Candidate Name:	Class:	Index No.:

FUHUA SECONDARY SCHOOL

Secondary Four Express

PRELIMINARY EXAMINATION 2024

4E

PHYSICS **6091/01**

Paper 1

DATE **27 Aug 2024**
TIME **0800 – 0900**
DURATION **1 hour**

Additional Material: 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, 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 on this paper.
The use of an approved scientific calculator is expected, where appropriate.

FOR EXAMINER'S USE	PARENT'S SIGNATURE

Setter: Mr Raymond Loh **Vetter:** Mr Nicholas Liu

This document consists of 15 printed pages and 1 blank page, including this page.

1 Which row correctly shows a scalar and a vector quantity?

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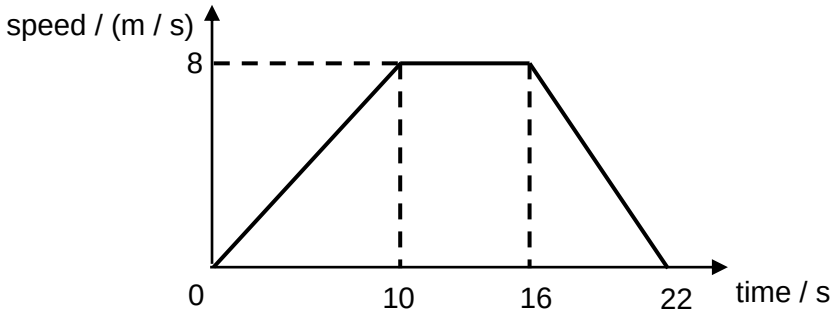
	scalar	vector
A	displacement	distance
B	mass	weight
C	temperature	pressure
D	velocity	acceleration

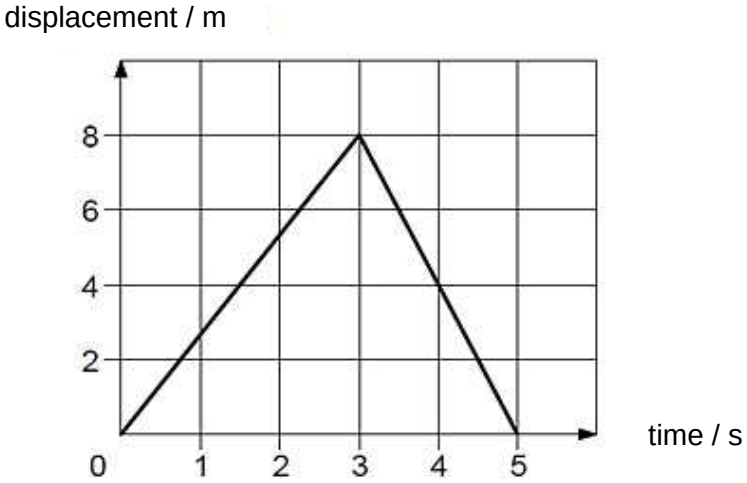
2 The speed-time graph below describes the motion of a toy car.



What is the average speed of the toy car while moving at constant deceleration?

A 2.8 m / s **B** 4.0 m / s **C** 5.1 m / s **D** 8.0 m / s

3 The graph shows the displacement-time graph of a car moving along a straight line.

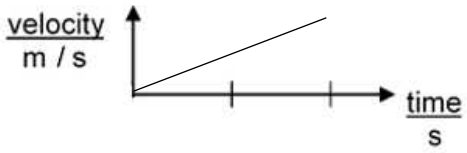


Which statement best describes the motion of the car?

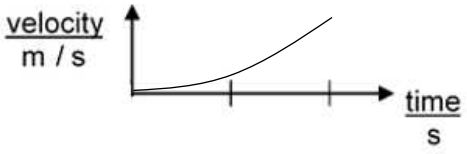
A It moves a greater distance in the initial 3 seconds than in the final 2 seconds.
B It moves at a higher speed in the first 3 seconds than in the last 2 seconds.
C It moves uphill in the first 3 seconds and then downhill in the last 2 seconds.
D It returns to its starting point after 5 seconds.

4 A body is acted upon by a constant resultant force. Which graph shows how the velocity of the body varies with time?

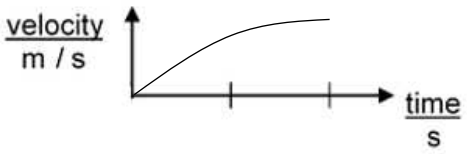
A



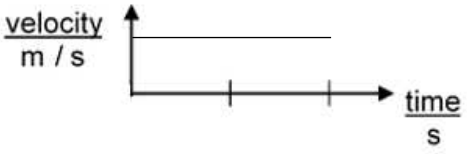
B



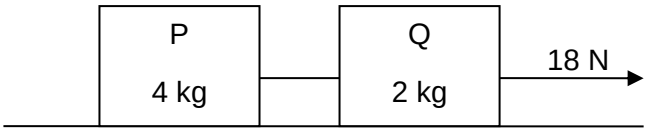
C



D



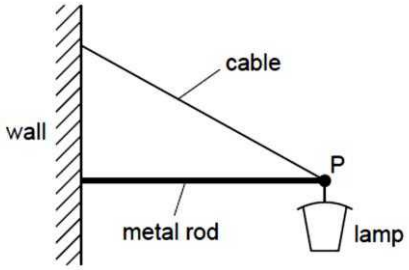
5 A force of 18 N acts on a block P and block Q of mass 4 kg and 2 kg respectively as shown.



Given that the floor is smooth, what is the tension of the string between P and Q?

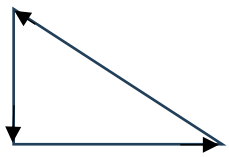
A 3 N **B** 6 N **C** 9 N **D** 12 N

6 A lamp is fixed to the wall by a metal rod and cable. The lamp does not move.

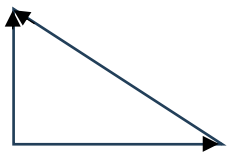


Which vector diagram represents the forces acting at point P?

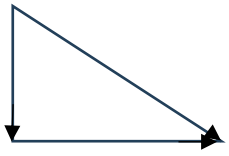
A



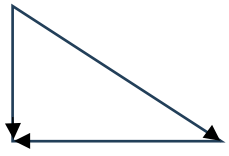
B



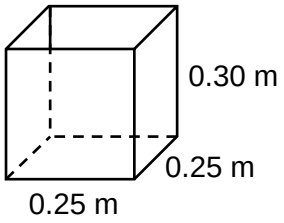
C



D



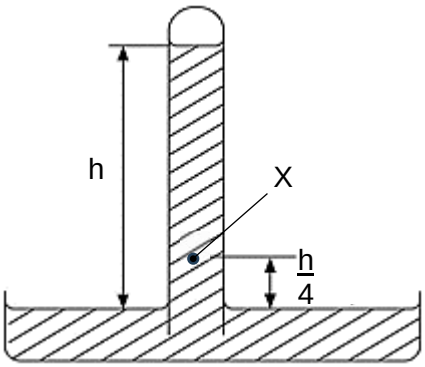
7 Four bags of flour, each of mass 2.0 kg, were used to fill up a box shown below. The box, with dimensions 0.30 m × 0.25 m × 0.25 m, has a mass of 1.0 kg.



What is the average density of the box after it is filled up?

A 160 kg / m^3 **B** 250 kg / m^3 **C** 430 kg / m^3 **D** 480 kg / m^3

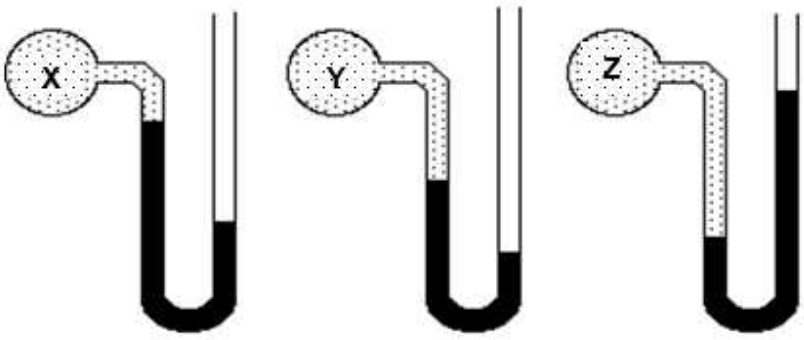
8 When the atmospheric pressure is 100 000 Pa, the height of a mercury barometer is h.



What is the pressure at X?

A 25 000 Pa **B** 75 000 Pa **C** 125 000 Pa **D** 175 000 Pa

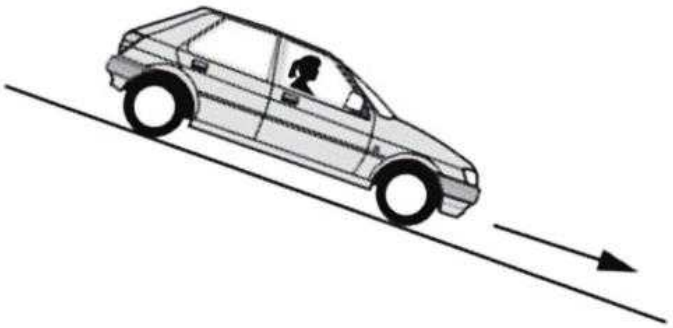
9 Three manometers are filled with mercury and connected to three different gas supplies, X, Y and Z, as shown in the figure below.



