康 柏 中 学

COMPASSVALE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
PHYSICS 6091/01

Paper 1 Multiple Choice

Secondary Four Express

Name: ______________________________ Duration: 1 hour

Index No: ______________________________ Date: 26 August 2022

Class: Sec 4 E5 Marks: _____ / 40

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name and index number on the optical mark sheet in the spaces provided.

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 mark sheet.

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.

This paper consists of **17** printed pages including this page. Setter: Mr Ng JunJie

1 Which order shows the units of energy in the correct order of increasing size?

A J → kJ → mJ → nJ → μJ

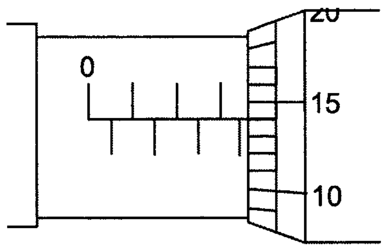
B mJ → nJ → μJ → kJ → GJ

C MJ → mJ → J → kJ → GJ

D nJ → μJ → mJ → kJ → MJ

2 A student measures the thickness of 20 sheets of metal with a micrometer.

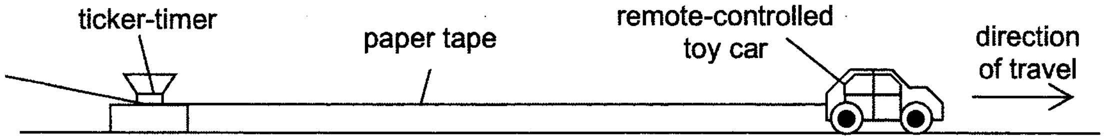
The diagram shows the reading on the micrometer.



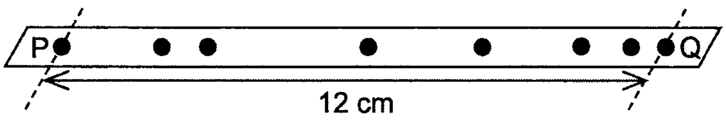
What is the average thickness of one sheet of metal?

A 0.157 mm **B** 0.182 mm **C** 0.207 mm **D** 0.357 mm

3 A student uses a ticker-timer to investigate the movement of a remote-controlled toy car.



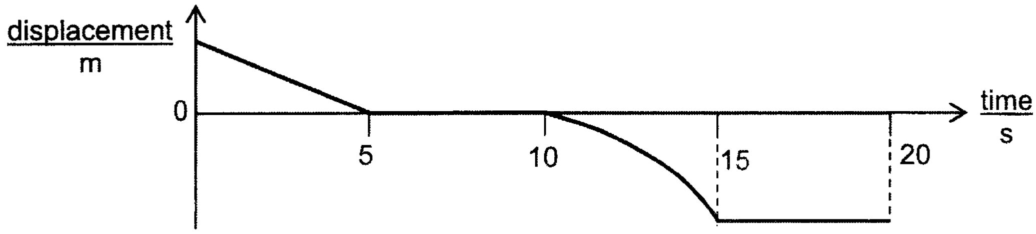
The ticker-timer vibrates at 10 Hz as the paper tape is pulled through the ticker-timer by the car and the diagram shows a section of the tape that was cut out to analyse its motion.



What is the average speed of the toy car between the two markings P and Q?

A 17 cm/s **B** 15 cm/s **C** 9.6 cm/s **D** 8.4 cm/s

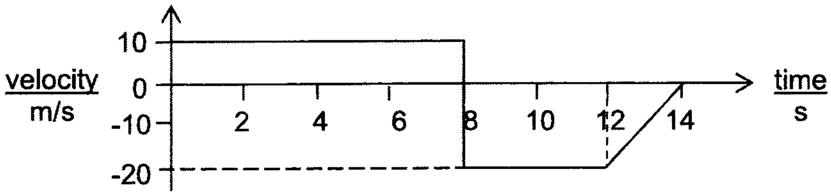
4 The graph shows how the displacement of a car changes with time.



Which row describes the car's motion for each five-second period?

	0 to 5 s	5 to 10 s	10 to 15 s	15 to 20 s
A	uniform deceleration	at rest	decelerating	uniform velocity
B	uniform velocity	at rest	accelerating	at rest
C	uniform velocity	at rest	accelerating	uniform velocity
D	uniform velocity	at rest	decelerating	at rest

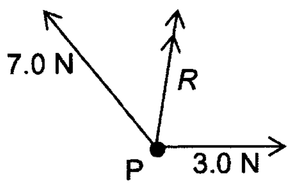
5 The graph shows how the velocity of a particle moving along a straight line, changes with time.



What is the displacement of the particle at the end of 14 s?

A 180 m **B** 20 m **C** - 20 m **D** - 100 m

6 The diagram shows the resultant *R* of a 3.0 N and a 7.0 N force that act at a point P.



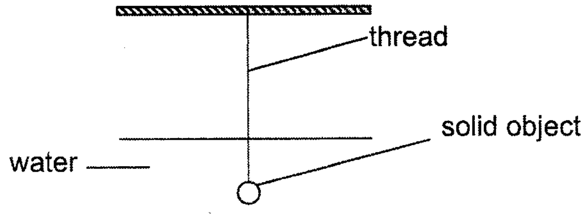
The angle between the 3.0 N force and the 7.0 N force can be any value from 0° to 180°.

Which value of R is not possible?

A 2.0 N **B** 4.0 N **C** 6.0 N **D** 8.0 N

7 A solid object, immersed in water, hangs from an elastic thread.

Three forces act on the object: its weight W, the tension in the thread T, and an upward force F from the water.



Which equation is correct when the object is stationary?

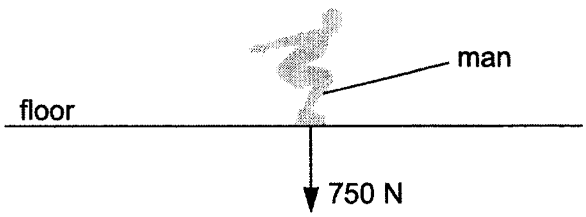
A $F + W = 0$

B $F - T = 0$

C $F - T - W = 0$

D $F + T - W = 0$

8 A man jumps vertically upwards by exerting a force of 750 N on the floor.



The man has a mass of 60 kg and the gravitational field strength g is 10 N/kg.

What is the acceleration of the man as he just leaves the floor?

A - 2.5 m/s^2 **B** 1.25 m/s^2 **C** 2.5 m/s^2 **D** 12.5 m/s^2

9 An astronaut in a space station orbits the Earth.

When he places his camera at eye level and lets go of it, it stays at his eye level.

At the height at which he orbits, the earth's gravitational field strength is 5.0 N/kg.

Which statement correctly describes the situation?

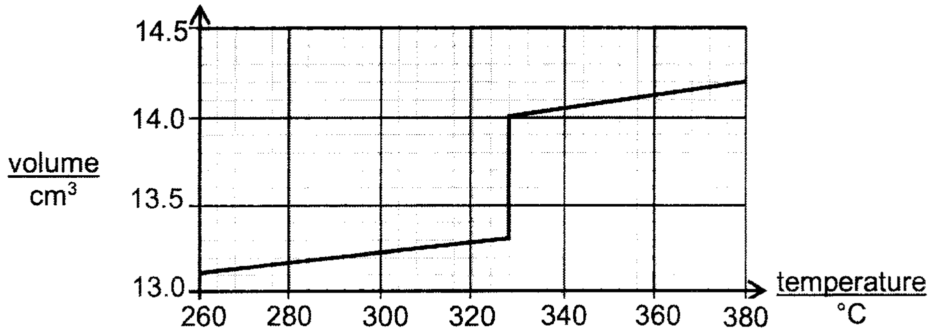
A The camera has mass and no weight.

B The camera has no weight and no mass.

C The camera has weight and mass.

D The camera has weight but no mass.

10 The graph shows how the volume of a sample of solid X changes with temperature as it is heated.



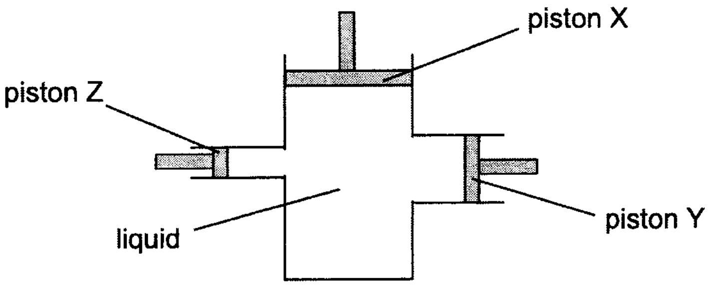
The mass of the sample of solid X is 160 g.

What is the density of the liquid X at 328 °C?

A 11.1 g/cm^3 **B** 11.4 g/cm^3 **C** 11.7 g/cm^3 **D** 12.0 g/cm^3

11 Piston X is pushed into a hydraulic cylinder. Piston X produces a pressure P_X in the liquid in the cylinder.

The diagram shows the cylinder viewed from above.



view from above

There are two other pistons, Y and Z, in the cylinder.

The pressures on piston Y and Z are P_Y and P_Z.

What is the relationship between P_X, P_Y and P_Z?

A $P_X = P_Y + P_Z$

B $P_X > P_Y > P_Z$

C $P_X < P_Y < P_Z$

D $P_X = P_Y = P_Z$

12 Blood pressure can be measured by using a mercury manometer.

Blood pressure varies by 5.5 kPa as a heart beats.

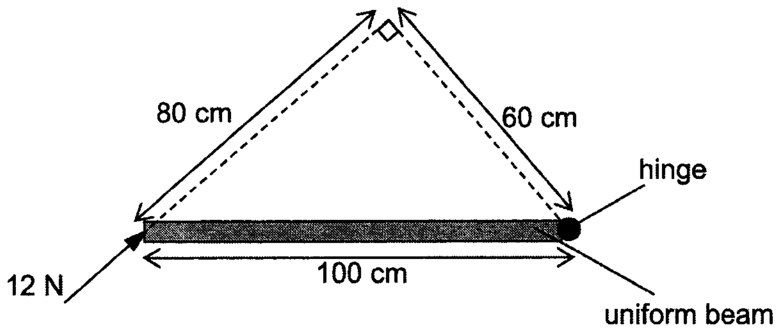
The density of mercury is 13600 kg/m^3 and the gravitational field strength g is 10 N/kg.

What is the change in the height difference between the levels in the manometer during a heartbeat?

A 40.4 mm **B** 80.9 mm **C** 404 mm **D** 809 mm

13 A uniform beam of length 100 cm is hinged at one end.

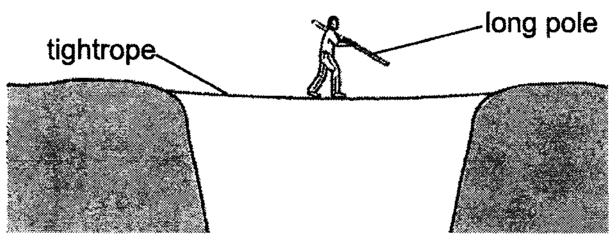
It is kept horizontal by applying a force of 12 N as shown.



What is the weight W of the beam?

A 7.2 N **B** 9.6 N **C** 14.4 N **D** 19.2 N

14 A man walks along a tightrope, carrying a long pole.



He carries the long pole to

A make it easier for him to keep his centre of gravity above the tightrope.

B raise his centre of gravity and make him more stable.

C reduce the pressure he exerts on the tightrope.

D spread out his weight.

15 A braking force F is applied on a car moving at a constant speed of 10 m/s. The car travelled a distance of 10 m before coming to rest.

