, colliding with air particles.

D Reflected light from smoke particles that move due to convection.

14 "When a substance is heated, the average kinetic energy of the particles in the substance remains constant. The particles begin to slide past each other."

What is the name of the process described above?

A boiling

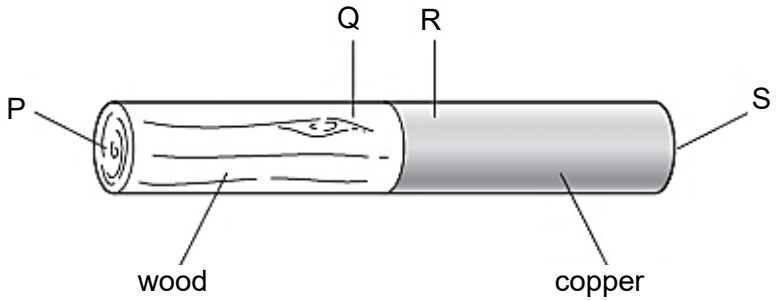
B condensation

C freezing

D melting

15 A rod is made up of copper and wood joined together.

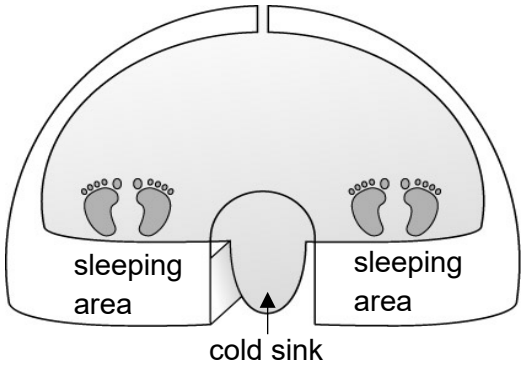
The rod is heated at the joint in the centre for about a minute.



At which labelled point will the temperature be lowest, and at which point will it be highest?

	lowest temperature	highest temperature
A	P	Q
B	P	R
C	S	P
D	S	R

16 Eskimos build igloos as temporary shelter in extremely cold places such as the Arctic. The diagram shows a cross-section of an igloo. The entrance is dug deep enough (lower than the sleeping area) to create a cold sink.



Which statement about the air in the igloo is correct?

A Cold air is denser and remains in the cold sink.

B The air in the igloo is heated up by conduction only.

C The warm air in the igloo is less dense, contracts and rises.

D Warm air in the cold sink expands, becomes denser and rises out of the cold sink to heat up the rest of the igloo.

17 In an experiment to find the specific heat capacity of a metal, it is found that 5200 J is needed to raise the temperature of a 2.0 kg block by 20 °C.

Calculate the specific heat capacity of the metal.

A 130 J/(kg °C)

B 520 J/(kg °C)

C 52 000 J/(kg °C)

D 104 000 J/(kg °C)

18 The speed of a wave is 4.0×10^5 m/s. The wavelength of the same wave is measured to be 5.0×10^6 m.

Determine the period of the wave.

A 5.0×10^{-13} s

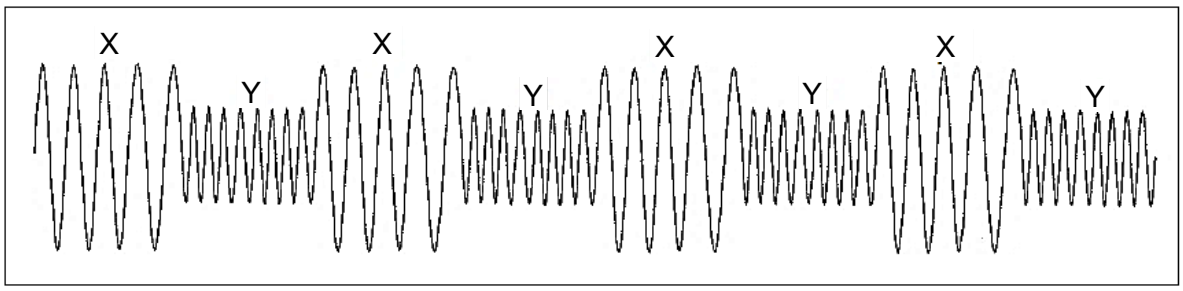
B 0.080 s

C 12.5 s

D 2.0×10^{12} s

19 A police car sounds its siren when travelling during an emergency. The siren produces two different sounds X and Y, which are emitted alternately.

The diagram represents the sound emitted by the siren.



Which sound is softer and which sound has a lower pitch?

	softer sound	sound of lower pitch
A	X	X
B	X	Y
C	Y	X
D	Y	Y

20 Which wave is part of the electromagnetic spectrum?

	speed / ms^{-1}	type
A	330	longitudinal
B	330	transverse
C	3.0×10^8	longitudinal
D	3.0×10^8	transverse

21 Waves H and J are components of the electromagnetic spectrum. H has a longer wavelength than J.

Which statement is true about H and J?

A H can travel faster than J in vacuum.

B H is radiowave and J is infra-red radiation.

C J has a lower frequency than H.

D J is ultraviolet ray and H is X-ray.

22 Waves in the electromagnetic spectrum have different uses.

Which uses of the electromagnetic spectrum are incorrect?

1 X-rays are used for pre-natal scanning of the foetus.
2 Infra-red radiation is used in suntanning beds.
3 Microwaves are used in wireless telecommunications.

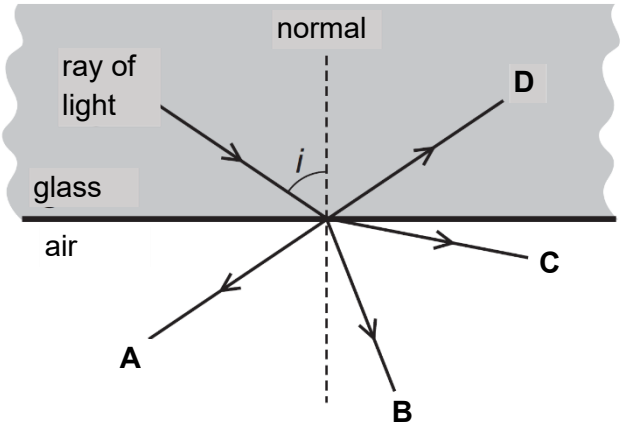
A 1 and 2 only

B 1 and 3 only

C 1, 2 and 3

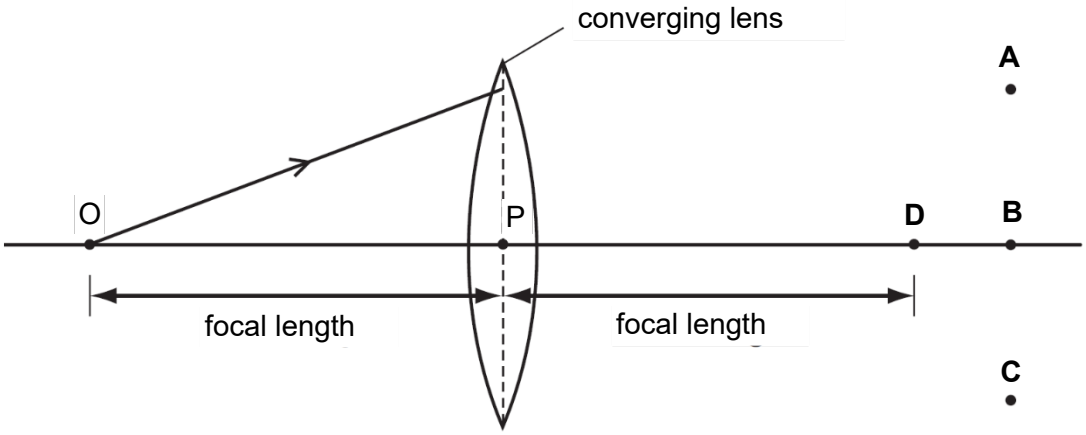
D 2 and 3 only

23 The diagram shows a ray of light incident on the edge of a piece of glass. The angle *i* is greater than the critical angle.
Which arrow shows the direction of the ray after it strikes the edge of the glass?

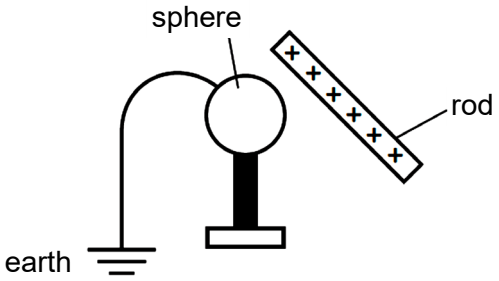


24 In the diagram, the distance OP is the focal length of the converging lens. One ray of light from O is shown.

Through which point will this ray pass, after passing through the lens?



25 A positively charged rod is held close to an earthed metal sphere.



Which statement correctly describes the charge on the metal sphere?

A It is negative because electrons are attracted towards the rod.

B It is negative because protons are repelled by the rod.

C It is neutral because electrons are attracted towards the rod and protons are repelled.

D It is neutral because it is earthed.

26 An electrical quantity is defined as “the energy converted by a source in driving a unit charge round a complete circuit.”

What is this quantity?

A current

B electromotive force

C potential difference

D power

27 The current in an electric heater is 10 A. It is switched on for five minutes.

How much charge flows through the heater?