What are the gas pressures in ascending order?

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

10 A car decelerates down a road as it goes downhill.

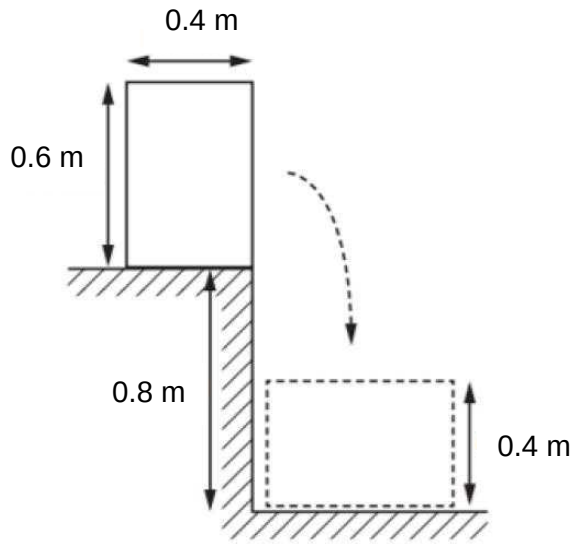


Which energy changes are taking place?

.

	energy in the gravitational store	energy in the kinetic store
A	decreasing	decreasing
B	decreasing	increasing
C	decreasing	remains the same
D	increasing	increasing

11 A uniform solid block has weight 200 N, width 0.4 m and height 0.6 m. The block rests on a step of depth 0.8 m, as shown in the diagram.

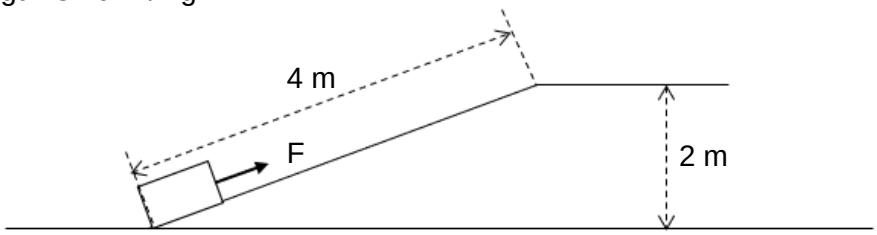


The block is knocked over the edge of the step and rotates through 90 ° before coming to rest with the 0.6 m side horizontal on the ground. The gravitational field strength g is 10 N / kg.

What is the change in gravitational potential energy of the block?

A 100 J **B** 140 J **C** 180 J **D** 220 J

12 A man used a force F to pull a 2 kg box up a smooth inclined plane for a distance of 4 m, as illustrated in the figure below. The box was lifted to a vertical height of 2 m. The gravitational field strength is 10 N / kg.



What is the force F exerted by the man on the box?

A 5 N **B** 10 N **C** 25 N **D** 40 N

13 In a Brownian motion experiment, illuminated smoke particles are seen to move randomly.

Which statement correctly explains the motion of the smoke particles?

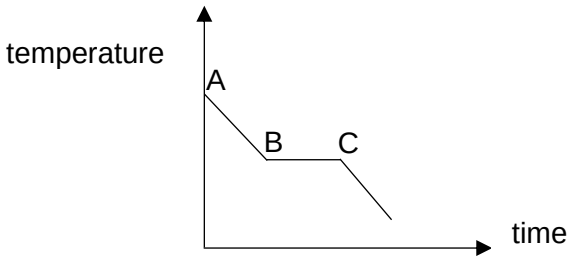
A They are continuously bombarded by the air molecules.
B They are moved by the convection currents in the air.
C They are shaken by the vibration of the air molecules.
D They are supplied with energy by the light illuminating them.

14 Air is pumped slowly into a car tyre to increase the pressure. The temperature of the air does not change.

Which row is correct?

	number of molecules hitting 1 cm^2 of the tyre each second	average speed at which molecules hit inner walls of the tyre
A	increases	increases
B	increases	unchanged
C	unchanged	increases
D	unchanged	unchanged

15 The graph shows the cooling curve of an unknown liquid.



What happens to the potential energy (PE) and the kinetic energy (KE) of molecules between AB and BC?

	between A and B	between B and C
A	KE constant, PE decreases	KE constant, PE decreases
B	KE decreases, PE constant	KE constant, PE decreases
C	KE decreases, PE constant	KE decreases, PE constant
D	KE constant, PE decreases	KE decreases, PE constant

16 Cooling fins are used in refrigerators, car radiators and many other cooling devices to dissipate thermal energy from the system to the environment.

i The cooling fins are made of a good conductor to ensure that thermal energy is being conducted quickly out to the environment.
ii Cooling fins are typically black to enhance the rate of thermal energy conduction.
iii The cooling fins have a large surface area to quickly dissipate heat to the environment through radiation and conduction.

Which statements about cooling fins are correct?

A **i** and **ii** only
B **ii** and **iii** only
C **i** and **iii** only
D **i**, **ii** and **iii**

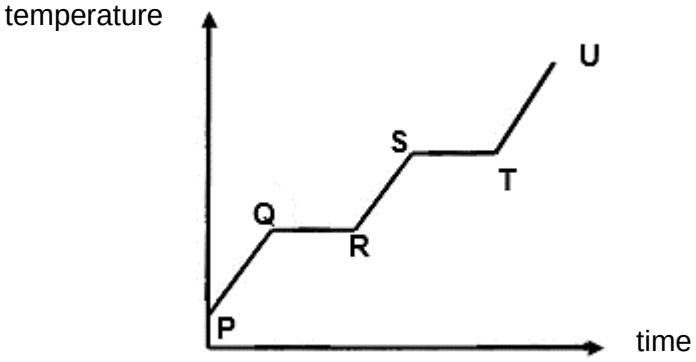
17 Three statements about boiling and evaporation of a liquid are stated below.

i Intermolecular attractive forces are overcome during boiling but not during evaporation.
ii Boiling does not change the average kinetic energy of molecules of the liquid but evaporation does.
iii Boiling involves all the molecules in the liquid but evaporation does not.

Which of the above statements are correct?

A **i** and **ii** only
B **ii** and **iii** only
C **i** and **iii** only
D **i**, **ii** and **iii**

18 The diagram below shows the graph of temperature against time where a solid is heated.



Between which two points on the graph does the beaker contain a mixture of liquid and solid?

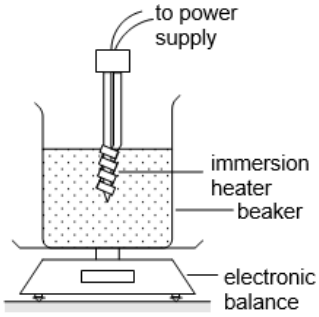
A P and Q
B Q and R
C R and S
D S and T

19 Metal X and metal Y, having identical dimensions but different densities, are heated with an equal amount of thermal energy. Metal X's temperature increases twice as much as metal Y's.

Why is this so?

A The heat capacity of X is half that of Y.
B The heat capacity of X is twice that of Y.
C The specific heat capacity of X is half that of Y.
D The specific heat capacity of X is twice that of Y.

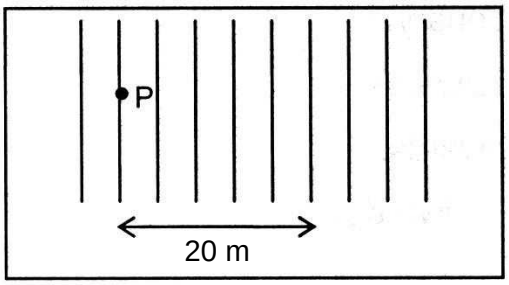
20 The diagram below shows an experimental arrangement for determining the specific latent heat of vaporisation of a liquid. The reading of the balance is noted when boiling begins. After 3.0 min, the balance reading decreases by 20 g. The heater operates at a power output of 100 W.



If 10% of the energy supplied is lost to the surroundings, what is the specific latent heat of vaporization of the liquid?

A 13.5 kJ / kg **B** 15 kJ / kg **C** 0.81 MJ / kg **D** 0.90 MJ / kg

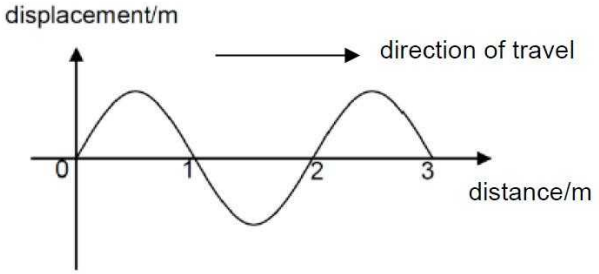
21 The diagram of a water wave in a ripple tank is shown below. The period of vibration of P is 0.10 s.



What is the frequency, wavelength and velocity of the water wave?

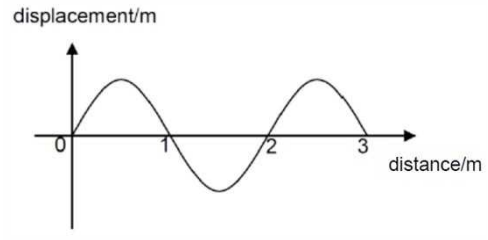
	frequency / Hz	wavelength / m	velocity / (m / s)
A	10	4.0	40
B	10	8.0	80
C	20	4.0	5.0
D	20	8.0	2.5

22 The diagram shows the displacement-distance graph of a transverse wave at a certain instant as it travels from left to right. The period of this wave is 2.0 s.