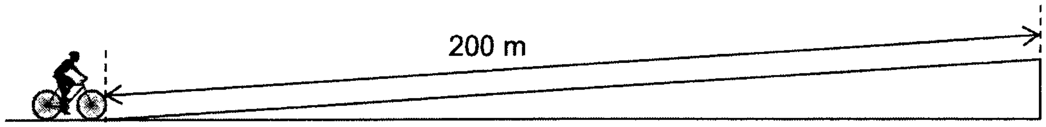
The car now travels at a constant speed of 30 m/s and the same braking force F is applied.

What is the distance travelled by the car before coming to rest?

A 17 m **B** 30 m **C** 52 m **D** 90 m

16 A cyclist, of weight 800 N, takes 10 s to cycle 200 m at a constant speed along a road.

The road rises vertically 1.0 m for every 50 m measured along the road.



Given that work done against friction by the cyclist is negligible, what is the average power produced by the cyclist?

A 32 W **B** 160 W **C** 320 W **D** 1600 W

17 When a thermometer is calibrated, the fixed points are marked.

What are fixed points?

A all the marks on the temperature scale which cannot be removed

B all the marks of the temperature scale

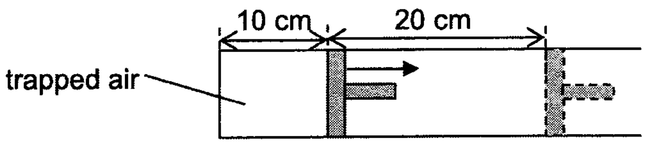
C the lowest and highest temperatures shown on the thermometer

D two temperatures of known value which are easily reproduced

18 Air is trapped in a cylinder by a piston. The pressure of the air is P and the length of the column of air is 10 cm.

The piston is moved outwards, and the length of the air column increases by 20 cm.

The temperature of the air remains constant.



What is the new air pressure?

A $\frac{P}{2}$ **B** $\frac{P}{3}$ **C** $2P$ **D** $3P$

19 A substance can exist in three different states: solid, liquid or gas

Each of the two statements below describe a change in state.

change 1 Molecules move closer together but continue to travel throughout the substance.

change 2 Molecules stop travelling throughout the substance and just vibrate about fixed positions

Which changes of state do these statements describe?

	change 1	change 2
A	condensation	melting
B	condensation	solidification
C	solidification	condensation
D	solidification	melting

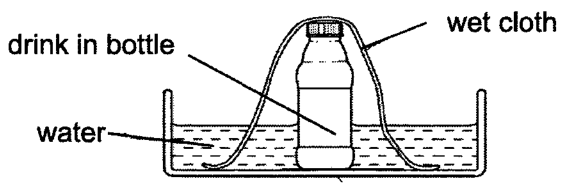
20 Solar panels are used to heat water with a mass of 5000 kg.

The total area of the solar panels is 10 m^2 and the average power output from each square metre of the panels is 300 W. The specific heat capacity of water is 4200 J/(kg °C).

Assuming that there is no thermal energy loss, what is the increase in the water temperature after 8.0 hours?

A 41 °C **B** 5.1 °C **C** 4.1 °C **D** 0.69 °C

21 On a hot day, the drink in a bottle can be kept cool by standing the bottle in a bowl of water and placing a wet cloth over it.



The drink is kept cool because

A water evaporating from the wet cloth cools the drink in the bottle.

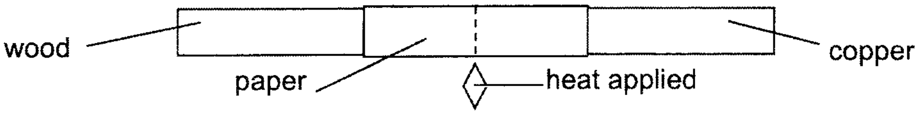
B the cloth prevents absorption of thermal energy from the surroundings.

C the cloth conducts thermal energy away from the bottle into the water.

D cool air cannot escape from the bottle.

22 A wooden bar and a copper bar are joined together at one end with a piece of paper wrapped tightly around the center as shown in the diagram.

Heat is applied strongly at the paper and the paper goes brown on one side only.

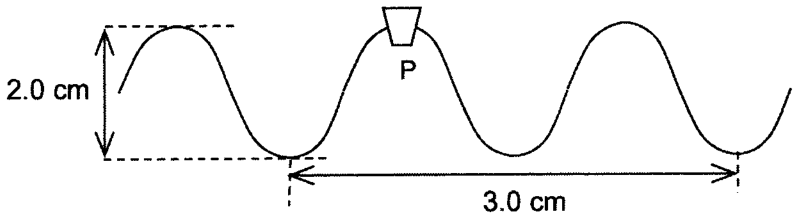


Which side of the paper goes brown and what can we conclude about wood and copper?

	brown side	wood	copper
A	copper	good conductor of heat	insulator of heat
B	copper	insulator of heat	good conductor of heat
C	wood	good conductor of heat	insulator of heat
D	wood	insulator of heat	good conductor of heat

23 In deep water, water waves cause a small cork P to rise up and down through one complete oscillation every 0.20 s, as shown in the diagram.

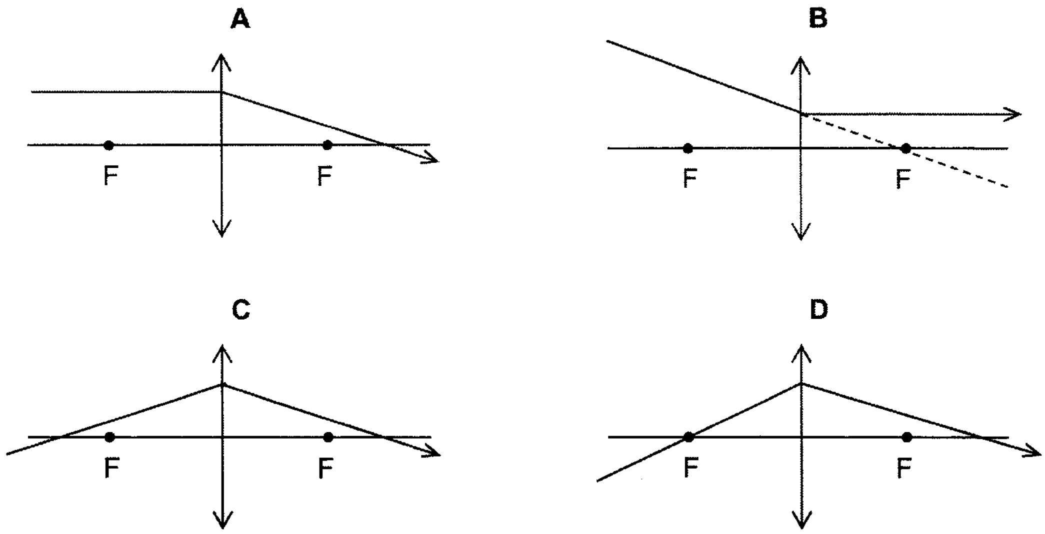
The water waves move into shallow water.



Which of the following describes the wavelength, frequency and speed of the water waves as they move from deep to shallow water?

	wavelength	frequency	speed
A	decreases below 1.0 cm	remains at 5.0 Hz	decreases below 5.0 cm/s
B	decreases below 1.5 cm	remains at 5.0 Hz	decreases below 7.5 cm/s
C	increases above 1.5 cm	decreases below 5.0 Hz	remains at 7.5 cm/s
D	increases above 3.0 cm	decreases below 5.0 Hz	remains at 15 cm/s

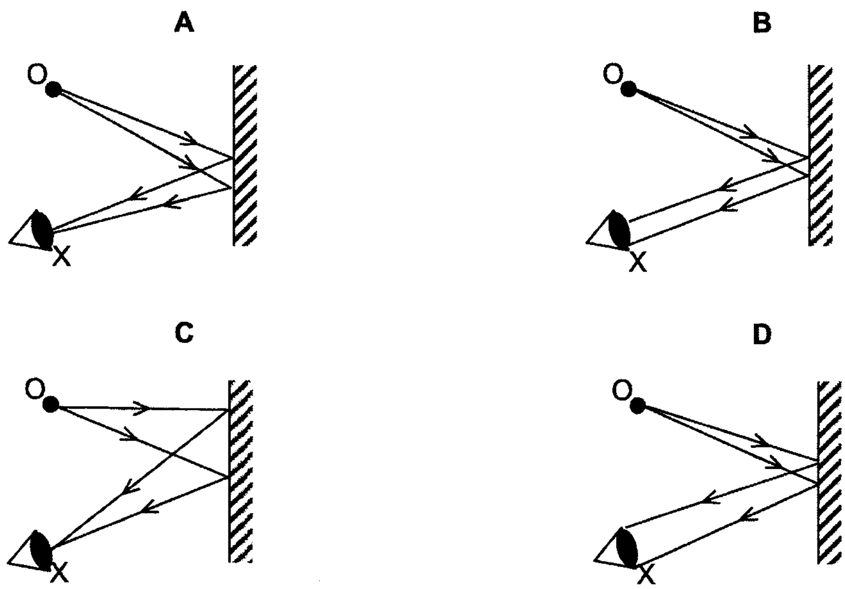
24 Which diagram shows the correct action of a converging lens on a light ray passing through the lens?



25 An object O is placed in front of a plane mirror.

A person looks into the mirror from position X.

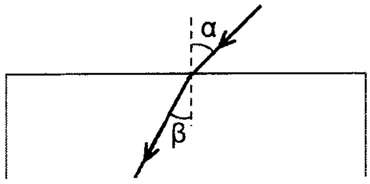
Which diagram shows the paths of the light rays from object O to the person at X?



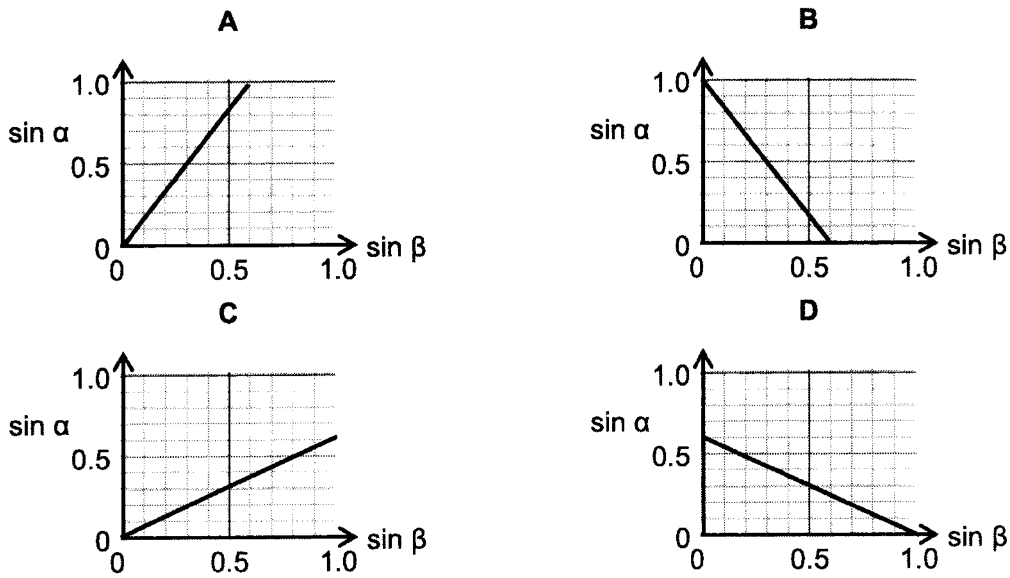
26 The speed of light in a glass block is 1.8×10^8 m/s.

A student shines a beam of light through the glass block at different angles of incidence.

The angle of incidence α and the corresponding angle of refraction β are measured and a graph of sin α against sin β is plotted.



Which graph is correct?



27 A sound wave of frequency 400 Hz travels through air with velocity of 320 m/s.

The frequency of the sound wave in air is doubled to 800 Hz.

