Geylang Methodist School (Secondary)
Preliminary Examination 2020

PHYSICS **6091/01**

Paper 1 **Sec 4 Express**

Additional materials : OAS

1 hour

Setter : Mr Sng PH

14 September 2020

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, index number and class on all the work you hand in.

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

Read the instructions on the Answer Sheet very carefully.

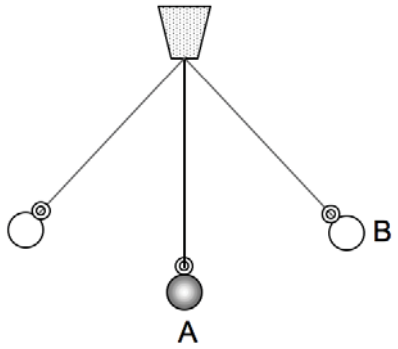
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough work should be done in this paper.

Acceleration due to gravity, ***g***, is assumed to be 10 m/s^2 and gravitational field strength, ***g***, is assumed to be 10 N/kg, unless otherwise specified.

This document consists of **16** printed pages.

[Turn over

1 The time taken for a pendulum to swing from the rest position A to its maximum displacement B is 0.5 s.



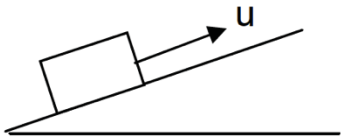
What is the frequency of the oscillation?

A 0.5 Hz **B** 1.0 Hz **C** 2.0 Hz **D** 4.0 Hz

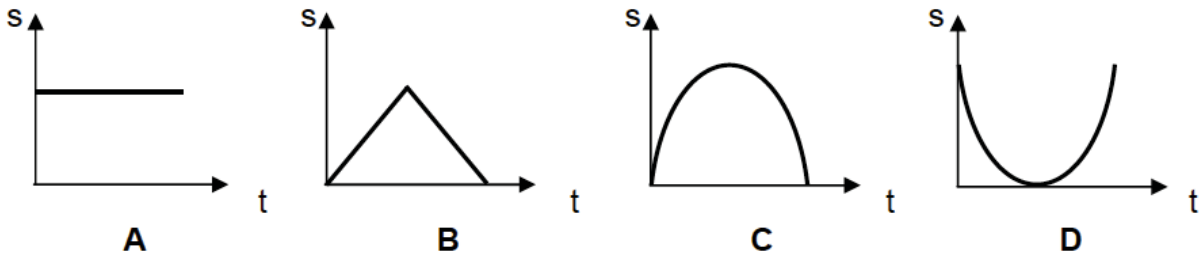
2 A particle released from rest at P falls freely under gravity and passes 2 positions, X and Y. If the particle takes 2.0 s to travel from X to Y, where XY= 40 m, how long does it take to fall from P to X?

A 0.5s **B** 1.0 s **C** 1.5 s **D** 2.0 s

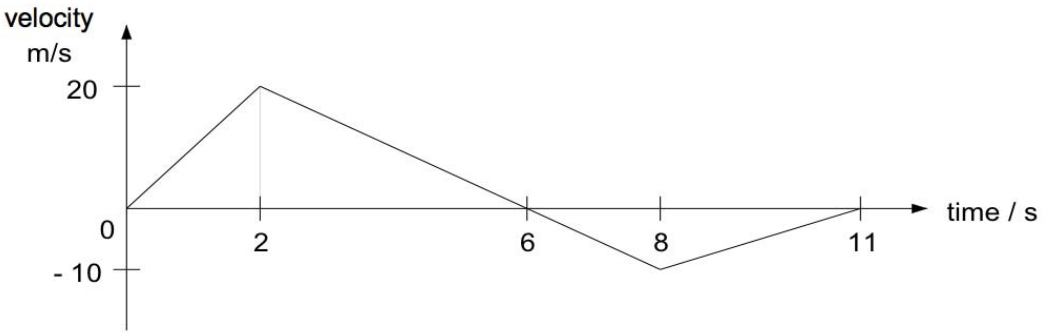
3 An object is projected up a smooth inclined plane with an initial velocity u.