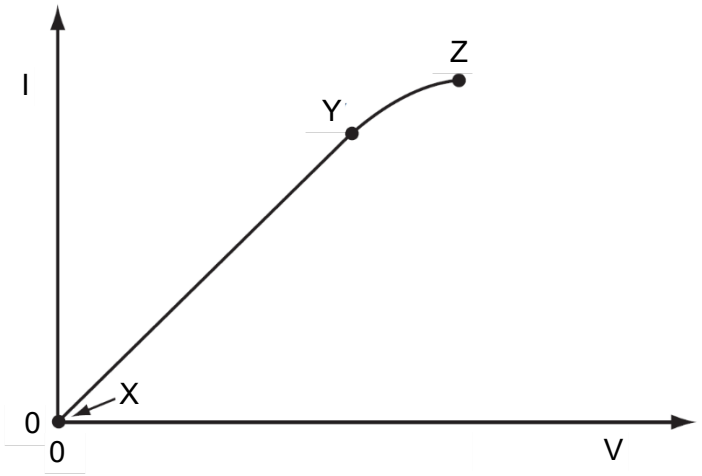
A 0.5 C

B 2.0 C

C 50.0 C

D 3000 C

28 The diagram shows the current-voltage (I-V) graph for a length of resistance wire.



Where can Ohm's Law be applied for the wire?

A at Y only

B at Z only

C from X to Y

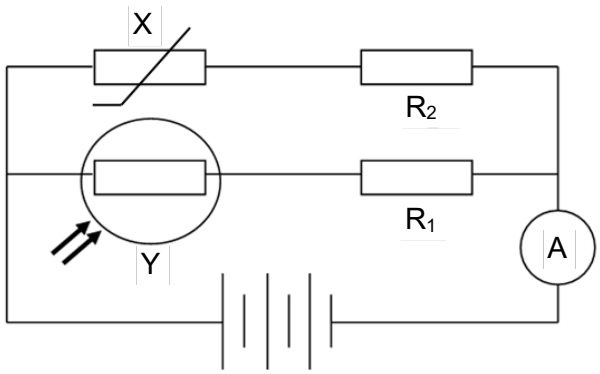
D from X to Z

29 A piece of wire 0.50 m long has a cross-sectional area of 1.0 mm^2.

Which wire of the same material has twice the resistance?

	cross-sectional area / mm^2	length / m
A	0.50	0.50
B	1.0	0.25
C	2.0	0.25
D	2.0	0.50

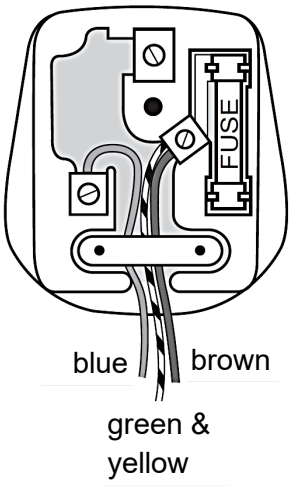
30 In the circuit shown, R_1 and R_2 are identical resistors.



Which changes to the electrical components X and Y will increase the reading of the ammeter by the greatest amount?

	component X	component Y
A	immerse completely in cold water	decrease the light intensity on Y
B	immerse completely in cold water	increase the light intensity on Y
C	immerse completely in hot water	decrease the light intensity on Y
D	immerse completely in hot water	increase the light intensity on Y

31 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.

32 A combined car entertainment unit consists of a game console and a monitor screen. Both components are controlled by one single switch. The power ratings of the game console and the monitor screen are 1.0 kW and 0.40 kW respectively. In a particular month, the monitor screen alone consumes 6.0 kWh of electrical energy.

How much electrical energy is consumed by the whole entertainment unit in that month?

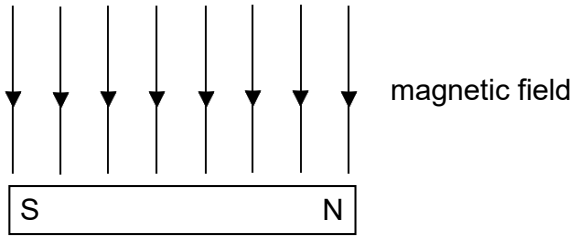
A 6.0 kWh

B 7.0 kWh

C 15 kWh

D 21 kWh

33 A bar magnet is placed in a magnetic field.



What will happen to the bar magnet?

A It will move in the direction of the magnetic field.

B It will move in the opposite direction of the magnetic field.

C It will rotate anti-clockwise by 90 °.

D It will rotate clockwise by 90 °.

34 Which statement about a simple d.c. motor is incorrect?

A No force is produced when the coil is perpendicular to the magnetic field of the magnets.

B The force on the coil will increase when the number of turns of the coil is increased.

C The split rings change the direction of current in the coil for every half a rotation.

D When the magnetic field is reversed, so will the direction of the force produced.

35 Why is a transformer used to connect a generator in a power station to a long distance transmission line?

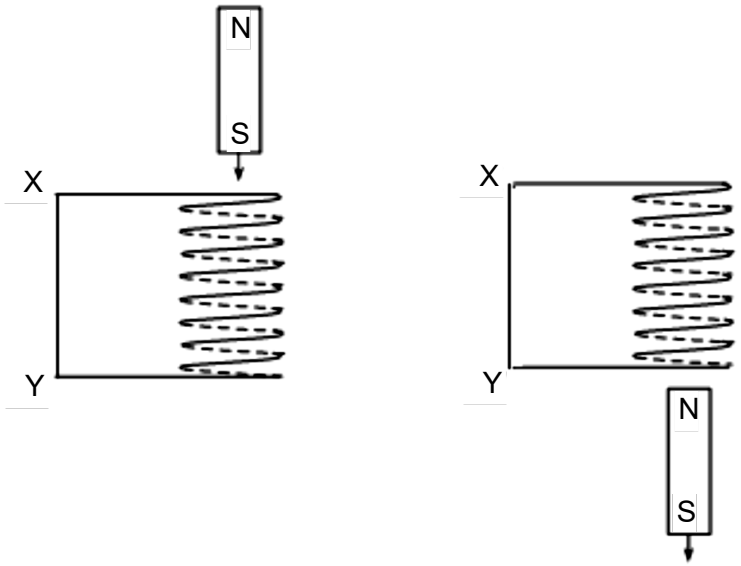
A to decrease the voltage and decrease the current

B to decrease the voltage and increase the current

C to increase the voltage and decrease the current

D to increase the voltage and increase the current

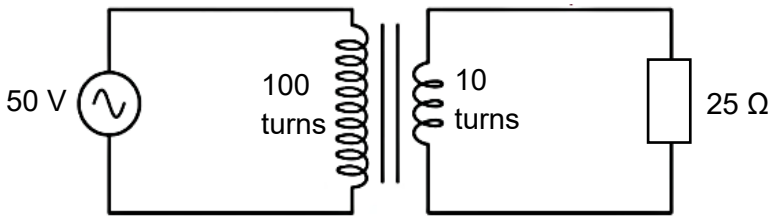
36 The diagrams below show the setup in which a short bar magnet is dropped through a coil of wire.



Which row correctly indicates the direction of the induced current between X and Y?

	as magnet enters the coil	as magnet leaves the coil
A	X to Y	X to Y
B	X to Y	Y to X
C	Y to X	X to Y
D	Y to X	Y to X

37 The diagram shows a transformer that has 100 turns in the primary coil and 10 turns in the secondary coil. 50 V of alternating voltage is applied to the primary coil. The secondary coil is connected to a resistor of 25 Ω.



What is the current flowing in the secondary circuit?

A 0.050 A

B 0.20 A

C 5.0 A

D 20 A

38 The count rate from a radioactive source falls from 400 to 50 in 3.0 minutes.

What is the half-life?

A 0.75 minutes

B 1.0 minutes

C 2.7 minutes

D 8.0 minutes

39 Which statement about nuclear fission or fusion is correct?

A During fission, hydrogen converts into helium and releases energy.

B During fission, uranium converts into daughter products and releases energy.

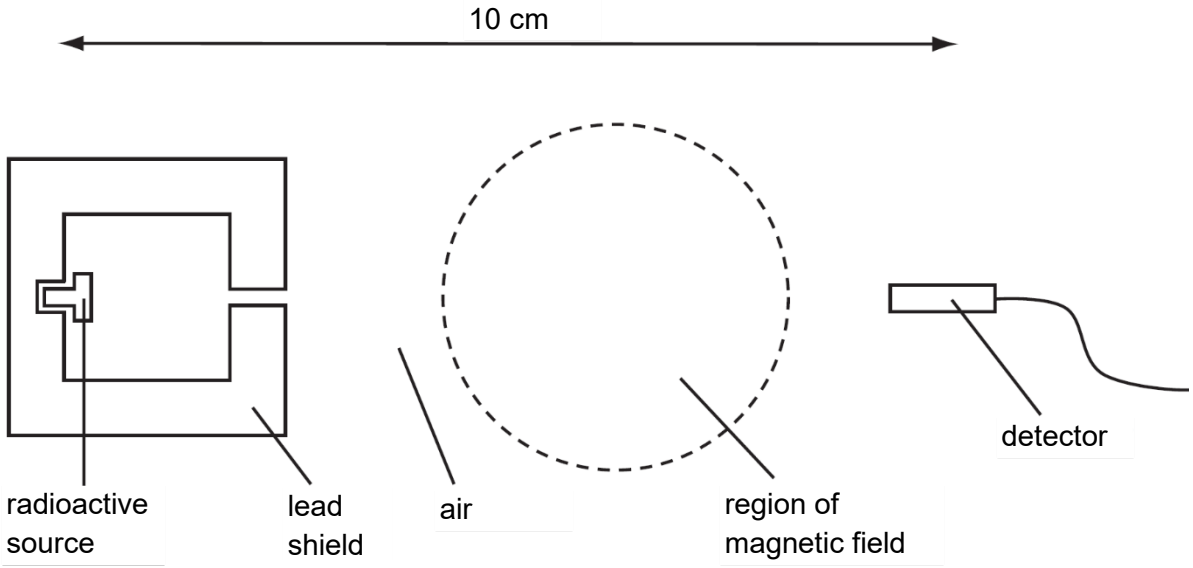
C During fusion, helium converts into hydrogen and releases energy.

