Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION

PHYSICS 6091/01
Paper 1

28 August 2024
1 Hour

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page and on the optical answer sheet.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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 optical answer sheet.

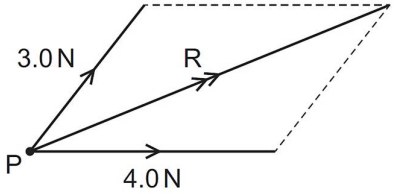
Read the instructions on the Answer Sheet very carefully.

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.

1 What is the typical diameter of a basketball?

A 24 μm **B** 24 mm **C** 24 cm **D** 24 dm

2 The diagram shows the resultant R of a 3.0 N force and a 4.0 N force that acts at a point P.

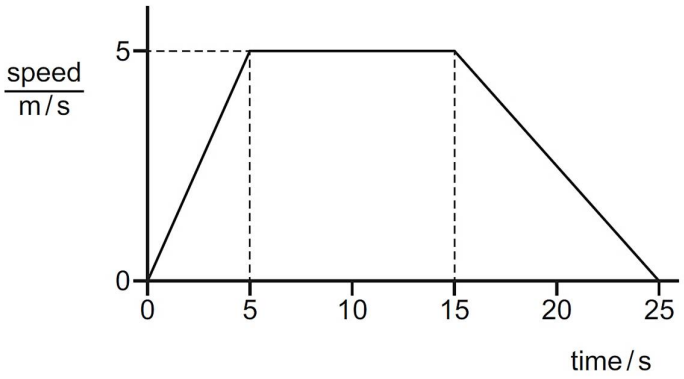


The angle between the 3.0 N force and the 4.0 N force can be any value from 0^{o} to 90^{o}.

Which value of R is **not** possible?

A 4.0 N **B** 5.0 N **C** 6.0 N **D** 7.0 N

3 The speed-time graph shows the motion of an object.

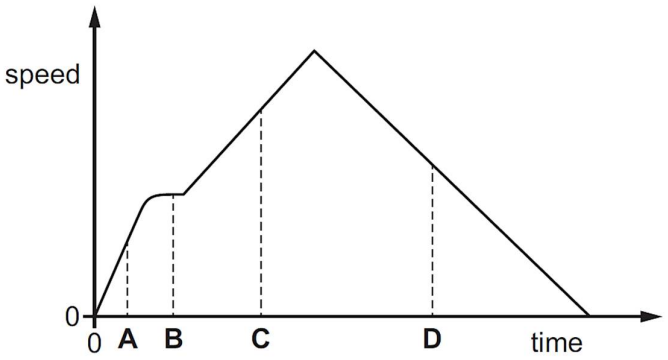


How far does the object travel when it is moving at constant speed?

A 25 m **B** 50 m **C** 75 m **D** 88 m

4 The graph shows how the speed of an object varies with time.

At which labelled time is the acceleration the greatest?



5 When a man is standing in an ascending lift, the magnitude of the force exerted on the man's feet by the lift floor is always equal to the magnitude of _____ .

A his weight

B the tension in the cable supporting the lift

C what it will be when the lift is stationary

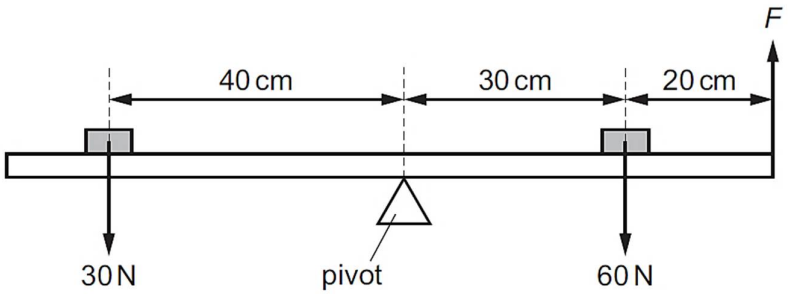
D the force exerted on the lift floor by his feet

6 A student releases a tennis ball from a tall building.

What happens to the velocity and to the acceleration of the ball during the first few seconds after release?

	velocity	acceleration
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

7 A uniform beam is pivoted at its centre. Two weights are placed on the beam in the positions shown and the beam is balanced by an upward force *F*.



What is the size of *F*?

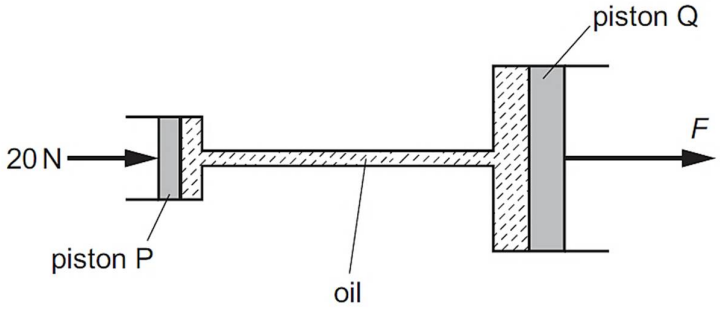
A 6 N **B** 12 N **C** 30 N **D** 60 N

8 When a car turns a corner at speed, it risks toppling over. Two factors affecting the stability of a car are the height of its centre of mass and the distance between its front wheels.

Which factors make the car most stable?

	centre of mass	distance between front wheels
A	high	small
B	high	large
C	low	small
D	low	large

9 The diagram shows a simple model of the braking system of a car. A force of 20 N is applied to piston P. As a result, there is a force *F* on piston Q.

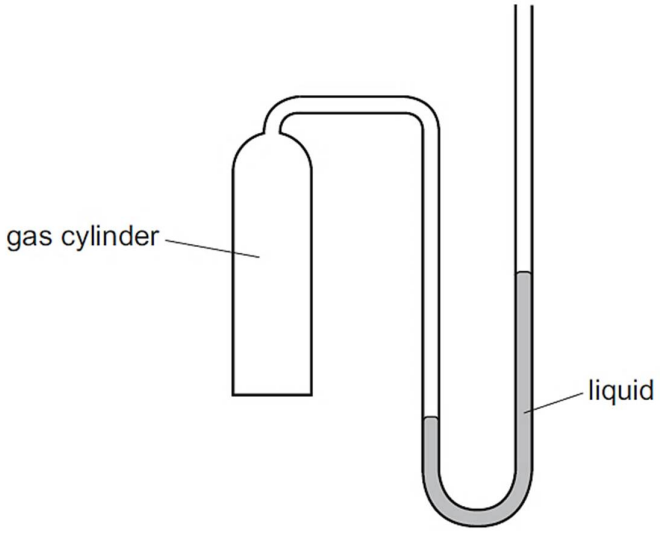


Piston P has an area of 5.0 cm^2 and piston Q has an area of 25 cm^2.

What is the force *F*?

A 4.0 N **B** 20 N **C** 100 N **D** 500 N

10 The diagram shows a manometer with one side connected to a gas cylinder and the other side open to the atmosphere.



What conclusion can be made using only the information from the liquid levels in the manometer?

A The density of the gas is less than the density of air.

B The density of the gas is greater than the density of air.

C The pressure of the gas is less than atmospheric pressure.

D The pressure of the gas is greater than atmospheric pressure.

11 A rocket of total mass M is travelling at a speed v. The engine of the rocket is fired and fuel is used up. The mass of the rocket decreases to $M / 2$ and its speed increases to $2v$.

What happens to the kinetic energy of the rocket?

A It halves.

B It stays the same.

C It doubles.

D It increases by a factor of four.

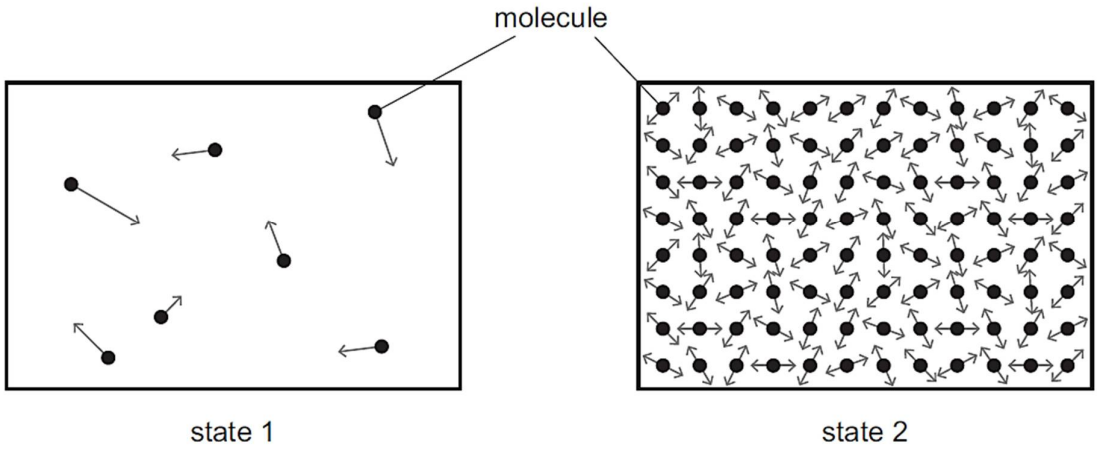
12 A worker lifts eight slabs from the ground on to the back of a lorry 1.5 m high.

The total time taken is 48 s and each slab weighs 200 N.

How much useful power does the worker produce?

A 6.3 W **B** 50 W **C** 500 W **D** 2400 W

13 The diagrams represent the molecules in two different states of matter. The arrows show the motion of the molecules.



What is state 1, and what is state 2?

	state 1	state 2
A	gas	liquid
B	gas	solid
C	liquid	gas
D	liquid	solid

14 A gas is in a sealed container of constant volume. The gas is heated and the pressure of the gas on the walls of the container increases.

How do the particles of the gas cause this increase in pressure?

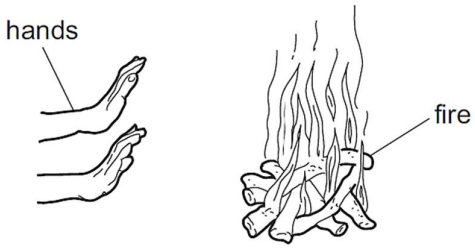
A They expand.

B They hit each other more frequently.

C They hit the container more frequently.

D They vibrate faster.

15 A girl is outdoors. She warms her hands by holding them near a fire, as shown.



How does the heat from the fire reach her hands?