Which of the following best represents the variation of the displacement s of the object along the plane with time t? You may ignore air resistance.



4 The diagram shows the velocity-time graph of an object moving along a straight line.

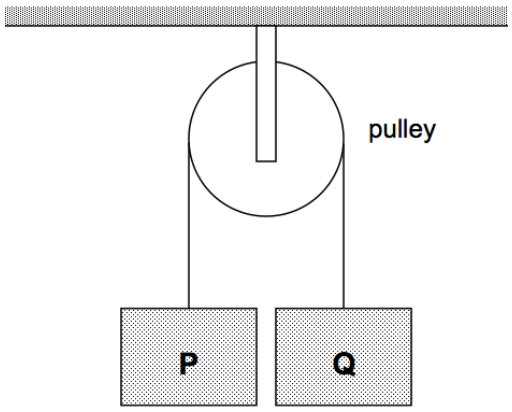


Which of the following statements is/are correct?

I. The object stops at t = 6 s.
II. The acceleration of the object at t = 6 s is zero.
III. The object is 35 m away from the starting point at t = 11 s.
IV. The object increases its speed at a rate of 3.33 m/s^2 from t = 8 s to t = 11 s.

A I only
B I and III only
C II and IV only
D I, III and IV only

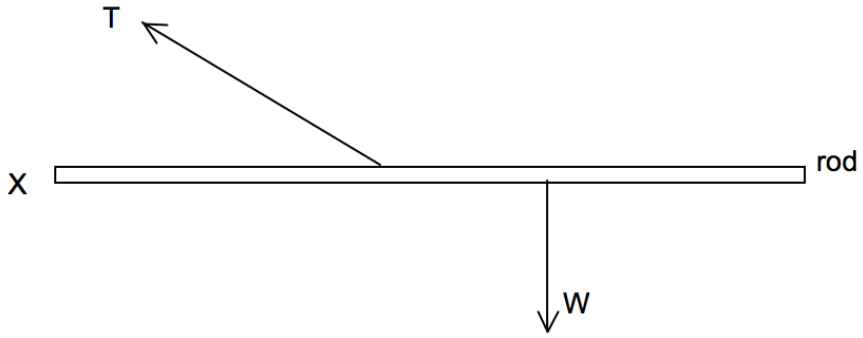
5 The diagram below shows two masses, P and Q, attached to the ends of a light inextensible string, which is hung over a frictionless pulley. When the masses are released from rest, it is observed that P moves down with uniform acceleration of 4.0 m/s^2.



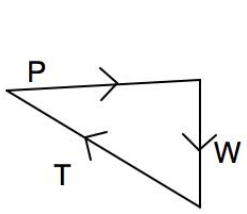
Given that the mass of P is 3 kg, calculate the tension on the string.

A 12 N **B** 18 N **C** 30 N **D** 42 N

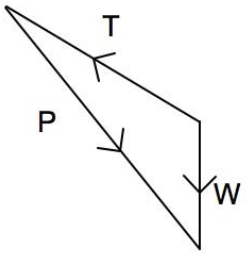
6 The diagram shows a rod. Only three forces act on the rod: tension T provided by a supporting cable, the weight of the rod and a force P (not shown) acting at point X.



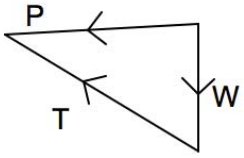
The rod is in equilibrium. Which diagram of forces is correct?



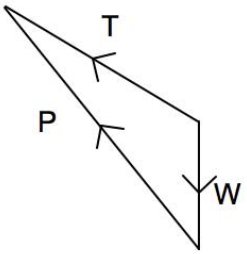
A



B



C



D

7 Which of the following statements are correct?

I. An object can be accelerating when its speed is constant.
II. An object can be moving when its acceleration is zero.
III. An object can change its velocity when its speed remains the same.
IV. Both the average velocity and average speed of an object must be the same.