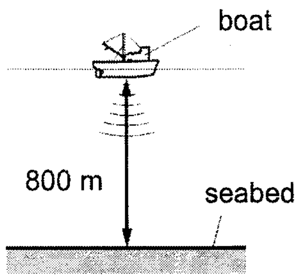
Which row describes the 800 Hz sound wave?

	velocity m/s	wavelength m
A	320	0.40
B	320	2.50
C	640	0.80
D	640	1.25

28 A pulse of sound is produced at the bottom of a boat. The sound travels through the water and is reflected from the seabed.

The sound reaches the boat again after 1.4 s.

The seabed is 800 m below the boat.

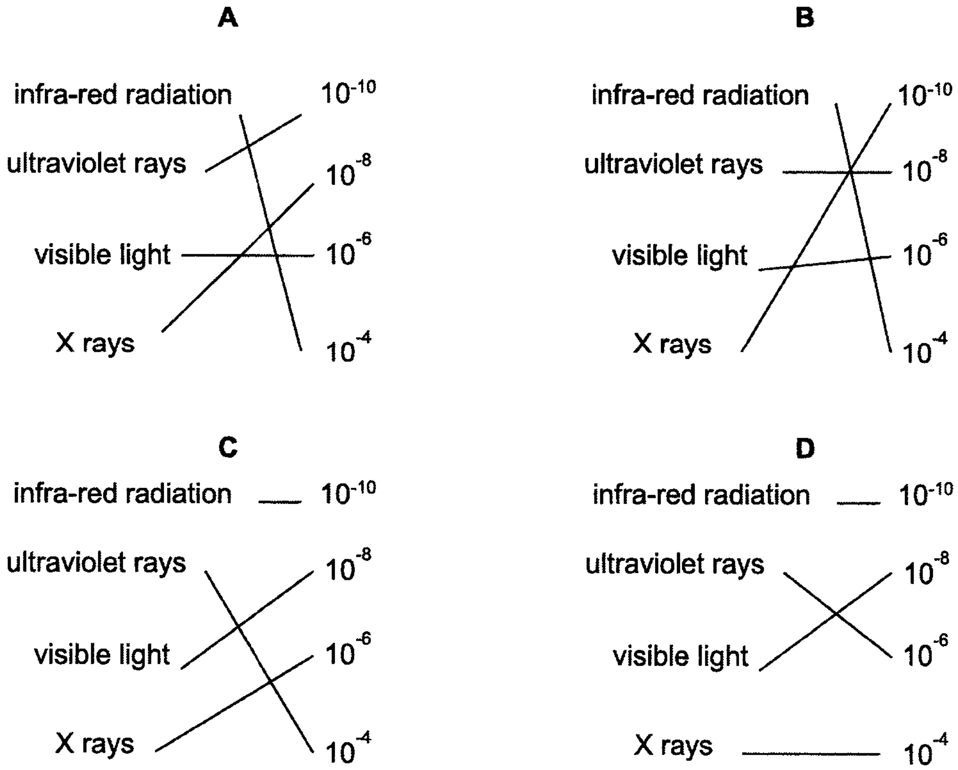


What is the speed of sound in the water?

A 286 m/s **B** 571 m/s **C** 1140 m/s **D** 2290 m/s

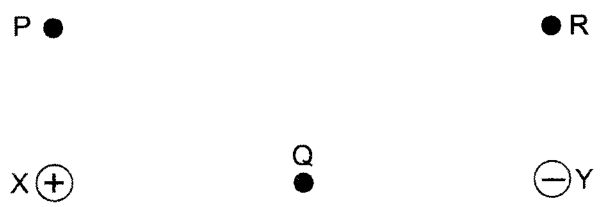
29 In a test, four students linked the different types of electromagnetic waves on the left with the order of magnitude of their wavelengths on the right.

Which student matched them all correctly?



30 The diagram shows isolated positive and negative point charges. These point charges are of equal magnitude.

P, Q, R and the point charges X and Y are located on a single vertical plane.



Which statement best describes the electric field lines between the two point charges?

A The field lines are horizontal at P and horizontal at Q.

B The field lines are horizontal at P and vertical at R.

C The field lines are vertical at Q and horizontal at R.

D The field lines are vertical at R and horizontal at Q.

31 In 3.0 s, 2.5×10^{19} electrons pass through a resistor.

As the electrons pass, thermal energy is produced in the resistor at a rate of 4.0 W.

The charge on the electron is 1.6×10^{-19} C.

What is the potential difference across the resistor?

A 3.0 V **B** 4.0 V **C** 12 V **D** 36 V

32 X and Y are lamps with filament made of the same material.

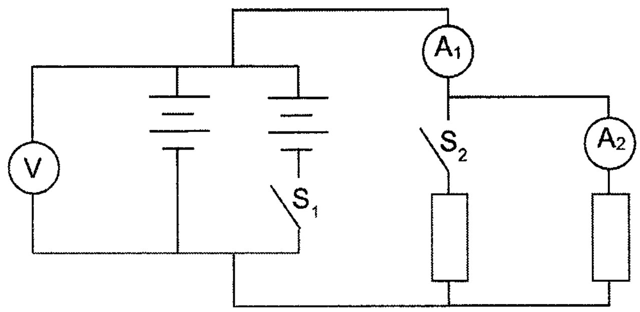
The filament of lamp X has a cross sectional area of $2A$ and a length of L. The filament of lamp Y has a cross sectional area of A and a length of $2L$.

Each lamp is connected to the mains and switched on.

Which is the brighter lamp and which lamp has a filament of larger resistance?

	brighter	larger resistance
A	X	X
B	X	Y
C	Y	X
D	Y	Y

33 The diagram shows a circuit containing two identical resistors and two switches.

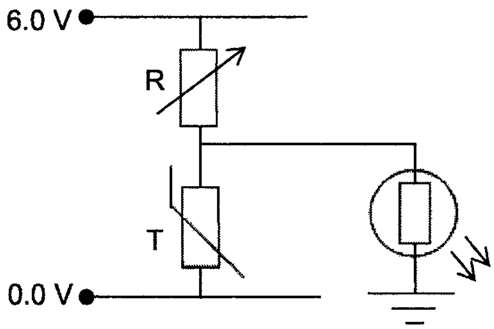


Switches S_1 and S_2 are closed.

Which row shows the changes in the readings of the two ammeters and the voltmeter?

	reading on A_1	reading on A_2	reading on voltmeter
A	decreases	increases	increases
B	increases	increases	unchanged
C	increases	decreases	increases
D	increases	unchanged	unchanged

34 The diagram shows a circuit comprising of three electrical components.



It is observed that when the temperature is low, the LED in the circuit lights up.

This is because in cold weather,

A the voltage of T increases while that of R decreases.

B the voltage of T decreases while that of R increases.

C the voltages of both T and R increase.

D the voltages of both T and R decrease.

35 An electrical cable contains three wires: live, neutral and earth.

The cable is correctly wired to a plug which contains a 3 A fuse. The insulation becomes damaged and bare metal wires show.

Five possible events can occur.

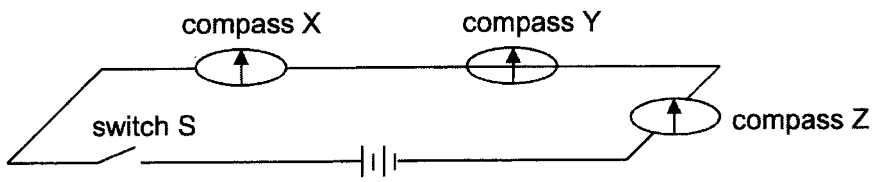
- A person touches the earth wire.
- A person touches the neutral wire.
- A person touches the live wire.
- The live wire touches the neutral wire.
- The live wire touches the earth wire.

How many of these five events cause the fuse in the plug to blow?

A one **B** two **C** three **D** four

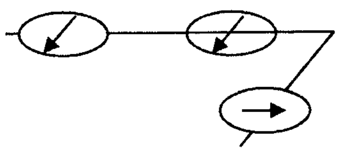
36 The diagram shows a circuit with a wire connected to a battery through switch S.

The compasses X and Z are placed above the wire and compass Y is placed below the wire.

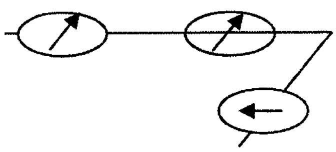


Which of the following diagrams show the correct orientation of the compass needles when switch S is closed?

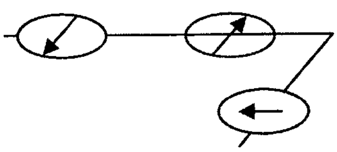
A



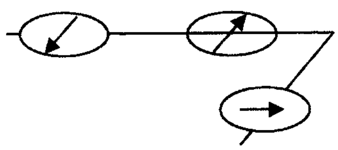
B



C



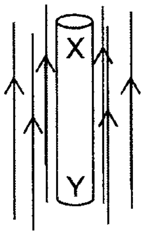
D



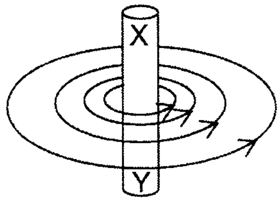
37 There is an upward current in a vertical wire XY. This produces a magnetic field in the region around XY.

Which diagram shows the pattern of the magnetic field lines produced by the current?

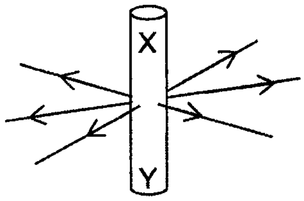
A



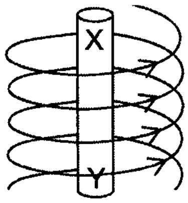
B



C

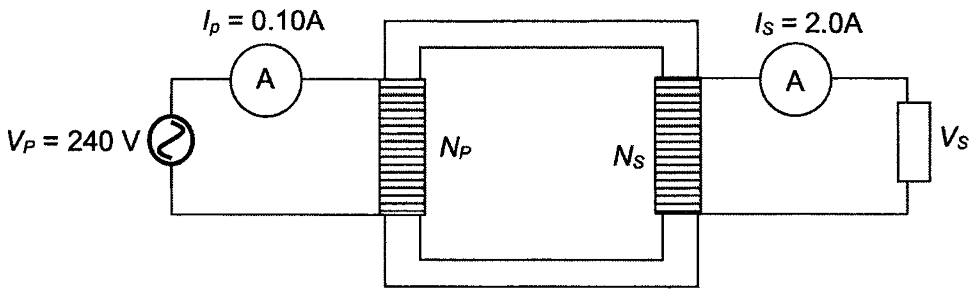


D



38 An ideal transformer supplies power to a load.

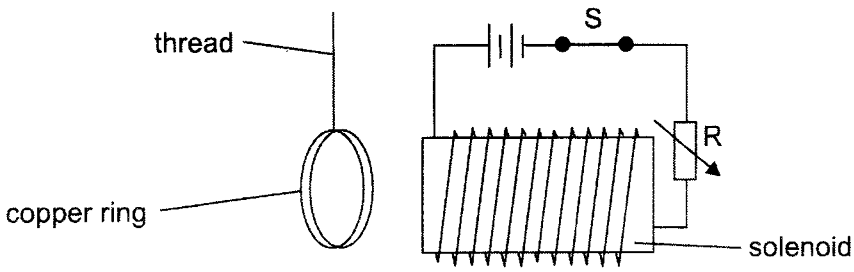
In order to deliver a current of 2.0 A to the load, the primary coil draws a current of 0.10 A from the 240 V mains.



Which row shows the correct set of values for the transformer?

	turns in primary coil, N_P	turns in secondary coil, N_S	potential difference, V_s / V
A	300	6000	12
B	300	6000	4800
C	6000	300	12
D	6000	300	4800

39 A copper ring is placed next to a solenoid.



At the moment the switch S is opened, the copper ring

A moves towards the coil.