A conduction only

B conduction and convection

C convection and radiation

D radiation only

16 The tubes inside solar heating panels use the Sun's radiation to warm water.

Why are the tubes painted black?

A Black surfaces absorb radiation well.

B Black surfaces conduct heat well.

C Black surfaces emit radiation well.

D Black surfaces reflect radiation well.

17 The same quantity of energy is transferred to the internal store of two objects X and Y. The temperature rise of object X is less than the temperature rise of object Y.

What accounts for this difference?

A X has a larger specific heat capacity than Y.

B X has a larger heat capacity than Y.

C Y has a larger specific heat capacity than X.

D Y has a larger heat capacity than X.

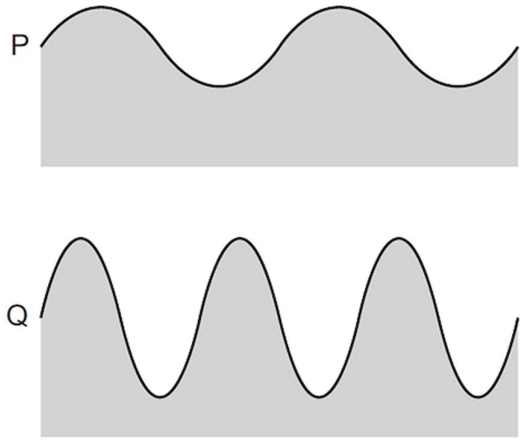
18 A student adds 37 g of ice at 0 °C to 100 g of water at 30 °C. All the ice melts and the final temperature of the mixture is 0 °C. No thermal energy is transferred to, or gained from, the surroundings.

The specific heat capacity of water is 4.2 J/(g °C).

What is the specific latent heat of ice?

A 47 J/g **B** 341 J/g **C** 4700 J/g **D** 12600 J/g

19 The diagrams show two water waves P and Q that are travelling at the same speed on the surface of a pond. The diagrams are to the same scale.



Which wave has the greater amplitude and which wave has the greater frequency?

	greater amplitude	greater frequency
A	P	P
B	P	Q
C	Q	P
D	Q	Q

20 Two sounds X and Y are produced by loudspeakers.

The amplitude and frequency of each sound wave are given in the table.

	amplitude / mm	frequency / Hz
X	1.3	475
Y	2.0	235

How does sound Y compare with sound X?

A Y is quieter and has a higher pitch

B Y is quieter and has a lower pitch

C Y is louder and has a higher pitch

D Y is louder and has a lower pitch

21 The diagram shows the electromagnetic spectrum, in order of increasing wavelength.

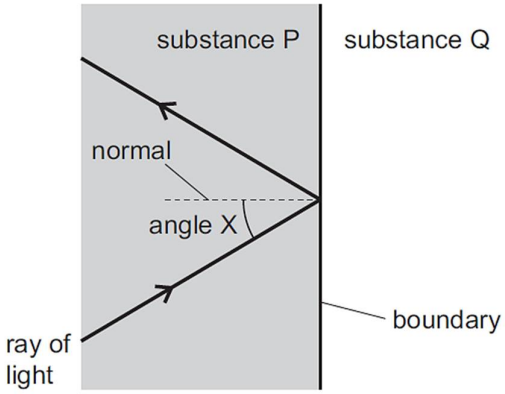
Three types of radiation, P, Q and R, are missing from the spectrum diagram.

γ-rays	X-rays	P	visible light	Q	microwaves	R

Which types of electromagnetic radiation are represented by P, Q and R?

	P	Q	R
A	infra-red	radio waves	ultraviolet
B	infra-red	ultraviolet	radio waves
C	ultraviolet	infra-red	radio waves
D	ultraviolet	radio waves	infra-red

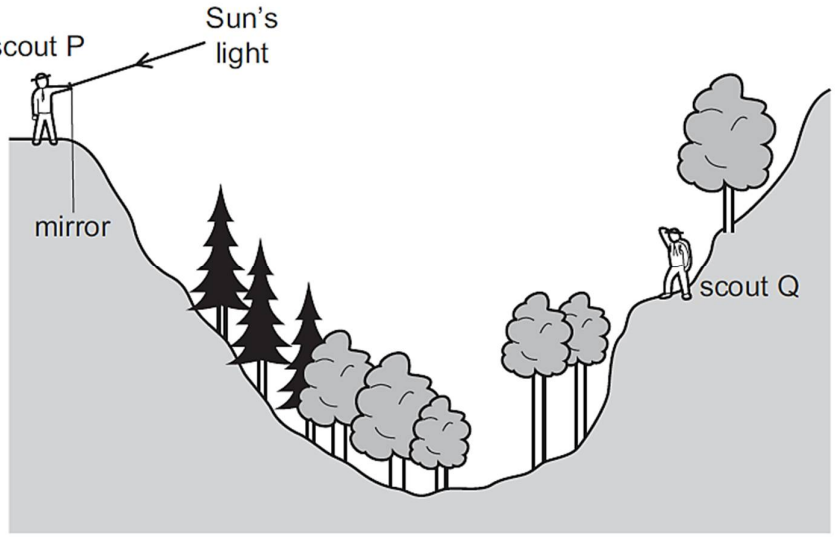
22 The diagram shows a ray of light travelling in a substance P. The ray reaches a boundary with a substance Q. Total internal reflection occurs at the boundary.



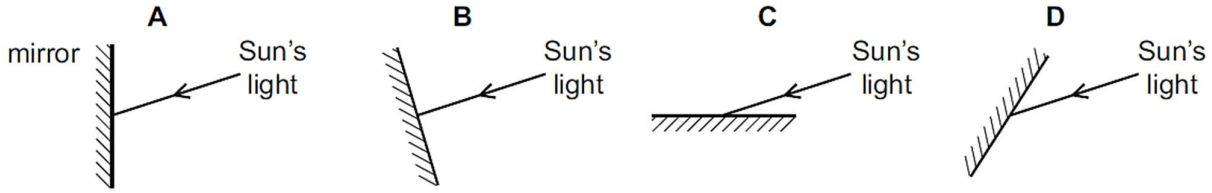
Which row contains correct statements about angle X and about the optical density of substance Q?

	angle X	optical density of substance Q
A	smaller than the critical angle	less dense than substance P
B	smaller than the critical angle	more dense than substance P
C	greater than the critical angle	less dense than substance P
D	greater than the critical angle	more dense than substance P

23 Scout P signals to scout Q on the other side of a valley by using a mirror to reflect the Sun's light.



Which mirror position allows the Sun's light to be reflected to scout Q?



24 An image is formed by a thin converging lens when it is used as a magnifying glass.

What is the correct description of the image?

A real and upright

B real and inverted

C virtual and upright

D virtual and inverted

25 Diagram 1 shows two thin, uncharged strips of plastic. Diagram 2 shows the same two strips after they have been rubbed with a dry cloth.

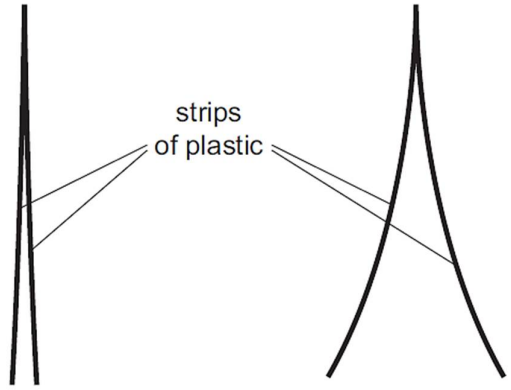


diagram 1 diagram 2

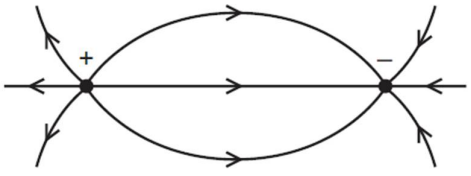
Which row describes the charge on the strips after rubbing, and the force between the strips after rubbing?

	charge on strips	force between the strips
A	opposite	attraction
B	opposite	repulsion
C	the same	attraction
D	the same	repulsion

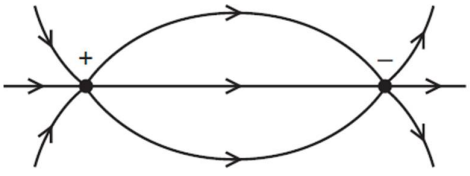
26 Four diagrams representing the electric field between two oppositely charged point charges are shown.

Which diagram correctly shows the electric field lines?

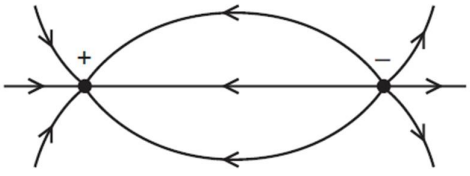
A



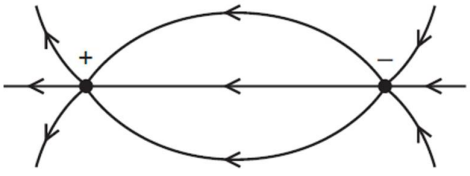
B



C



D



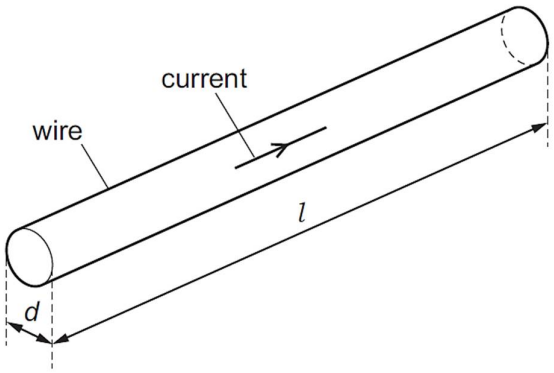
27 Four students are each given an identical resistor and asked to find its resistance. They each measure the potential difference across the resistor and the current flowing through it.

One student makes a mistake.

Which row shows the results of the student that made a mistake?

	potential difference / V	current / A
A	1.2	0.500
B	2.4	1.100
C	1.5	0.625
D	3.0	1.250

28 A metal wire of circular cross-section has diameter *d* and length *l*.



Which pair of changes, if both are carried out, **must** increase the resistance of the wire?