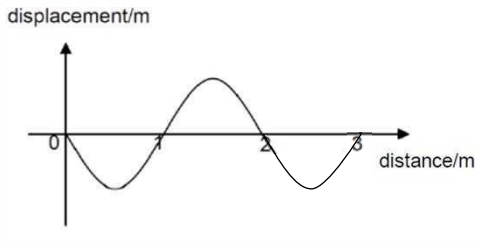


Which diagram shows the displacement-distance graph of the wave 3.0 s later?

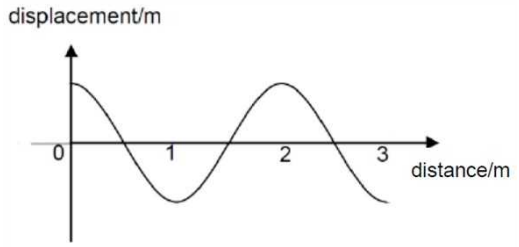
A



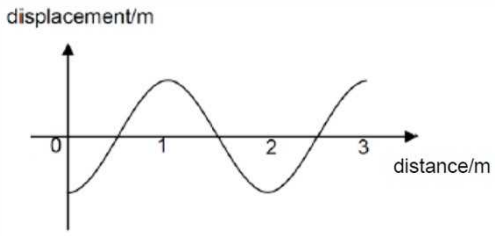
B



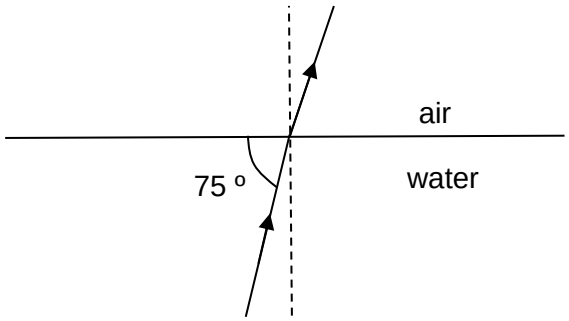
C



D



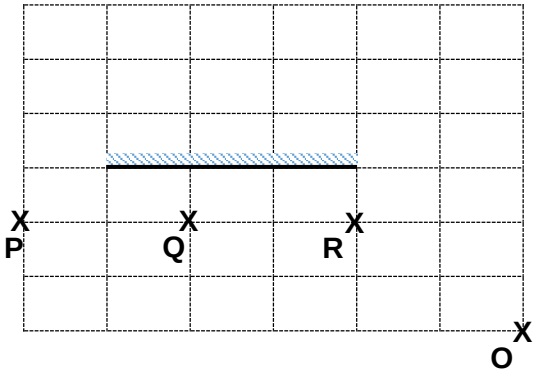
23 A ray of light is incident from below the surface of water as shown in the diagram. The refractive index of water is 1.3.



What is the angle of refraction in air?

A 11 ° **B** 15 ° **C** 20 ° **D** 48 °

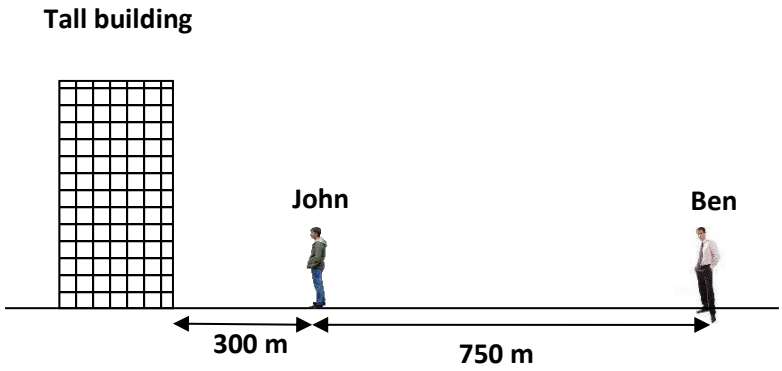
24 **P**, **Q** and **R** are objects placed in front of a plane mirror. An observer at **O** looks into the plane mirror.



Which image(s) can the observer see in the plane mirror?

A **P** and **Q** only
B **Q** and **R** only
C **P** and **R** only
D **P**, **Q** and **R**

25 John, positioned 300 m in front of a tall building, shouts loudly. Ben, who is 750 m behind John, hears two shouts with a 2 s interval between them.



What is the speed of sound in air?

A 300 m / s **B** 320 m / s **C** 340 m / s **D** 375 m / s

26 A wave of frequency 500 Hz has a wavelength of 0.660 m.

How long does it take for the waves to travel 1.0 km?

A 1.3 s **B** 2.0 s **C** 3.0 s **D** 5.6 s

27 Below are four statements about the uses of electromagnetic radiation.

1. Infra-red waves are used in intruder alarms and thermal imaging.
2. Gamma rays are used in detection of cancer and its treatment.
3. Ultra-violet waves are used in bank note authentication and disinfecting water.
4. X-rays are used in medical radiology and industrial defect detection.

How many of these statements is/are correct?

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

28 The diagram shows the relationship between the energy and the wavelength of electromagnetic radiation waves.

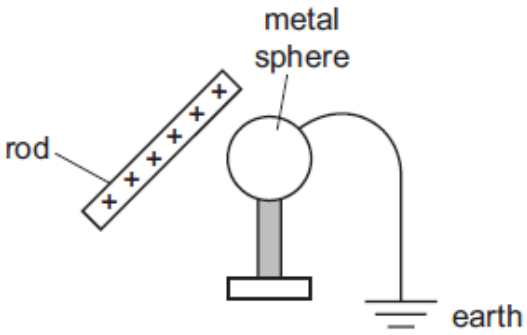
Which has the lowest energy?

A gamma rays
B microwaves
C ultra-violet radiation
D X-rays

29 A band member plays a note on a trumpet. He then plays a softer note of higher pitch. How do the amplitude and frequency of the sound compare with the first?

	amplitude of second sound	frequency of second sound
A	smaller	higher
B	smaller	lower
C	larger	higher
D	larger	lower

30 A positively charged rod is held close to an insulated metal sphere. The sphere is earthed as shown.



The earth connection is removed and then the rod is removed.

Which diagram shows the charges on the sphere after the rod was removed?

A

B

C

D

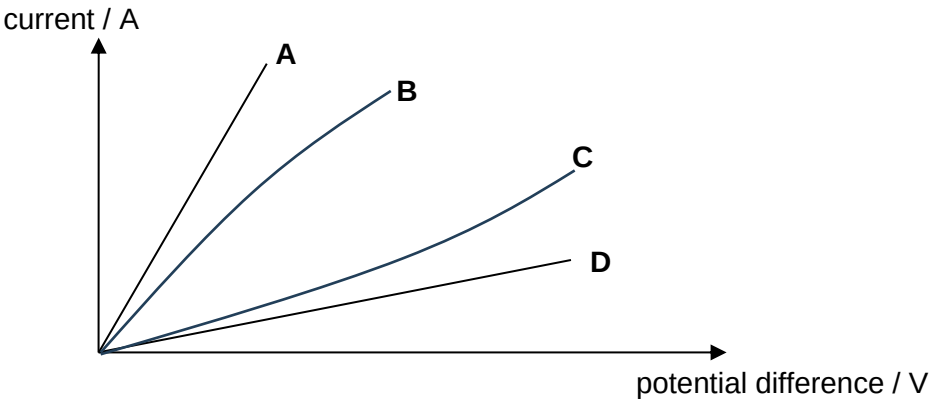
31 When a plastic rod is rubbed with wool, the wool acquires a positive charge.

Why is this so?

A Electrons are transferred from the rod to the wool.
B Electrons are transferred from the wool to the rod.
C Protons are transferred from the rod to the wool.
D Protons are transferred from the wool to the rod.

32 The diagram shows a graph of current against potential difference across four wires, **A**, **B**, **C** and **D**. The wires are of the same material and length.

Which wire is the thickest?



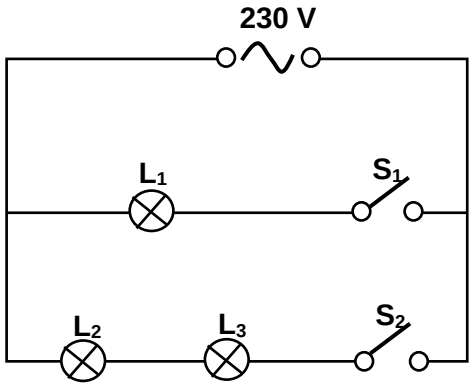
33 During a thunderstorm, a lightning strike transferred an electric charge of 150 C from a thundercloud to the earth. The potential difference between the thundercloud and the earth was 2.0×10^{10} V during the discharge.

How much energy was produced during the lightning strike?

A 1.3 kJ **B** 1.3 MJ **C** 3.0 GJ **D** 3.0 TJ

34 The diagram below shows part of the lighting circuit of a house.

All the bulbs are identical and are rated 100 W, 230 V.



What is the current flowing through L_3 when the switches S_1 and S_2 are closed?

