YISHUN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2023
SECONDARY 4 EXPRESS

CANDIDATE NAME

CLASS | INDEX NUMBER

PHYSICS **6091/01**
Paper 1 Multiple Choice **24 August 2023**
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** or **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

1 A list of physical quantities is shown.

length
mass
speed
temperature
time
volume

How many of these quantities are base quantities?

A 2

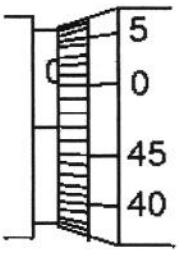
B 3

C 4

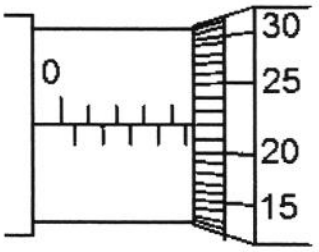
D 5

2 A micrometer screw gauge is used to measure the thickness of a uniform rod.

The figure below shows the reading on the micrometer screw gauge when it is closed before measurement is taken and the reading when it is taken with the rod.



closed before measurement



measurement with rod

What is the cross-sectional area of the rod?

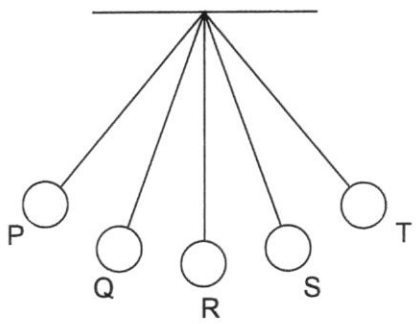
A 14.7 mm^2

B 14.9 mm^2

C 17.3 mm^2

D 17.7 mm^2

3 The diagram below shows a pendulum at five different positions of its oscillation.



Which movement represents one oscillation?

A P → R → T

B Q → T → Q

C S → T → P → S

D T → P → T → P

4 A student is given a reel of wire of diameter less than 0.2 mm and is asked to find the density of the metal.

Which pair of instruments would be most suitable for finding the volume of the wire?

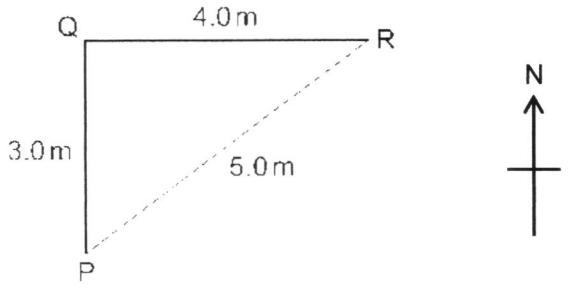
A electronic balance and micrometer

B metre rule and micrometer

C metre rule and vernier calipers

D micrometer and vernier calipers

5 A boy starts at P and walks 3.0 m due north to Q and then 4.0 m due east to R.



What is the shortest distance that he must now walk to have an overall displacement of zero?

A 3.0 m

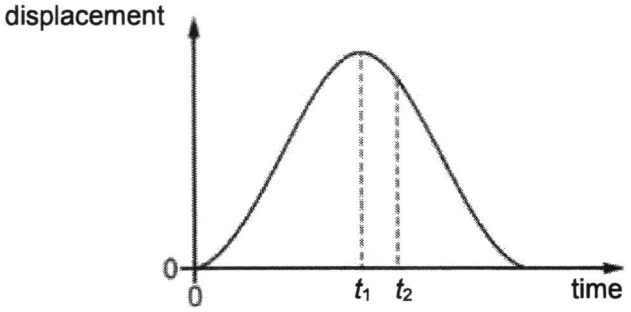
B 4.0 m

C 5.0 m

D 7.0 m

6 A train sets off from a station at time $t = 0$.

The graph shows how the displacement between the train and the station varies with time.



Which statement about the movement of the train between time t_1 and t_2 is correct?

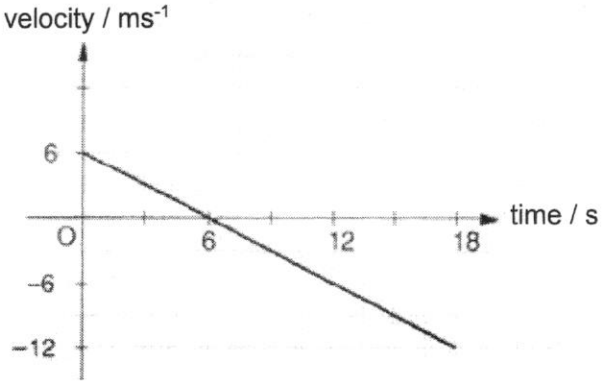
A Its speed is decreasing, and it is moving away from the station.

B Its speed is decreasing, and it is moving towards the station.

C Its speed is increasing, and it is moving away from the station.

D Its speed is increasing, and it is moving towards the station.

7 The left diagram shows a man near a cliff throwing a stone vertically upwards. The right diagram shows the stone's velocity-time graph. The stone hits the sea's surface after 18 s.



What is the height between the man's hand and the surface of the sea?

A 18 m

B 54 m

C 72 m

D 90 m

8 The gravitational field strength in space is smaller than on the Earth's surface. A rocket is used to launch a satellite from the Earth's surface into space.

How are the mass and the weight of the satellite affected as the satellite moves away from the surface of the Earth into space?

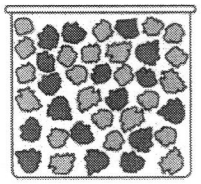
A Both the mass and the weight are unaffected.

B Both the mass and the weight decreases.

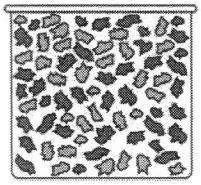
C The mass decreases and the weight is unaffected.

D The mass is unaffected and the weight decreases.

9 A box X full of large granite rocks is weighed. An identical box Y full of small granite chippings is then weighed.



box X with granite rocks



box Y with granite chippings

Which box weighs more and why?

	heavier box	reason
A	X	more air in box X
B	X	density of a chipping is less than a rock
C	Y	less air in box Y
D	Y	density of a chipping is more than a rock

10 A single metal bolt has a mass of 34 g. Three of the bolts are immersed in a measuring cylinder that contains 18 cm^3 of water. The reading on the measuring cylinder rises to 30 cm^3.

What is the density of the metal?

A 1.1 g/cm^3

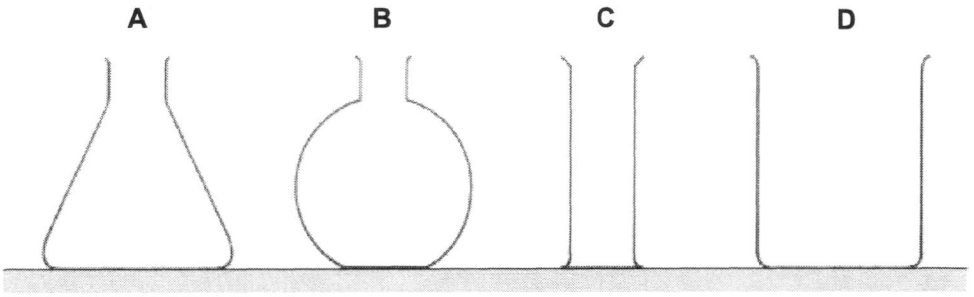
B 2.8 g/cm^3

C 3.4 g/cm^3

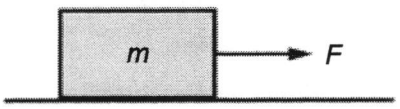
D 8.5 g/cm^3

11 The diagram shows four containers made of thin glass.

Which container is the most stable?



12 The diagram shows a block of mass m pulled in a straight line along a horizontal surface by a force *F*.



The block moves a distance *d* in time *t*. The average speed at which the block moves is *v*.

Which two quantities must be known to calculate the power generated?

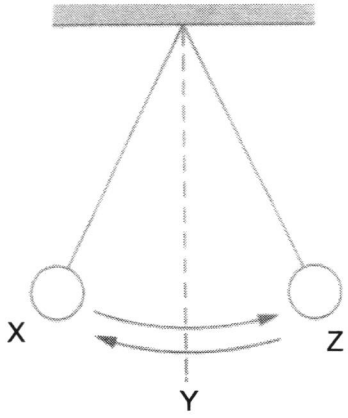
A *F* and *d*

B *F* and *m*

C *F* and *t*

D *F* and *v*

13 A pendulum swings between X and Z.



Which row is correct?

	energy at point X	energy at point Z
A	kinetic	kinetic
B	kinetic	gravitational potential
C	gravitational potential	kinetic
D	gravitational potential	gravitational potential

14 Illuminated smoke particles, suspended in air, are viewed with a microscope. They are seen to move randomly.

Which statement about the smoke particles is correct?

A They are bombarded continually by air molecules.

B They are moved about by convection currents.

C They are shaken by the vibration of the molecules within them.