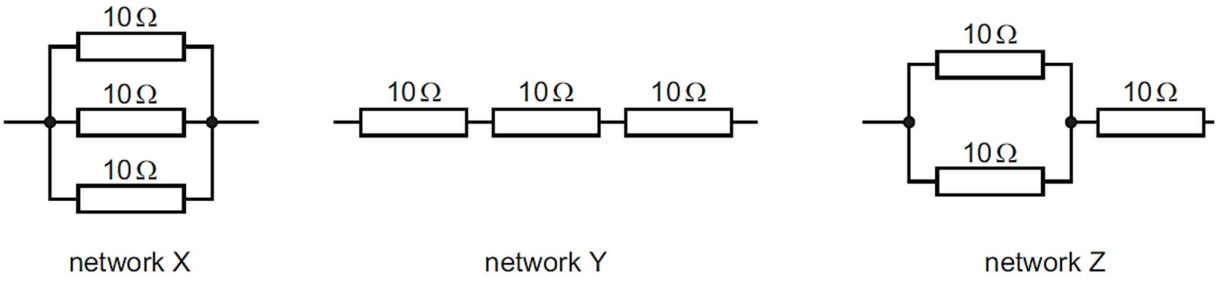
A decrease *l* and decrease *d*

B decrease *l* and increase *d*

C increase *l* and decrease *d*

D increase *l* and increase *d*

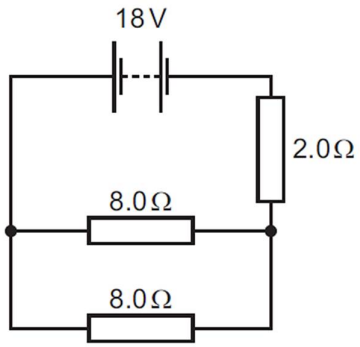
29 Three 10 Ω resistors are connected together to form networks X, Y and Z.



What is the order of the total resistance of the networks going from the smallest total resistance to the largest total resistance?

A X → Y → Z **B** X → Z → Y **C** Z → X → Y **D** Z → Y → X

30 A power supply of 18 V is connected to three resistors as shown.



What is the potential difference across the 2.0 Ω resistor?

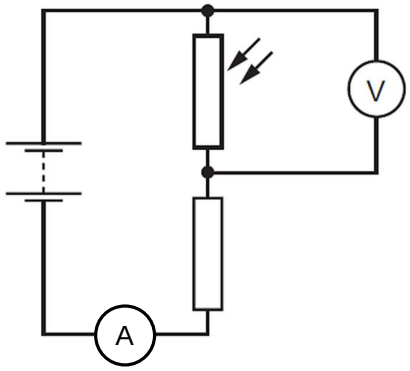
A 2.0 V **B** 3.6 V **C** 6.0 V **D** 12 V

31 An electrical power generator produces 100 kW of power at a potential difference of 10 kV. The power is transmitted through cables having a total resistance of 5.0 Ω.

How much power is dissipated in the cables?

A 50 W **B** 250 W **C** 500 W **D** 20 MW

32 The diagram shows a light-dependent resistor (LDR) connected in a potential divider circuit.



The brightness of the light falling on the LDR is increased.

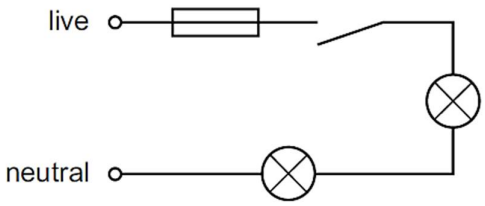
Which row shows what happens to the reading on the ammeter and voltmeter?

	reading on ammeter	reading on voltmeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

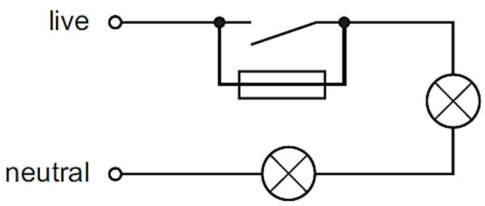
33 A fuse is a safety feature in an electric circuit.

Which diagram shows the most appropriate placement for the fuse in the circuit?

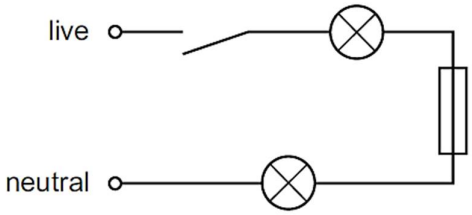
A



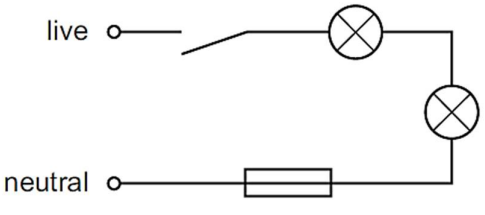
B



C

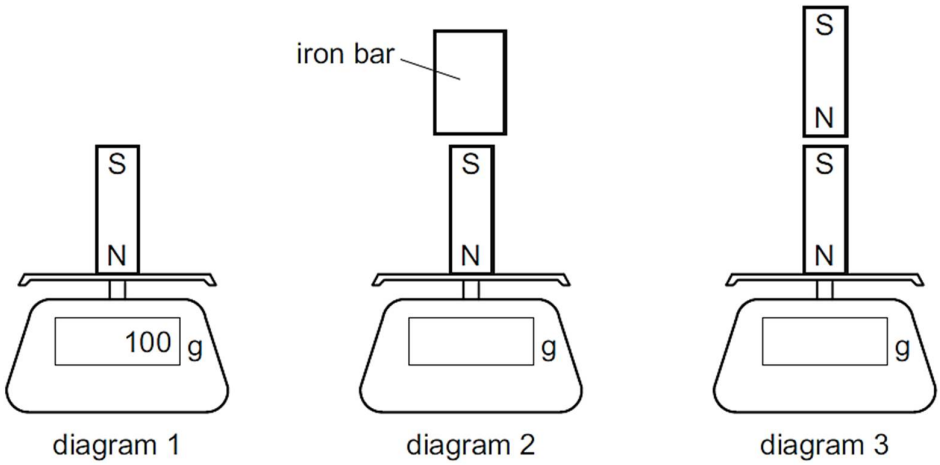


D



34 A magnet is placed on a balance. The balance reading changes when an iron bar and another magnet is held close to the first magnet.

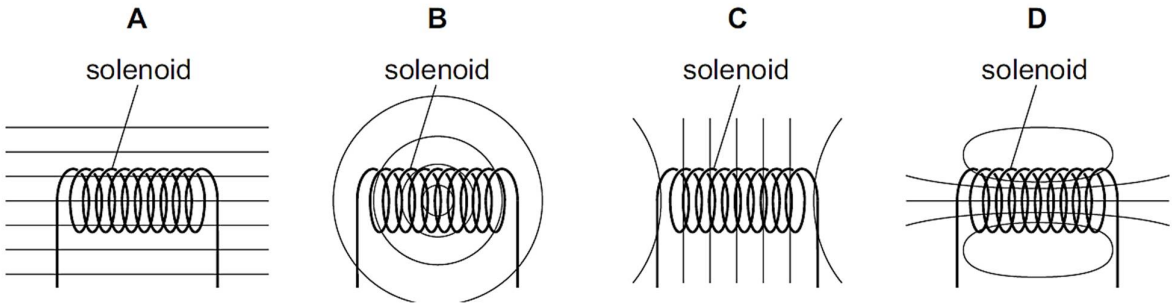
The arrangements are as shown in the diagrams.



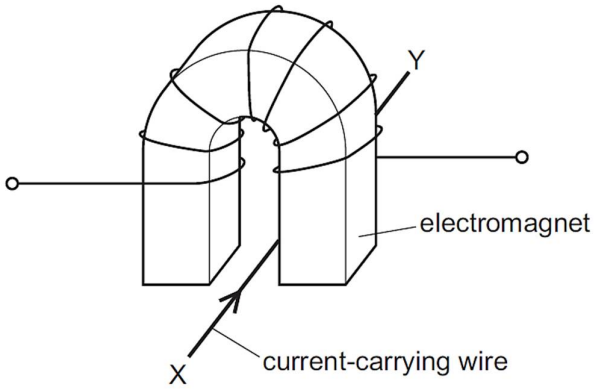
Which row gives the balance reading in diagram 2 and in diagram 3?

	balance reading in diagram 2 / g	balance reading in diagram 3 / g
A	less than 100	less than 100
B	less than 100	more than 100
C	more than 100	less than 100
D	more than 100	more than 100

35 Which diagram shows the pattern of the magnetic field produced by a current-carrying solenoid?



36 A current-carrying wire XY lies in the magnetic field between the two poles of a U-shaped electromagnet. A force acts on the wire XY because of the magnetic field.



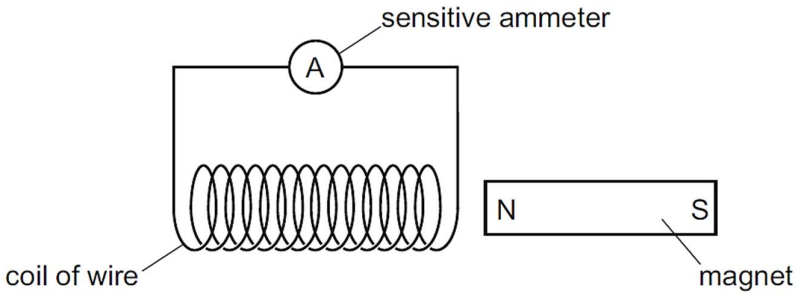
Each of the following actions is carried out separately.

- The current in the wire XY is reversed.
- The magnetic field is reversed.
- Both the current in the wire XY and the magnetic field are reversed at the same time.

How many of these actions cause the direction of the force on the wire XY to be reversed?

A 0 **B** 1 **C** 2 **D** 3

37 A student investigates electromagnetic induction. She has a bar magnet and a coil of wire that is connected to a sensitive ammeter.



Which movement does **not** cause a reading on the ammeter?

A moving the coil to the right

B moving both the magnet and the coil to the left at the same speed

C moving both the magnet and the coil towards each other at the same speed

D moving the magnet to the left

38 Electric power cables transmit electrical energy over large distances using high-voltage, alternating current.

What are the advantages of using a high voltage and of using an alternating current?

	advantage of using a high voltage	advantage of using an alternating current
A	high current is produced in the cable	the resistance of the cable is reduced
B	high current is produced in the cable	the voltage can be changed using a transformer
C	less energy is wasted in the cable	the resistance of the cable is reduced
D	less energy is wasted in the cable	the voltage can be changed using a transformer

39 A factory continuously produces plastic sheets. A radioactive isotope and a detector are used to check the thickness of the sheets.