D During fusion, uranium converts into daughter products and releases energy.

40 A student investigates the emission from an unknown radioactive source.

The source is 10 cm in front of a detector.

A strong magnetic field between the source and the detector is then switched on.



The results are shown.

	average count per minute
without magnetic field	4500
with magnetic field	2000
background radiation	50

Which radioactive source produced these results?

source	emissions from source
A	alpha-particles and gamma-rays only
B	beta-particles only
C	beta-particles and gamma-rays only
D	gamma-rays only

DUNMAN SECONDARY SCHOOL

CANDIDATE NAME			
CLASS		**INDEX NUMBER**	

PRELIMINARY EXAMINATION 2024
SECONDARY 4 EXPRESS

PHYSICS **6091/02**

Paper 2 Structured and Free Response

20 August 2024
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

Candidates are reminded that all quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

Section A

Answer **all** questions.

1 A shot putter holds a shot of weight W_1 = 60 N in the palm of his hand. His upper arm is vertical and his forearm, of weight W_2 = 15 N, is horizontal.

Fig. 1.1 shows the forces exerted on the forearm. F_1 is the upward force exerted by the bicep muscle. F_2 is the downward force exerted by the humerus bone.

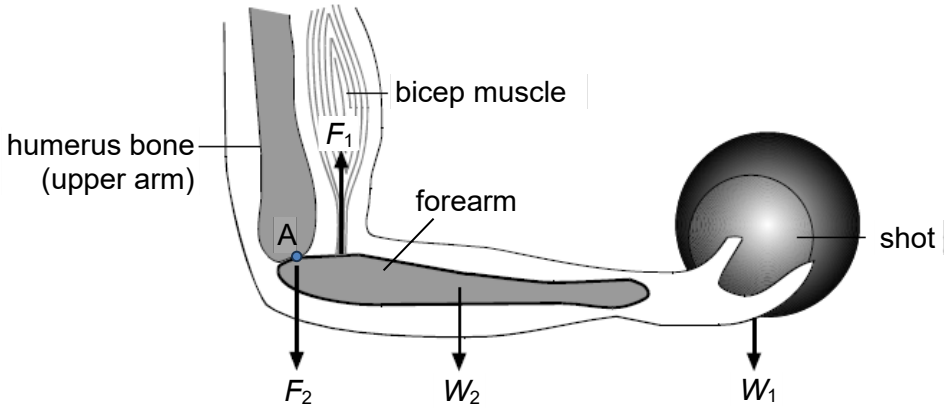


Fig. 1.1

Fig. 1.2 is a simplified representation of Fig. 1.1, with the distances shown.

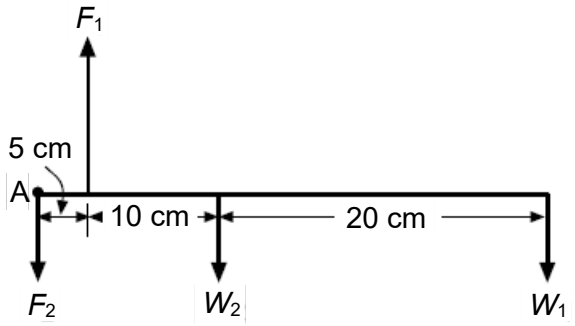


Fig. 1.2

(a) Determine the upward force F_1 exerted by the bicep muscle when holding the shot in the position shown in Fig. 1.1.

upward force F_1 = ……..……..…….. [2]

(b) Calculate F_2, the force exerted by the humerus bone on the forearm.

F_2 = ……..……..….. [2]

[Total: 4]

2 Fig. 2.1 shows two spherical-shaped glass containers connected by a transparent tube containing mercury which has a density of 13.6 g / cm^3.

Both glass containers contain trapped gases. One is painted black and the other is painted white.

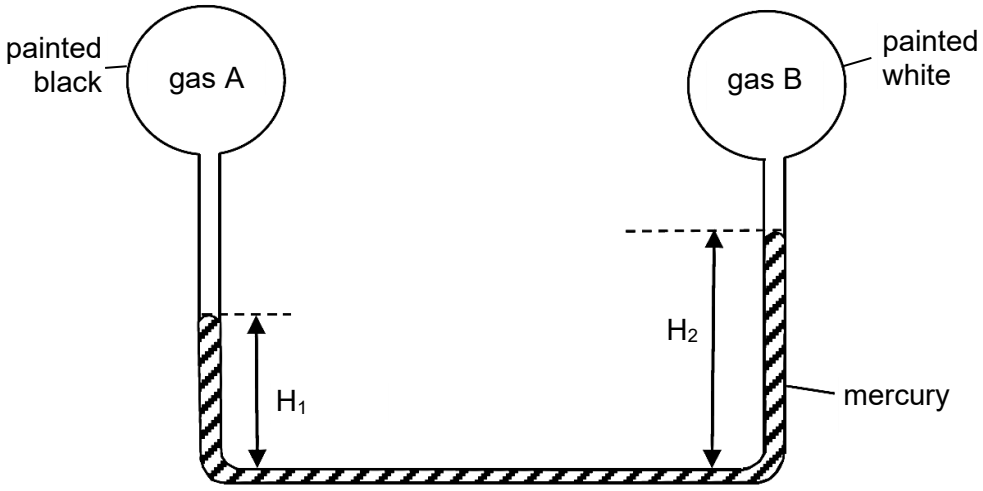


Fig. 2.1

(a) **(i)** Which gas is at a higher pressure?

……..……..... [1]

(ii) Given that H_1 = 30.0 cm, H_2 = 48.0 cm and pressure of B is 100 000 Pa, calculate the pressure of gas A.

pressure = ……..…….. [2]

(iii) A student wants the difference between the liquid levels to be larger, without changing the pressures of gas A and gas B.

Suggest one modification that can be done to the setup shown in Fig. 2.1 to achieve this.

……..…….....

……..……..... [1]

(b) A heater is placed at equal distance from the two glass containers, as shown in Fig. 2.2.

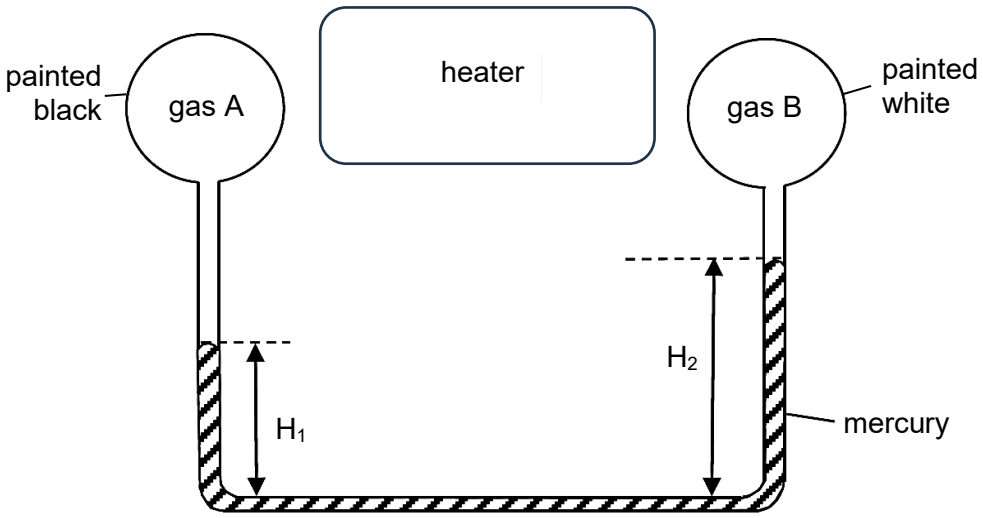


Fig. 2.2

State and explain what happens to H_1 and H_2 after the heater has been switched on for 10 minutes.

……..

……..

……..

……..

……..