D They are supplied with energy by the light illuminating them.

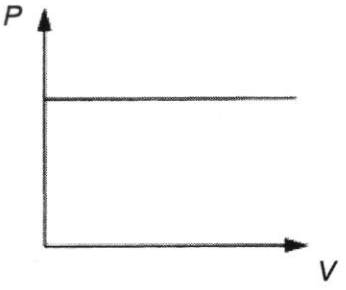
15 According to the kinetic theory, matter is made up of very small particles in a constant state of motion.

Which row best describes the particle behaviour in the gaseous state?

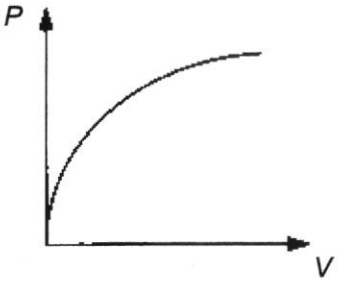
	forces between particles	arrangement of particles
A	strong	close but packing is more disorderly than in a liquid
B	strong	far apart in a disorderly arrangement
C	weak	close but packing is more disorderly than in a liquid
D	weak	far apart in a disorderly arrangement

16 Which of the following graphs shows the relationship between pressure, P, and volume, V, when the temperature of the gas is kept constant?

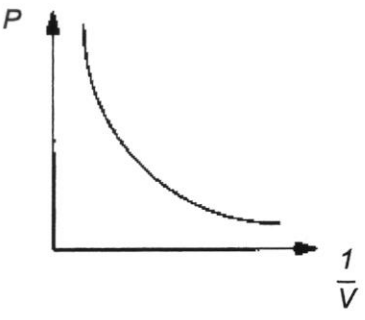
A



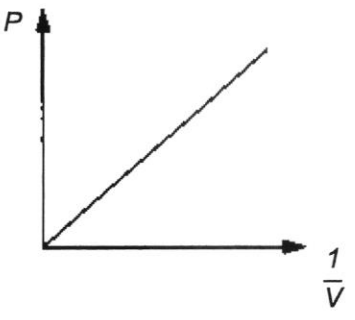
B



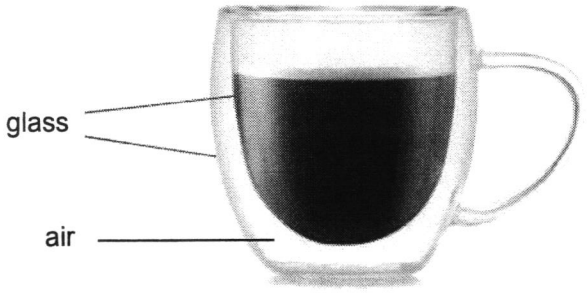
C



D



17 The diagram shows a double wall glass cup. The cup has two layers of clear glass separated by air.



How does the cup help to keep the hot drink hot?

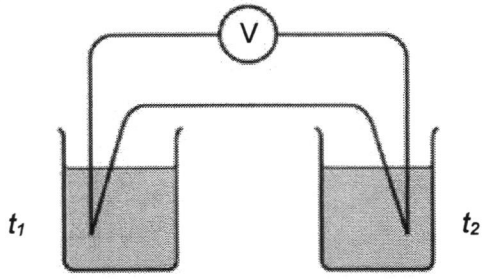
A It reduces thermal energy lost by conduction.

B It reduces thermal energy lost by conduction and convection

C It reduces thermal energy lost by conduction, convection and radiation.

D It reduces thermal energy lost by convection and radiation.

18 A thermocouple thermometer uses a voltmeter to measure the electromotive force (e.m.f.) generated between two junctions. The junctions are at temperatures t_1 and t_2.



Which pair of values of t_1 and t_2 produces the largest voltmeter reading?

	t_1 / °C	t_2 / °C
A	20	40
B	20	80
C	60	100
D	100	125

19 The temperature of a mercury-in-glass thermometer increases.

Which property remains constant?

A The mass of the mercury.

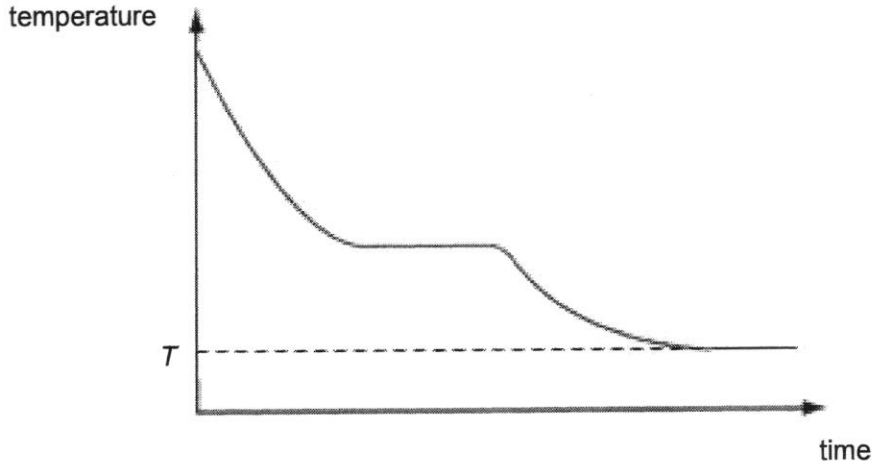
B The density of the mercury.

C The volume of the mercury.

D The internal energy of the mercury.

20 A hot pure liquid is carefully poured into a beaker.

The graph shows how its temperature changes as it cools.



What is temperature *T*?

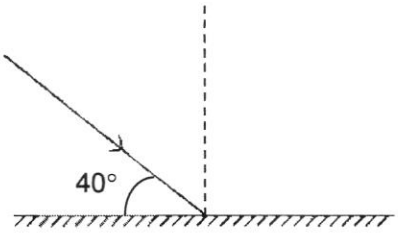
A boiling point

B crystallisation temperature

C melting point

D room temperature

21 The diagram shows a ray of light incident on a plane mirror.

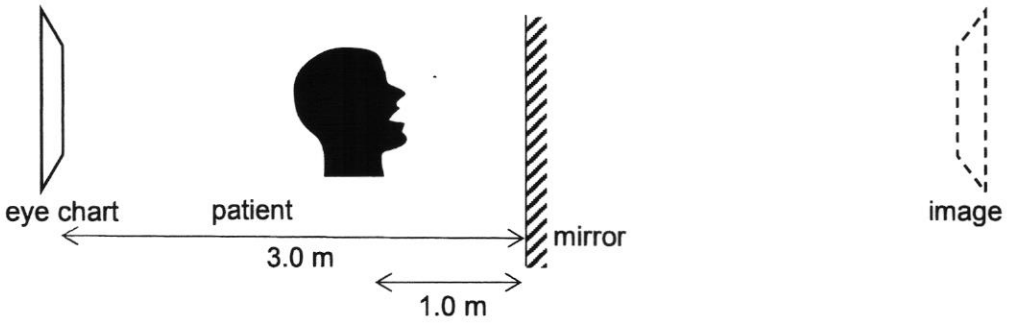


The angle the ray of light makes with the mirror is 40°.

What is the angle between the incident and reflected ray?

A 50° **B** 80° **C** 100° **D** 120°

22 The diagram shows a plane mirror used to test the eyesight of a patient. The eye chart is hung behind the patient and the patient is required to see the image of the eye chart in the plane mirror.

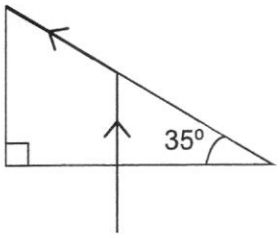


The patient is 1.0 m in front of the plane mirror and the eye chart is 3.0 m in front of the plane mirror.

If the mirror is moved 0.2 m towards the patient, what is the distance of the image from the patient?

A 5.8 m **B** 5.6 m **C** 3.8 m **D** 3.6 m

23 A ray of light enters a prism made of unknown material and travels along the path as shown in the diagram below.



What is the refractive index of material?

A 1.74 **B** 1.50 **C** 1.33 **D** 1.22

24 What are the properties of an image formed by a thin converging lens?

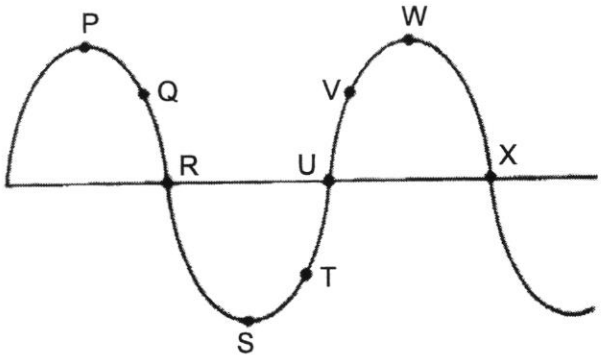
A real, inverted and magnified

B real, upright and diminished

C virtual, inverted, magnified

D virtual, upright, diminished

25 The diagram below shows a snapshot of a transverse wave.



Which pair of points is vibrating in phase?