What is the most suitable source to use?

A an alpha source with a half-life of a few minutes

B an alpha source with a half-life of a several years

C a beta source with a half-life of a few minutes

D a beta source with a half-life of a several years

40 A source contains a radioactive material.

Without the radioactive source present, a detector records a background count rate of 20 counts per minute.

This source is placed in a fixed position near the detector. Initially a count rate of 520 counts per minute is recorded.

What count rate is recorded after a time of two half-lifes of the radioactive source?

A 125 counts per minute

B 130 counts per minute

C 135 counts per minute

D 145 counts per minute

End of Paper

Class:	Register No:	Name:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION

PHYSICS **6091/02**
Paper 2

28 Aug 2024

1 hr 45 min

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page and on all separate answer sheets used.
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 fluids.

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.

For Examiner's Use	
Section A	/70
Section B	/10
TOTAL	

This paper consists of 14 printed pages (including the cover page).

Section A

Answer **all** questions. Write your answers in the spaces provided in the question paper.

1 Fig. 1.1 shows a free-fall sky-diver falling vertically downwards at constant velocity.

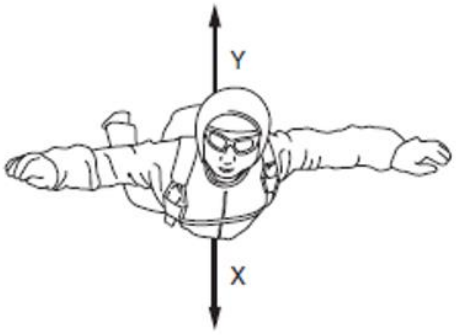


Fig. 1.1

Arrows X and Y shows the two main forces acting on the sky-diver.

(a) State the name of the forces X and Y.

X: ……[1]

Y: ……[1]

(b) Using ideas about forces, explain why he falls at constant velocity.

……

……

……

……

……[3]

(c) Initially when the sky-diver starts to fall, his velocity is not constant. After some time, his velocity becomes constant. Sketch on Fig. 1.2, his velocity-time graph.

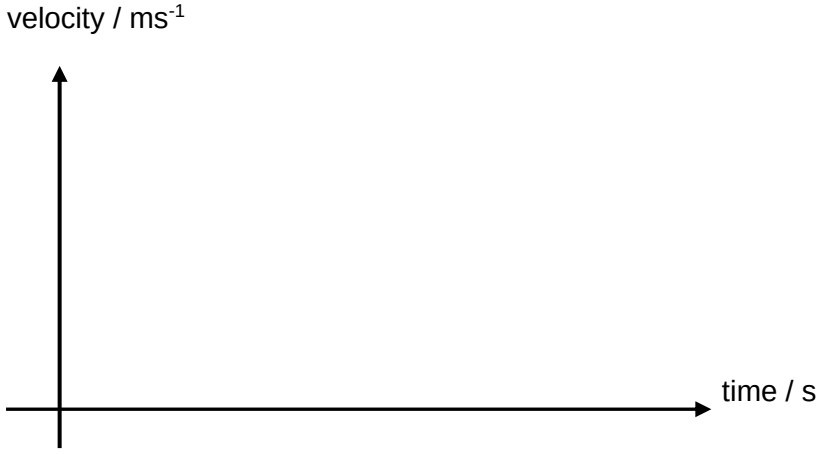


Fig. 1.2

……[2]

2 Fig. 2.1 shows a barrier pivoted near one end. The barrier is raised to allow cars to pass. The barrier has a weight of 200 N that acts at a distance of 2.0 m from the pivot.

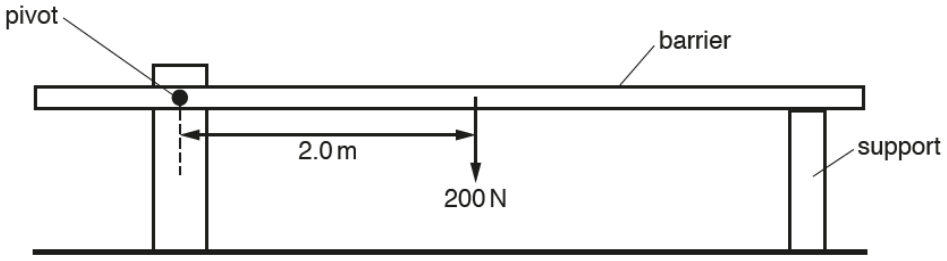


Fig. 2.1

(a) State the principle of moments.

……..

……..…[1]

(b) A force is used to raise the barrier off the support.

(i) On Fig. 2.1 , draw an arrow to show the position and direction of the smallest force that can be used to raise the barrier. Label the force F. [2]

(ii) Calculate the moment due to the weight of the barrier about the pivot.

moment of the weight = ……[2]

(iii) When the barrier is rising, describe what happens to the moment in (ii).

……..

……..…[1]

(c) To reduce the force needed to raise the barrier, a counterweight is added, as shown in Fig. 2.2.

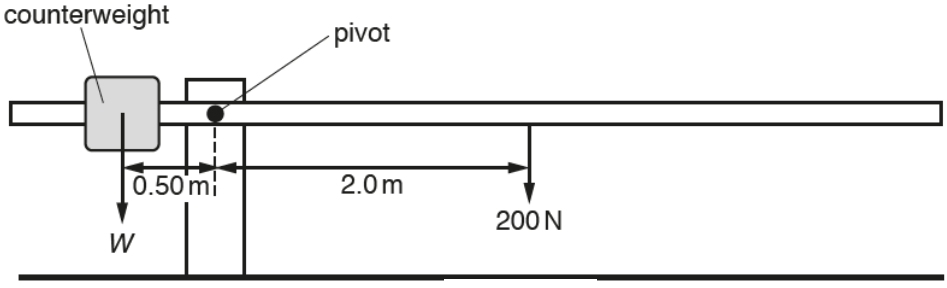


Fig. 2.2

The weight W of the counterweight acts at a distance of 0.5 m from the pivot. The barrier is in equilibrium, without the support. Calculate the weight W, of the counterweight.

weight W = ……[2]

3 A falling metal hammer is used to drive a hollow steel post into the ground, as shown in Fig. 3.1. The hammer is lifted by an electric motor and then falls freely to hit the baseplate.

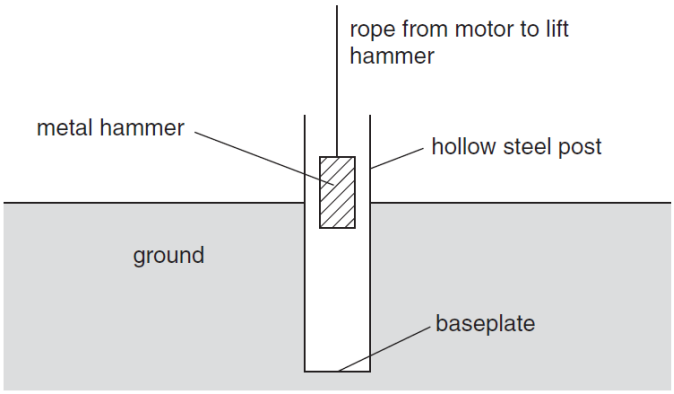


Fig. 3.1

(a) State the principle of conservation of energy.

……..
……..
……..
……..…[2]

(b) The metal hammer has a mass of 1500 kg and it hits the baseplate with a speed of 8.0 ms^{-1}. Take g as 10 Nkg^{-1}.

(i) Calculate the kinetic energy of the hammer as it hits the baseplate.

kinetic energy = ……[2]

(ii) Calculate the height above the baseplate from which the hammer is dropped.

height = ……[2]

(iii) Describe the energy conversion when the hammer hits the base plate.

……..
……..
……..
……..
……..…[2]

4 Fig. 4.1 shows the variation with time to the height of water at the same place in a water tank. The height is sometimes above and sometimes below the mean level which is marked as 0.

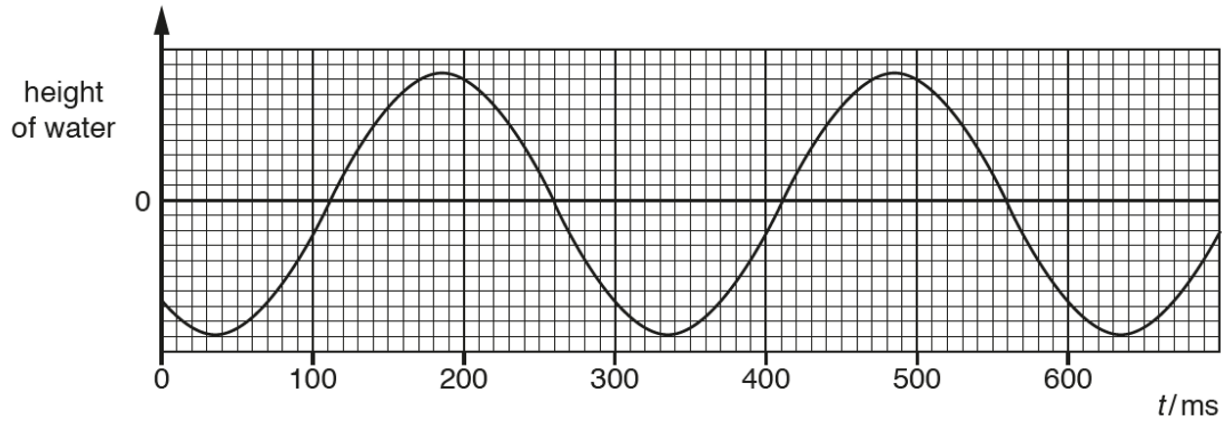


Fig. 4.1

(a) Water waves are transverse waves. Describe what is meant by a transverse wave.

……..

……..