……..... [3]

[Total: 7]

3 Two different kettles are used to heat water, as shown in Fig. 3.1.

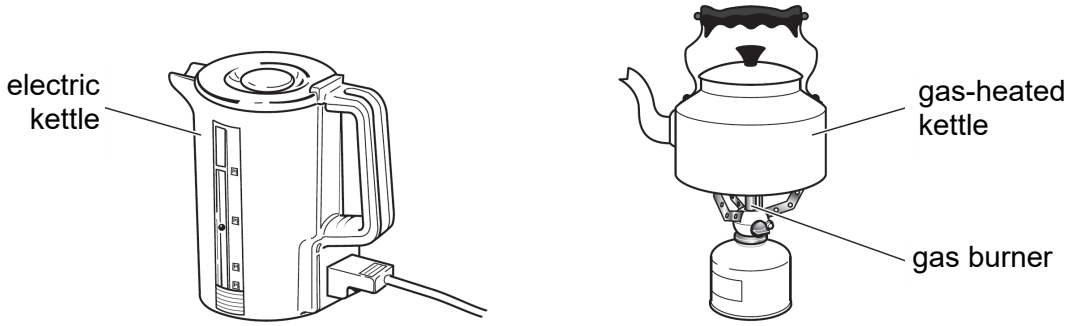


Fig. 3.1

Data for the two kettles are shown in Table 3.1.

Table 3.1

	energy supplied to the kettle in one minute / J	thermal energy (heat) supplied by the kettle to the water in one minute / J
electric kettle	120 000	95 000
gas-heated kettle	130 000	90 000

(a) Explain what is meant by *efficiency*.

……..

……..... [1]

(b) **(i)** Calculate the efficiency of the electric kettle.

efficiency = ……..…….. [2]

(ii) Calculate the useful power output of the gas-heated kettle.

power = ……..…….. [2]

(c) Both kettles contain the same volume of water, at the same initial temperature.

State and explain which kettle brings the water to its boiling point first.

……..

……..

……..... [1]

(d) The boiling water at 100 °C produces steam at 100 °C.

As this is happening, state the changes, if any, to the

(i) kinetic energy of the molecules,

……..……..... [1]

(ii) potential energy of the molecules.

……..……..... [1]

[Total: 8]

4 Fig. 4.1 shows an apparatus used to measure the specific latent heat of fusion of water.

In this question, you may ignore heat transfer to the ice from the surroundings.

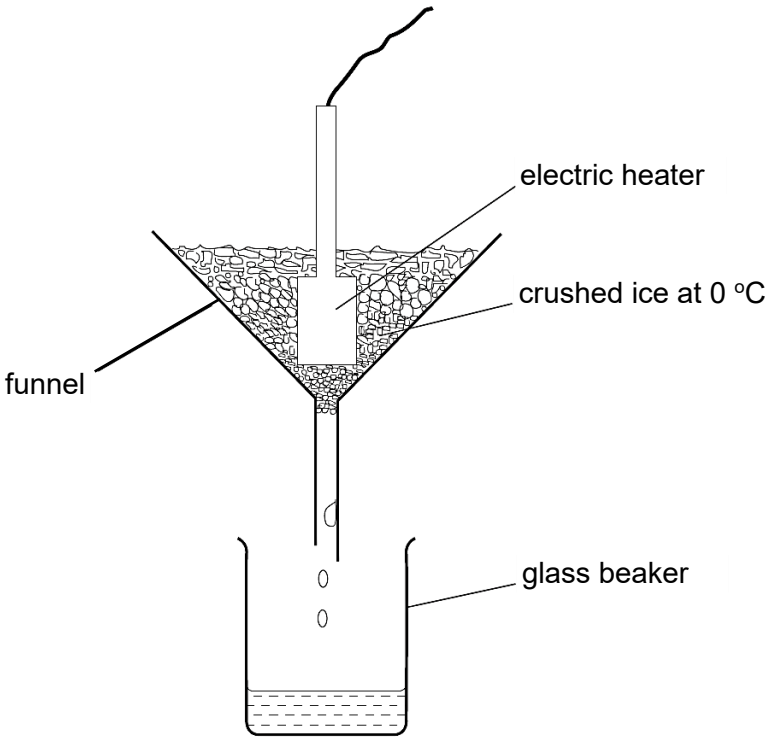


Fig. 4.1

The heater is switched on and water drips into the beaker at a constant rate.

In 2.0 minutes, 31 g of water drips into the beaker. The power of the heater is 85 W.

(a) Calculate the amount of electrical energy supplied to the heater in 2.0 minutes.

electrical energy = ……..……..…….. [2]

(b) Use your answer in **(a)** to calculate the specific latent heat of fusion of water.

specific latent heat of fusion = ……..……..…….. [2]

(c) In another experiment using the same heater, ice at a temperature lower than 0 °C is used. Explain why less water drips into the beaker in 2.0 minutes.

……..

……..

……..... [1]

[Total: 5]

5 Fig. 5.1 shows part of a ray diagram of a converging lens.

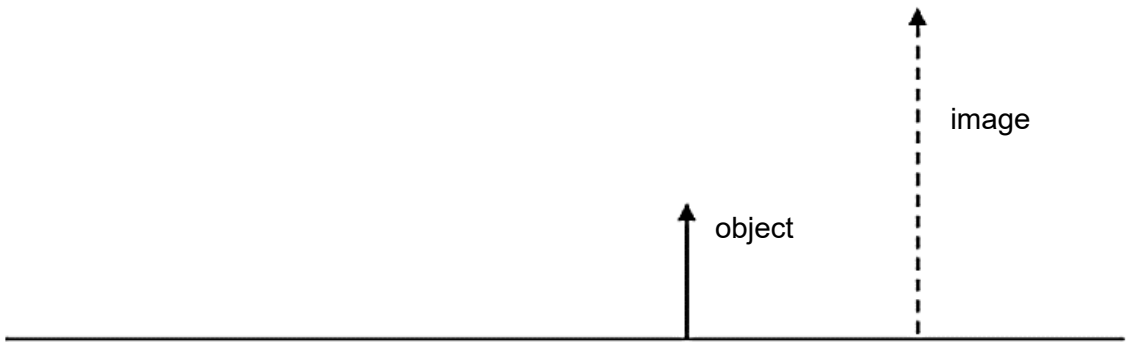


Fig. 5.1

By drawing two rays from the object, locate the position of the lens, L and its principal focus, F.

Label your diagram clearly. [3]

[Total: 3]

6 Fig. 6.1 shows the path of a light ray entering a glass prism at D and its subsequent path in the prism.

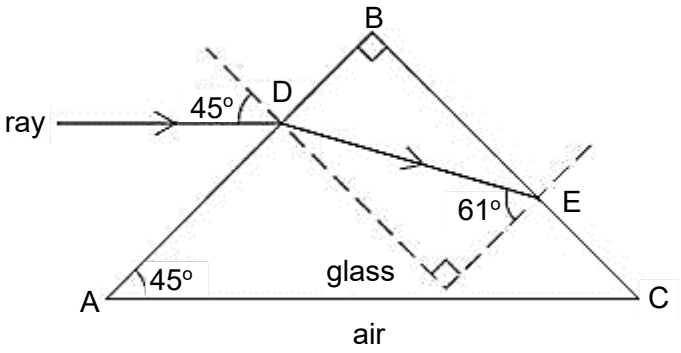


Fig. 6.1

(a) Determine the refractive index of the glass prism.

refractive index = ……..…….. [2]

(b) Calculate the critical angle of the glass prism.

critical angle = ……..…….. [1]

(c) State and explain the path taken by the light ray immediately after point E.

……..

……..

……..

……..

……..... [3]

[Total: 6]

7 A student rubs a polythene rod with a dry cloth. The polythene rod becomes negatively charged and the cloth becomes positively charged.

(a) Describe, in terms of the movement of electrons, what happens during the charging process.

……..

……..... [1]

(b) The charged rod is placed near the stream of water from a tap, as shown in Fig. 7.1.

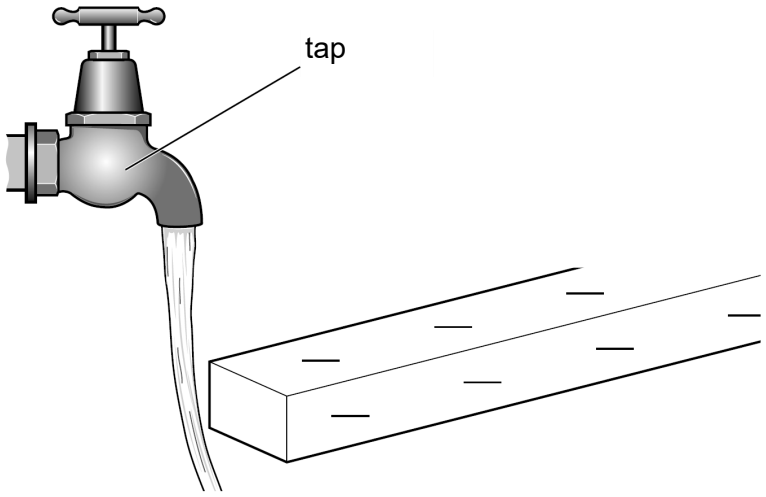


Fig. 7.1

The stream of water bends because the rod is charged.

Explain how the charge on the rod affects the particles in the water.

……..

……..

……..

……..

……..... [3]

[Total: 4]

8 A computer hard disk contains a thin layer of magnetic material.

(a) Describe how a magnet is used to find out whether a sample of material is magnetic or non-magnetic.