B remains stationary.

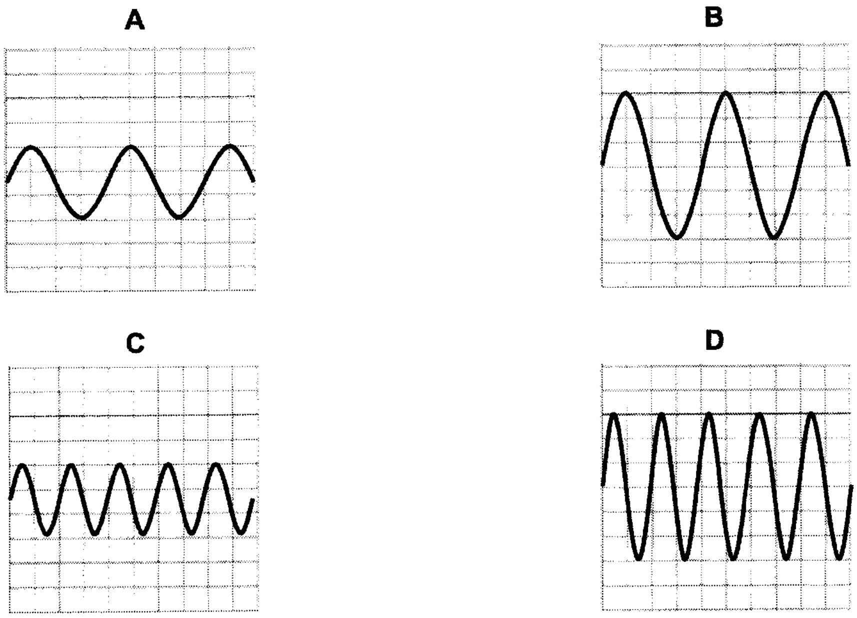
C repels away from the coil.

D rotates momentarily.

40 The Y-input terminals of an oscilloscope are connected to a supply of peak value 15 V and of frequency 50 Hz.

The time-base setting is 10 ms per division and the Y-gain at 5.0 V per division.

Which trace could be obtained?



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COMPASSVALE SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2022
PHYSICS 6091/02

Paper 2 Theory

Secondary Four Express

Name : ______________________		Duration:	1 h 45 min
Index No: ______________________		Date:	29 August 2022
Class	: Sec 4 E5	Marks:	_____ / 80

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 12 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
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.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This paper consists of **20** printed pages including this page. Setter: Mr Ng JunJie

Section A (50 marks)

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

1 Para-sailing is a leisure pursuit where a person is attached to a parachute and pulled over the sea by a tow-rope.

The tow-rope is attached to a motor boat as shown in Fig. 1.1.

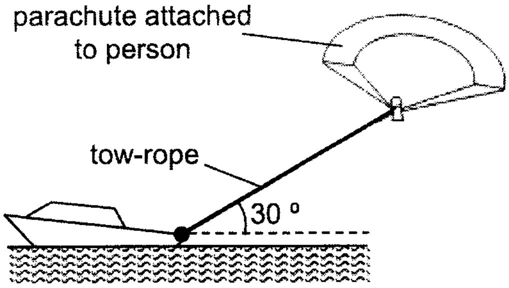

Fig. 1.1

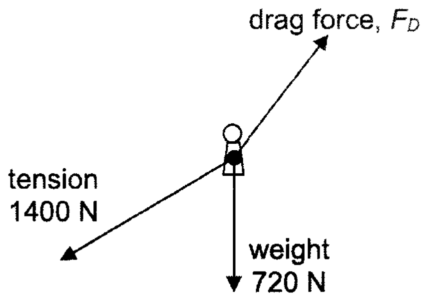

Fig. 1.2

(a) Fig. 1.2 shows the directions of the forces acting on a person when being pulled horizontally across the sea at a constant speed.

The weight of the person is 720 N and the tension in the tow-rope is 1400 N.

Determine the drag force F_D acting on the person using a scale drawing.

drag force, F_D = ... [3]

(b) The tow-rope is released at X and the path of the person with the parachute after the release of the tow-rope is shown by the dashed line in Fig. 1.3.

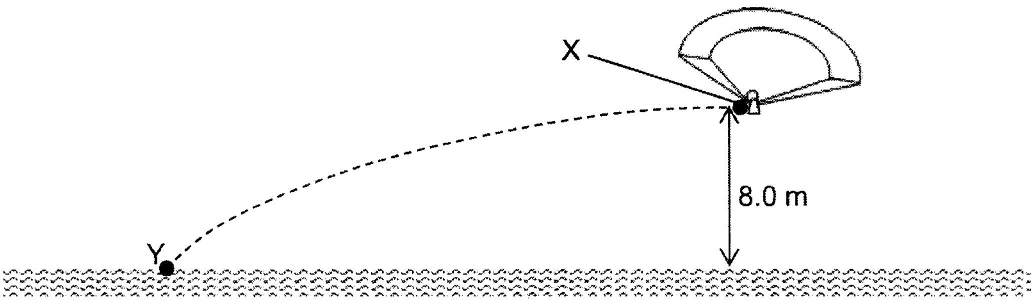

Fig. 1.3

The speed of the person with the parachute is the fastest at X, at the moment the tow-rope is released.

(i) Describe the energy changes from the moment the tow-rope is released at X until the person reaches the surface of the sea at Y.

....

....

....[2]

(ii) The vertical height between X and Y is 8.0 m and the speed of the person at X is 12 m/s.

As the person moves from X to Y, 10 kJ of work is done against air resistance.

Determine the speed of the person at Y.

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

speed at point Y = ... [3]

(iii) A student suggests that the speed of the person at Y does not depend on his mass.

Explain briefly whether the suggestion is correct.

....

....[1]

2 A horizontal, uniform beam is balanced on supports P and Q of a stand when a weighted toy is placed on the beam.

(a) Fig. 2.1 shows the forces acting on the horizontal beam and the distances between these forces when the weighted toy is placed on the beam and the beam is balanced on the stand.

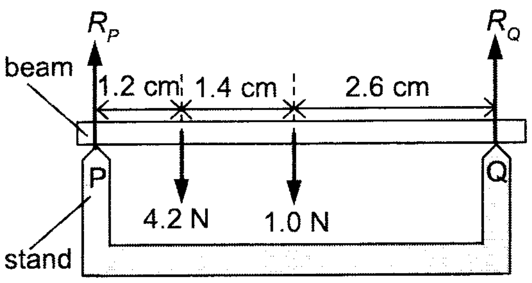

Fig. 2.1

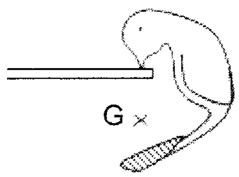

Fig. 2.2a

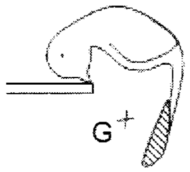

Fig. 2.2b

(i) State the *principle of moments.*

....

....[2]

(ii) The weight of the horizontal beam is 1.0 N and the weight of the weighted toy is 4.2 N.

Determine the forces R_P and R_Q acting on the horizontal beam.

Rp = ...

R_Q = ... [3]

(b) Fig. 2.2a and Fig. 2.2b show the rest position of the weighted toy balanced on its beak and the displaced position of the same toy respectively.

G is the position of the centre of gravity of the weighted toy.

By making reference to the centre of gravity, explain why the weighted toy returns to its rest position when displaced and released.

....

....

....[2]

3 **(a)** Fig. 3.1 shows a mercury barometer used to measure atmospheric pressure on a particular day and the scale alongside the barometer is marked in cm.

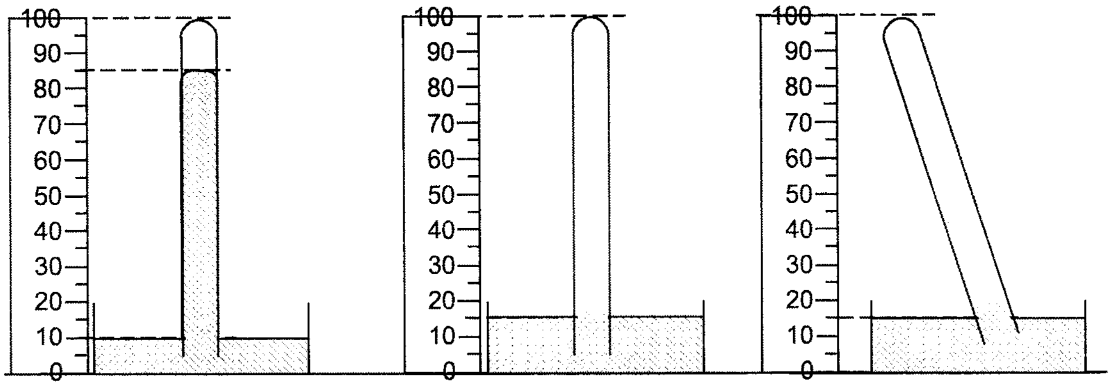

Fig. 3.1 **Fig. 3.2** **Fig. 3.3**

Fig. 3.2 and Fig. 3.3 shows two other mercury barometers located next to that in Fig. 3.1.

(i) On Fig. 3.2, draw the level of mercury inside the tube after more mercury is poured into the reservoir. [1]

(ii) On Fig. 3.3, draw the level of mercury inside the tube after the tube is tilted from the position shown in Fig. 3.2. [1]

(b) A student attempts to build his own barometer by lowering an inverted glass tube vertically into a mercury bath at the same location.

Some air is trapped in the sealed end of the inverted glass tube.

(i) Explain why the reading obtained using his own barometer is lower from the actual atmospheric pressure obtained using the mercury barometer in Fig. 3.1.

....

....[1]

(ii) Suggest and explain using ideas about molecules, how the reading obtained using his own barometer will change if the student pushes the inverted glass tube further into the mercury bath.

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....

....

....[3]

4 Light is incident on a glass prism, as shown in Fig. 4.1.

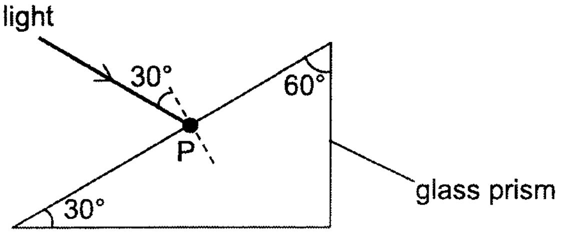

Fig. 4.1

(a) The refractive index of the glass prism is 1.5.

The ray of light enters the glass prism at point P and the angle of incidence at point P is 30°.

Calculate the angle of refraction of the ray of light at point P.

angle of refraction = ... [2]

(b) Another glass prism is used to allow light from the Sun into a room which is below ground level, as shown in Fig 4.2. The prism is made using the same glass as the prism in Fig. 4.1.

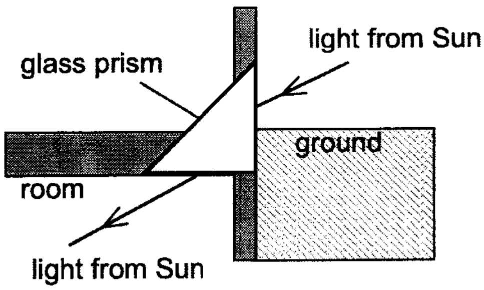

Fig. 4.2

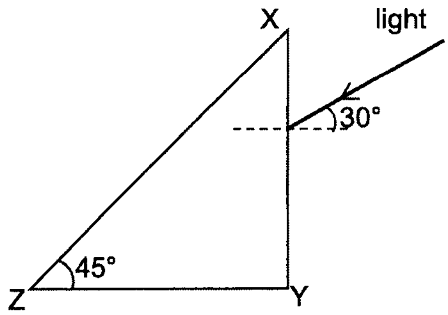

Fig. 4.3

The critical angle of the glass prism is 42°.