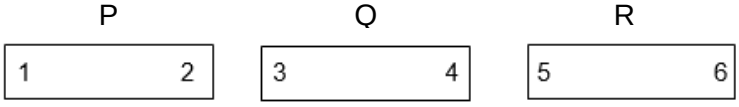
A 0.22 A **B** 0.29 A **C** 0.65 A **D** 2.3 A

35 In a water heating system, a 1 kW heater and a 50 W lamp are connected in parallel and controlled by the same switch. Over one month, the lamp alone consumes 1 kWh of electrical energy. The electricity costs $0.20 per kWh.

How much does it cost to use the water heating system in that month?

A $ 2.50 **B** $ 4.00 **C** $ 4.20 **D** $ 6.80

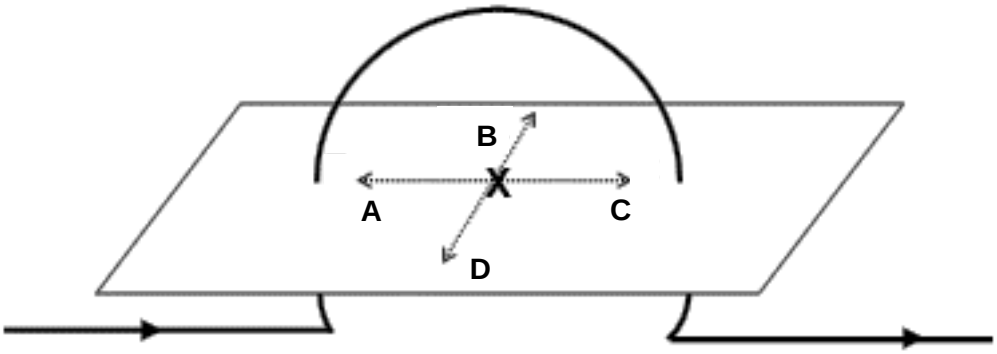
36 Three metal bars P, Q and R, which are identical in size and shape, are suspected of being magnets. Tests are carried out and it is found that there is attraction between poles 1 and 6, between poles 2 and 4, and between poles 2 and 6. However between poles 2 and 3, there is repulsion.



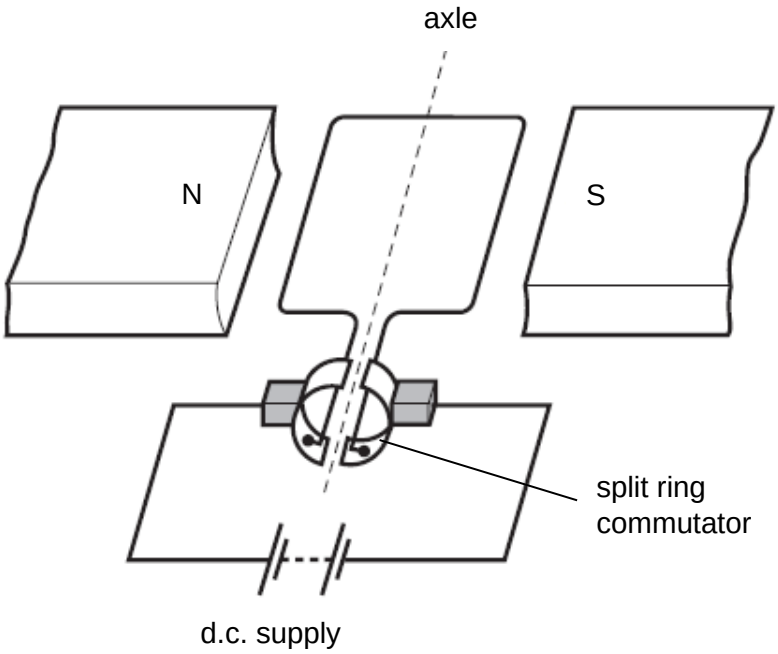
Without making any further tests, which statement is correct?

A P and Q are magnets only
B P and R are magnets only
C Poles 2 and 5 would repel one another.
D P, Q and R are magnets.

37 A current is passed through the coil while a compass is placed at point X on the cardboard as shown in the diagram below. Which direction will the north pole of the compass needle be pointing towards?



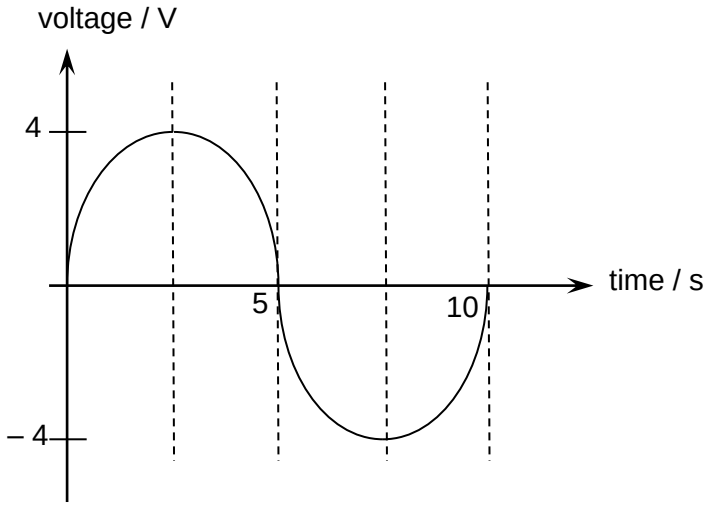
38 The diagram shows a simple d.c. motor with its coil horizontal.



What is the main function of the split ring commutator?

A To allow current to flow in the coil.
B To prevent the wires from twisting.
C To reverse the current direction in the coil as the coil passes the horizontal position.
D To reverse the current direction in the coil as the coil passes the vertical position.

39 A simple a.c. generator produces a voltage that varies with time as shown.



How will the period and the maximum voltage change if the speed of rotation of the coil in the generator is halved?

	period of wave / s	maximum voltage / V
A	5	2
B	5	8
C	20	2
D	20	8

40 The count rate from a radioactive source falls from 4000 counts per minute to 500 counts per minute in 1 hour.

What is the half-life of the source?

A 5 minutes
B 10 minutes
C 15 minutes
D 20 minutes

End of Paper

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Candidate Name:	Class:	Index No.:

FUHUA SECONDARY SCHOOL

Secondary Four Express

PRELIMINARY EXAMINATION 2024

4E

PHYSICS **6091/02**

Paper 2

DATE **21 Aug 2024**
TIME **1115 – 1300**
DURATION **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST
Write your name, class and register number on the question paper and work you submit.
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/ tape.

Section A
Answer **all** questions.

Section B
Answer **one** question.

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			PARENT'S SIGNATURE
Section A	Section B	**Total**	
/70	**/10**	**/80**	

Setter: Mr Raymond Loh **Vetter:** Mr Nicholas Liu

This document consists of 17 printed pages and 1 blank page, including this page.

Section A

Answer **all** questions in this section.

1 Fig. 1.1 shows an aircraft of mass 60 000 kg making its take-off run from rest. The engines produce a constant forward thrust of 145 000 N. Throughout the take-off run, the total resistive force acting on the aircraft can be assumed as being constant at 40 000 N.

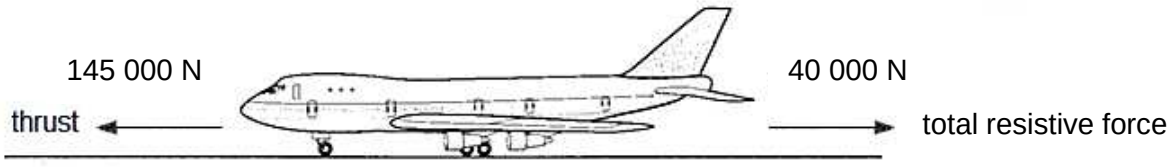

Fig. 1.1

(a) Calculate the acceleration of the aircraft along the horizontal runway.

acceleration = …….. [2]

(b) Calculate the duration of the take-off run if the aircraft becomes airborne at a speed of 60 m / s.

duration = …….. [2]

(c) Hence, calculate the distance the aircraft was on the runway before it becomes airborne.

distance = …….. [2]

(d) In reality, resistive forces during the take-off run vary. Explain the reason for this variability.

…….....

…….....

…….....

……..... [1]

2 Fig. 2.1 shows a student doing a push-up. A total force *F* acts upwards on his hands. There is also a force *R* acting upwards on his toes.

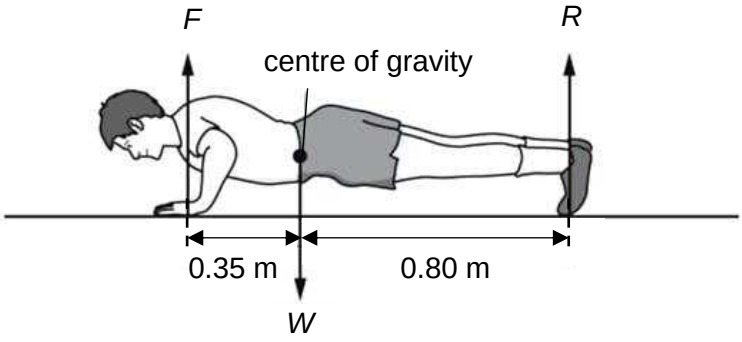

Fig. 2.1

The mass of the student is 60 kg and the gravitational field strength is 10 N / kg.

(a) Calculate the weight *W* of the student.

weight = …….. [2]

(b) Describe how work is done on his body as it rises from the ground.