A P and W

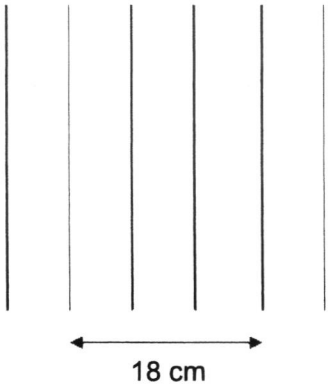
B Q and V

C R and U

D S and U

26 A ripple tank, filled with water, is used to study waves.

The diagram below shows some wavefronts when viewed from the top.



The frequency of the water waves is 15 Hz.

Which is the speed of the wave?

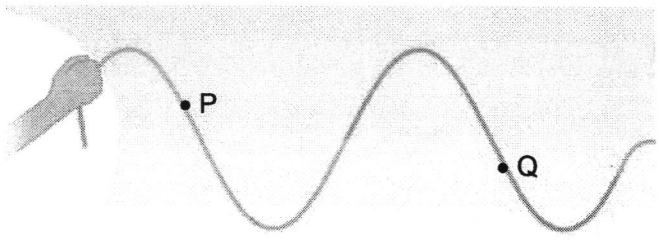
A 15 Hz × (18 cm ÷ 4)

B 15 Hz × (18 cm ÷ 3)

C 15 Hz ÷ (18 cm ÷ 4)

D 15 Hz ÷ (18 cm ÷ 3)

27 The diagram shows a hand producing a series of waves using a rope.

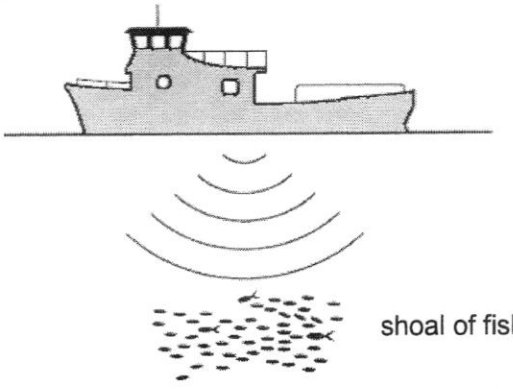


Point P and Q are two points on the rope. The wave is moving from left to right.

What is the direction of motion of P and Q at the instance shown above?

	point P	point Q
A	up	up
B	up	down
C	down	up
D	down	down

28 The diagram shows a fishing boat using echo to detect a shoal of fish.



Short pulses of high frequency sound are sent out from the boat and the echo from the shoal of fish is detected 0.20 s later. Sound waves travel through water at a speed of 1400 m/s.

What is the distance of the shoal of fish from the boat?

A 560 m **B** 360 m **C** 280 m **D** 140 m

29 A student is playing a guitar.

Which statement concerning the vibrations of a string on the guitar is correct?

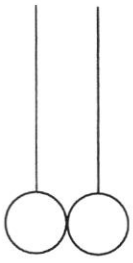
A A transverse wave is produced by the vibrations of the string.

B The frequency of the note produced is smaller if the vibrating length of the string is longer.

C The pitch of the note produced can be increased by plucking the string harder.

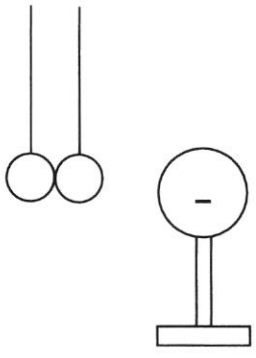
D The velocity of the sound can be increased by increasing the tension in the string.

30 Two identical neutral conducting balls, suspended by insulating thread, are in contact with each other as shown.

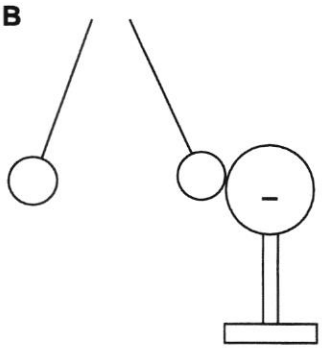


Which of the following shows the final position of the conducting balls when a negatively charged conducting sphere is placed close to them?

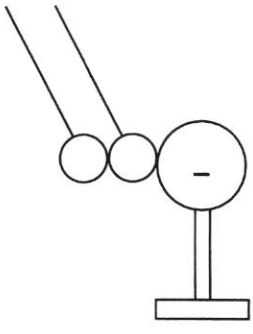
A



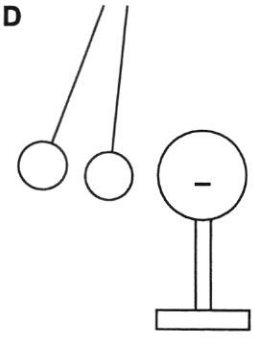
B



C



D

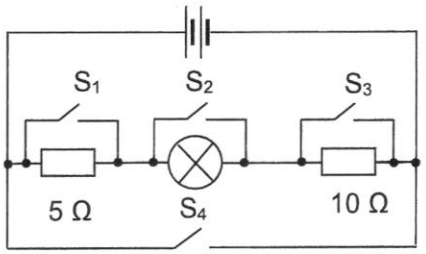


31 A steady current of 0.50 A flows through a bulb when it is connected to a 1.5 V cell.

How much charge passes through the lamp in 1.0 min?

A 0.50 C **B** 1.5 C **C** 30 C **D** 45 C

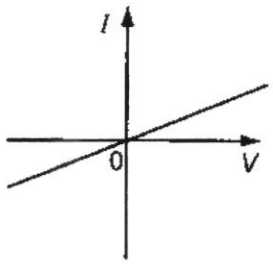
32 The diagram shows a circuit.



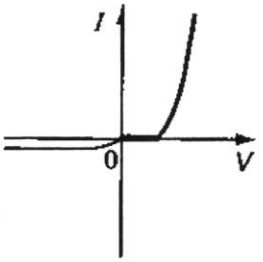
Which switch should be closed to have maximum brightness in the lamp?

A S_1 **B** S_2 **C** S_3 **D** S_4

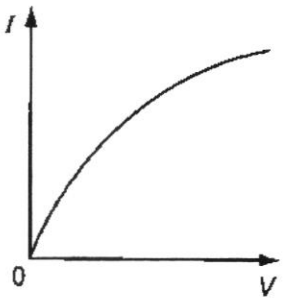
33 The three graphs X, Y and Z show the I-V characteristics for three different components.



graph X



graph Y



graph Z

Which components do the graphs represent?

	graph X	graph Y	graph Z
A	filament lamp	diode	metallic conductor
B	metallic conductor	diode	filament lamp
C	metallic conductor	filament lamp	diode
D	diode	filament lamp	metallic conductor

34 The diagram shows the label on an electric iron.

ELECTRIC IRON	
Operating Voltage	240 V
Power	2.8 kW
Fuse Rating	13 A

This iron is used for 2 hours every day. The cost of 1 kWh of electrical energy is 25 cents.

Which statement about the electric iron is correct?

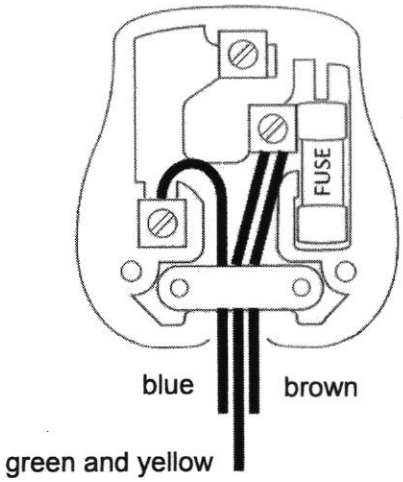
A The fuse will melt.

B The energy used per week is 39.2 kWh.

C The cost of using the electric iron per day is 70 cents.

D The electric iron is operating at 100% efficiency.

35 The plug of the toaster is wrongly wired as shown.



What will happen when the plug is used as shown?

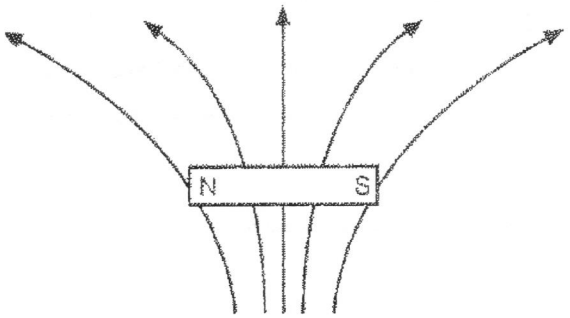
A The fuse in the plug melts.

B The toaster continues to work.

C The toaster does not work.

D The toaster continues to work but the casing becomes live.

36 The diagram shows the top view of a magnet held in a magnetic field.



What happens to the magnet when it is released?