……[1]

(b) Indicate in Fig. 4.1, the amplitude of the wave. [1]

(c) The speed of the water wave is 0.20 ms^{-1}. Determine

(i) the frequency of the wave,

frequency = ……[2]

(ii) the wavelength of the wave.

wavelength = ……[2]

5 Fig. 5.1 shows a ray of light passing through the edge of a converging lens made of glass.

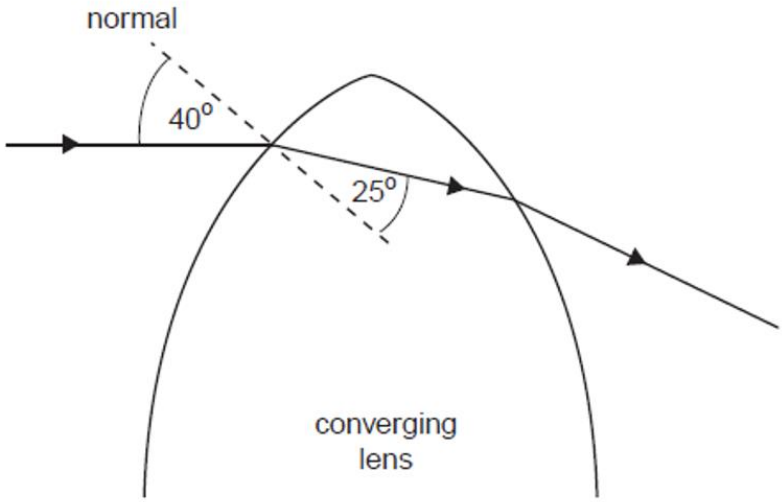


Fig. 5.1

(a) State what happens to the speed and frequency of the light as it enters the lens.

……..

……..……[2]

(b) Calculate the refractive index of the glass used in the lens.

refractive index = ……[2]

(c) The lens is replaced with an identical lens made with an optically denser glass. The same ray of light entering the new lens resulted in total internal reflection occurring.

(i) State the two conditions required for total internal reflection to occur.

……..

……..

……..

……..

……..…[2]

(ii) Draw in Fig. 5.1, the path of the ray of light in the new lens. [2]

6 Fig. 6.1 shows the negatively-charged metal rod placed near to a neutral conducting sphere. The sphere is suspended by an insulating thread.

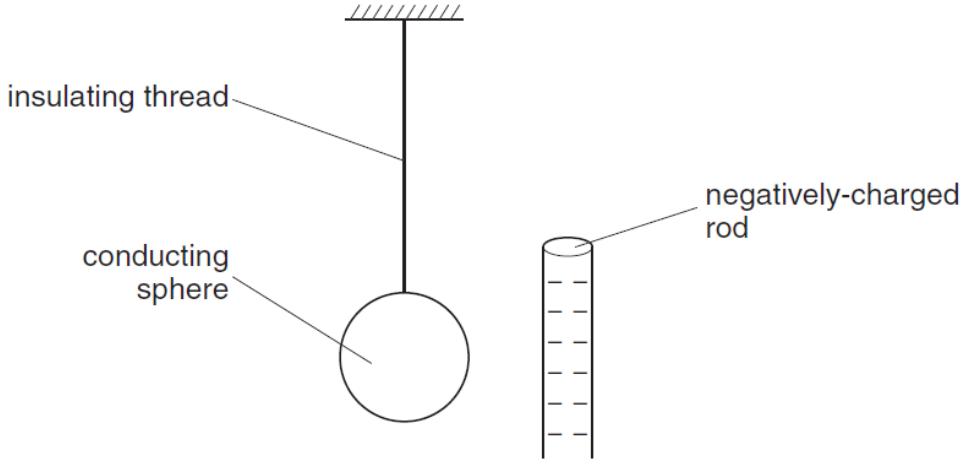


Fig. 6.1

(a) On Fig. 6.1. draw the distribution of positive and negative charges on the sphere [2]

(b) Explain why the sphere is attracted to the rod.

……..
……..
……..
……..…[2]

(c) The sphere swings and touches the rod.

(i) Describe the movement of charges between the sphere and the rod.

……..
……..……[1]

(ii) State the charge on the sphere and the rod.

……..
……..……[2]

7 A typical hairdryer comes with a two-pin plug. There is a fuse found within the plug.

(a) Describe how the fuse protects the wires in the hairdryer.

……..
……..
……..
……..……[2]

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

(i) Calculate the current in the hairdryer.

current = ……[2]

(ii) Suggest a suitable rating for the fuse.

fuse rating = ……[1]

(c) The hairdryer does not contain an earth wire to connect to the plug. State the feature of the hairdryer which ensures that it is safe to use without an earth wire.

……..
……..……[1]

8 A wire is wound around a soft-iron core forming a solenoid, as shown in Fig. 8.1.

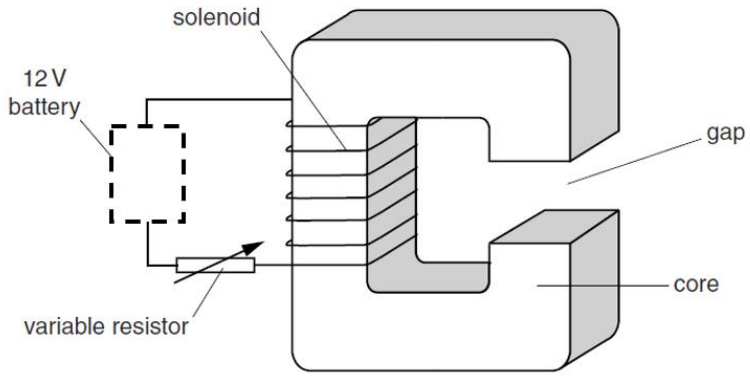


Fig. 8.1

The solenoid is connected in series with a 12V battery and a variable resistor. There is a gap in the core. The magnetic field in the gap is uniform and vertically upwards.

(a) On Fig 8.1, complete the circuit diagram by adding the circuit symbol for a battery in the dotted box. [1]

(b) Without replacing any components, explain how the electrical circuit could be used to increase the strength of the magnetic field.

……..

……..

……..……[2]

(c) Fig. 8.2 shows a horizontal, current-carrying wire PQ in the gap.

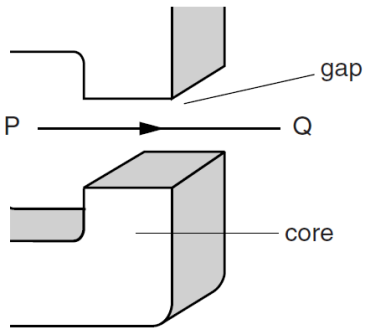


Fig. 8.2

The current in PQ is from left to right. Describe the effect of the magnetic field on PQ.

……..

……..

……..……[2]

9 Fig. 9. 1 shows a simple transformer.

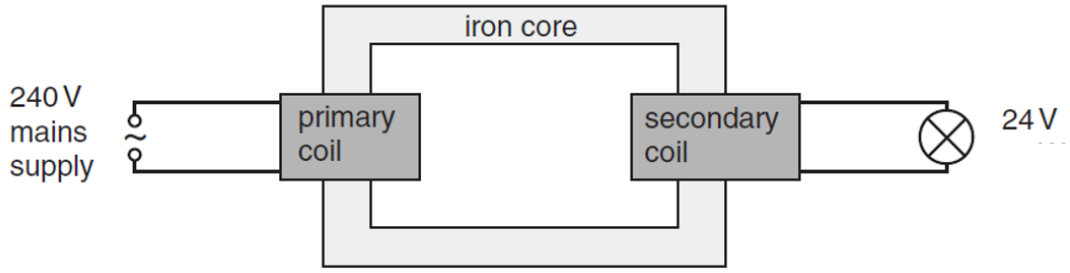


Fig. 9.1

(a) Explain how a transformer works.

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

(b) The primary coil has 200 turns. Determine the number of turns in the secondary coil.

number of turns = ……[2]

(c) The current flowing through the bulb is 1.5 A. Determine the current flowing in the primary coil. Assume the transformer is ideal.

current = ……[2]

10 Fig. 10.1 gives details about some radioactive isotopes.

radioactive isotope	type of radiation emitted	half-life
Uranium-238	alpha-particle	4.5×10^9 years
Uranium-235	alpha-particle	7.1×10^8 years
Carbon-14	beta-particle	5600 years
Strontium-90	beta-particle	28 years
Cobalt-60	gamma-ray	5 years
Technetium-99	gamma-ray	6 hours

Fig. 10.1

(a) State what is meant by a beta-particle.

……..

……..……[1]

(b) State the isotope with the strongest penetrating power and how it should be stored safely.

……..

……..……[2]

(c) Scientists use Carbon-14 to determine how old objects are. The amount of Carbon-14 found in a living tissue is 16 times more than that found in an archaeological object of the same mass. Use this information to estimate the age of the archaeological object.

age of archaeological object = ……[2]

(d) Radioactive sources are used to detect leaks from pipes underground. A liquid containing a radioactive source is allowed to flow through the pipe. Some liquid leaks from the pipe and the radiation it emits can be detected above ground.

(i) State the most suitable radioactive isotope in Fig. 10.1 for this purpose.

……..……[1]

(ii) Explain why the half-life of the isotope you have chosen and the radiation it emits are suitable for this purpose.

……..

……..

……..

……..……[2]

Section B

Answer **one** question from this section.

11 A student has an open tank for storing water outside her house as shown in Fig. 11.1. The tank is black and is in direct sunlight. She notices that the level of water inside the tank slowly decreases as water evaporates.

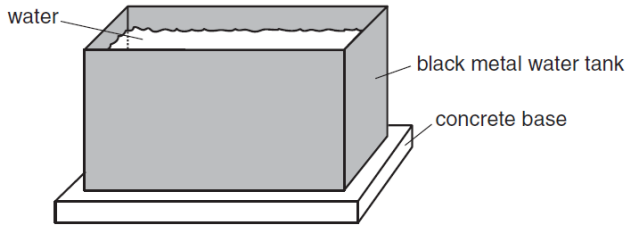


Fig. 11.1

She notices that the water level in the tank falls by 0.0050 m in a day.
The cross-sectional area of the tank is 3.0 m^2. The density of water is 1000 kgm^{-3}.
The specific latent heat of vaporisation of water is 2.2 x 10^6 Jkg^{-1}.

(a) Calculate the volume of water that evaporates in a day.

volume = ……[2]

(b) Calculate the mass of water that evaporates in a day.

mass = ……[2]

(c) Determine the energy required to evaporate the water.

energy required = ……[2]

(d) The humidity of the surrounding increases. State how the rate of evaporation is affected.