……

…….. [1]

(c) At the position shown in Fig. 2.1, the student is stationary. The weight *W* of the student causes a moment about his toes. Calculate the moment due to his weight about his toes.

moment = …….. [2]

(d) Hence, calculate the magnitude of the forces *F* and *R*.

F = ……..

R = …….. [3]

(e) State the force that forms a Newton's Third Law action-reaction pair with *F*.

……

…….. [1]

3 Fig. 3.1 shows the hydraulic braking system of a bicycle.

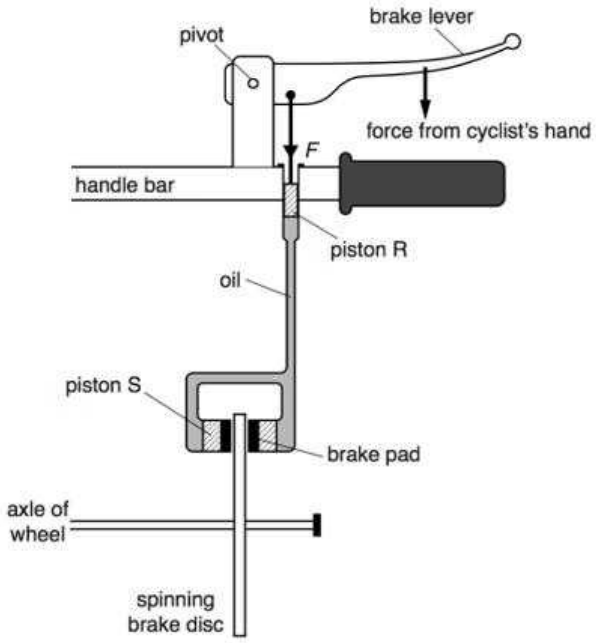

Fig. 3.1

(a) The cyclist applies a force on the brake lever. This increases the pressure in the oil by 1.2×10^{6} Pa. The cross-sectional area of piston R is 5.0×10^{-5} m^2.

Calculate the force *F* applied by the brake lever on piston R.

force *F* = …….. [2]

(b) Explain why the force applied to each of the brake pads is larger than *F*.

……

……

……

…….. [2]

(c) Suggest and explain why the hydraulic system does not work properly if the oil contains bubbles of air.

……

……

……

…….. [2]

4 Before a small inflatable boat is used, air is pumped into its rubber chamber.
Fig. 4.1 shows a man using an air pump to inflate the boat.

Fig. 4.1

Before the man starts to use the pump, the air in the vertical cylinder of the pump is at atmospheric pressure.

(a) Explain, in terms of molecules, how the air inside the cylinder exerts a pressure.

……

……

……

…… [2]

(b) Once the boat is fully inflated, the valve is shut to seal the air within the rubber chamber, and the air pump is disconnected.

As the man sits on the side of the boat, the volume of the rubber chamber decreases, causing the air pressure inside the chamber to rise. The temperature of the air remains constant.

Explain, in terms of molecules, why the pressure increases.

……

……

……

…… [2]

5 Plaque is a thin layer of bacteria on teeth. When it is on the teeth, the surfaces of the teeth are negatively-charged and the plaque is positively-charged as shown in Fig. 5.1.

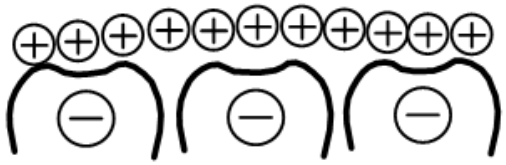

Fig. 5.1

(a) With reference to Fig. 5.1, explain why plaque clings on the teeth and is difficult to remove.

……..…….... [1]

(b) Fig. 5.2 shows a novel toothbrush designed to clean teeth using electrostatic charge. The handle is connected to the positive terminal of the battery, becoming highly positively charged. The head and bristles of the toothbrush are connected to the negative terminal of the battery, becoming negatively charged.

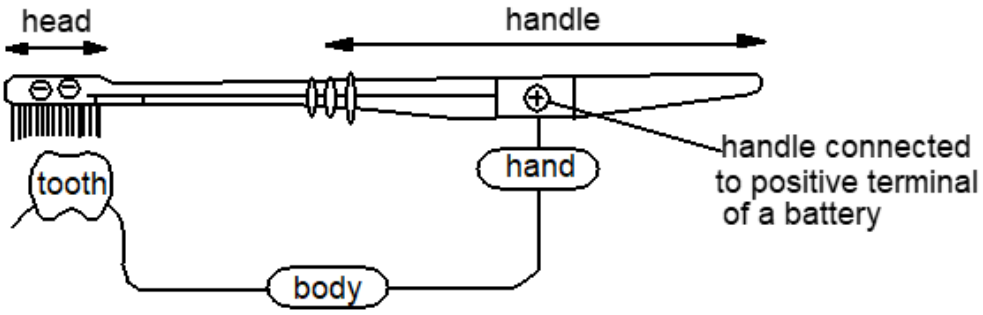

Fig. 5.2

(i) Describe how the teeth becomes positively-charged when the toothbrush is used.

……

……

……

…….. [2]

(ii) Explain why the positively charged plaque leaves the surface of the tooth.

……

……

……

…….. [2]

(c) It is recommended that the teeth should be brushed for 5 minutes. Calculate the total charge passing through the brush in this duration given that a steady current of 0.15 mA passes.

total charge = …….. [2]

6 Fig 6.1 shows a circuit with a 4700 Ω resistor connected in series with a light-dependent resistor (LDR), which has a resistance of 3300 Ω, and with a 12 V power supply.

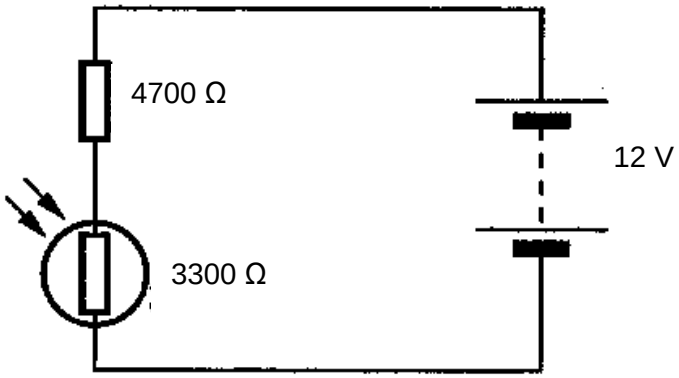

Fig. 6.1

(a) **(i)** Calculate the current through the LDR.

current = …….. [2]

(ii) Calculate the potential difference across the LDR.

potential difference across the LDR = …….. [2]

(b) Explain how the potential difference across the LDR changes as the brightness of the light that falls on it decreases.

……

……

……

…….. [2]

7 Fig. 7.1 shows the circuit in a household connected to a 220 V mains supply.

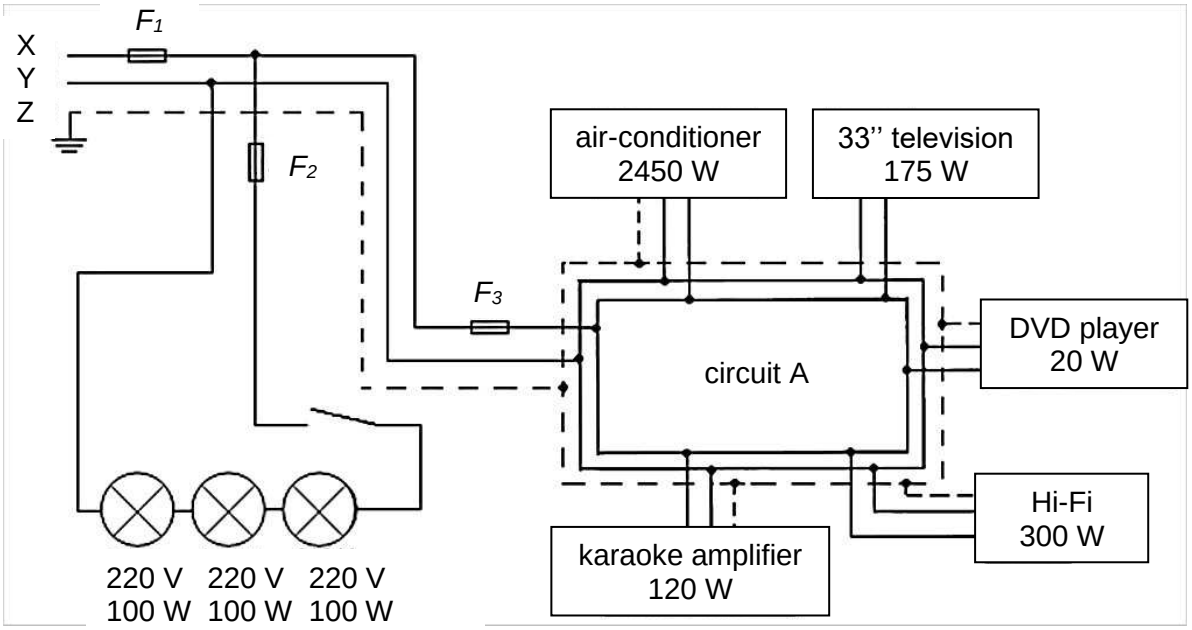

Fig. 7.1

(a) Identify wires X, Y and Z.