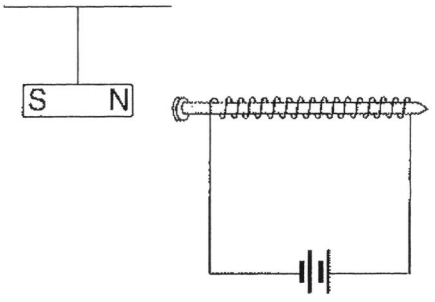
A The magnet will move to the right.

B The magnet will move to the left.

C The magnet will rotate clockwise.

D The magnet will rotate anticlockwise.

37 A length of wire connected to a battery is wound around an iron nail. A magnet which is suspended by a thread is placed near the iron nail.



What will happen to the magnet?

A The magnet moves towards the nail.

B The magnet moves away from the nail.

C The magnet does not move.

D The magnet swings towards to and away from the nail.

38 Which statement about a transformer is false?

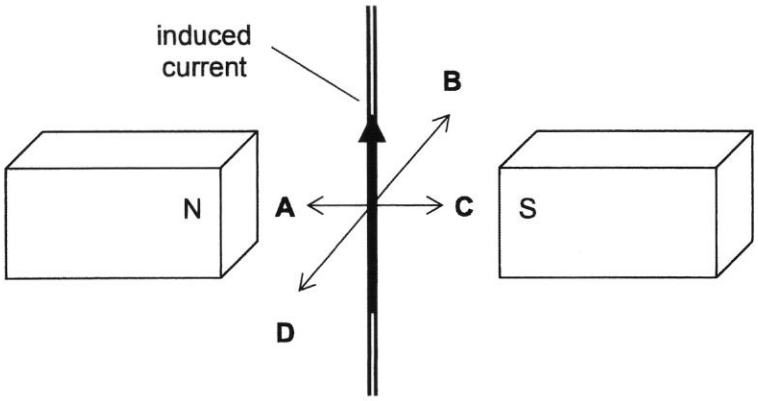
A The primary coil is always connected to an alternating current source.

B The core is laminated to minimise loss in power output.

C The core is made of material that can be easily magnetised and demagnetised.

D The turns ratio of the transformer can be used to determine the magnitude of the power output.

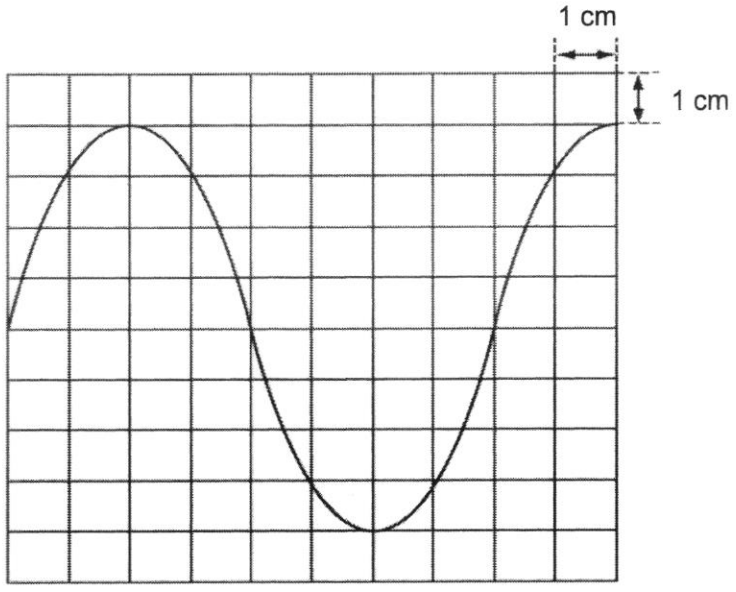
39 The diagram shows a wire placed between a pair of magnets.



An induced current flows upwards when the wire is moved between the magnets.

What is the direction of the motion of the wire?

40 The diagram shows the screen of a C.R.O. connected to an a.c. source.



The time base of the C.R.O. is set at 0.50 ms/cm and the Y-gain is set at 10.0 V/cm.

Which row gives the correct frequency and voltage of the a.c. source?

	frequency / Hz	voltage / V
A	250	40
B	250	80
C	500	40
D	500	80

End of Paper

39	**D**	Using Fleming's Right Hand Rule
40	**A**	period = 0.50 ms/cm × 8 cm = 4.0 ms = 0.0040 s frequency = 250 Hz voltage = 10 V/cm × 4 cm = 40 V

YISHUN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2023
SECONDARY 4 EXPRESS

CANDIDATE NAME	
CLASS	
INDEX NUMBER	

PHYSICS
Paper 2

6091/02
22 August 2023
1 hour 45 minutes

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

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions.

Section B
Answer **all** the questions. Question13 has a choice of parts to answer.

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.

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.

Section A

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

1 Fig. 1.1 shows the speed-time graph for a rocket from the moment the fuel starts to burn at $t = 0$ s.

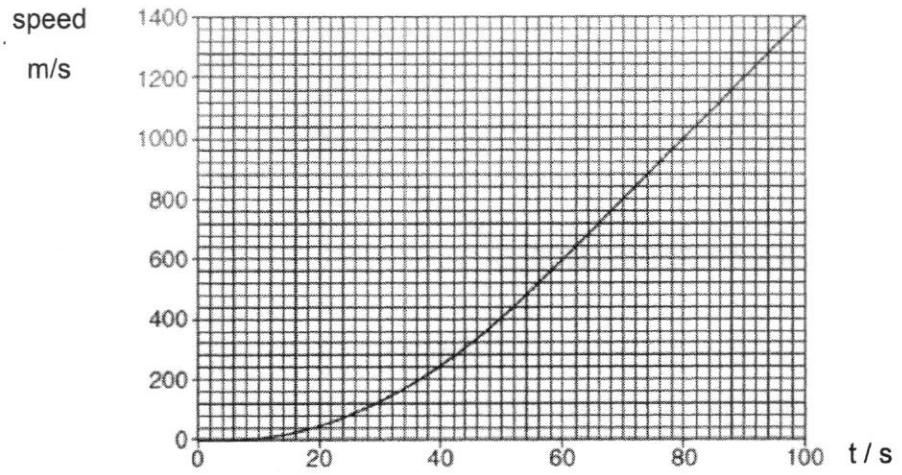


Fig. 1.1

(a) Describe the acceleration of the rocket between $t = 5$ s and $t = 80$ s.

.....

..... [2]

(b) **(i)** Calculate the acceleration of the rocket at $t = 80$ s.

acceleration = ... [2]

(ii) The total mass of the rocket at $t = 80$ s is 1.6×10^6 kg.

Calculate the upward force on the rocket due to the burning fuel at this time.

upward force = ... [2]

2 Fig. 2.1 shows the horizontal forces exerted on a tree by two tractors in an attempt to pull it out of the ground.

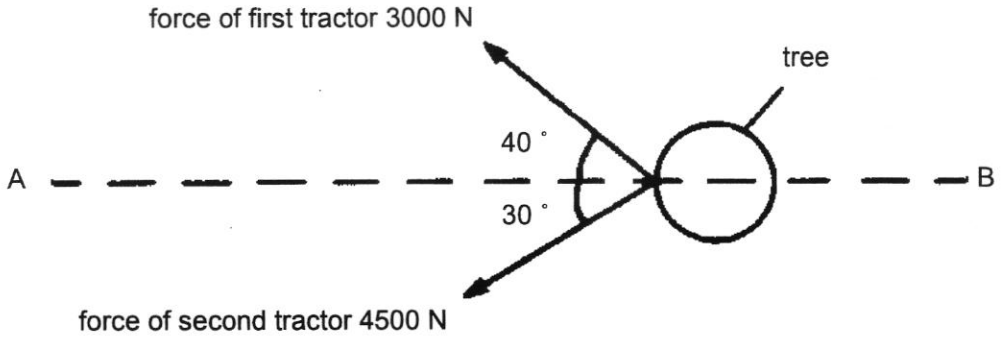


Fig. 2.1

Using a suitable scale, draw a labelled vector diagram to determine the magnitude of the resultant force exerted on the tree by the two tractors.

scale = ...

magnitude = ...
[4]

3 Fig. 3.1 shows a desk lamp with the dimensions shown. The base of the lamp is circular and has a radius of 10 cm. The total weight of the light bulb and shade is 5.0 N and each of the uniform arms has a weight 1.5 N.