……[1]

(e) The external surface of the water tank was found to be at a higher temperature than the water. Describe how molecules transfer thermal energy through the water tank.

……..

……..

……..

……[3]

12 Fig. 12.1 shows an electrical circuit.

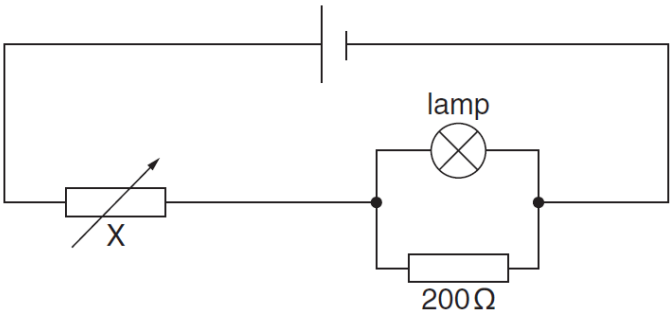


Fig. 12.1

(a) State what is meant by current flow in a circuit.

……..

……..……[1]

(b) Fig. 12.2 shows the graph of current against potential difference for the lamp.

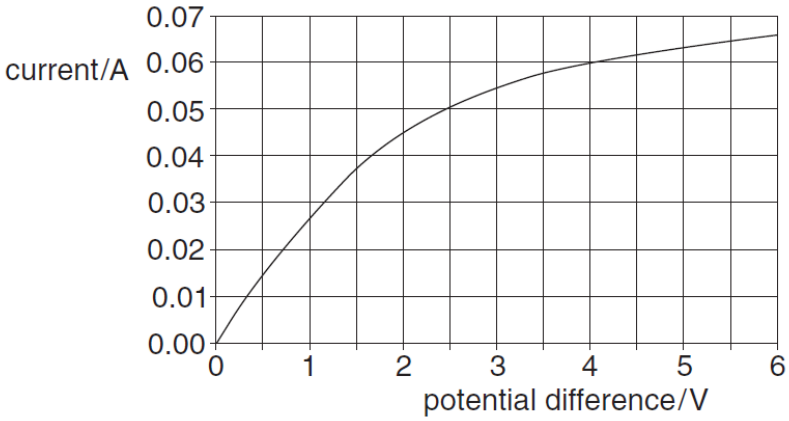


Fig. 12.2

The potential difference across the lamp is 2.5 V.

(i) Using Fig. 12.2, determine the current in the lamp.

current in the lamp = ……[1]

(ii) Determine the current in component X.

current in component X = ……[3]

(iii) Sketch in Fig. 12.2, the graph for the 200 Ω resistor. [2]

(c) Component X is replaced with a thermistor.

(i) Draw the symbol for a thermistor below.

……[1]

(ii) The temperature around the thermistor increases. Describe what happens to the resistance and potential difference across the thermistor.

……..

……..

……..……[2]

End of paper

2024 Crescent Prelim Paper 1 answer

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

Class:	Register No:	Name: Mark Scheme

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION

PHYSICS **6091/02**
Paper 2

28 Aug 2024

1 hr 45 min

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces provided at the top of this page and on all separate answer sheets used.
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 fluids.

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.

For Examiner's Use	
Section A	/70
Section B	/10
TOTAL	

Section A

Answer **all** questions. Write your answers in the spaces provided in the question paper.

1 Fig. 1.1 shows a free-fall sky-diver falling vertically downwards at constant velocity.

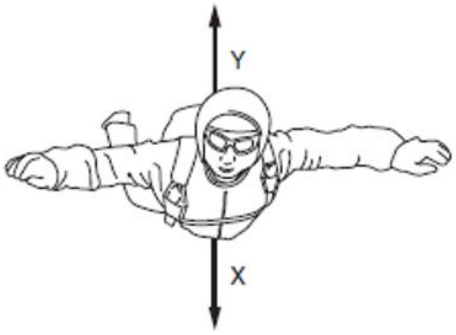


Fig. 1.1

Arrows X and Y shows the two main forces acting on the sky-diver.

(a) State the name of the forces X and Y.

X: **Weight / gravitational force. [1]**

Y: **air resistance / friction [1]**

(b) Using ideas about forces, explain why he falls at constant velocity.

Forces X and Y are equal (in magnitude but opposite in direction). [1]

The net force is 0 N. [1]

Using F = ma, the acceleration is 0 ms^{-2}. OR using Newton's Law. [1]

Therefore the velocity is constant.

(c) Initially when the sky-diver starts to fall, his velocity is not constant. After some time, his velocity becomes constant. Sketch on Fig. 1.2, his velocity-time graph.

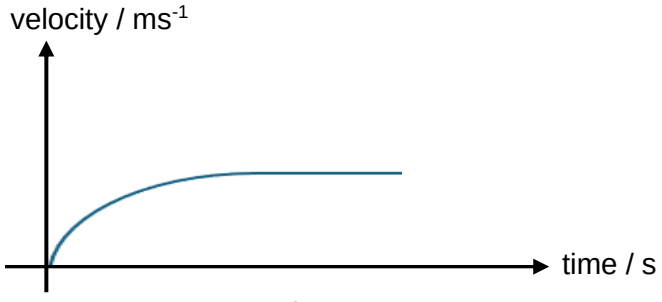


Fig. 1.2

Curve starts at v = 0 m/s, with decreasing gradient. [1]

Followed by horizontal straight line. [1]

2 Fig. 2.1 shows a barrier pivoted near one end. The barrier is raised to allow cars to pass. The barrier has a weight of 200 N that acts at a distance of 2.0 m from the pivot.

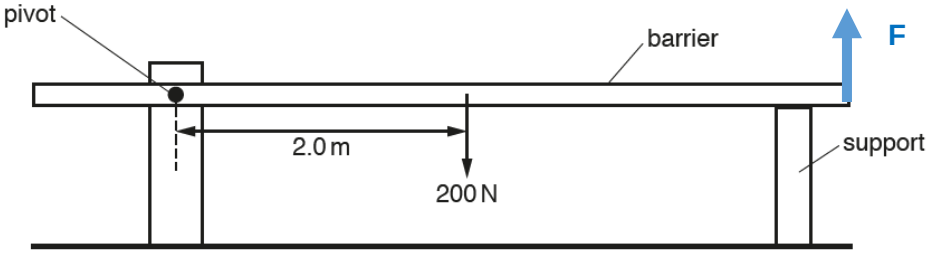


Fig. 2.1

(a) State the principle of moments.

When an object is in equilibrium, the sum of clockwise moments about the pivot is equal to the sum of anticlockwise moments about the same pivot. [1]

(b) A force is used to raise the barrier off the support.

(i) On Fig. 2.1 , draw an arrow to show the position and direction of the smallest force that can be used to raise the barrier. Label the force F. [2]

Arrow on right edge of barrier + F label. [1]
Direction of arrow upwards. [1]

(ii) Calculate the moment due to the weight of the barrier about the pivot.

M = F x d
= 200 x 2.0 [1]
= 400 Nm [1]

moment of the weight = ……[2]

(iii) When the barrier is rising, describe what happens to the moment in (ii).

The moment will decrease (as the perpendicular distance decreases). [1]

(c) To reduce the force needed to raise the barrier, a counterweight is added, as shown in Fig. 2.2.

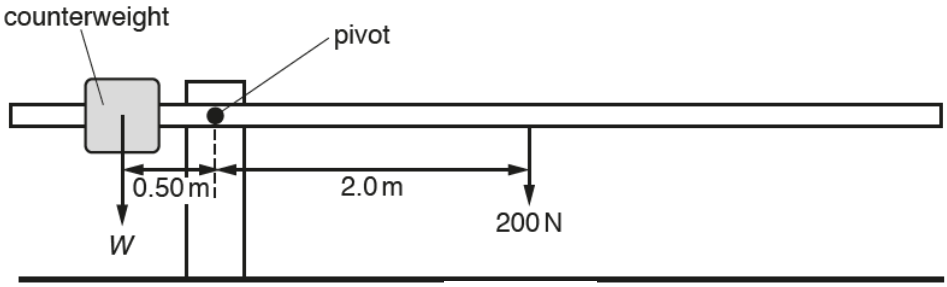


Fig. 2.2

The weight W of the counterweight acts at a distance of 0.5 m from the pivot. The barrier is in equilibrium, without the support. Calculate the weight W, of the counterweight.

Total Ma = total Mc
W x 0.50 = 200 x 2.0 [1]
W = 800 N [1] (ecf bii)

weight W = ……[2]

3 A falling metal hammer is used to drive a hollow steel post into the ground, as shown in Fig. 3.1. The hammer is lifted by an electric motor and then falls freely to hit the baseplate.

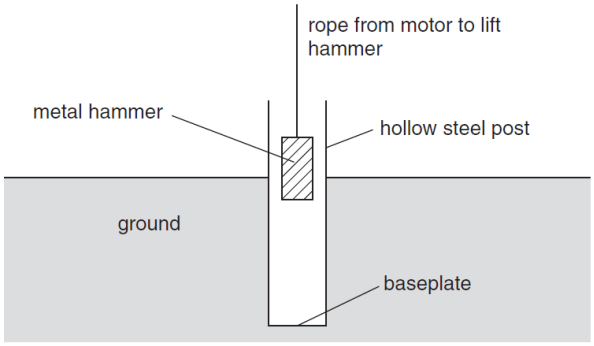


Fig. 3.1

(a) State the principle of conservation

The principle of conservation of energy states that energy cannot be created or destroyed. Energy can be converted / transferred from one store to another / converted from one form to another. **[1]**

Total energy of an isolated system is constant. **[1]**

(b) The metal hammer has a mass of 1500 kg and it hits the baseplate with a speed of 8.0 ms^{-1}. Take g as 10 Nkg^{-1}.

(i) Calculate the kinetic energy of the hammer as it hits the baseplate.

E_k = ½ mv^2
= ½ x 1500 x 8.0^2 **[1]**
= 48 000 J **[1]**

kinetic energy = ……[2]

(ii) Calculate the height above the baseplate from which the hammer is dropped.

Change E_k = change in E_p
48 000 = mgh
48 000 = 1500 x 10 x h **[1]**
h = 3.2 m **[1]** **(ecf (i))**

height = ……[2]

(iii) Describe the energy conversion when the hammer hits the base plate.