On Fig. 4.3, draw the path of the ray of light as it passes through side XY and emerges from the prism into the room which is below ground level from side YZ. [1]

5 A piece of metal foil is attached to a metal rod as shown in Fig. 5.1.

Both metal foil and metal rod are initially uncharged.

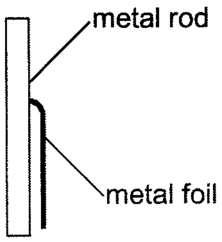

Fig. 5.1

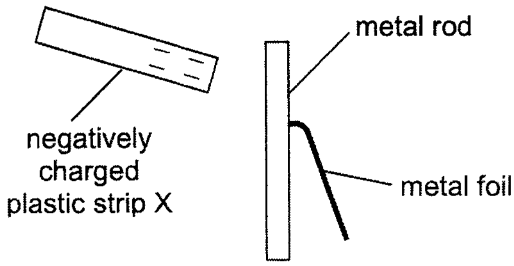

Fig. 5.2

A negatively charged plastic strip X is held close to the top of the metal rod. The metal foil moves away from the metal rod as shown in Fig. 5.2.

(a) Explain why the metal foil moves away from the metal rod.

....

....

....

....

....[2]

(b) Another strip Y is brought near the top of the metal rod. It is held next to the negatively charged plastic strip X without touching the plastic strip as shown in Fig. 5.3.

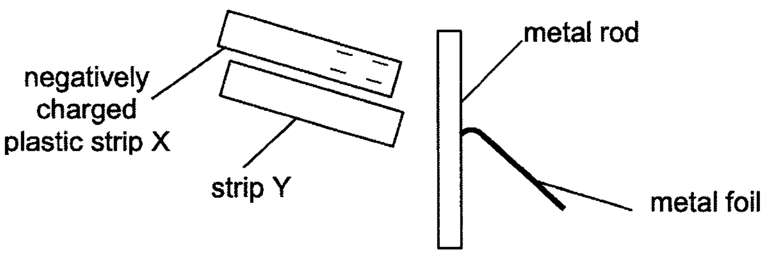

Fig. 5.3

The metal foil moves further away from the metal rod as shown.

State and explain what can be deduced about strip Y.

....

....

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....[2]

6 Fig. 6.1 shows the I/V characteristic graphs for a light-emitting diode (LED) and for a filament lamp.

The LED is a semiconductor diode that emits light.

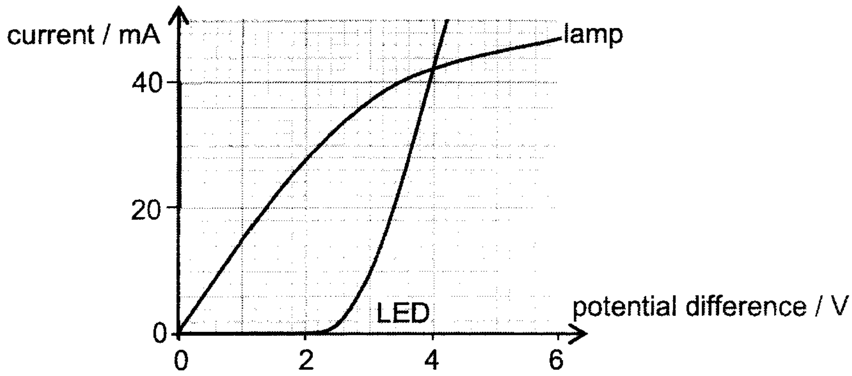


Fig. 6.1

(a) Describe how the resistance of the LED changes as the potential difference increases from zero.

....

....

....[2]

(b) A student uses the lamp and the LED whose characteristics are as shown in Fig. 6.1.

He connects the lamp and the LED to a d.c. power supply. All three components are in parallel.

The current in the LED is 20 mA.

Using Fig. 6.1, determine

1. the current through the power supply,

total current = ... [1]

2. the effective resistance of the LED and the lamp in parallel.

effective resistance = ... [2]

7 Fig. 7.1 shows an apparatus that is used to measure the acceleration of a falling card.

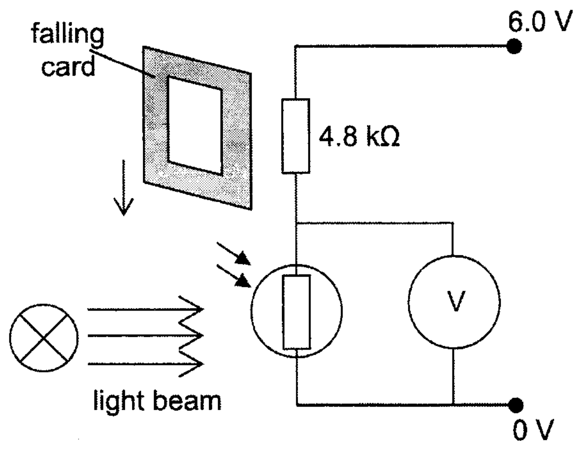


Fig. 7.1

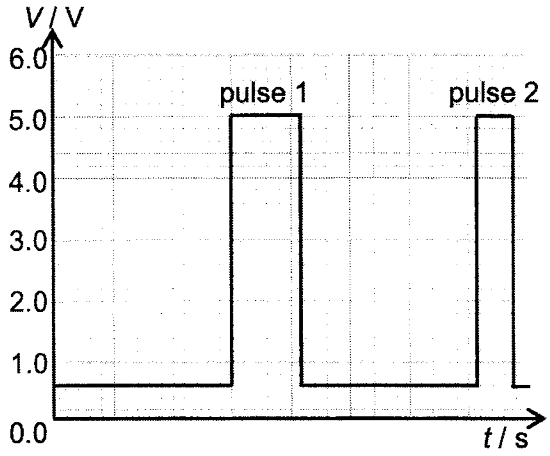


Fig. 7.2

There is a square hole in the centre of the falling card. When the card blocks the light beam, no light reaches the LDR (light-dependent resistor).

The variation of the potential difference V with time elapsed t after releasing the card is shown in Fig. 7.2.

(a) Describe and explain the changes in the voltmeter reading as the card falls.

....

....

....

....[2]

(b) Determine the resistance of the LDR when the card blocks the light beam.

resistance of LDR = ... [2]

(c) Explain briefly, the difference between pulse 1 and pulse 2 in Fig. 7.2.

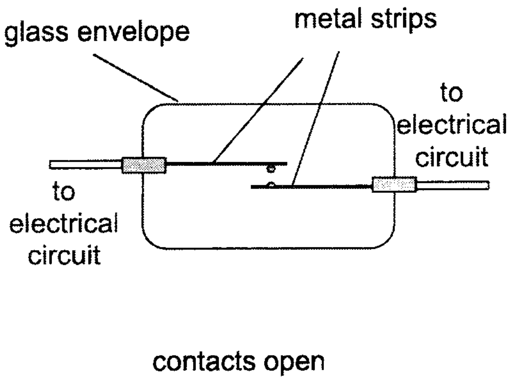
....

....

....[1]

8 A reed switch is one type of switch for an electrical circuit.

The reed switch contains two metal strips that are not in contact unless a magnet is close to them, as shown in Fig. 8.1.



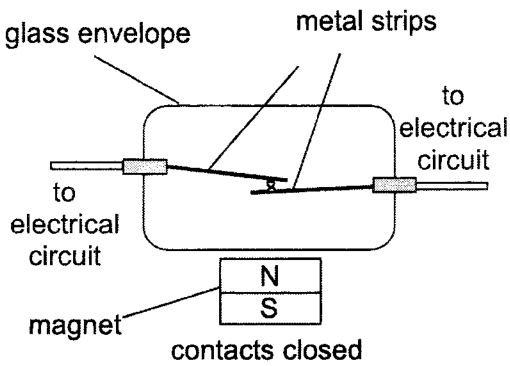


Fig. 8.1

(a) Explain why bringing the magnet close to the reed switch will cause the metal strips to come into contact and close the reed switch.

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....

....

....[2]

(b) Suggest why the metal strips will not lose contact when the magnet is removed if the strips are made of steel.

....

....

....

....

....[2]

(c) Suggest a modification to the reed switch so that the reed switch would be normally closed unless a magnet is brought close to it.

....

....[1]

9 Fig. 9.1 shows a d.c. motor.

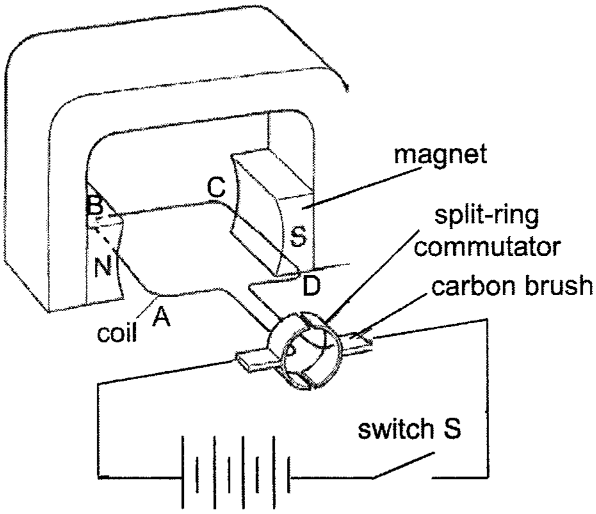


Fig. 9.1

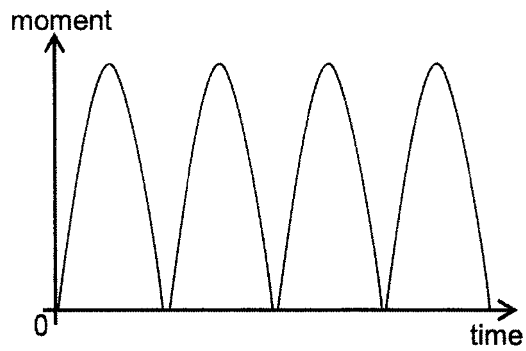


Fig. 9.2

The coil is horizontal, as shown in Fig. 9.1.

(a) **On Fig. 9.1**, draw the forces that act on sides AB and CD of the coil when the switch S is closed. [1]

(b) Explain why the coil turns when the switch is closed.

....

....

....

....

....[2]

(c) Explain why the coil continues to turn in the same direction when it has turned 180°.

....

....

....

....[2]

(d) Fig. 9.2 shows how the moment acting on the coil changes with time.

Sketch, **on Fig. 9.2**, how the moment acting on the coil changes with time if the e.m.f. of the battery is halved. [1]

Section B (30 marks)

Answer **all** the questions from this section.

Answer only one of the two alternative questions in **Question 12**.

10 A vertical-axis wind turbine (VAWT) that can be installed on top of buildings to generate electricity using a renewable energy source.

(a) State what is meant by a *renewable energy source*.

....

....[1]

(b) Fig. 10.1 shows the structure of a VAWT installed on a building.