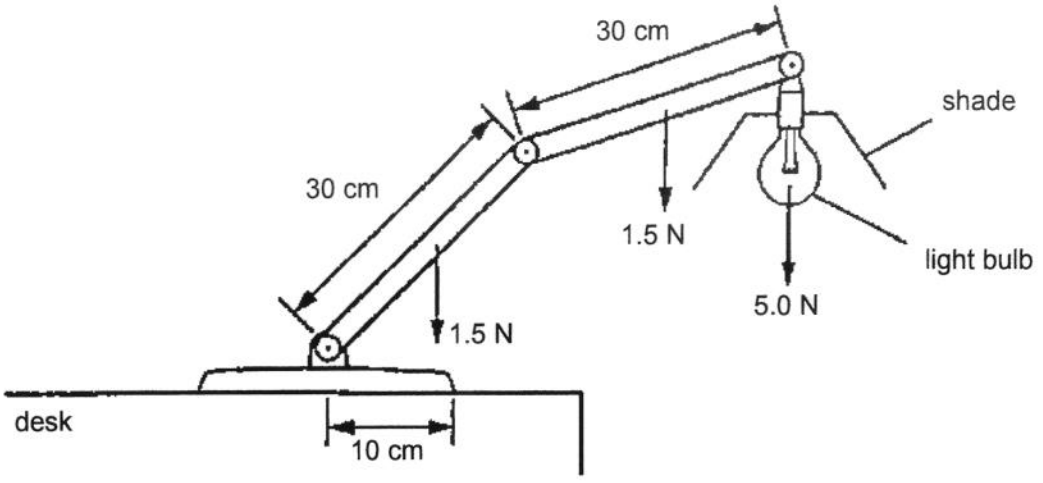


Fig. 3.1

(a) The lamp must be constructed so that it does not topple over when fully extended as shown in Fig. 3.2.

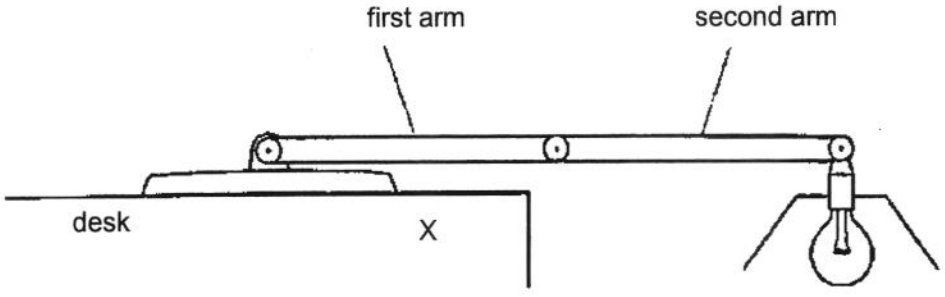


Fig. 3.2

(i) Explain why the lamp has a higher possibility to topple over when fully extended.

.....

.....

..... [2]

(ii) The base must be heavy enough so that the lamp will not topple about point X.

By taking moments about point X, calculate the minimum weight of the base required to prevent toppling.

weight = ... [2]

(b) State and explain one change that could be made to the base to increase the stability of the lamp. The weight of the base is to remain constant.

.....

..... [2]

4 Fig. 4.1 shows a manometer that is connected to two separate containers containing pressurised gases X and Y.

There are two immiscible liquids A and B in the manometer, of densities 5.2 g/cm^3 and 2.8 g/cm^3 respectively. The length of liquid B is 6.0 cm and the height difference of liquid A between the two columns is 8.0 cm.

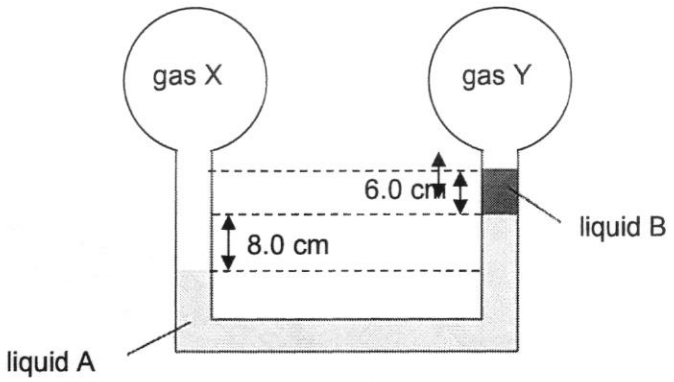


Fig. 4.1

The gravitational field strength is 10 N/kg.

(a) State and explain which gas has a larger pressure.

.....

..... [1]

(b) Calculate the pressure difference between the gases.

pressure difference = ... [3]

(c) The pressure of both gases is much greater than the atmospheric pressure. There is a small hole due to a crack in the container containing gas X.

State and explain what will happen to the liquid levels in the manometer.

.....

.....

..... [2]

5 Fig. 5.1 shows a loaded cart pulled at a constant speed up an inclined plane from point A to point B by a uniform force *F*. The inclined plane is smooth.

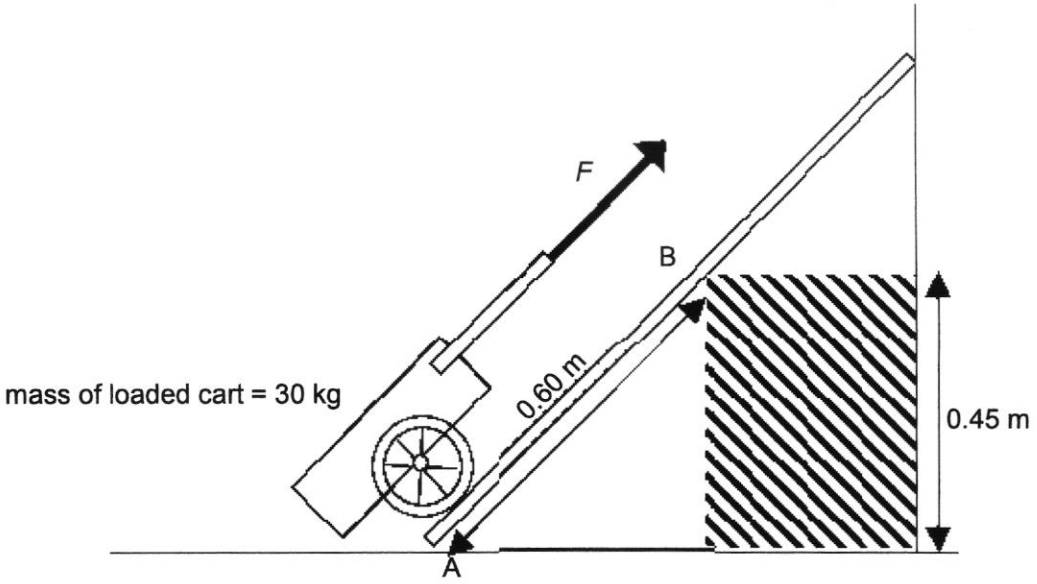


Fig. 5.1

The mass of the loaded cart is 30 kg and the height of point B on the inclined plane from the ground is 0.45 m. The distance travelled by the loaded cart up the inclined plane to point B is 0.60 m.
Take gravitational field strength, g, to be 10 N/kg.

(a) State the *principle of conservation of energy*.

.....

.....

..... [2]

(b) Calculate the gain in gravitational potential energy of the loaded cart when it moves from point A to point B.

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

(c) Calculate the force, F, needed to pull the loaded cart up the inclined plane.

force = ... [2]

6 When an aircraft is flying at high altitudes, a passenger seals some air inside a plastic bag as shown in Fig. 6.1.

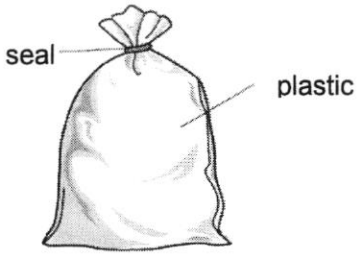


Fig. 6.1

(a) Explain how the air particles in the bag exert a pressure inside the bag.

.....

..... [1]

(b) The plastic bag is tightly sealed, and no air particles are able to escape from the bag.

When the aircraft lands on the ground, the plastic bag is observed to decrease in volume.

(i) Explain this observation assuming that the temperature of the air remains constant.

.....

..... [1]

(ii) State and explain, in terms of the air particles, what happens to the air pressure inside the bag.

.....

..... [2]

7 Fig. 7.1 shows how the length *L* of a mercury thread in a thermometer varies with temperature *T*.

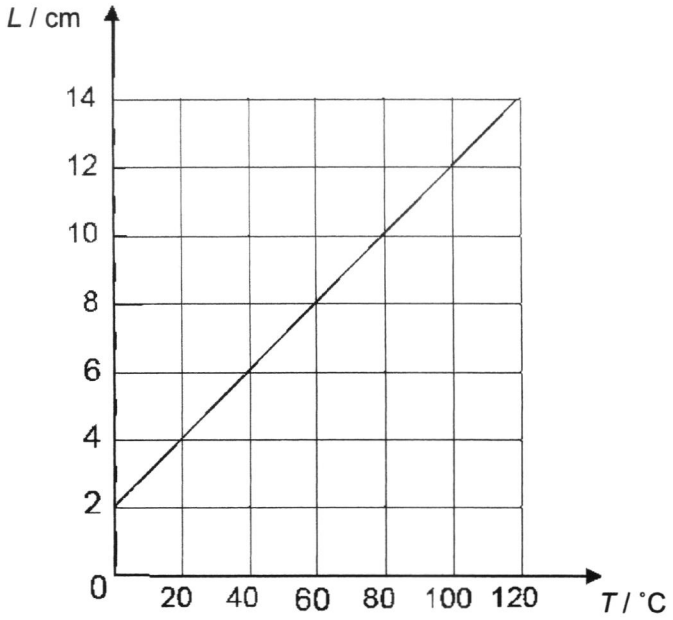


Fig. 7.1

(a) State what is meant by *ice point*.