Energy in the kinetic store of the hammer is transferred

- **mechanically to the kinetic store of the base plate** **[1]**

- **mechanically to the internal store of the base plate / hammer** **OR**
- **by propagation of waves to the internal store of the surrounding. [1]**

4 Fig. 4.1 shows the variation with time to the height of water at the same place in a water tank. The height is sometimes above and sometimes below the mean level which is marked as 0.

Cc c

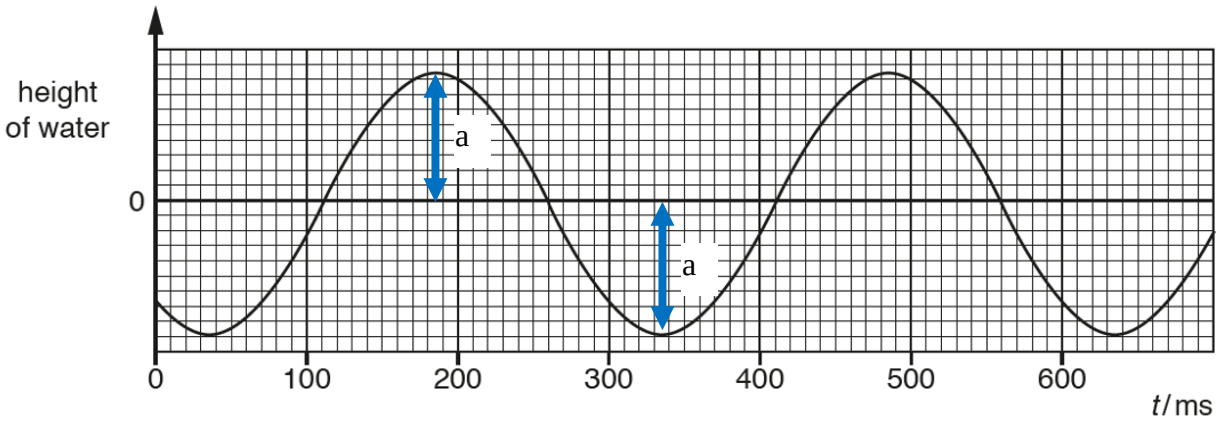


Fig. 4.1

(a) Water waves are transverse waves. Describe what is meant by a transverse wave.

Particles of a transverse wave vibrate perpendicular to the direction of travel of the wave motion / energy propagation. [1]

(b) Indicate in Fig. 4.1, the amplitude of the wave. [1]

Distance indicated from rest position to crest or trough. [1]

(c) The speed of the water wave is 0.20 ms^{-1}. Determine

(i) the frequency of the wave,

f = 1 / T
= 1/ 300 x 10^{-3} [1]
= 3.3 Hz [1] (multiple of 10 error, max 1m)

frequency = ……[2]

(ii) the wavelength of the wave.

v = fλ
0.20 = 3.3 x λ [1]
λ = 0.061 m [1] (ecf (ii))

wavelength = ……[2]

5 Fig. 5.1 shows a ray of light passing through the edge of a converging lens made of glass.

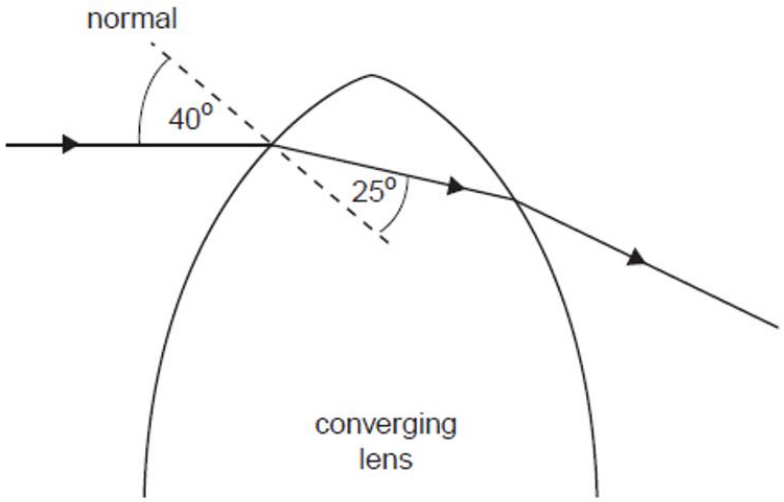


Fig. 5.1

(a) State what happens to the speed and frequency of the light as it enters the lens.

Speed decrease. [1] **Frequency no change. [1]**

……[2]

(b) Calculate the refractive index of the glass used in the lens.

η = sin i / sin r
= sin 40 / sin 25 [1]
= 1.5 [1]

refractive index = ……[2]

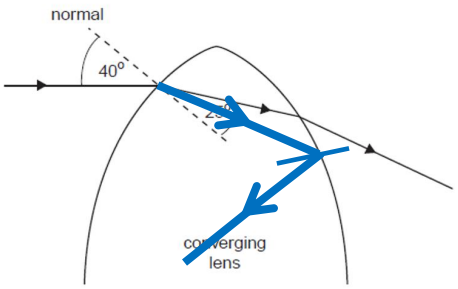
(c) The lens is replaced with an identical lens made with an optically denser glass. The same ray of light entering the new lens resulted in total internal reflection occurring.

(i) State the two conditions required for total internal reflection to occur.

Light ray travelling from optically denser to less dense medium. [1]
Angle of incidence is greater than critical angle. [1]

……[2]

(ii) Draw in Fig. 5.1, the path of the ray of light in the new lens. [2]



Refracted ray bends more towards normal. [1]

TIR
Reflected angle = incident angle (visual) [1]

6 Fig. 6.1 shows the negatively-charged metal rod placed near to a neutral conducting sphere. The sphere is suspended by an insulating thread.

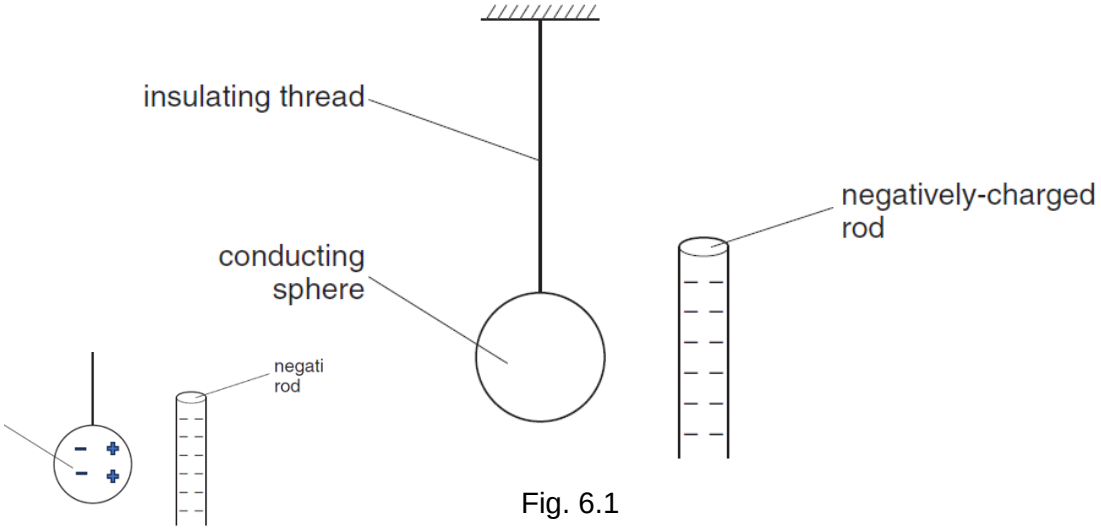


Fig. 6.1

(a) On Fig. 6.1. draw the distribution of positive and negative charges on the sphere [2]

Positive charges on the right and negative charges on the left. [1]
Equal number of positive and negative charges. [1]

(b) Explain why the sphere is attracted to the rod.

Attractive forces greater than repulsive forces. [1]
Unlike charges are closer than like charges. [1]

(c) The sphere swings and touches the rod.

(i) Describe the movement of charges between the sphere and the rod.

Electrons / negative charges move from rod to sphere. [1]

……[1]

(ii) State the charge on the sphere and the rod.

Sphere is negatively charged. [1]
Rod is negatively charged. [1]

……[2]

7 A typical hairdryer comes with a two-pin plug. There is a fuse found within the plug.

(a) Describe how the fuse protects the wires in the hairdryer.

When the current is above the fuse rating, the fuse will blow / melt. [1]
This will open the circuit / current stops flowing. [1]

……[2]

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

(i) Calculate the current in the hairdryer.

P = IV
1500 = I x 240 [1]
I = 6.3 A [1]

current = ……[2]

(ii) Suggest a suitable rating for the fuse.

7 A – 10 A (integer value stated) [1] (ecf (i)

fuse rating = ……[1]

(c) The hairdryer does not contain an earth wire to connect to the plug. State the feature of the hairdryer which ensures that it is safe to use without an earth wire.

The hairdryer is double insulated / outer casing is made or plastic / rubber / non-metallic / electrical insulator / etc. [1]
Accept: insulator

……[1]

8 A wire is wound around a soft-iron core forming a solenoid, as shown in Fig. 8.1.

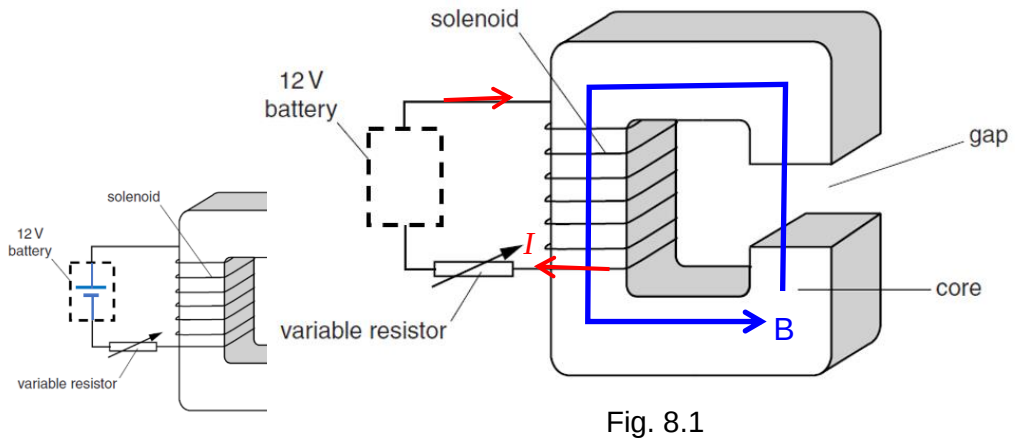


Fig. 8.1

The solenoid is connected in series with a 12V battery and a variable resistor. There is a gap in the core. The magnetic field in the gap is uniform and vertically upwards.