……..

……..... [1]

(b) Data is stored on the hard disk as a series of N-poles and S-poles.

Fig. 8.1 shows part of the hard disk. The thin layer of magnetic material contains small regions. Each region has a N-pole and a S-pole. Some magnetic field lines are shown in Fig. 8.1.

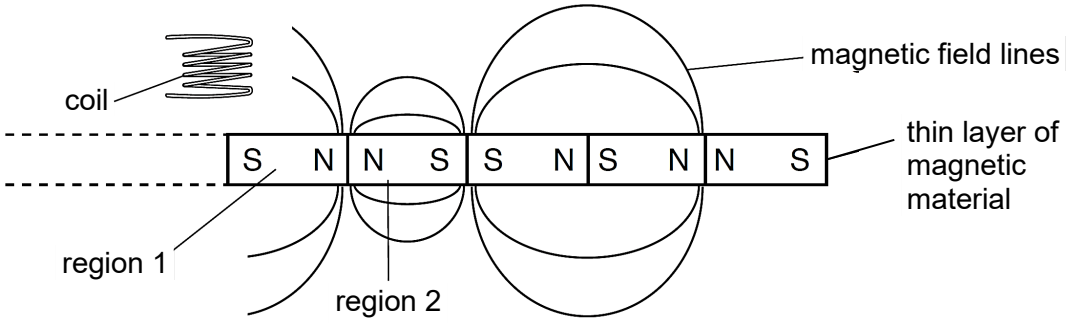


Fig. 8.1 (not to scale)

(i) Region 2 causes a magnetic force on region 1.

State the direction of the magnetic force on region 1 and explain why it acts in that direction.

……..…….....

……..…….....

……..…….... [2]

(ii) On Fig. 8.1, draw arrows on the magnetic field lines to show the direction of the magnetic field near the boundary between region 1 and region 2. [1]

(iii) The coil in Fig. 8.1 is fixed in position above the thin layer of magnetic material. The thin layer of magnetic material passes quickly under the coil towards the left.

A voltage is induced in the coil as some of the boundaries between the regions pass under the coil.

1. Explain why a voltage is induced in the coil.

……

……

…… [1]

2. Suggest why the coil must be close to the thin layer of magnetic material.

……

……

…… [1]

[Total: 6]

9 Sodium-24 and sodium-23 are two isotopes of sodium. Sodium-24 is a radioactive isotope that emits beta-particles and gamma-rays as it decays.

(a) A nucleus of sodium-24 decays. It emits a beta-particle and produces a nucleus of an isotope of magnesium (Mg).

Complete the nuclide equation for the emission of a beta-particle (β) by sodium-24.

$$^{24}_{11}\text{Na} \rightarrow \overset{\cdots\cdots}{\underset{\cdots\cdots}{}}\beta + \overset{\cdots\cdots}{\underset{\cdots\cdots}{}}\text{Mg}$$

[2]

(b) Fig. 9.1 shows a beam of beta-particles and a beam of gamma-rays entering an electric field between two oppositely-charged plates.

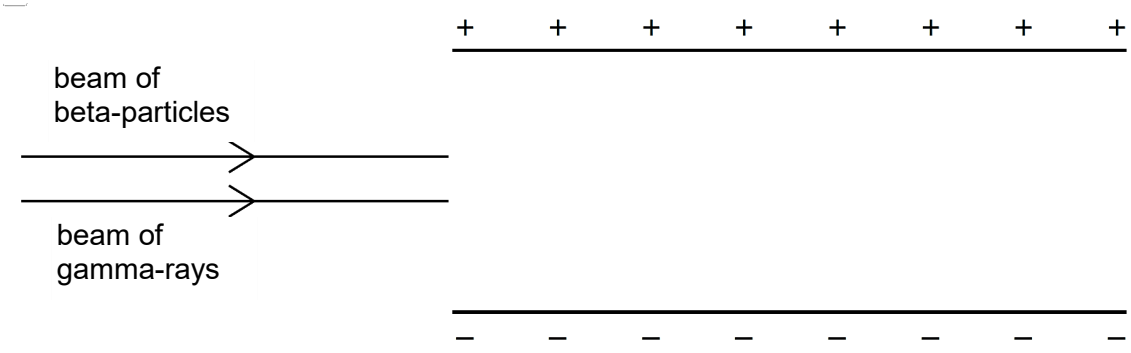


Fig. 9.1 (not to scale)

(i) On Fig. 9.1, draw the path of the beta-particles in the electric field between the charged plates. [1]

(ii) On Fig. 9.1, draw the path of the gamma-rays in the electric field between the charged plates. [1]

(iii) Explain why the path taken by the beta-particles differs from that taken by the gamma-rays.

……

……

…… [1]

(c) Sodium-24 is sometimes used as a tracer in diagnosing medical conditions. The patient consumes the sodium-24 and it moves through the patient's body. The half-life of sodium-24 is 15 hours.

Explain why a half-life of 15 hours makes the sodium-24 isotope suitable for use in the human body.

……..

……..

……..

……..... [2]

[Total: 7]

10 Table 10.1 shows the stopping distances for a 1000-kg car when it travels at different speeds.

Table 10.1

speed / ms^{-1}	thinking distance / m	braking distance / m	total stopping distance / m
5.0	3.0	1.9	4.9
10	6.0	7.5	13.5
15	9.0	17	26
20	12	30	42
25	15	47	62
30	18	68	85
35	21	92	113

The thinking distance is the distance travelled by the car due to the driver's reaction time.

The driver's reaction time is the time taken for the driver to become aware of a dangerous situation before applying the brakes.

The braking distance is the distance travelled by the car after the brakes are applied.

(a) State the formula which relates the speed of the car, the thinking distance and the reaction time.

……..

……..... [1]

(b) Using data from Table 10.1, calculate the driver's reaction time when the speed is 10 m/s.

reaction time = …… [1]

(c) Suggest a reason why the braking distance increases when the speed of the car is higher.

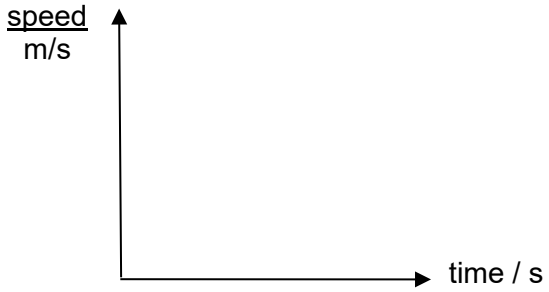
……..

……..... [1]

(d) A car is travelling at a constant speed of 25 m/s and approaches a traffic junction. When the traffic light turns red, the driver applies the brakes and the car travels with uniform deceleration before stopping.

Using data from Table 10.1,

(i) sketch on Fig. 10.1 the speed-time graph of the car from the time the driver applies the brakes to when the car stops,



[1]

Fig. 10.1

(ii) calculate the time taken for the car to stop after the driver applies the brakes.

time = ... [1]

(iii) Hence, calculate the braking force of the car.

braking force = ... [3]

[Total: 8]

11 Fig. 11.1 shows part of a circuit diagram with a battery of electromotive force 12.0 V. Two resistors and a voltmeter are connected to the circuit.

A potentiometer with a resistance range between 10 Ω to 30 Ω is connected between points X and Y.

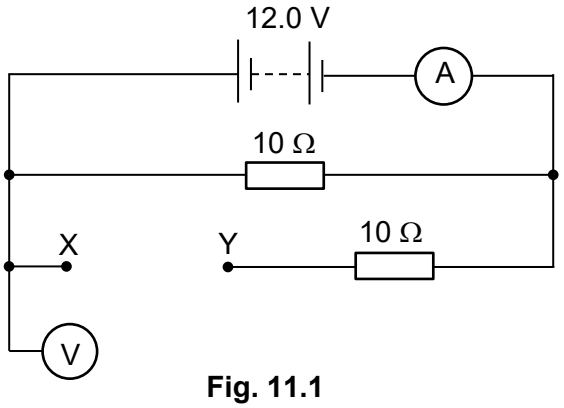


Fig. 11.1

(a) On Fig. 11.1, draw in the space between X and Y the circuit symbol for the potentiometer that is connected to the voltmeter. [1]

(b) **(i)** Calculate the maximum resistance of the circuit.

resistance = ……..…….. [2]

(ii) Hence, calculate the ammeter reading when resistance is at the maximum.

ammeter reading = ……..…….. [1]

(iii) Calculate the potential difference shown on the voltmeter based on your resistance in **(b)(i)**.

potential difference = ……..…….. [2]

(c) The slider of the potentiometer is moved from X to Y.

Describe and explain how the reading shown on the voltmeter changes.

……..

……..

……..... [2]

(d) Fuse are often used in household appliances.

Fig. 11.2 shows the fuse inside the plug of a hairdryer.

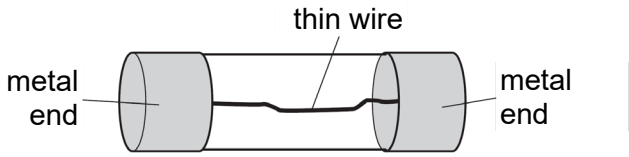


Fig. 11.2

(i) State how the fuse protects the hairdryer.