.....

..... [1]

(b) The thermometer could be used to measure temperature below 0 °C.

Calculate the temperature when the length of the mercury thread is 0.50 cm

temperature = ... [2]

8 Fig. 8.1 shows a ray of light travelling from the bottom of an object through the optical centre of a thin converging lens without bending. F is one of the two focal points of the lens.

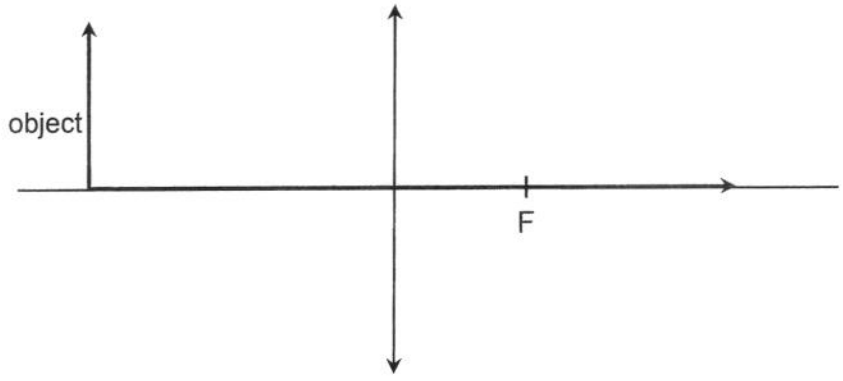


Fig. 8.1

(a) Explain why the ray of light does not bend as it travels from air into the lens and from the lens into air again.

.....

..... [1]

(b) On Fig. 8.1, draw two rays to locate the image of the object. Label the image I. [2]

(c) State one application of the above lens arrangement.

..... [1]

A negatively charged plastic spoon can be used to extract fine grains of pepper from a dry mixture of salt and pepper by holding the plastic spoon above it.

The fine grains of pepper is attracted first and if the spoon is brought nearer to the mixture, grains of salt will also be attracted.

(a) Explain why the grains of pepper is attracted to the charged spoon.

.....

.....

..... [2]

(b) Explain why the grains of salt will only be attracted to the charged spoon if the spoon is placed nearer to the mixture.

.....

..... [1]

(c) Describe and explain one way to discharge the plastic spoon.

.....

.....

..... [2]

10 Modern power stations rely on renewable energy sources to drive the turbines. The turbines in turn generate electricity in a.c. generators.

Step-up and step-down transformers are used when power is transmitted from the power station to the homes through the transmission cables.

(a) Explain what is meant by *renewable energy*.

.....

..... [1]

(b) State a suitable renewable energy source for Singapore.

..... [1]

(c) Explain the need to step-up the voltage when power is transmitted from the power station.

.....

.....

..... [2]

(d) On a particular day, the power transmitted by a power station is 1.0×10^7 W and the output voltage in the step-up transformer is 2.5×10^5 V.

Calculate the current in the transmission cable.

current = ... [2]

Section B

Answer **all** the questions in this section

Answer only one of the two alternative questions in **Question 13**.

11 Fig. 11.1 shows a simple circuit consisting of a cell, a switch, an ammeter and a resistance wire connected across PQ.

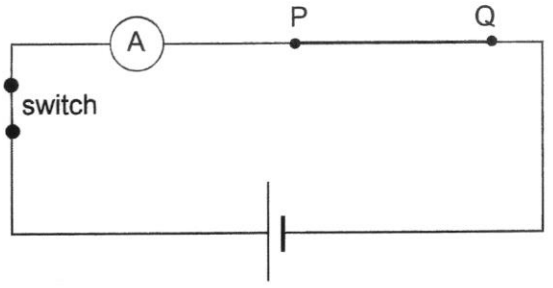


Fig. 11.1

To investigate how the dimensions of resistance wires affect the current, an experiment was carried out using the above circuit. Resistance wires of the same material but different dimensions are connected across PQ and the current is recorded.

(a) Define the term *current*.

.....

..... [1]

(b) Fig. 11.2 shows how the current varies with the dimensions of the resistance wire when the switch is closed.

length / cm	cross-sectional area / mm^2	current / A
300.0	4.0	0.15
300.0	5.0	0.19
300.0	6.0	0.23
300.0	7.0	0.26
300.0	8.0	0.30
300.0	12.0	0.45

Fig. 11.2

(i) Using Fig. 11.2, describe how the current varies with the cross-sectional area of the resistance wire.

.....

..... [1]

(ii) PQ is now connected by a resistance wire of length 150.0 cm and cross-sectional area 24.0 mm^2.

Calculate the current recorded by the ammeter.

current = ... [2]

(iii) The above resistance wire is removed. PQ is now connected by 10 pieces of resistance wires in parallel. Each wire is of length 300.0 cm and cross-sectional area 12.0 mm^2.

Calculate the current recorded by the ammeter.

current = ... [1]

(c) When PQ is connected by a single resistance wire, it is placed in the magnetic field of a strong bar magnet. It is observed that the resistance wire bends.

(i) Explain what is meant by *magnetic field.*

.....

.....

..... [1]

(ii) Explain the above observation.

.....

.....

.....

..... [2]

(iii) On Fig. 11.3, draw the magnetic field pattern of the bar magnet. [2]

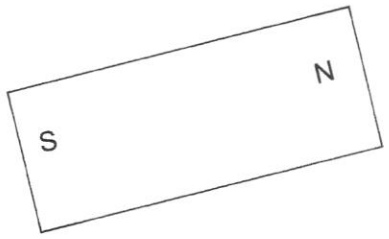


Fig. 11.3

(d) Fig. 11.4 shows an input transducer and a bulb connected in parallel across PQ.

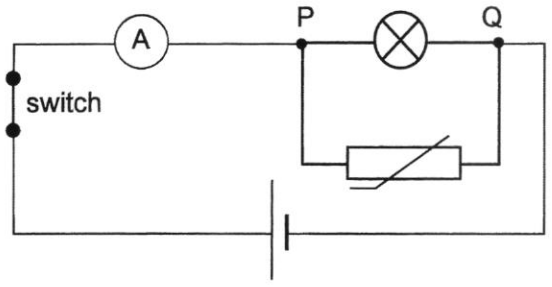


Fig. 11.4

(i) Describe how changes in one surrounding physical condition changes the resistance of the input transducer.

.....

..... [1]

(ii) Explain how the brightness of the bulb is affected, if any, by the changes in the physical condition mentioned in **(i)**.

.....

..... [1]

12 Infrared is an example of electromagnetic waves.

(a) State one similar and one different property between infrared and ultrasound.

similar: .....

.....

different: .....

.....

[2]

(b) Sources of infrared can be found around us.

Identify a common source in our homes or school that gives out large amount of infrared.

..... [1]

(c) Identify one electromagnetic waves that has a longer wavelength than infrared.

..... [1]

(d) A ray of infrared travels from air into two transparent blocks, X and Y. Fig. 12.1 shows the incident ray in air.

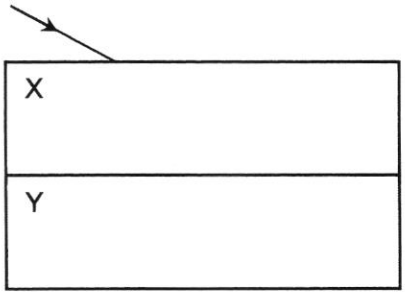


Fig. 12.1

In medium X, the speed of the infrared is 2.7×10^8 m/s. In medium Y, the speed of the infrared is 2.9×10^8 m/s.

(i) Identify **one other** physical property of the infrared that changes when it travels from air into the transparent block X. Describe the change of this physical property.

..... [2]

(ii) On Fig. 12.1, sketch the path of the ray of infrared until it emerges into air from the opposite side of block Y. [2]

13 EITHER

The Public Warning System is a network of sirens that the Singapore Civil Defence Force has placed at strategic points throughout Singapore. The purpose of this system is to warn the public of imminent threats that could endanger lives and property.

Every year, there are a few public warning system sirens exercise.

Fig. 13.1 shows a typical siren installed on the roofs of residential and commercial buildings.

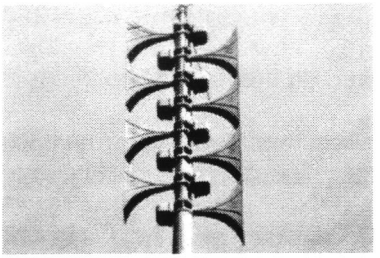


Fig. 13.1

(a) Describe, using the motion of air particles, how the sound is transmitted from the siren to the public.