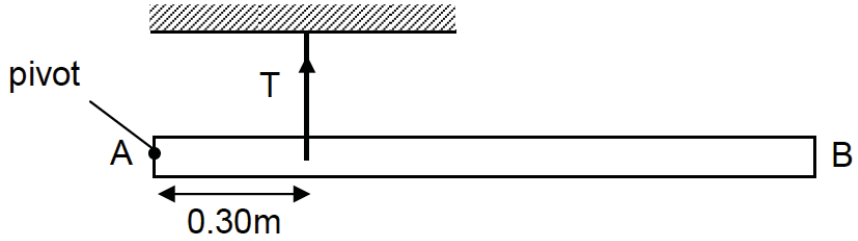
A I and II only
B II and III only
C I, II and III only
D All of the above

8 A mass of liquid with density ρ is thoroughly mixed with another liquid of equal mass but with a density 2ρ. The total volume of the mixture is the summation of the volumes of the two liquids.

What is the density of the liquid mixture?

A $\frac{4}{3}\rho$ **B** $\frac{3}{2}\rho$ **C** $\frac{5}{3}\rho$ **D** 3ρ

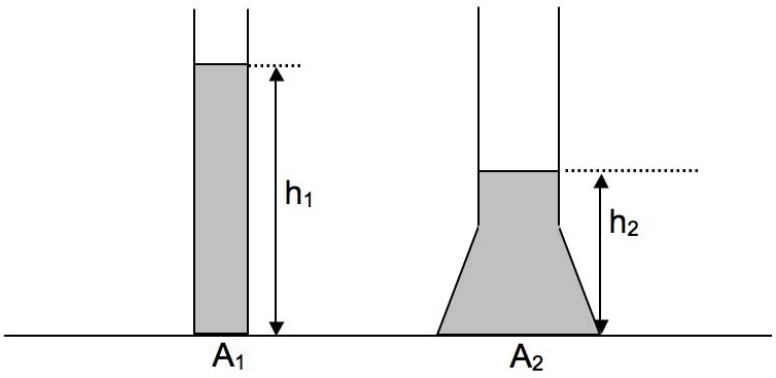
9 A 1.0 m long horizontal rod AB has negligible mass. It is pivoted at A and hung with a string at a distance of 0.30 m from A. Tension, T in the string is 2.0 N and a force is acting at B. The rod AB is in equilibrium.



What is the magnitude and direction of the force exerted at B?

	magnitude	direction
A	0.6 N	upward
B	0.6 N	downward
C	2.0 N	upward
D	2.0 N	downward

10 Water is poured into a container of base area A_1 up to a height of h_1. Water is also poured into a second container of bigger base area A_2, but up to a smaller height of h_2. The pressure exerted on base A_1 is P_1 while that exerted on base A_2 is P_2.



Which of the following statements is correct?

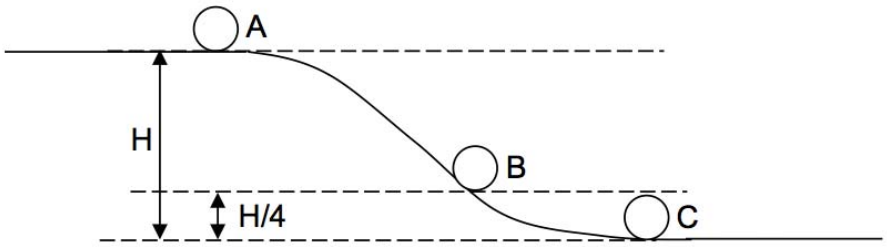
A $P_1 < P_2$ because $A_2 > A_1$.

B $P_1 > P_2$ because $A_2 > A_1$.

C $P_1 > P_2$ since $h_1 > h_2$.

D It is possible that $P_1 = P_2$ since $A_2 > A_1$ and $h_1 > h_2$.