X = …… Y = …… Z = ……

[1]

(b) Calculate the current flowing in fuse F_2.

current = …… [2]

(c) The electrician observed that the metal casing of the TV was not linked to wire Z of circuit A. Upon discovering that the TV operated normally despite this, the electrician chose not to take any action regarding the issue.

Explain why this is dangerous.

……

……

……..… [2]

8 The distribution of electrical energy across a country occurs through a network of transmission cables, illustrated in Fig. 8.1. A power station produces 100 MW of power at a voltage of 25 kV.

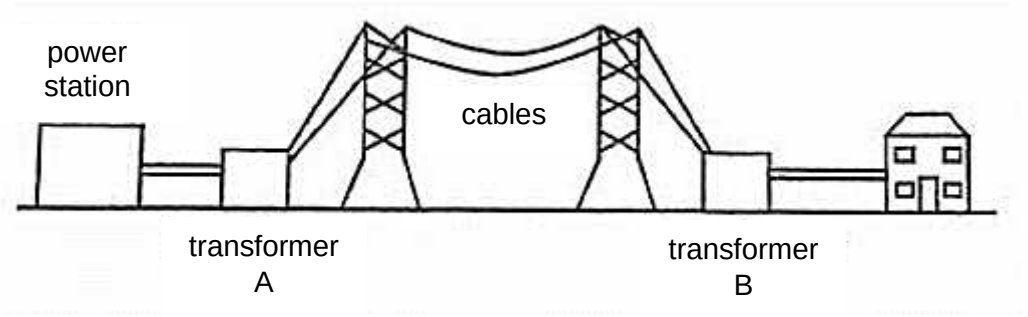

Fig. 8.1

Transformer A, which links the power station to the transmission cables, has 4000 turns in the primary coil and 44 000 turns in the secondary coil.

(a) Calculate the voltage in the secondary coil of transformer A.

voltage = …….. [2]

(b) Calculate the current in the secondary coil of transformer A.

current = …….. [2]

(c) Is electrical transmission in the cables at a high or low voltage?

Give a reason for your answer.

……..

……..

……..

…….. [2]

9 The correlation between the wavelength and frequency of sound waves in a river is studied across three temperatures: 20 °C, 30 °C, and 40 °C, focusing on both shallow and deep-water areas.

Specific data are gathered from shallow and deep-water regions, and the findings are presented in the graphs depicted in Fig. 9.1.

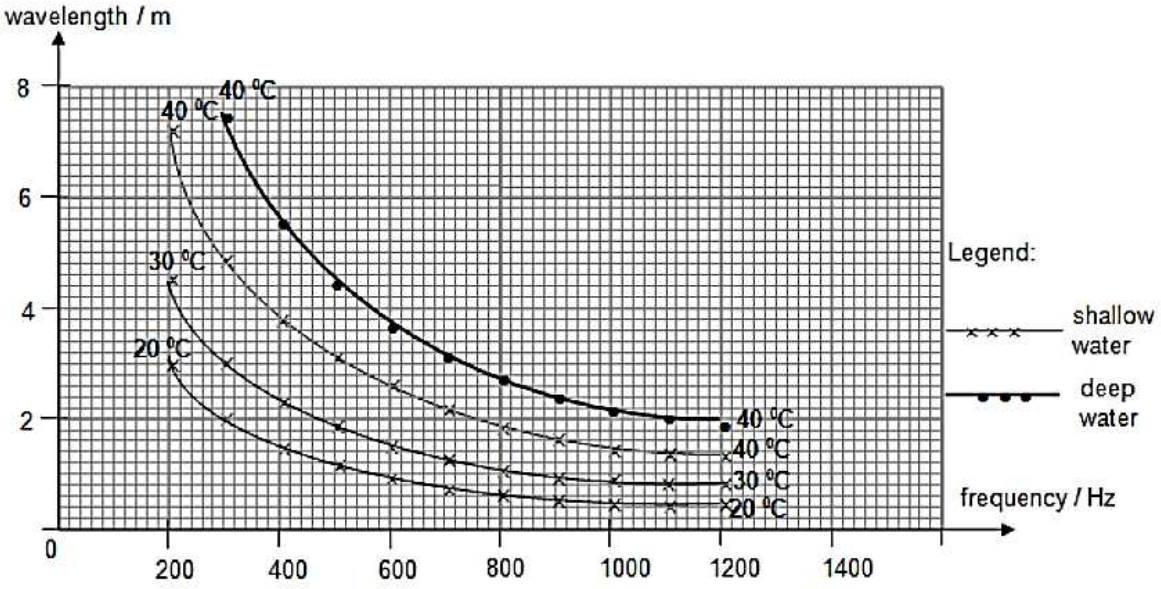

Fig. 9.1

(a) By referring to the graphs, calculate the speed of the sound waves with frequency 400 Hz at temperatures 20 °C and 40 °C in the shallow water region.

(i) At 20 °C

speed = …….. [1]

(ii) At 40 °C

speed = ……. [1]

(b) State and explain the relationship between the speed of the sound waves of the same frequency and the temperature of water in which they travel.

……

……

…… [2]

(c) The sound wave moves from shallow water to deep water, with the water temperature maintained at a constant 40 °C and the emitted sound waves having a frequency of 400 Hz.

(i) Identify the nature of sound waves.

……..…... [1]

(ii) State the changes, if any, that could occur to the frequency, wavelength and speed of the sound wave.

……

……

……

……

…….. [3]

(iii) Fig. 9.2 (not drawn to scale) illustrates the propagation of sound waves moving perpendicularly from shallow water to deep water. Areas of compression are denoted as C, and areas of rarefaction are denoted as R.

Referring to the graphs in Fig. 9.1, depict the complete formation of sound waves in deep water in Fig. 9.2. Indicate in Fig. 9.2, the wavelengths of the sound waves in both regions. [2]

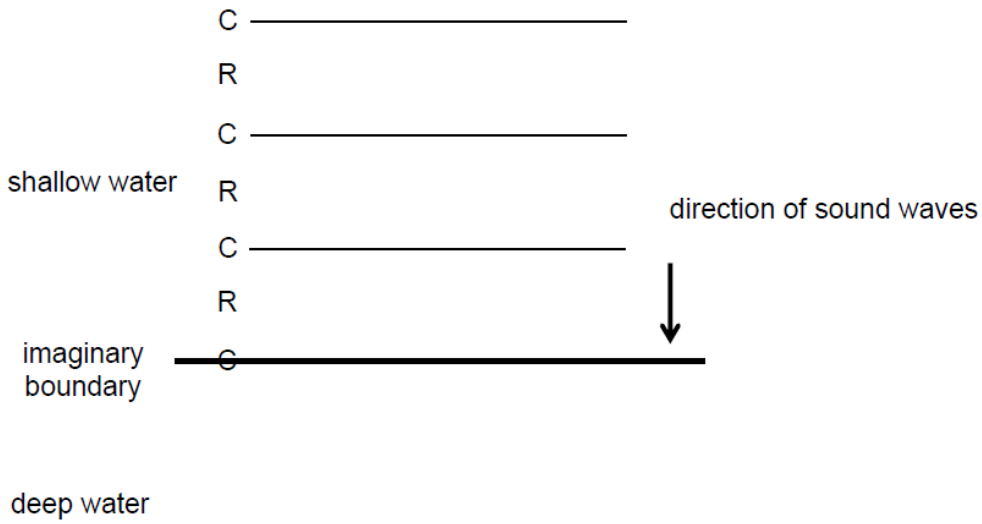

Fig. 9.2 (not drawn to scale)

10 **(a)** Fig. 10.1 shows a small but intense light source S is placed at the bottom of a swimming pool. The refractive index of the water in the pool is 1.33.

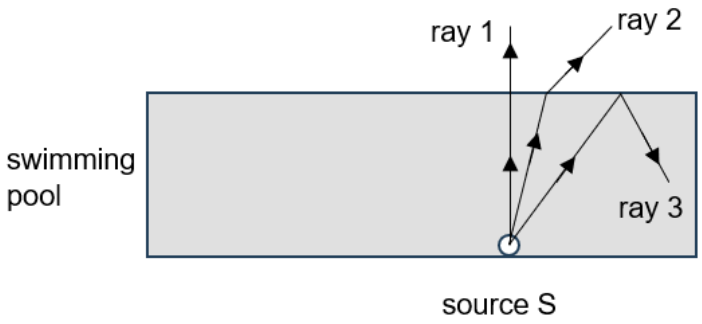

Fig. 10.1 (not drawn to scale)

(i) Explain what happens to each ray as it reaches the surface of the pool in Fig. 10.1.

Ray 1 ……

……

Ray 2 ……

……

Ray 3 ……

……..… [3]

(ii) Calculate the critical angle.

critical angle = …….. [2]

(b) A collector observes a postage stamp, which is 1.5 cm tall, through a lens. The lens is positioned 2.0 cm away from the stamp, and the ratio of the image height to the object height is 3.0. The resulting image is virtual.