(a) On Fig 8.1, complete the circuit diagram by adding the circuit symbol for a battery in the dotted box. [1]

Correct symbol for battery AND positive terminal on top. [1]

(b) Without replacing any components, explain how the electrical circuit could be used to increase the strength of the magnetic field.

Reduce the resistance of the variable resistor. [1]

This will increase the current in the solenoid. [1]

(c) Fig. 8.2 shows a horizontal, current-carrying wire PQ in the gap.

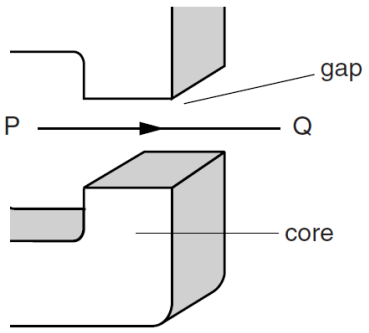


Fig. 8.2

The current in PQ is from left to right. Describe the effect of the magnetic field on PQ.

Force acts on PQ, [1]
out of the plane of the paper. [1]

……[2]

9 Fig. 9. 1 shows a simple transformer.

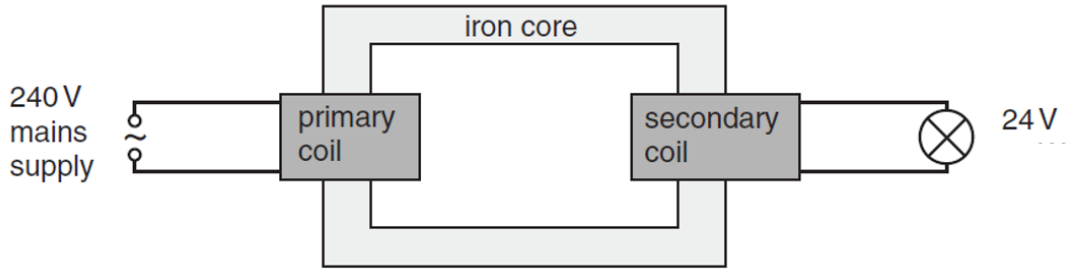


Fig. 9.1

(a) Explain how a transformer works.

As the alternating current flows through the primary coil, the primary coil generates a continuously changing / varying magnetic field [1]

The soft-iron core links the changing magnetic field to the secondary coil and the secondary coil will cut the changing magnetic field lines in the soft-iron core. OR the secondary coil will experience a changing magnetic flux in the soft-iron core. [1]

This results in an induced emf and current in the secondary coil. [1]

(b) The primary coil has 200 turns. Determine the number of turns in the secondary coil.

N_s / N_p $= V_s / V_p$
$N_s / 200$ $= 24 / 240$ [1]
N_s $= 20$ turns [1]

number of turns = ……[2]

(c) The current flowing through the bulb is 1.5 A. Determine the current flowing in the primary coil. Assume the transformer is ideal.

IpVp = IsVs
Ip x 240 = 1.5 x 24 [1]
Ip = 0.15 A [1]

current = ……[2]

10 Fig. 10.1 gives details about some radioactive isotopes.

radioactive isotope	type of radiation emitted	half-life
Uranium-238	alpha-particle	4.5×10^9 years
Uranium-235	alpha-particle	7.1×10^8 years
Carbon-14	beta-particle	5600 years
Strontium-90	beta-particle	28 years
Cobalt-60	gamma-ray	5 years
Technetium-99	gamma-ray	6 hours

Fig. 10.1

(a) State what is meant by a beta-particle.

An electron. **[1]**

(b) State the isotope with the strongest penetrating power and how it should be stored safely.

Cobalt-60 / Technetium **[1]**

It should be stored in a lead box. **[1]**

……..…[2]

(c) Scientists use Carbon-14 to determine how old objects are. The amount of Carbon-14 found in a living tissue is 16 times more than that found in an archaeological object of the same mass. Use this information to estimate the age of the archaeological object.

16 → 8 → 4 → 2 →1
4 half lives **[1]**

Age = 4 x 5600
= 22 400 years **[1]**

age of archaeological object = ……[2]

(d) Radioactive sources are used to detect leaks from pipes underground. A liquid containing a radioactive source is allowed to flow through the pipe. Some liquid leaks from the pipe and the radiation it emits can be detected above ground.

(i) State the most suitable radioactive isotope in Fig. 10.1 for this purpose.

Technetium-99 **[1]**

(ii) Explain why the half-life of the isotope you have chosen and the radiation it emits are suitable for this purpose.

With 6 hours, the radioactive source will not stay in the ground for too long. **[1]**
Gamma rays is required for it to pass through the soil / pipe to be detected. **[1]**

Section B

Answer **one** question from this section.

11 A student has an open tank for storing water outside her house as shown in Fig. 11.1. The tank is black and is in direct sunlight. She notices that the level of water inside the tank slowly decreases as water evaporates.

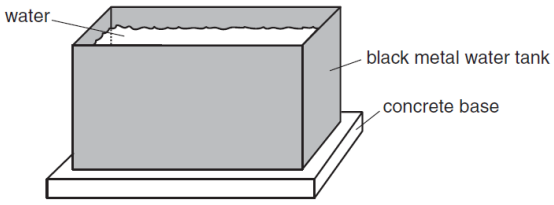


Fig. 11.1

She notices that the water level in the tank falls by 0.0050 m in a day.
The cross-sectional area of the tank is 3.0 m^2. The density of water is 1000 kgm^{-3}.
The specific latent heat of vaporisation of water is 2.2 x 10^6 Jkg^{-1}.

(a) Calculate the volume of water that evaporates in a day.

Volume = area x depth
= 3.0 x 0.0050 [1]
= 0.015 m^3 [1]

volume = ……[2]

(b) Calculate the mass of water that evaporates in a day.

Density = mass / volume
1000 = mass / 0.015 [1]
mass = 15 kg [1] (ecf (a))

mass = ……[2]

(c) Determine the energy required to evaporate the water.

L = $m\ell_v$
= 15 x (2.2 x 10^6) [1]
= 33 x 10^6 J [1] (ecf (b))

energy required = ……[2]

(d) The humidity of the surrounding increases. State how the rate of evaporation is affected.

Rate of evaporation decrease. [1]

……[1]

(e) The external surface of the water tank was found to be at a higher temperature than the water. Describe how molecules transfer thermal energy through the water tank.

The molecules near the external surface gains energy and vibrate more vigorously / faster. [1]
They collide with neighboring molecules and transfer energy during collision. [1]
Hence energy is transferred by conduction. [1]

12 Fig. 12.1 shows an electrical circuit.

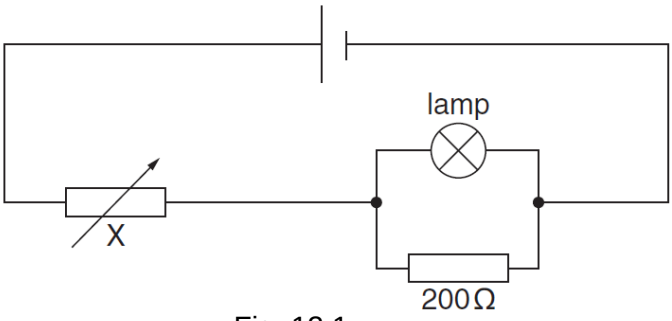


Fig. 12.1

(a) State what is meant by current flow in a circuit.

Current is the rate of flow of charges / electrons in a circuit. [1]

……[1]

(b) Fig. 12.2 shows the graph of current against potential difference for the lamp.

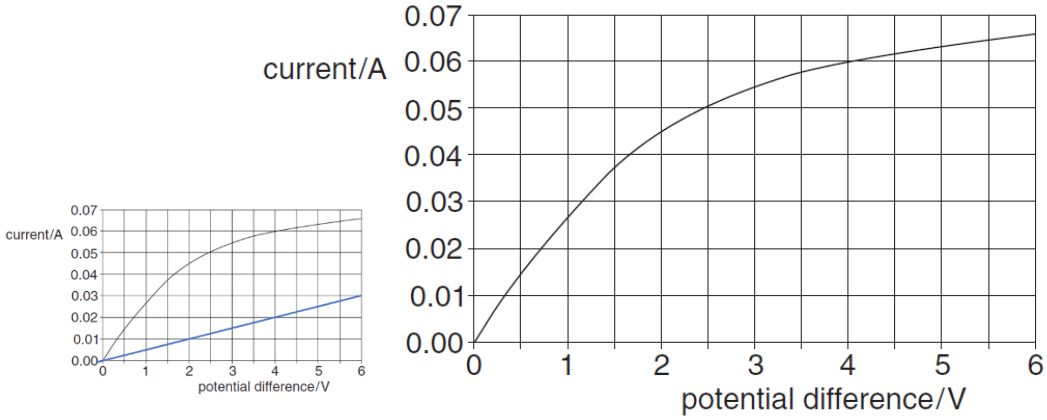


Fig. 12.2

The potential difference across the lamp is 2.5 V.

(i) Using Fig. 12.2, determine the current in the lamp.

0.050 A [1]

current in the lamp = ……[1]

(ii) Determine the current in component X.

For 200 Ω resistor

V = IR

2.5 = I x 200

I = 0.013 A [1]

Current in X = Current in lamp + current in 200 Ω resistor.

= 0.050 + 0.013 [1]

= 0.063 A [1]

current in component X = ……[3]

(iii) Sketch in Fig. 12.2, the graph for the 200 Ω resistor. [2]

Straight line through origin. [1]

Pass through 2.5 V, 0.013 A [1] (understand 200 Ω in graphical form)

(c) Component X is replaced with a thermistor.

(i) Draw the symbol for a thermistor below.

[1]

……[1]

(ii) The temperature around the thermistor increases. Describe what happens to the resistance and potential difference across the thermistor.

Resistance of thermistor will decrease. **[1]**

Potential difference across thermistor will decrease. **[1]**

……[2]

End of paper