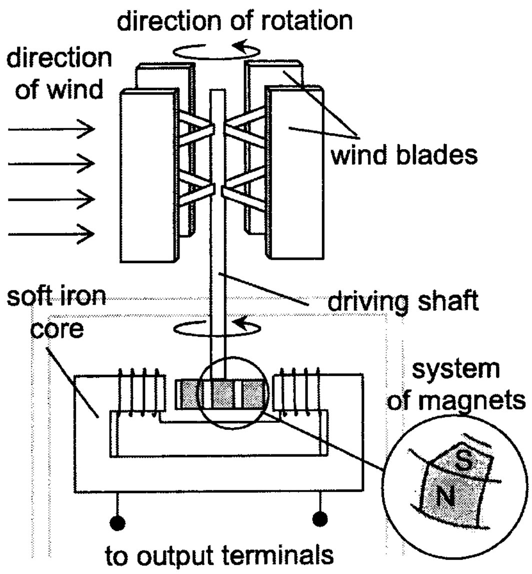


Fig. 10.1

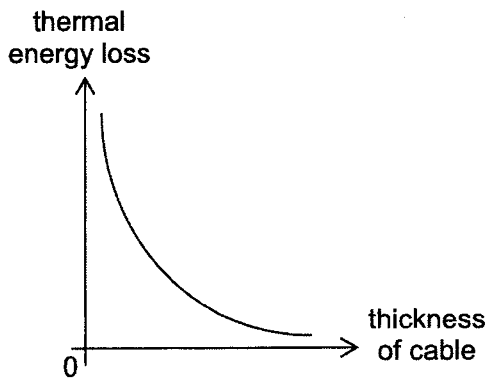


Fig. 10.2

The turbine consists of four blades which catches the wind and turns the driving shaft.

A system of magnets connected to the end of the driving shaft, is placed within a soft-iron core wound with coils of wires. These coils of wires are connected to the output terminals leading to the building.

Explain how the wind produces an alternating electromotive force (e.m.f.) across the output terminals in Fig. 10.1.

....

....

....

....

....[3]

(c) Fig. 10.2 shows how the loss of thermal energy from a transmission cable from the output terminals to the building varies with the thickness of the cable.

Explain why the loss of thermal energy is less if the transmission cable is thicker.

....

....

....

....[2]

(d) Fig. 10.3 shows how the power output of a single unit of the VAWT varies with wind speed.

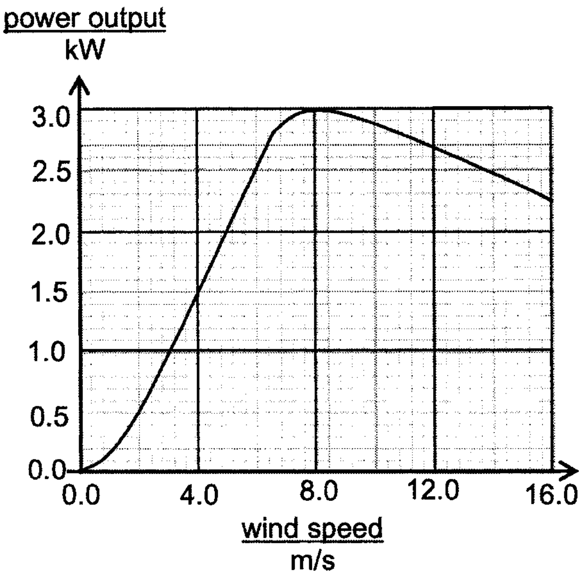


Fig. 10.3

time min	wind speed m/s
0	2.0
1	4.0
2	8.0
3	14.0
4	14.0
5	8.0
6	12.0
7	6.0
8	5.0
9	3.0

Table 10.1

The wind speed is recorded at one minute intervals, as shown in Table 10.1.

(i) Use the data in Fig. 10.3 and Table 10.1 to estimate the total energy produced in the ten minute interval by a single VAWT. Give your answer in joules.

energy = ... J [3]

(ii) Explain why your answer in **(i)** is only an estimate.

....

....

....[1]

(iii) Five VAWTs are installed on top of another building where the average wind speed varies between 0 to 8.0 m/s daily.

The unit cost of electricity is 32 cents.

Using the data in Fig. 10.3, calculate the estimated cost savings from the electricity generated from the five VAWTs in a day.

cost savings = ... [2]

11 Ultrasound and X-rays are used to provide information about structures inside the human body.

(a) Fig. 11.1 shows ultrasound being used to detect a cyst, which is a sac may be filled with air, fluids or other materials, in a human body.

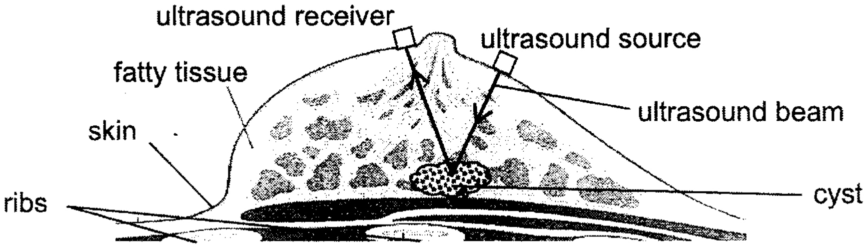


Fig. 11.1

(i) Explain how the vibrations of the source produce waves of ultrasound.

....

....

....

....

....

....[2]

(ii) Suggest how these waves of ultrasound are transmitted through the body tissue to the receiver.

....

....[1]

(iii) Ultrasound used in medicine has a frequency that is about 100 times higher than the maximum frequency that can be heard by humans.

The speed of ultrasound in the human body is 1500 m/s.

Determine the wavelength of the ultrasound used in medicine.

wavelength = ... [2]

(b) The wavelength of X-rays used to detect fractures is roughly the size of an atom.

(i) Determine the frequency of the X-rays.

State the value of any constant used.

frequency = ... [2]

(ii) Describe the effects on living cells and tissues when X-rays cause ionization.

....

....

....[1]

12 EITHER

A standing steam iron uses hot steam to loosen the bonds of the fabric and reduces the appearance of wrinkles and creases.

(a) Fig. 12.1 shows the standing steam iron connected to the mains supply.

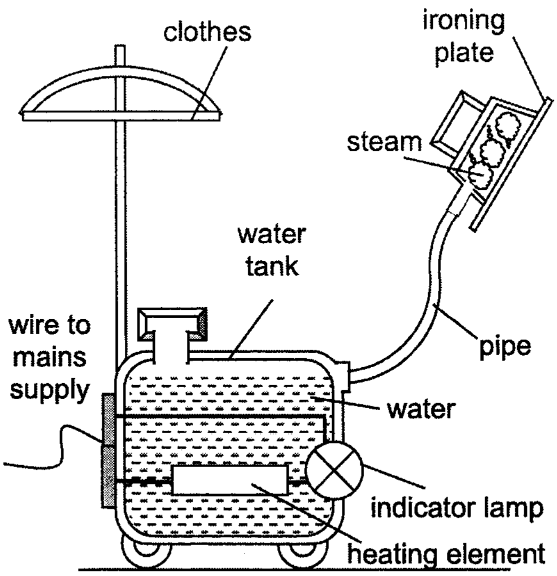


Fig. 12.1

<u>Specifications of standing iron</u>
Power: 2.0 kW
Operating voltage: 240 V
Capacity: 1.5 litre
Heat-up time: 45 s
<u>Thermal properties of water</u>
Specific heat capacity:
4.2 J / (g °C)
Specific latent heat of vaporisation:
2.3 kJ / g

Table 12.1

Table 12.1 shows data relevant to the standing steam iron.

The appliance is filled with 1.5 litres of water at 32 °C. The mass of 1.0 litre of water is 1.0 kg.

The appliance is used until 80% of the water has been turned to steam and released through the ironing plate.

(i) Calculate the amount of energy used to raise the temperature of the water in the tank to its boiling point.

energy used = ... [2]

(ii) Calculate the amount of energy used to produce the steam released.

energy used = ... [2]

(iii) Suggest a reason, other than thermal energy loss to the surroundings, why the actual amount of energy used is more than the calculated values in **(a)(i)** and **(a)(ii)**.

....

....[1]

(b) To ensure that no damage or injury is caused, the standing steam iron has a 10 A fuse connected to the live wire.

Explain why replacing the 10 A fuse with a 15 A fuse presents a risk of damage or danger.

....

....

....[1]

(c) Fig. 12.2 shows some key design features of the water tank of the standing steam iron.

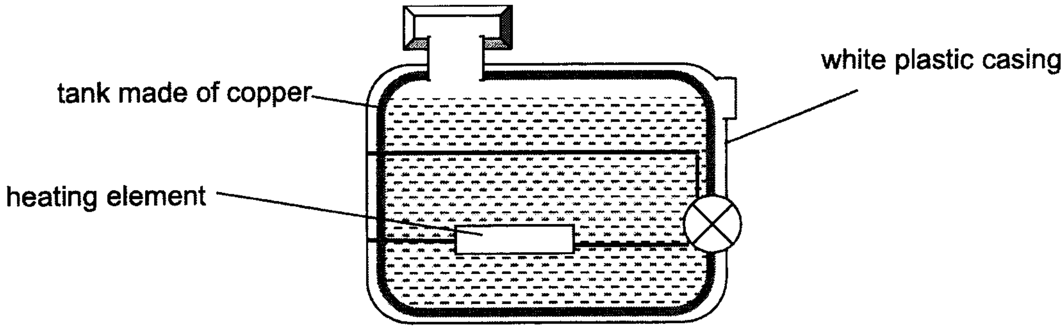


Fig. 12.2

(i) Describe how all of the water in the tank is heated up by the heating element.

....

....

....

....[2]

(ii) Explain how these key design features of the water tank help to reduce thermal energy loss to the surroundings.

....

....

....

....[2]

12 OR

(a) A stationary swimmer starts to swim by pushing off from one side of a swimming pool.

Fig. 12.3 shows the velocity-time graph of the swimmer's motion with four points indicated.

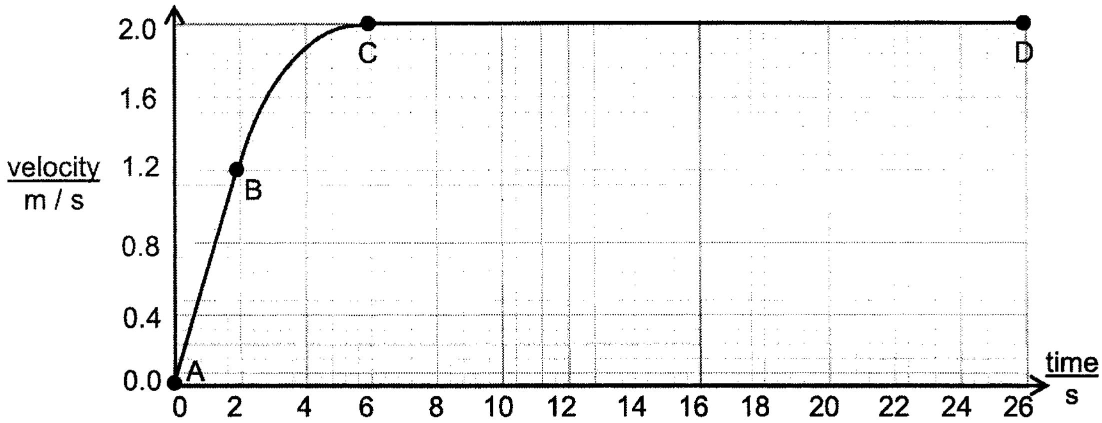


Fig. 12.3

(i) The mass of the swimmer is 80 kg and the resistive forces acting on him at between A and B is 320 N.

Determine the force exerted by the swimmer on the water between A and B.

force exerted = ... [3]

(ii) The distance between A and D is 50 m. The displacement of the swimmer is zero at point A.