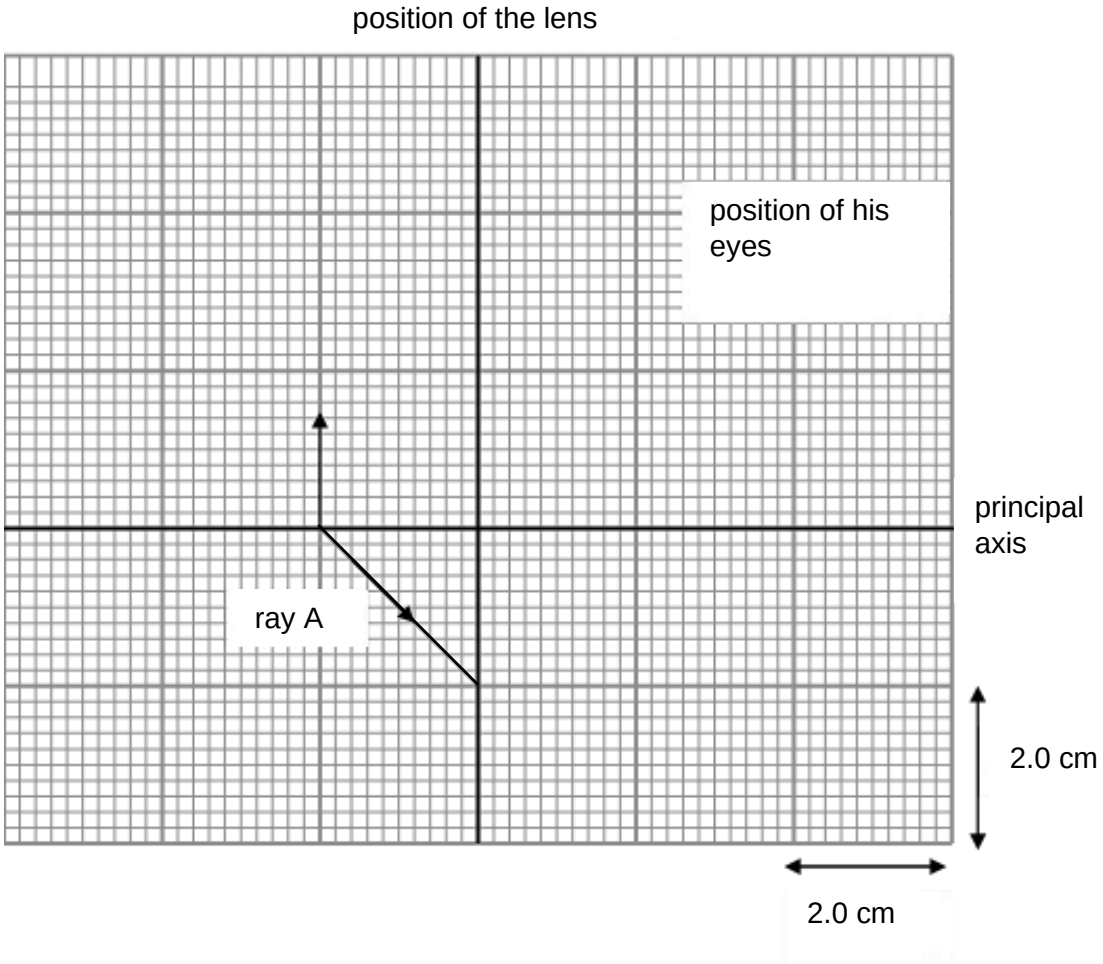

Fig. 10.2 (drawn to scale)

(i) State what is a virtual image.

……... [1]

(ii) On Fig. 10.2, complete the ray diagram to determine the image of the stamp.

[2]

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

focal length = …… [1]

(iv) On Fig. 10.2, complete the path of ray A after passing through the lens. [1]

Section B

Answer **one** question from this section.

11 Table 11.1 presents information on seven distinct nuclides.

nuclide	radiation emitted	half-life
hydrogen-2	none	-
hydrogen-3	beta	12 year
francium-223	beta	22 min
iridium-192	gamma	74 day
phosphorus-32	beta	14 day
radon-222	alpha	4 day
technetium-99	gamma	6 hour

Table. 11.1

(a) **(i)** Hydrogen-2 and hydrogen-3 are isotopes of the element hydrogen.

Define the term *isotope*.

……...

……. [1]

(ii) The equation for the decay of phosphorus-32 (P-32) as it emits a beta particle is:

$$^{32}_{15}\mathrm{P} \rightarrow {}^{0}_{-1}\beta + {}^{32}_{16}\mathrm{Q}$$

Explain whether the equation indicates that Q is another isotope of phosphorus. Q does not represent the chemical symbol for the atom.

……...

……. [1]

(b) One of the sources listed in Table 11.1 is employed in a medical procedure to identify abnormal bone structures. It is administered to a patient through injection, and the emitted radiation is detected externally.

(i) State which source in Table 11.1 is most suitable for this type of medical use.

……. [1]

(ii) Explain **two** reasons for your choice.

……...

……...

……...

……. [2]

(c) Radon-222 decays by alpha-particle emission to a stable isotope.

(i) State how a nucleus of radon-222 changes when it emits an alpha-particle.

……...

……...

……. [2]

(ii) In a laboratory without radioactive samples, there is a radiation detector that, when switched on, registers an average count rate of 22 counts per minute.

Explain why the radiation detector registers a count rate.

……...

……. [1]

(iii) A sample of radon-222 is positioned 2 cm from the detector, displaying a reading of 8000 counts per minute. When the sample is moved 10 cm away from the detector, the reading reverts to an average value of 22 counts per minute.

Explain why the reading returns to its original value.

……...

……...

……...

……. [2]

12 Fig. 12.1 shows the heating element positioned in the base of the kettle. The casing of the electric kettle is made of white plastic.

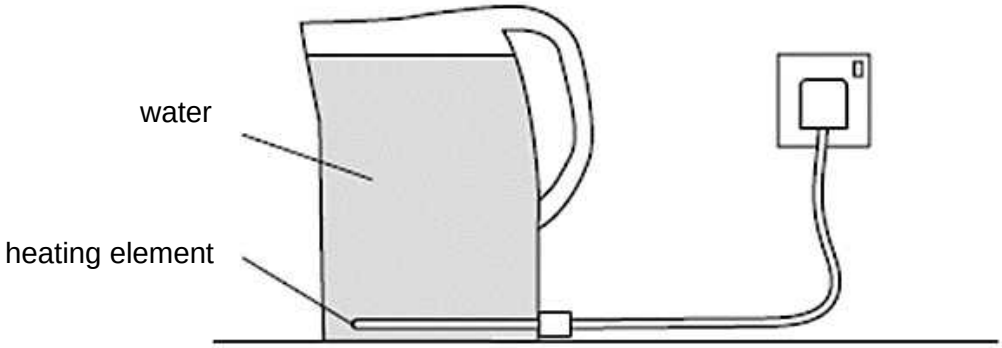

Fig. 12.1

(a) The heating element supplies thermal energy to the water at the bottom of the kettle.

Describe and explain how the thermal energy is transferred throughout the water.

……

……

……

…… [3]

(b) The kettle operates using a 230 V power supply. It remains switched on for 3.5 min with a current of 9.6 A flowing through the heating element.

(i) Calculate the energy transfer by heating in the heating element during this time.

energy = …… [2]

(ii) The kettle holds 1.6 kg of water initially at a temperature of 22 °C. The specific heat capacity of water is 4200 J / (kg °C).

Determine the highest achievable temperature of the water.

temperature = …… [2]

(c) Explain one advantage of choosing white as the colour for the outside of the casing.

……...

…….....

……..... [1]

(d) The kettle is turned on again, causing the water to reach its boiling point where it starts boiling continuously.

Describe what happens to the supplied thermal energy in terms of molecules when the water boils.

……..

……..

……..

…….. [2]