.....

.....

.....

.....

..... [3]

(b) A siren is installed 1.2 km from our school. The speed of sound in air is 320 m/s.

Calculate the time it takes for the sound to travel from the siren to our school.

time = ... [1]

(c) The frequency of the siren is set at 19 kHz.

Explain why this is not an ideal frequency.

.....

..... [1]

(d) On a windless day, it is discovered that the sound heard by residents whose homes are nearer to the siren than our school is louder.

Explain one reason for the difference in the loudness of the sound.

.....

.....

..... [1]

(e) The sirens that are installed on the roofs of buildings may be damaged by lightning.

One way to protect the sirens and buildings from lightning is to installed lightning conductors on the exterior of buildings. These lightning conductors stretch from the roof to the ground.

Lightning, caused by the discharge of high amount of electrons from the bottom of the thunderclouds, will strike the positively charged lightning conductor instead of the other parts of the buildings.

(i) Explain why the lightning conductors become positively charged when thunderclouds move above them.

.....

.....

..... [2]

(ii) During one lightning strike, the potential difference between the thundercloud and the lightning conductor is 25 MV and a current of 50 kA is recorded. 350 C of charges flow through the conducting rod.

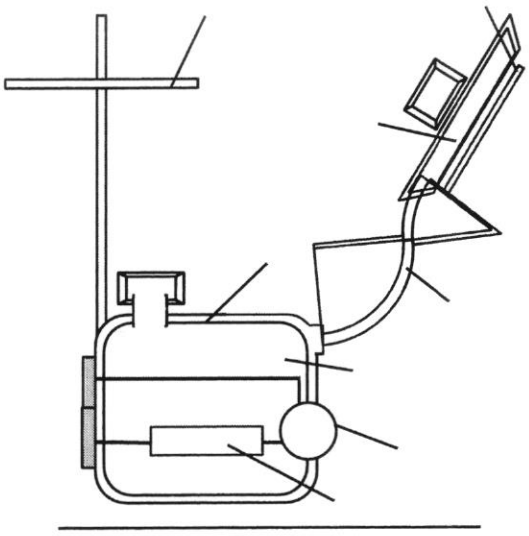
Calculate the energy dissipated during the lightning.

energy dissipated = ... [2]

13 OR

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

(a) Fig. 13.2 shows the standing steam iron connected to the mains supply.



steam

wire to mains supply

ironing plate

heating element

indicator lamp

pipe

water tank

water

clothes stand

specifications of standing iron

power: 2.0 kW

operating voltage: 240 V

capacity: 1.5 litre

heat-up time: 45 s

thermal properties of water

specific heat capacity:

4.2 J / (g °C)

specific latent heat of vaporisation:

2.3 kJ / g

Fig. 13.2 **Fig. 13.3**

Fig. 13.3 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 thermal energy used to raise the temperature of the water in the tank to its boiling point.

energy used = ... [2]

(ii) Calculate the amount of thermal energy used to produce the steam during usage.

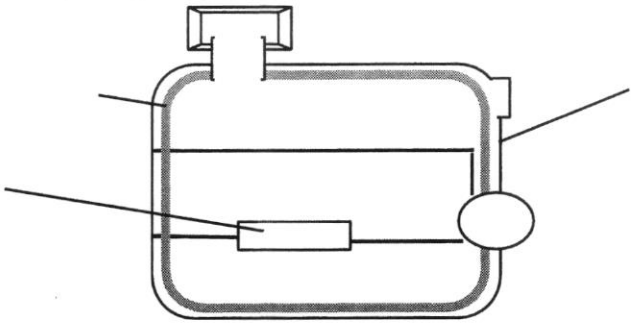
energy used = ... [2]

(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) Fig. 13.4 shows some key design features of the water tank of the standing steam iron.



tank made of copper

heating element

white plastic casing

Fig. 13.4

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

.....

.....

.....

..... [3]

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

.....

.....

..... [2]

End of Paper

Answers for Paper 1

1	C	The base quantities are length, mass, temperature, and time. The rest are derived quantities
2	D	zero error = - 0.03 mm observed reading = 4.72mm diameter of rod = 4.75 mm cross sectional area = $\pi (4.75/2)^2 = 17.7$ mm^2
3	C	option A: ½ oscillation option B: less than 1 oscillation option D: 2 oscillation
4	B	Micrometer must be used for measuring the diameter. Vernier calipers are not suitable for measuring length of wires.
5	C	The shortest distance will be 5.0 m in the direction of RP to have a displacement of zero
6	D	From t_1 to t_2, the speed of the train is increasing (represented by the magnitude of the gradient). The negative sign of the gradient represents moving backwards (i.e. moving back to the train station)
7	B	From t = 0 – 6s: This represents the upward motion of the stone to its highest position. From t = 6 – 12s: This represents the downward motion of the stone back to the position of the man's hand From t = 12 – 18s: This represents the downward motion of the stone from the man's hand to the surface of the sea. Height = area under graph from t = 12 to 18s = ½ (6+12)(6) = 54 m
8	D	Mass is unaffected by gravitational field strength Weight is affected by gravitational field strength. The smaller the gravitational field strength, the smaller the weight.
9	C	Density of the granite remains the same whether it is in a bigger piece or smaller piece. Box Y will be heavier as it is able to fit more granite within the same volume. (i.e. greater mass per unit volume)
10	D	density = mass / volume = (34 x 3) / (30-18) = 8.5 g/cm^3
11	A	Object A has a wider base as compared to its top. Lower centre of gravity with a wider base area makes for a more stable object
12	D	power = $\frac{w.d}{t} = \frac{F \times d}{t} = F \times \left(\frac{d}{t}\right) = F \times v$
13	D	X: GPE, Y: KE, Z: GPE
14	A	The random movement of the smoke particles are due to the collisions of the air particles which are moving randomly.
15	D	Gas particles have weak intermolecular forces between them. They are far apart and move in a disorderly arrangement.
16	D	When temperature remains constant $P \propto (\frac{1}{V})$ A graph of P against $(\frac{1}{V})$ should give a straight line passing through the origin.
17	A	The trapped air between the layers of glass is a poor conductor of thermal energy. The trapped air does not prevent radiation or convection
18	B	The largest difference in temperature will give the largest voltmeter reading. | B
19	A	As temperature increases, the mercury in the thermometer expands (volume increases). Its density decreases as a result. As it expands, internal KE increases. Only mass remains constant.
20	D	The first horizontal line on the graph represents the liquid solidifying.

		Temperature T represents room temperature.
21	C	angle of incidence = angle of reflection = 50°
22	D	new distance of chart from mirror = 2.8 m = new distance of image from mirror new distance of patient from mirror = 0.8 m distance of image from patient = 2.8 m + 0.8 m = 3.6 m
23	A	angle of incidence in prism = 35° angle of refraction in air = 90° refractive index = sin 90° ÷ sin 35° = 1.74
24	A	All real images are inverted but can be magnified or diminished. All virtual images are upright and magnified.
25	A	Particles vibrating in phase (same velocity and same displacement from rest position) are one wavelength apart.
26	B	wavelength = 18 cm ÷ 3 speed = f × λ = 15 Hz × 18 cm ÷ 3
27	A	By shifting the rope wave slightly to the right, the new position of P and Q are higher.
28	D	distance = ½ (1400 m/s × 0.2 s) = 140 m
29	B	Sound waves are longitudinal waves. If the string is longer, the no. of vibration of the strings per unit time decreases. If string is plucked harder, the loudness increases. Velocity of sound only depends on the medium.
30	D	Both neutral conducting balls will be attracted to the sphere (because all neutral bodies are attracted to charged body). Once they make contact (as shown in option C), negative charges will flow from the sphere to the two balls. They will repel each other since like charges repel.
31	C	Q = 0.50 A × 60 s = 30 C
32	C	S1 closes: no current flows through 5 Ω resistor but current flows through 10 Ω resistor, and the current through lamp is lower so we do not have maximum brightness S2 closes: no current flows through lamp S3 closes: no current flows through 10 Ω resistor but current flows through 5 Ω resistor, and the current through lamp is higher so we have maximum brightness S4 closes: no current flows through lamp and resistors
33	B	Metallic conductor obeys Ohm's Law. Diode has very high resistance when voltage across is reversed and current is negligible. Filament lamp does not obey Ohm's Law.
34	B	Current is 11.7A (= 2800W ÷ 240V) and so fuse will not melt. Energy per week = 2.8 kW × 2h × 7 = 39.2kWh. Cost per day = 2.8 kW × 2h × 25 cents = 140 cents. There is no information on the efficiency of the electric iron and the magnitude is always less than 100%.
35	D	Both the live and earth wires are connected to the high voltage of the supply. Current will continue to flow normally in the live and neutral wires and so the fuse will not melt. But the metal casing, connected to the earth wire, will be at high voltage but no current will flow in the earth wire since it is not connected to the Earth/ground.
36	C	The direction shows the direction of the magnetic force acting on a N-pole. Hance the N-pole of the magnet will move in the direction of the field and the S-pole will move in the opposite direction of the field.
37	A	Using Right Hand Grip, a N-pole is induced on the right side of the nail and a S-pole is induced on the left side of the nail. Since unlike poles attract, the magnet is attracted to the nail.
38	D	The turns ratio of the transformer can be used to determine the magnitude of the **voltage** output. Power output = power input if the transformation is 100% efficient.