……..……..

……..……..... [1]

(ii) The hairdryer is rated at 240 V, 1500 W.

Suggest a suitable fuse rating.

fuse rating = ……..…….. [2]

(iii) The hairdryer does not contain an earth wire to connect to the plug.

Which feature of the hairdryer ensures that the hairdryer is safe to use even without an earth wire?

……..……..

……..……..... [1]

[Total: 12]

Candidate Name:	Class:	Index No:

Section B

Answer **one** question from this section.

12 Fig. 12.1 shows a transverse wave travelling along a rope. The positions of the wave at the time intervals t = 0 s and t = 2.0 s are shown.

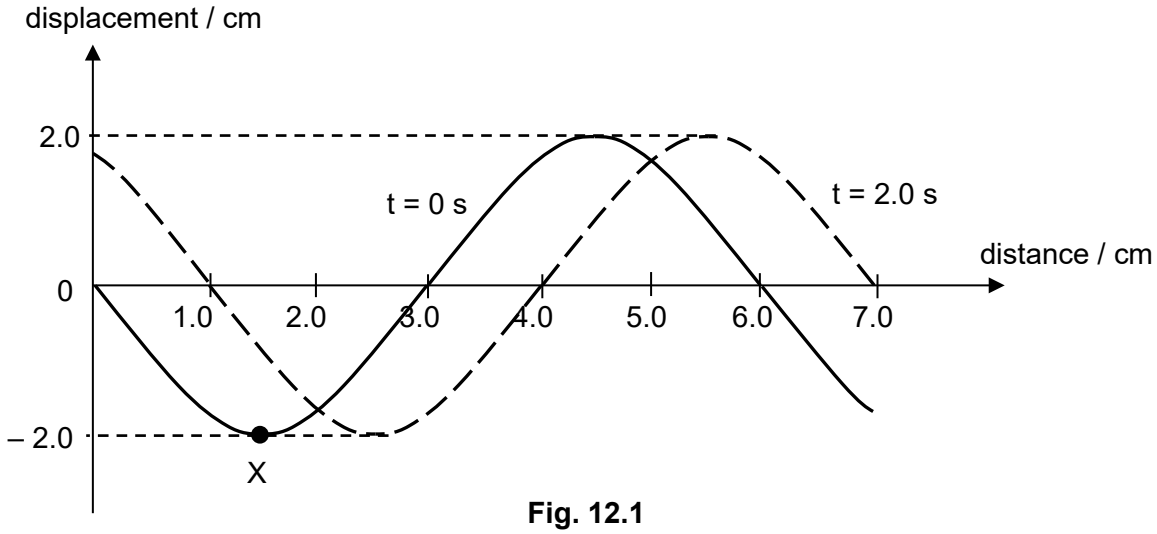


Fig. 12.1

(a) Explain what is meant by *transverse wave*.

……..

……..... [1]

(b) Use Fig. 12.1 to calculate the

(i) speed of the wave,

speed = ……..…….. [1]

(ii) frequency of the wave.

frequency = ……..…….. [2]

(c) X is a particle on the wave at t = 0 s.

On Fig. 12.1, mark the new position of X at t = 6.0 s. Label this position Y. [1]

(d) A water wave in a ripple tank is an example of a transverse wave. The wave passes from deep water into shallow water. The speed of the wave decreases when it enters shallow water.

(i) State how this affects the wavelength of the wave. Explain how this affects the distance travelled by the wave.

……

……

…… [2]

(ii) The wave in deep water shown in Fig. 12.2 travels towards the right and enters the shallow water at an angle. The wave refracts.

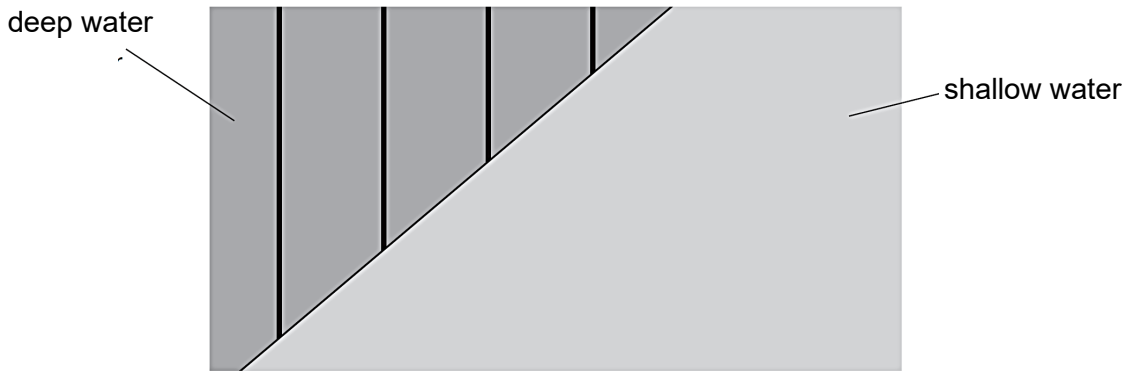


Fig. 12.2

On Fig. 12.2, draw the wavefronts in shallow water. [2]

(e) Sound is also a wave.

State one difference between a sound wave and a water wave.

……

……

…… [1]

[Total: 10]

13 Fig.13.1 shows the top view of two wires X and Y. The wires carry equal currents vertically downwards through a piece of card.

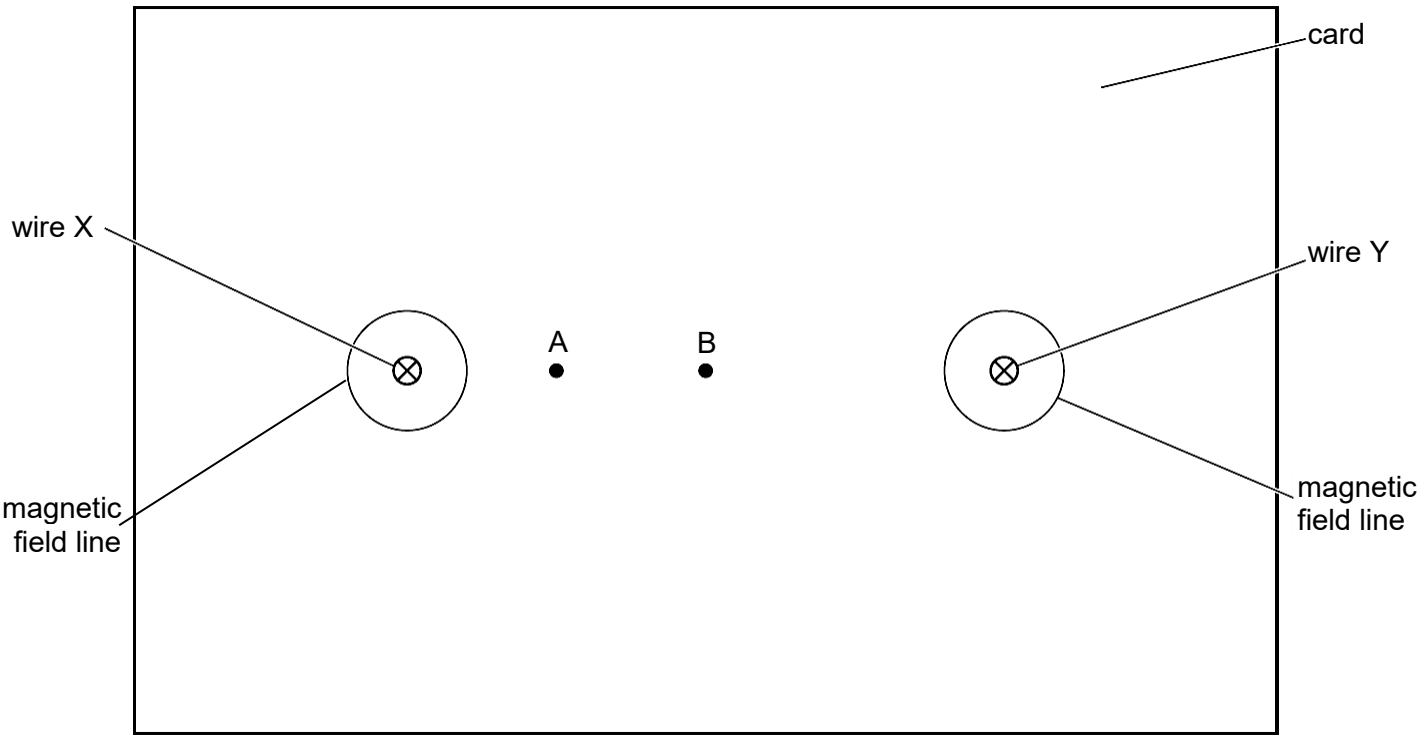


Fig. 13.1

One complete magnetic field line is drawn around each wire.

In this question, ignore the effects of the Earth's magnetic field.

(a) On Fig. 13.1, draw the complete magnetic field line due to the current in wire X that passes through point A.

Mark the direction of this magnetic field line. [2]

(b) Point B is midway between the two wires. Explain why the magnetic field at B is zero.

……..

……..... [1]

(c) There is a force on wire Y due to the current in wire X.

(i) State the direction of the force on wire Y due to wire X.

……..……..... [1]

(ii) Explain why there is a force on wire Y.