On Fig. 12.4, sketch the displacement-time graph for the motion. [3]

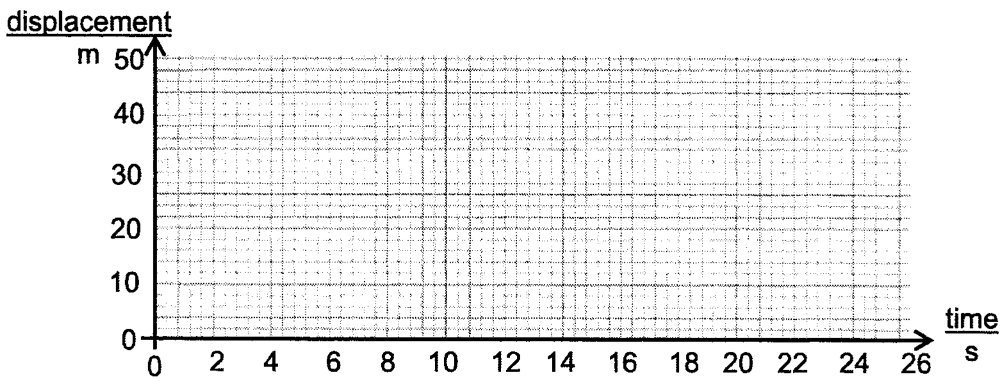


Fig. 12.4

(b) The swimmer reaches the wall at the other end of the swimming pool and turns around under the water.

Fig. 12.5 shows the swimmer immediately after turning around.

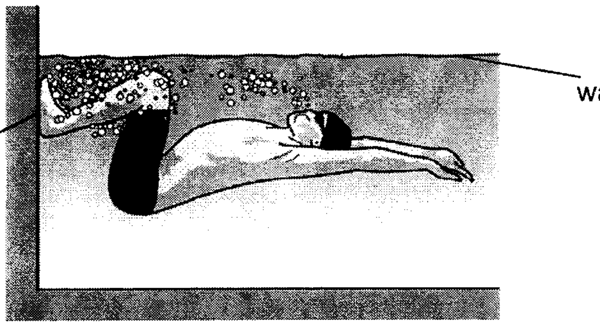


Fig. 12.5

(i) The swimmer pushes against the end wall of the swimming pool with his legs.

Explain, in terms of Newton's law(s), why the swimmer accelerates away from the end wall.

....

....

....

....

....[2]

(ii) While swimming, there is a constant forward force on the swimmer.

His velocity increases until eventually he reaches a constant velocity.

Explain, in terms of forces, why he reaches a constant velocity.

....

....

....

....

....[2]

- END OF PAPER -

2022 Sec 4 Express Preliminary Examinations Answers

Paper 1 MCQ [40 marks]

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

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

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

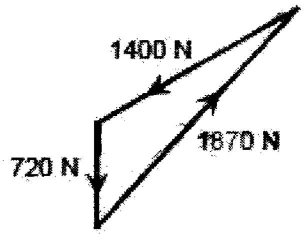
31	32	33	34	35	36	37	38	39	40
A	B	D	A	B	C	B	C	A	D

Paper 2 Section A [50 marks]

1 (a) Appropriate scale (at least half of space given)

Correct scale drawing with correct direction of arrows [B2]

drag force F_D: 1870 N (1600 N to 2150 N) & 40 ° (38 ° to 42 °) from vertical [A1]



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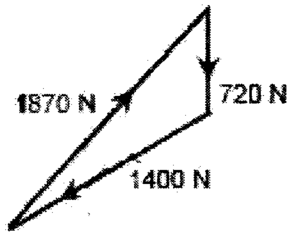

(b) (i) Kinetic energy of the person with parachute decreases and his gravitational potential energy decreases to zero [1] as work is done against air resistance and energy is converted to thermal energy [1].

(ii) By conservation of energy,

total energy at X = total energy at Y [M1]

$\frac{1}{2} \times 72 \times (12)^2 + 72 \times 10 \times 8 = \frac{1}{2} \times 72 \times v^2 + 10000$ [M1]

$\frac{1}{2} \times 72 \times v^2 = 944$

$v = 5.1$ m/s (to 2 sf) [A1]

(iii) The suggestion is incorrect.

Since there is work done against air resistance, the speed of the person at Y will be faster if the person has a larger mass [accept any other sensible suggestion or reference made to working in (ii)] [1]

2 (a) (i) The *principle of moments* states that for an object in equilibrium [1], the sum of clockwise moments about any point as the pivot is equal to the sum of anti-clockwise moments about the same point as pivot. [1]

2022 Sec 4 Express Preliminary Examinations Answers

(ii) Taking moments about Q,

1.0 x 2.6 cm + 4.2 x (1.4 + 2.6) cm = R_P x (1.2 + 1.4 + 2.6) cm [M1]

R_P = 3.730769231 ≈ 3.7 N [A1]

Total upward force = total downward force

$R_P + R_Q = 4.2 + 1.0$

R_Q = 1.469230769 ≈ 1.5 N or [A1]

Taking moments about P,

1.0 x 2.6 cm + 4.2 x (1.2 + 1.4) = R_Q x (1.2 + 1.4 + 2.6)

R_Q = 1.469230769 ≈ 1.5 N

(b) When the toy is displaced, its centre of gravity is displaced upward and to the right and the weight now has a turning effect about the pivot [1].

The moment of the weight about the pivot would cause the toy to turn clockwise and return to its rest position [1].

3 (a)

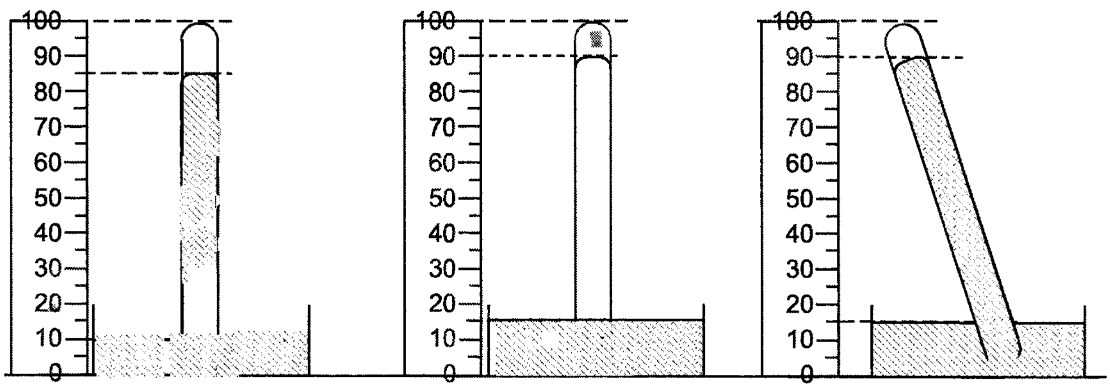

Fig. 3.1 **Fig. 3.2** **Fig. 3.3**

(i) B1 for h = 75 cm (at 90 cm mark on metre rule)

(ii) B1 for h = 75 cm (at 90 cm mark on meter rule, horizontal line)

(b) (i) The trapped air exerts a pressure on the column of mercury in the inverted glass tube, causing the level of mercury in the tube to be lower. (or equivalent) [1]

(ii) The reading obtained using his own barometer will become lower. [1]

When the student pushes the inverted glass tube further into the mercury bath, the volume of trapped air becomes smaller and the number of molecules per unit volume increases. [1] The frequency of collisions between the molecules and the walls of the glass tube and mercury increases, causing the pressure of the trapped air to increase and the level of mercury in the glass tube to become lower. [1]

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4 **(a)** $n = \sin i / \sin r$

$1.5 = \sin 30 / \sin r$ [M1]

$r = \sin^{-1} (\sin 30° / 1.5)$

$= 19.47122063 \approx 19°$ [A1]

(b)

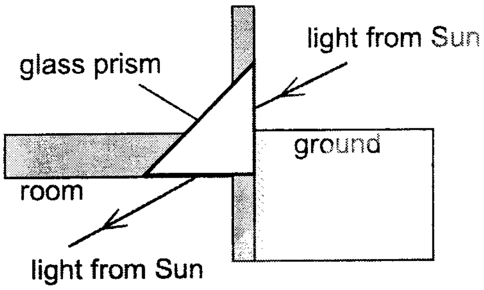

Fig. 5.2

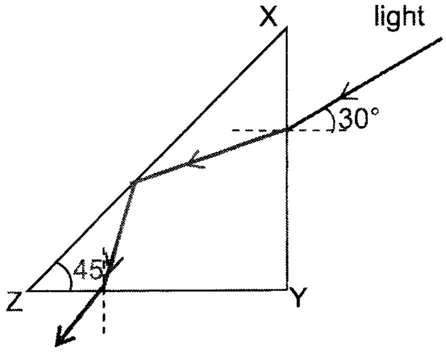

Fig. 5.3

B1 for TIR at XZ and correct bending at XY and YZ

5 **(a)** Electrons in the metal foil and rod are repelled away by the negative charges on the plastic strip, leaving the sides nearer to the strip positively charged and the sides furthest from the strip negatively charged. [1]

The repulsion between like charges on the furthest end of the rod and foil causes the metal foil to move away from the metal rod. [1]

(b) Strip Y is negatively charged. [1] Since the metal foil moves further away from the metal rod, the repulsion between like charges on the furthest end of the rod and foil is stronger when strip Y is brought close so strip Y must be charged negatively like strip X [1]

6 **(a)** As the potential difference (p.d) increases from zero to 2.0 V, resistance of LED remains undefined/infinitely large (since current through LED remains at 0 A). [1]

As the p.d. increases from 2.0 V to 4.2 V, resistance of LED decreases as current increases (since ratio of V to I decreases). [1] or

As the p.d increases from 2.0 V to 3.0 V, resistance of LED decreases (since ratio of V to I decreases). As the p.d increases from 3.0 V to 4.2 V, resistance of LED remains constant (since ratio of V to I remains constant). [1]

(b) 1. Current through power supply = 20 + 40

= 60 mA [A1]

2. $R_{eff} = V / I$

$= 3.4 / (60 \times 10^{-3})$ [M1]

$= 56.66666.. \approx 57\ \Omega$ [A1]

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7 **(a)** When the card falls but does not block the light, the resistance *R* of the LDR remains constant and the potential difference *V* across the LDR remains at 0.60 V. [1]

As the card continues falling, whenever the light is blocked by the card, the resistance *R* of the LDR increases and potential difference *V* across the LDR increases from 0.60 V to 5.0 V since $V_{LDR} = \frac{R_{LDR}}{R_{LDR}+4000} \times 6$ [1] or equivalent

(b) $V = \left(\frac{R_{LDR}}{R_{LDR}+4800}\right) \times 6.0$

$5.0 = \left(\frac{R_{LDR}}{R_{LDR}+4800}\right) \times 6.0$ [M1]

$V = 24000\ \Omega$ [A1]

(c) Pulse 2 has a shorter duration than pulse 1. As the card falls, it accelerates and falls at faster speed so the time that the light is blocked by the upper part of the card of the same length would become shorter. [1]

8 **(a)** When the magnet is brought close to the reed switch, the metal strips become induced magnets such that the side closer to the magnet is a South pole and the side further from the bar magnet is a North pole. [1]

Attraction between unlike poles induced on the two metal strips causes the metal strips to come in contact and close the reed switch.

(b) Steel does not lose its magnetism easily/ retains its magnetism. [1]

The metal strips made of steel would retain its magnetism and the sides of the metal strips facing each other will still attract each other and not lose contact even when the bar magnet is removed since unlike poles attract. [1]

(c) Install/Place a bar magnet on the glass envelope. [1]

9 **(a)** B1 for both arrows in correct direction (see Fig. 9.1)

(b) The combined magnetic fields due to the magnets and the current in the coil ABCD results in AB experiencing a downward force and CD experiencing an upward force by Fleming's Left Hand Rule. [1].