End of Paper

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FHSS Prelim 2024 Paper 1 MS

1	2	3	4	5	6	7	8	9	10
B	B	D	A	D	A	D	B	A	A

11	12	13	14	15	16	17	18	19	20
C	B	A	B	B	C	B	B	A	C

21	22	23	24	25	26	27	28	29	30
A	B	C	A	A	C	D	B	A	C

31	32	33	34	35	36	37	38	39	40
B	A	D	A	C	A	B	D	C	D

Section A

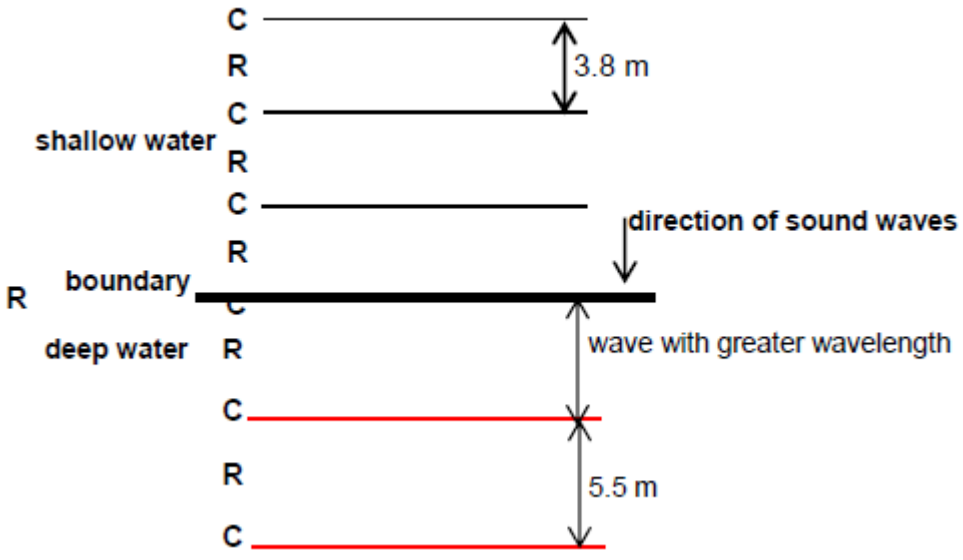
1	(a)	F = ma 145000 – 40000 = 60000a a = 105000 / 60000 = 1.75 m / s^2	[1] [1]
	(b)	a = (v – u) / t t = (v – u) / a = (60 – 0) / 1.75 = 34.3 s or 34 s	[1] [1]
	(c)	distance = ½ x 34.3 x 60 = 1030 m	[1] [1]
	(d)	Air resistance increases as the speed of the aircraft increases. Thus, the total resistive forces acting against the aircraft will increase with its speed.	[1]
2	(a)	W = mg = 60 × 10 = 600 N	[1] [1]
	(b)	When he pushes the floor, his body rises and <u>moves through a distance in the same direction as the force F</u>, hence work is done.	[1]
	(c)	Moment due to the weight about his toe = 600 N x 0.80 m = 480 Nm	[1] [1]
	(d)	By Principle of Moments, taking moments about his toes, F x 1.15 m = 480 F = 417 N or 420 N total upward force = total downward force F + R = W 417 + R = 480 R = 63 N or 60 N	[1] [1] [1]
	(e)	The force exerted by the hand on the floor.	[1]
3	(a)	F = pressure x area F = 1.2 x 10^6 x 5.0 x10^{-5} = 60 N	[1] [1]

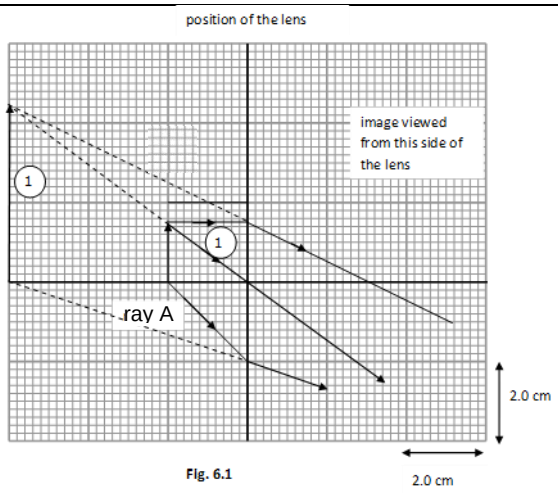
	(b)	**Pressure in oil remains the same**. ($F_1/A_1 = F_2/A_2$) There is a **greater cross-sectional area** at the brake pads. Thus a **larger force** will be applied.	[1] [1]
	(c)	**Bubbles of air** are highly **compressible**. Hence, some pressure is used to compress the bubbles and **the pressure is not fully transferred to S**.	[1] [1]
4	(a)	Air molecules are moving around randomly and at high speeds. They **collide or hit the walls** of the cylinder thus **exerting a force** on walls, resulting in pressure.	 [1] [1]
	(b)	Molecules are now closer / spaced more compactly / more molecules per unit volume / less space to move. They collide **more frequently** with the wall of chamber, causing higher pressure	 [1] [1]
5	(a)	**Unlike charges attract**. The **negative charges on the teeth** are attracted to the **positively charges on the plaque**.	[1]
	(b)(i)	When the hand is holding to the positively charged handle, **the excess electrons on the tooth are attracted to the handle** and neutralised. More electrons continue to be transferred to the handle due to the high positive charge. Since the **teeth have more positive charges than negative charges**, the teeth become positively charged.	 [1] [1]
	(ii)	As **opposite charges attract,** the **positively charged plaque is attracted to the negatively charged bristles** of the toothbrush OR it is **repelled by the positively charged teeth** since **like charges repel**.	[1] [1] [1] [1]
	(c)	Q = It = 0.00015 x 5 x 60 = 0.045 C	 [1] [1]
6	(a)(i)	$I = \frac{12}{8000}$ $I = 1.50\times10^{-3}$ A	[1] [1]
	(ii)	$V = 1.50\times10^{-3}\times3300$ $V = 4.95$ V	[1] [1]
	b	When brightness decreases, the **resistance of LDR increases**.	

		Since total resistance increases, the **current flowing through the series circuit decreases**. Since **V = RI**, **potential difference across the fixed resistor decreases**. Since e.m.f. is equal to the sum of p.d. across fixed resistor and p.d. across LDR, **potential difference across LDR increases**.	[1] [1]
7	(a)	X = Live wire Y = Neutral wire Z = Earth wire	[1]
	(b)	$P = V^2/R$ $R = V^2/P = 220^2/100 = 484\ \Omega$ $I = V / R_{total}$ $= 220 / (484 \times 3)$ $= 0.15$ A or 0.152 A	 [1] [1]
	(c)	When a fault occurs and causes the live wire to touch the **metal casing the metal casing will be live**. This is dangerous as anyone who contacts the metal casing will be electrocuted as there is **no earth wire to provide a path of almost zero resistance for the current to flow to earth** instead of to the user.	[1] [1]
8	(a)	$V_s = (44000 / 4000) \times (25 \times 10^3)$ $V_s = 275$ kV or 275 000V	 [1] [1]
	(b)	$I_pV_p = I_sV_s$, $100 \times 10^6 = I_s \times 275\ 000$ $I_s = 364$ A (3 s.f.)	 [1] [1]
	(c)	Electrical power is transmitted at a **high voltage**. The transmission **current** will be **low**. This **reduces power loss** due to heating effect (joule heating) in the transmission cables.	[1] [1]

Section B

9	(a)(i)	From the graph, when f = 400 Hz, λ = 1.4-1.6 m at temperature 20 ^oC, $v = f\lambda$	

		= 400 × (1.4~1.6) or 400 x 1.5 = 560-640 m / s or 600 m / s	[1]
	(ii)	λ = 3.6-3.9 m at temperature 40 °C v = f λ = 400 × (3.6~3.9) or 400 x 3.8 = 1440~1560 m / s or 1520 m / s	[1]
	(b)	The **speed of sound increases** as the temperature increases. This is due to a **larger wavelength** at higher temperature. Or The **speed of sound increases** as the temperature increases. At higher temperature, the water molecules have **more kinetic energy and vibrate more vigorously**, making it easier for the series of compressions and rarefactions to pass through.	[1] [1] [1] [1]
	(c)(i)	Longitudinal	[1]
	(ii)	At constant temperature, frequency remains constant. Since the wavelength increases in deeper water, the speed increases in deeper water.	[1] [1] [1]
	(iii)	Larger wavelength in deep water. Indicate wavelengths.  	[1] [1]
10	(a)(i)	Ray 1: Since the **angle of incidence is 0°** (or along the normal), it emerges from the surface **without refraction**. Ray 2: It undergoes **refraction** as its **angle of incidence is smaller than the critical angle**.	[1] [1]

		Ray 3: It undergoes **total internal reflection** as is **angle of incidence is bigger than the critical angle**.	[1]
	(ii)	$c = \sin^{-1}(1/1.33)$ $= 48.753$ $= 48.7^{o}$ or 49^{o}	[1] [1]
	(b)(i)	A virtual image is an image that cannot be formed on a screen	[1]
	(ii)	 Fig. 6.1	[2]
	(iii)	focal length = 3.0 cm	[1]
	(iv)	ray A : see (ii)	[1]
11	(a)(i)	The nucleus has a **different number of neutrons / mass number / nucleon number**. It has the **same number of protons / same atomic number**.	[1]
	(ii)	It is not an isotope **and** Q has a different proton number / atomic number	[1]
	(b)i	technetium–99	[1]
	(b)ii	only gamma detected outside body **EITHER** half-life / 6 hours is short **and** less damage (to others / long term) / loses radioactivity quickly **OR** half-life / 6 hours is long enough for isotope to reach site and be detected / long enough to examine patient / does not need to be replaced	[1] [1]
	(c)i	any **two** from:	

		number of protons decreases by two number of neutrons decreases by two **or** number of nucleons decreases by four	[1] [1]
	(ii)	background radiation (detected) **or** source of background radiation mentioned (e.g. cosmic rays; radiation in the air)	[1]
	(iii)	alpha-particles are absorbed by the air (between the source and detector) alpha-particles travel less than 10 cm (in air)	[1] [1]
12	(a)	When heated, the hot water expands, becomes **less dense and rises**. The **colder, denser water at the top sinks** to replace it, forming **convection currents**.	[1] [1] [1]
	(b)i	P = IV Q/t= IV Thermal energy, Q = IVt = (9.6)(230)(3.5 × 60) = (2 208)(210) = 463 680 = 4.6×10^5 J (2 s.f.)	 [1] [1]
	ii	*Q = mc$\Delta\theta$* *463 680 = (1.6)(4200)($\Delta\theta$)* *Change in temperature, $\Delta\theta$ = 69* *Maximum possible temperature of water = 22 + 69 = 91 ℃ (2 s.f.)*	[1] [1]
	c	White colours are **poor emitters of infrared radiation**, hence there will be **less heat loss to the surroundings**.	[1]
	d	Thermal energy is used to **do work to increase the potential energy** of the molecules, so as to **overcome the inter-molecular forces** and separate the molecules far apart.	[1] [1]