……..…….... [1]

(d) Fig. 13.2 shows a simple a.c. generator.

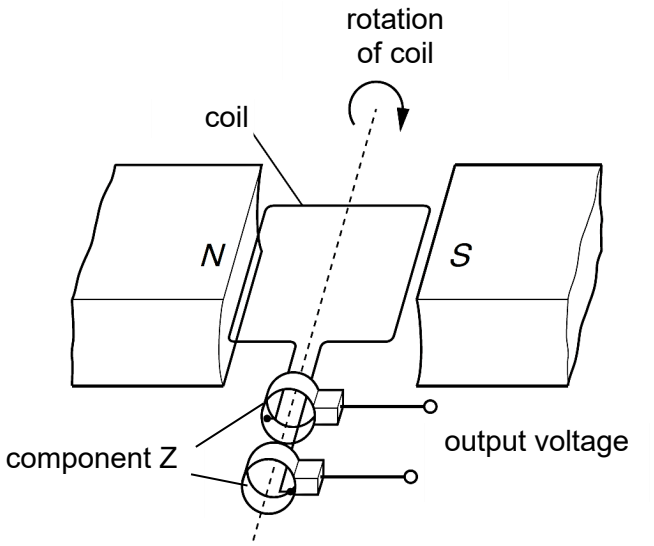


Fig. 13.2

The coil rotates and an alternating electromotive force (e.m.f.) is induced in the coil.

Fig. 13.3 shows how the alternating e.m.f. varies with time as the coil rotates.

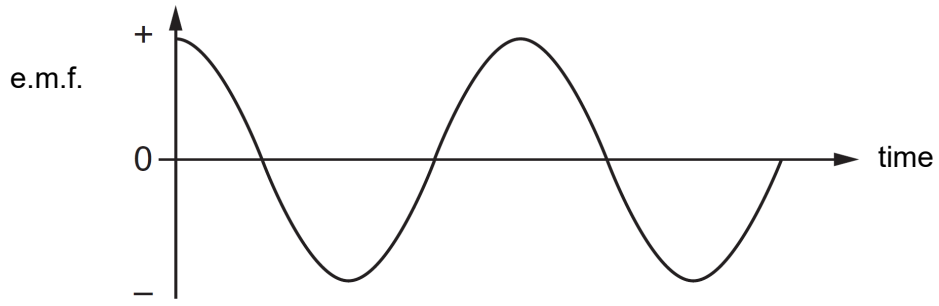


Fig. 13.3

(i) Name component Z and explain its purpose.

……..…….....

……..…….....

……..…….... [1]

(ii) Explain why the e.m.f. is alternating between positive and negative values.

……

……

……

…… [2]

(iii) Changes are made to the a.c. generator, one at a time as follows:

- stronger magnets are used
- the coil is turned faster.

Complete Table 13.1 to show what happens to the maximum value of the e.m.f. and to the frequency of the alternating e.m.f when each change is made.

Table 13.1

change made	what happens to the maximum value of the e.m.f.	what happens to the frequency of the e.m.f.
stronger magnets		
the coil is turned faster		

[2]

[Total: 10]

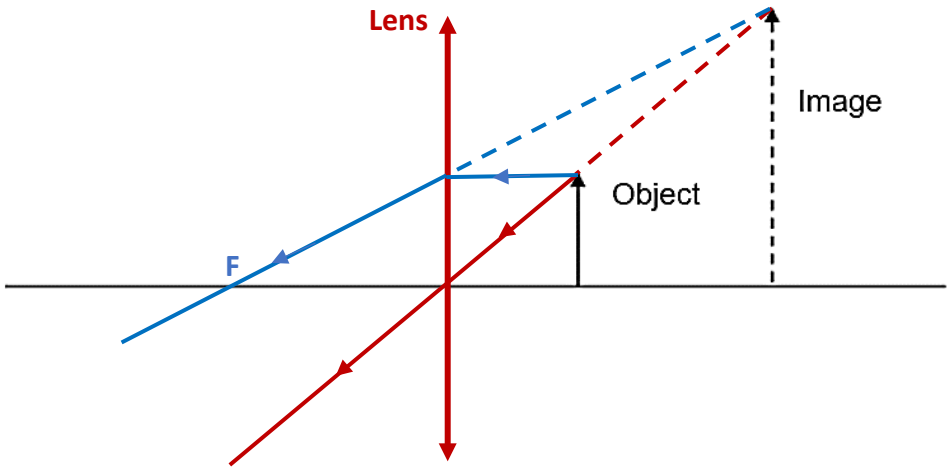
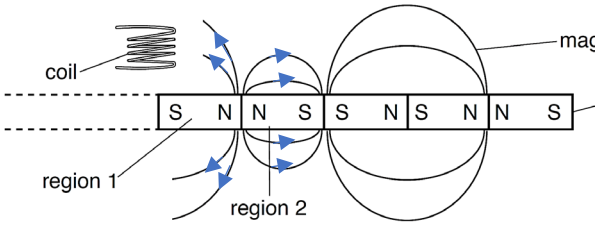
DUNMAN SECONDARY SCHOOL
PRELIMINARY EXAMINATIONS 2024
SEC 4 EXPRESS PHYSICS 6091
MARKSCHEME

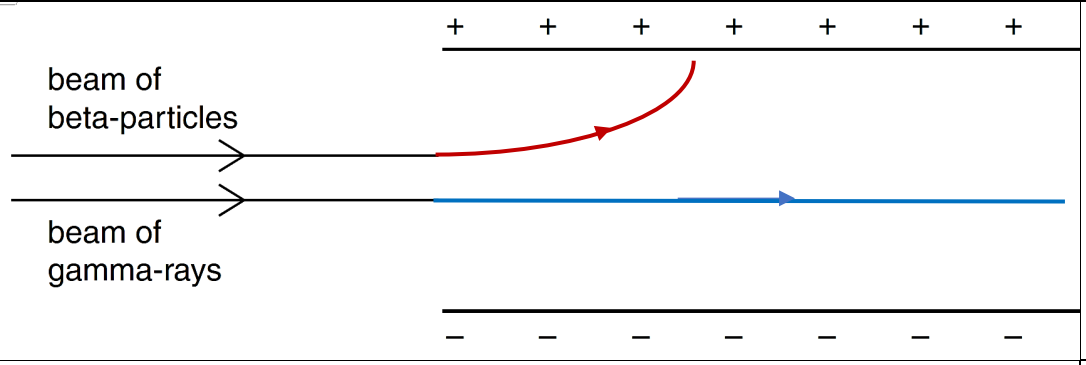
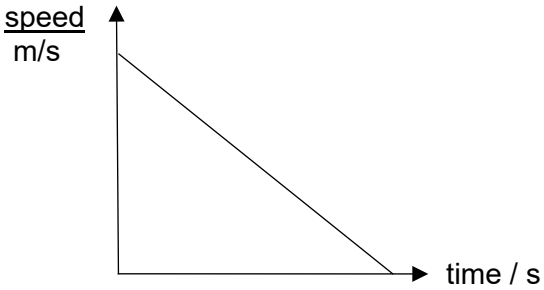
PAPER 1

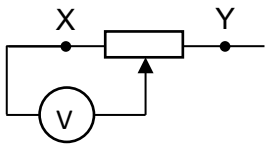
Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
A	D	B	B	B	D	B	A	B	B
Q11	**Q12**	**Q13**	**Q14**	**Q15**	**Q16**	**Q17**	**Q18**	**Q19**	**Q20**
C	D	C	D	B	A	A	C	C	D
Q21	**Q22**	**Q23**	**Q24**	**Q25**	**Q26**	**Q27**	**Q28**	**Q29**	**Q30**
B	A	D	A	A	B	D	C	A	D
Q31	**Q32**	**Q33**	**Q34**	**Q35**	**Q36**	**Q37**	**Q38**	**Q39**	**Q40**
B	D	D	A	C	C	B	B	B	C

PAPER 2 – SECTION A

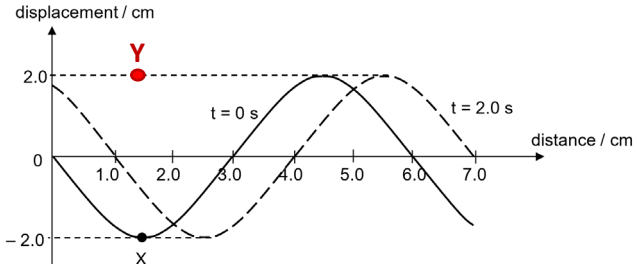
1(a)	Sum of clockwise moments = sum of anticlockwise moments $0.05 \times F_1 = 0.15 \times W_2 + 0.35 \times W_1$ $0.05 \times F_1 = 0.15 \times 15 + 0.35 \times 60$ $F_1 = 465$ N $= 470$ N (2 sf)	 M1 A1
1(b)	Sum of upwards forces = sum of downwards forces $F_2 = F_1 - W_1 - W_2$ $F_2 = 465 - 60 - 15$ $F_2 = 390$ N	 M1 A1
2(ai)	Gas A	B1
2(aii)	$P_A = 100000 + (0.180)(13600)(10)$ $= 124480$ Pa $= 124000$ Pa (3 sf)	M1 A1
2(aiii)	Use a liquid that has lower density OR move the set-up to where there is lower gravitational field strength	B1
2(bii)	H_1 will decrease while H_2 will increase. Black is a better absorber of infrared radiation. The temperature of gas A will increase at a faster rate than gas B. Hence, pressure of gas A will be greater than pressure of gas B.	B1 B1 B1
3(a)	Efficiency is defined as the percentage ratio of the output energy to the input energy.	B1
3(bi)	Efficiency = (useful energy/input energy) ×100% = (95000 / 120000) ×100% = 79% (2 sf)	 M1 A1
3(bii)	Useful output power = 90000/60 = 1500 W	M1 A1
3(c)	Electric kettle AND • More thermal energy/heat per minute output supplied OR • More power output and hence energy transfers at a faster rate.	 B1
3(di)	Internal KE remains constant/no change	B1 t
3(dii)	Internal PE increases	B1
4(a)	E = Pt = 85 × 2.0 × 60	 M1 A1