Both forces produce anti-clockwise moments about the centre of the coil and as a result, the coil ABCD would rotate in an anti-clockwise direction. [1]

(c) When the coil has turned 180°, the split-ring commutator reverses the current in the coil (i.e. from ABCD to DCBA). [1]

According to Fleming's Left Hand Rule, the direction of force acting on AB and CD is reversed such that both forces produce anti-clockwise moments about the centre of the coil and the coil will continue to rotate in the same direction. [1]

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(d) B1 for correct graph with amplitude and frequency halved (period doubled) (see Fig. 9.2)

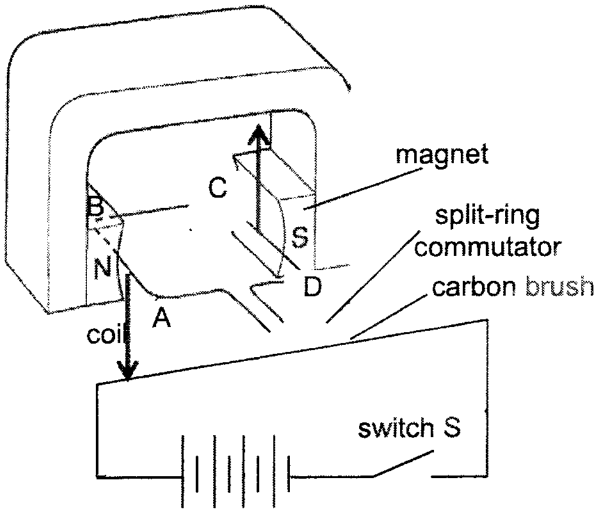

Fig. 9.1

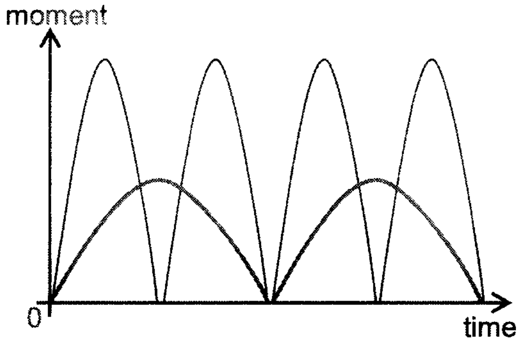

Fig. 9.2

Paper 2 Section B [30 marks]

10 **(a)** A renewable source of energy is a source of energy that can be replenished / replaced / renewed. [1]

(b) The wind turns the turbine/driving shaft and the system of magnets as the blades catch the wind. [1]

As the driving wheel turns and the system of magnets rotate such that the N-pole is moving from the position shown out of the plane of the paper (or moving in one direction), the change in the magnetic field lines cutting the coil induces an e.m.f in one direction. [1]

When the system of magnets continues to rotate such the N-pole is now moving into the plane of the paper (or moving in the opposite direction) , the change in the magnetic field lines cutting the coil induces an e.m.f in the opposite direction. [1]

(c) When the transmission cable is thicker, the cross-sectional area *A* of the cable is larger. [1]

This results in the thicker transmission cable of the same length having a lower resistance (since $R = \frac{\rho L}{A}$) and the loss of thermal energy would be lesser for the same current given that $P_{loss} = I^2R$. [1]

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(d) (i)

time /min	wind speed /m s^{-1}	power / kW	energy / J
0	2.0	0.5	0.5 x 1000 x 60
1	4.0	1.5	1.5 x 1000 x 60
2	8.0	3.0	3.0 x 1000 x 60
3	14.0	2.5	2.5 x 1000 x 60
3	14.0	2.5	2.5 x 1000 x 60
5	8.0	3.0	3.0 x 1000 x 60
6	12.0	2.7	2.7 x 1000 x 60
7	6.0	2.5	2.5 x 1000 x 60
8	5.0	2.0	2.0 x 1000 x 60
9	3.0	1.0	1.0 x 1000 x 60
total energy			1 272 000 J ≈ 1.3 x 10^6 J

1m for obtaining correct values of power from graph based on table.

1m for calculating correct values of energy per second (their P x 1000 x 60)

1m for calculating correct total energy

(ii) The wind speed may not be constant throughout the one-minute interval following the measurement. The power output will not be constant as a result of the different wind speed so the calculation of the total energy is only an estimate.

(iii) Average power = 1.5 kW

Total energy = 5 x 1.5 kW x 24 h

= 180 kWh [M1]

Cost savings = 180 x 32

= 5760 cents or $57.60 [A1]

11 (a) (i) Vibrations of the source causes the layers of particles around/next to the source to be displaced. [1]

These layers of particles which are displaced, vibrates parallel to the direction of travel of the ultrasound beam (at frequencies higher than 20 kHz), forming alternating regions of compression and rarefactions and produce waves of ultrasound. [1]

(ii) These waves of ultrasound are transmitted from the source as longitudinal waves that are reflected off structures (such as the cyst) in the body and through the body tissue to the receiver. [1]

(iii) $v = f\lambda$

$1500 = (100 \times 20\,000)\,\lambda$ [M1]

$\lambda = 7.5 \times 10^{-4}$ m [A1]

(b) (i) $v = f\lambda$

$3.0 \times 10^{8} = f\,(10^{-10} / 10^{-11})$ [M1]

$f = 3.0 \times 10^{17}$ or 3.0×10^{18} Hz [A1]

(ii) Ionising radiation absorbed by human tissues may result in damage to proteins, nucleic acids and other vital molecules found in cells. [1] or
Ionising radiation may also cause damage to chromosomes and an abnormal pattern of cell division possibly leading to cancers such as leukaemia [1]

12 EITHER

(a) (i) Energy to raise temperature $Q_1 = mc\Delta\theta$

$= (1.5 \times 1000) \times 4.2 \times (100 - 32)$ [M1]

$= 428\ 400 \approx 430\ 000$ J [A1]

(ii) Energy to produce steam $Q_2 = ml_v$

$= (80/100 \times 1.5 \times 1000) \times 2.3 \times 1000$ [M1]

$= 2\ 760\ 000 \approx 2\ 800\ 000$ J [A1]

(iii) The heat capacity of the appliance was not included/considered in the calculated values in **(a)(i)** and **(a)(ii)**. [1]

(b) The appliance has a working/operating current of 8.3 A. A fuse rating of 15 A is much higher than the working current so the fuse may not melt when there is excessive current, and the appliance may overheat and be damaged. [1]

(c) (i) The water near the heating element gets heated up, expands, become less dense and rises while the cooler water sinks/gets displaced downwards and gets heated, in turn. [1 for description of density changes] This sets up a convection current in the water and all the water inside the tank gets heated up by convection. [1]

(ii) Plastic is a poor conductor of thermal energy so thermal energy transfer from water through the copper tank to the plastic casing to the surroundings by conduction is reduced. [1] White is a poor emitter of radiant heat so thermal energy transfer from the water tank to the surroundings by radiation is reduced. [1]

12 OR

(a) (i) $a = (v - u) / t$

$= (1.2 - 0) / 2$ [M1]

$= 0.60$ m/s^2

$F_{net} = ma$

$F - 320 = 80 \times 0.60$ [M1]

$F = 368 \approx 370$ N [A1]

(ii) 1 m for each section of motion (see Fig. 12.4)

AB – curve with increasing gradient (from (0,0) to (2,1.2)

BC – curve with decreasing gradient (from (2,1.2) to (6,10)

CD – straight line with positive gradient (from (6,10) to (26, 50)

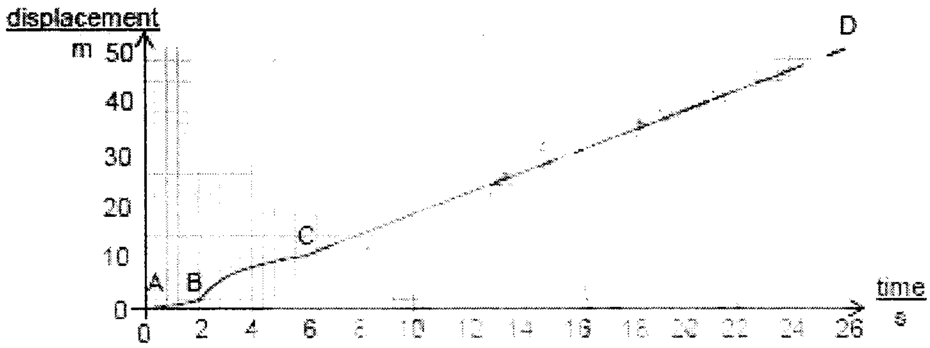

Fig. 12.4

(b) (i) By Newton's third law, when the swimmer pushes against the end wall with his legs, the end wall exerts an equal and opposite force on the swimmer. [1]

By Newton's Second Law, since an object will accelerate in the direction of the resultant force acting on the object, the swimmer will accelerate away from the end wall due to the resultant force (the force exerted on him by the end wall) acting on him. [1]

(ii) As his velocity increases, the resistive forces acting on the swimmer increases. [1]

When the the resistive forces acting on the swimmer is equal and opposite to the constant forward force, the resultant force acting on the swimmer becomes zero and he reaches a constant velocity, by Newton's first law. [1]

2022 Sec 4 Express Preliminary Examinations Answers

Paper 3 Practical [40 marks]

1 (a) **MMO** 1
h_0 measured to nearest 1 mm with unit
(b) **MMO** 1
h_1 measured to nearest 1 mm with unit
(c) **ACE** 1
correct calculation of *m* and values within 10%
(d) **ACE** 1
correct calculation of *f* and values within 10%
PDO 1
f to 3 sf
(e) **P** 5
correct constant variable (lens, distance from lens to eye) and correct independent variable (distance from card to lens, u)
Keeping key variables constant,
varies independent variable, *u and* measures h_1 to determine corresponding *m*
plots suitable graph: graph of *u* against *m*
correct sketch of graph given correct relationship

MMO: 2, ACE: 2, PDO: 1, P: 5

2 (a) (i) **MMO** 1
L measured to nearest 0.1 cm with units
(ii) **MMO** 2
$I_{standard}$ measured to 0.01 A with unit
V_L measured to 0.05 V with unit
(b) **MMO** 1
V_1 and V_2 measured to 0.05 V with units and correct trend between V_1 and V_2
(c) (i) **ACE** 1
R_1 calculated correctly with units and R_1 within 10%
PDO 1
R_1 to 3 sf
(ii) **ACE** 1
R_2 calculated correctly with units and R_2 within 10%
PDO 1
R_2 to 3 sf
(d) **ACE** 2
any one from to explain difference between R_1 and R_2:
Kinks in wire causes *x* and *L* to be inaccurate
Wire heats up after some time, affects values of *I* and *V*

MMO: 4, ACE: 4, PDO:2

3 (a) (i) **MMO** 2
L measured to nearest 0.1 cm with units
d measures to nearest 0.1 cm with units
(ii) **MMO** 1
l measured to nearest 0.1 cm with units
(iii) **ACE** 1
correct calculation of *x* to 0.1 cm with correct units

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ACE 1
correct calculation of *F* to 2 sf with correct units

(b) MMO 1
5 sets of data (including 0 g) with correct trend
PDO 1
table with quantities with correct units
PDO 1
m to nearest 100 g
PDO 1
L, d measured to nearest 0.1 cm with units
ACE 1
correct calculation of *x* to 1 dp
ACE 1
correct calculation of *F* to 2/3 sf

(c) (i) PDO 1
axes labelled with units and correct orientation
PDO 1
suitable scale with plotted data occupying more than half the page in both directions
PDO 1
all points plotted correctly (points must be less than half a small square from correct position)
PDO 1
best fit straight line and small crosses

(ii) ACE 1
Correct calculation of gradient and use of a gradient triangle spanning more than half of the drawn line
ACE 1
correct calculation to 2/3 sf and correct units

(d) ACE 1
any sensible explanation about why masses greater than 400 g is not used

(e) MMO 1
any sensible source of error with clear indication of reading affected

(f) MMO 1
any sensible suggestion to improve accuracy

MMO: 6, ACE: 7, PDO: 7

MMO: 12 (30%) ACE: 13 (32.5 %) PDO: 10 (25 %) P: 5 (12.5%)

2022 Sec 4 Express Preliminary Examinations Answers