[Turn over

Answers to Section A

1 **(a)** t = 5 s to t = 50 s: increasing acceleration [1]
t = 50 s to t = 80 s: constant acceleration [1]
[note: to accept if the cut off timing is slightly below or above 50s]

(b) acceleration
= (1400 – 400) / (100 – 50) [1]
= 20 m/s^2 [1]

(c) upward force – weight = ma
upward force – (1.6 x 10^6 x 10) = (1.6 x 10^6) x 20 [1]
upward force = 4.8 x 10^7 N [1]

2 scale: 1.0 cm : 500 N [1]
accuracy of diagram showing the correct tractor forces and angle [1]
correct labelling of diagram with arrows [1]
correct magnitude of resultant force: 6100 N ± 100 N [1]

3 **(a)** The perpendicular distances from the lines of action of the components of the weights to the pivot are maximum, [1] creating the maximum clockwise moments about X. [1]

(b) Total anticlockwise moments = total clockwise moments
W x 10 = (1.5 x 5) + (1.5 x 35) + (5.0 x 50) [1]
W = 31 N [1]

(c) Larger radius of the base / area of the base could be increased. [1]
This decreases the clockwise moment about the new point X. [1]

4 **(a)** Gas X has a larger pressure because the liquid level is lower than that exerted by gas Y. [1]

(b) pressure difference
= pressure difference due to the liquid levels
= (0.080 x 5200 x 10) [1] + (0.060 x 2800 x 10) [1]
= 5840 Pa [1]

(c) Gas X will escape from the container, decreasing its pressure within the container. [1]
The liquid level on the left will increase, while the liquid level on the right will decrease. [1]

5 **(a)** Principle of conservation of energy states that energy cannot be created or destroyed, it can only be converted from one form to another. [1]
Total energy in the system is conserved. [1]

(b) Gain in g.p.e.
= mgh
= 30 x 10 x 0.45 [1]
= 135 J [1]

(c) work done = gain in g.p.e.
F x 0.60 = 13.5 [1]
F = 22.5 N [1]

6 **(a)** The air particles collide with and exerts a force per unit area on the inside of the bag. [1]

(b) **(i)** The atmospheric pressure is higher than pressure of air inside bag. This creates a net force inwards, causing bag to decrease in volume. [1]

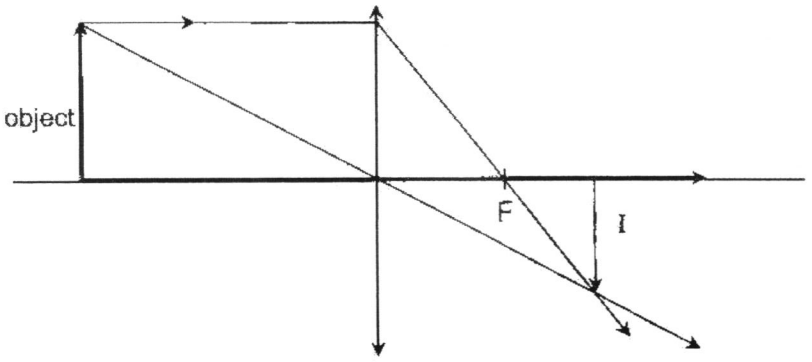
(ii) The air pressure increases. [1]
There are more particles per unit volume. The particles collide with the inside of bag more frequently (though with the same force). [1]

7 **(a)** It is the temperature of pure, melting ice at standard atmospheric pressure, (and is assigned a value of 0 °C.) [1]

(b)
$$\theta = \frac{l_\theta - l_0}{l_{100} - l_0}$$

$= \frac{0.5-2.0}{12.0-2.0}$ [1]
$= -15\,^{\circ}C$ [1]

8



(a) The angle of incidence at both boundaries is 0°. [1]
Reject: the angle the ray makes with the boundaries is 90°.

(b) See above. Correct rays with arrows [1] and image is correctly drawn and labelled. [1]

(c) Camera lens or eye lens [1]

9 (a) The plastic spoon has an electric field and will induce an opposite and like charges on the grains of pepper. [1]
The attraction force between unlike charges is higher than the repulsion force between the like charges. [1]

(b) Grains of salt has a higher weight and require strong attractive forces to be attracted. [1]

(c) Place the plastic spoon near a flame [1].
The flame ionises the air particles and ions of opposite charge will be attracted to the sandpaper. [1] OR
Spray water on the plastic spoon. [1]
Water are electrical conductors and excess charges will be exchanged between the spoon and the water particles. [1]

10 (a) Energy from sources that can be replenished naturally. [1]

(b) Solar energy [1]

(c) To decrease the current in the transmission cable [1] so as to decrease the power lost during transmission. [1]

(d) current = power / voltage
$= 1.0 \times 10^7$ W / 2.5×10^5 V [1]
= 40 A [1]

Answers to Section B

11 (a) Rate of flow of charges. [1]

(b) (i) Current is directly proportional to the cross-sectional area of the resistance wire. [1]

(ii) Using values for 300.0 cm and 12.0 mm^2 wire:
- current due to shorter length = 0.45 A × 2
- current due to thicker wire = 0.45 A × 2

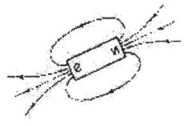
effective current = 0.45 A × 4 [1] = 1.8 A [1]

(iii) current is 10 times larger because resistance is ten times smaller = 4.5 A [1]

(c) (i) The region where a magnetic material experiences a magnetic force. [1]

(ii) The interactions of the magnetic field of the magnet and the current [1] induces a force on the wire. [1]

(iv)



Correct pattern [1] and direction [1]

(d) (i) When the temperature decreases, its resistance increases, vice versa. [1]
No penalty if vice versa is omitted.

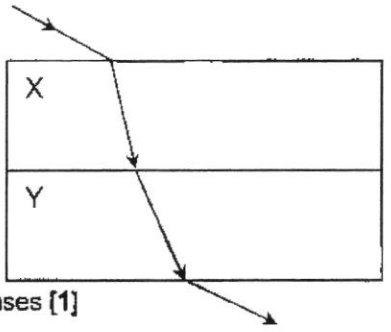
(ii) Brightness is not affected because the p.d. across the bulb in parallel remains the same (as the e.m.f.) [1]

12 (a) similar: they transfer energy OR they obey laws of reflection / refraction OR they do not carry charges etc [1]
different: infra-red rays are transverse waves and ultrasound is longitudinal waves OR infra-red rays can travel in vacuum and ultrasound needs a medium for transmission. [1] Reject they have different frequency / wavelength.

(b) Any sources that are hot OR hot objects. [1]

(c) Radio waves OR microwaves. [1]

(d)



(i) Wavelength [1] decreases [1]

(ii) See above.
All 3 rays have correct bending in all the media [2] 2 rays correct bending [1]
Rays must have arrows.

13E (a) Siren vibrates and collide with neighbouring air particles causing them to vibrate. They in turn collide with other air particles and transfer energy. [1]
The vibration is parallel to the sound (wave) propagation. [1]
Sound is thus transmitted in a series of compressions and rarefactions. [1]

(b) time = distance / speed = 1200 m / 320 m/s = 3.75 s [1]

(c) It is near the upper range of audible frequency (or frequency is very high) and some people are not able to detect the sound. [1]

(d) Sound waves diverge as they move and cover a larger surface area. Points further away will receive less sound energy. [1]

(e) (i) Electrons in the lightning conductor are repelled to the ground [1] since like charges repel. [1]

(ii) energy dissipated = voltage × charge
= 25 000 000 V × 350 C [1]
= 8.75×10^{10} J [1]

13O (a) (i) Energy to raise temperature Q_1
= $mc\Delta\theta$ = (1.5 x 1000) x 4.2 x (100 – 32) [1]
= 428 400 ≈ 430 000 J [1]

(ii) Energy to produce steam Q_2
= ml_v = (80/100 x 1.5 x 1000) x 2.3 x 1000 [1]
= 2 760 000 ≈ 2 800 000 J [1]

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

(b) (i) The water near the heating element gets heated up, expands, become less dense and rises [1]
while the cooler water sinks/gets displaced downwards and gets heated, in turn. [1]
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.
White is a poor emitter of infrared rays so thermal energy transfer from the water tank to the surroundings by radiation is reduced.
Trapped air between the layers of plastic is a poor conductor of thermal energy.
[any two] [1 + 1]