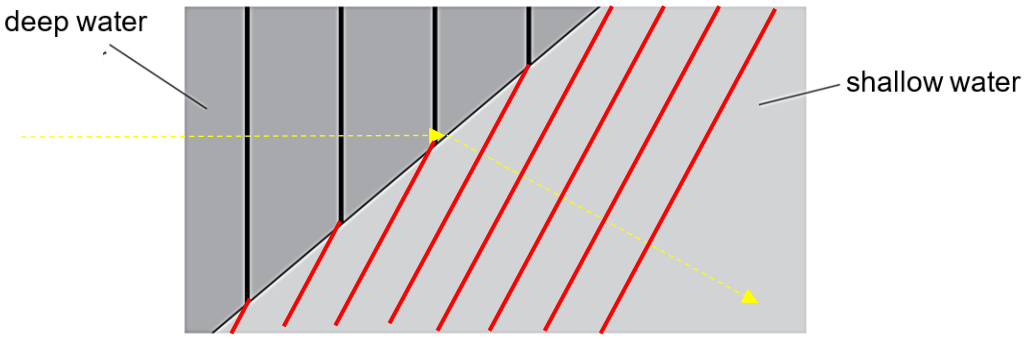
	= 10200 J = 10000 J (2 sf)	
4(b)	Energy to melt ice = mL_f $10200 = 31 \times L_f$ $L_f = 330$ J/g (2 sf)	M1 B1
4(c)	More heat/time is required to warm the ice to 0 °C to reach the melting point.	B1
5	 *deduct 1m for failure to indicate arrows of light ray direction	B1 – correct light rays to locate lens, and correct symbol/position of converging lens B1 – correct parallel light rays drawn to locate F and labelling of F B1 – accurate real and virtual light rays
6(a)	$n = \frac{sin45}{sin29}$ $n = 1.46$ = 1.5 (2 sf)	M1 A1
6(b)	$1.46 = \frac{1}{sinc}$ $c = 43.2°$ [accept 41.8 if using n = 1.5]	B1
6(c)	The light ray will undergo total internal reflection. The angle of incidence is larger than the critical angle. The light is travelling from an optically more dense to less dense medium.	B1 B1 B1
7(a)	Electrons move from the dry cloth to the polythene rod.	B1
7(b)	The water particles are neutral. As the rod comes close, the electrons on the water will be repelled away by the rod **as like charges repel** and the positive charges will be attracted nearer to the rod as **unlike charges attract**. However, the attractive force between the rod and water particles is stronger than the repulsive force between the rod and the water particles, as the electrons are further from rod and the positive charges are nearer to the rod. This causes a net attractive force.	B1 B1 B1
8(a)	Magnet is attracted to magnetic material or is not attracted to the non-magnetic material	B1
8(bi)	(direction) to the **left** or **away from** region 2. This is because **like poles repel**.	B1 B1
8(bii)		B1 – all arrow directions correct
8(biii) 1	Magnetic field lines cut the coil OR Magnetic field/flux (in coil) changes	B1

8(biii) 2	Induced voltage will be large(r) OR Magnetic field is stronger / to be closer to the magnetic field OR More magnetic field lines cut (in a given time) OR Magnetic field lines closer together/ magnetic field lines cut in small(er) time.	B1
9(a)	$^{24}_{11}Na \rightarrow {}^{0}_{-1}\beta + {}^{24}_{12}Mg$	B1 – for beta nuclide notation B1 – for Mg nuclide notation
9(bi) **9(bii)**		B1 – correct beta-particle path way B1 – correct gamma pathyway
9(biii)	Beta-particle is negatively charged while gamma ray is uncharged. Hence gamma ray is not affected by electric field	B1
9(c)	The half-life of Sodium-24 is long enough for doctors to record measurements. The half-life is short enough so that the body is not irradiated for long.	B1 B1
10(a)	Reaction time = (thinking distance)/(speed of car)	B1
10(b)	Reaction time = 6.0 / 10 = 0.60 s (2 sf)	B1
10(c)	For the same braking force and deceleration, More time needed to stop the car / greater distance is covered in the same amount of time *do not accept inertia as inertia is affected by mass*	B1
10(di)		B1
10(dii)	Braking distance = area under speed time graph (triangle) d = ½ x t x v 47 = ½ x t x 25 t = 3.76 s or 3.8 s(2 sf)	B1
10 (diii)	acceleration, a = (v – u) / t = (0 - 25) /3.76 = - 6.64 m/s^2 Deceleration = 6.6 m/s^2 (2 sf) Braking force, F = ma = 1000 x 6.6 = 6600 N (2 sf) [Allow ecf from 10dii]	M1 M1 A1

11(a)		B1 *reject rheostat
11(bi)	$\frac{1}{R} = (\frac{1}{10} + \frac{1}{30+10})$ $= \frac{5}{40}$ R = 8.0 Ω	M1 A1
11(bii)	$R = \frac{V}{I}$ $8.0 = \frac{12}{I}$ I = 1.5 A	 B1
11 (biii)	$V_1 = \frac{R_1}{R_1 + R_2} \times V$ $= \frac{30}{30+10} \times 12$ = 9.0 V	 M1 A1
11(c)	• <u>voltmeter reading increases</u> • <u>resistance</u> of potential divider increases thus <u>potential difference</u> across potential divider increases by the formula $V_1 = [R_1/(R_1+R_2)] \times V$	B1 B1
11(di)	The fuse <u>will blow and melt</u> / cuts off circuit and current when there is <u>high current beyond the fuse rating</u> passing through.	B1
11(dii)	I = P / V = 1500 / 240 = 6.25 A Fuse rating = 7A (accept 8A and 9A)	 B1 B1
11 (diii)	Double insulation OR Outside casing is plastic/rubber	B1

SECTION B

12(a)	Transverse wave is a wave that travels perpendicular to the direction of the vibration of the wave particles.	B1
12(bi)	Speed = 1 cm / 2.0 = 0.50 cm/s	 B1
12(bii)	v = f λ f = 0.50 cm/s / 6.0 cm = 0.083 Hz	 M1 A1
12(c)	 period of wave = 12 s	B1
12(di)	Since frequency remains the same (using v = f λ), <u>wavelength decreases</u> and <u>travels a shorter distance in the same time</u>	B1 B1

<table>
<tr><td>12(dii)</td><td> 
</td><td>B1 -smaller wavefronts and slanted down

B1 – wavefronts join those in shallow water</td></tr>
<tr><td>12(e)</td><td><table>
<tr><td>sound</td><td>water</td></tr>
<tr><td>particles / wave / source
• vibrate / oscillate / move in direction of (travel of) wave / along wave
• move backwards and forwards</td><td>particles / wave / source
• vibrate / oscillate / move at 90° to direction of (travel of) wave
• move up and down</td></tr>
<tr><td>(contains) compressions and rarefactions
or particles come closer / further apart</td><td>(contains) crests and troughs</td></tr>
<tr><td>speed 300–330 m / s</td><td>wave slower (than sound)</td></tr>
</table></td><td>B1 – any one</td></tr>
<tr><td>13(a)</td><td>Oval/circle through or near A centered on or near X
Clockwise arrow on lines around X and none wrong</td><td>B1
B1</td></tr>
<tr><td>13(b)</td><td>Fields (due to X and Y) cancel or X and Y fields are equal and opposite</td><td>B1</td></tr>
<tr><td>13(ci)</td><td>To the left (towards X/A/B)</td><td>B1</td></tr>
<tr><td>13(cii)</td><td>Current (in wire Y) and magnetic field (caused by other wire) OR
Interaction between two magnetic fields</td><td>B1</td></tr>
<tr><td>13(di)</td><td>Slip rings
It allows transfer of the alternating e.m.f induced in the coil to external circuit/secondary circuit / allows constant contact with the circuit and coils</td><td>B1 - both</td></tr>
<tr><td>13(dii)</td><td>One side of the coil cuts one way and then the other side moves another way in one direction before returning. One direction is taken to be positive direction.
The magnetic flux /interacting magnetic field lines increases and then decreases</td><td>B1

B1</td></tr>
<tr><td>13(diii)</td><td>Stronger magnets: increase in emf; no change/same frequency

Turn coil faster: increase in emf; increase in frequency</td><td>B1 – both correct
B1 – both correct</td></tr>
</table>