11 A ball, initially at rest, rolls down a smooth slope as shown in the figure below.

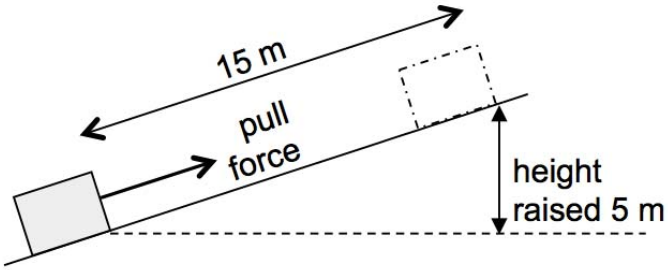


Which statements are correct about the kinetic energy (KE) and gravitational potential energy (GPE) of the ball?

I. KE at B = ¼ x KE at C
II. KE at B = ¾ x KE at C
III. KE at B = GPE at B
IV. KE at C = GPE at A

A I and IV only
B I and III only
C II and III only
D II and IV only

12 An object of mass 20 kg is pulled up a slope of 15 m. The frictional force between the object and the slope is 30 N.



What is the minimum work done by the pulling force?

A 450 J **B** 1000 J **C** 1450 J **D** 3000 J

13 A fixed mass of gas is heated while its volume is kept constant.

How do the properties of the molecules of the gas change?

	average speed	frequency of collision	average distance apart
A	increases	increases	decreases
B	increases	increases	unchanged
C	increases	unchanged	unchanged
D	unchanged	increases	increases

14 When a liquid evaporates, it cools down.

Which molecular behaviour is the reason for this cooling?

A All molecules slow down.

B Fast molecules leave the surface.

C Molecular collisions result in loss of kinetic energy of the molecules.

D The molecules collide with each other less frequently.

15 The radiator fins in a car radiator are usually painted dull black in order to prevent the engine from overheating.

This is because dull black surface is a

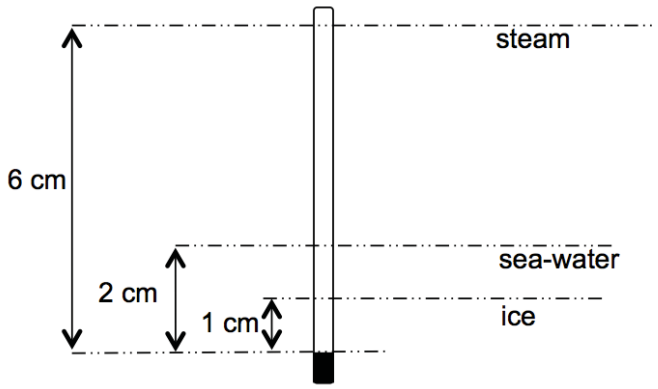
A good absorber of infra-red radiation.

B good conductor of heat.

C good emitter of infra-red radiation.

D poor emitter of infra-red radiation.

16 A student puts the bulb of an unmarked liquid-in-glass thermometer into melting ice, then into steam and finally into sea-water. The diagram shows the liquid levels measured from the bulb.



What is the temperature of the sea-water?

A 2 °C **B** 20 °C **C** 33 °C **D** 40 °C

17 A lump of lead of specific heat capacity 130 J $kg^{-1}°C^{-1}$ is dropped from the top of a tall building of height 26 m. Assuming that all the initial potential energy of the lead becomes heat energy when the lump strikes the ground, the increase in temperature of the lead is

A 0.2 °C **B** 0.5 °C **C** 2.0°C **D** 5.0 °C

18 The energy required to change liquid water into water vapour at the same temperature is called latent heat of vaporisation.

What does this energy do?

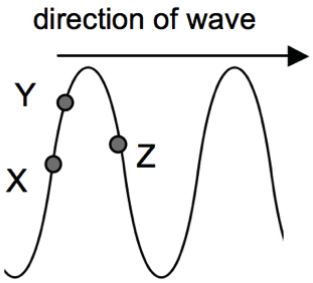
A It splits the water molecules into their separate atoms.

B It increases the average speed of the water molecules.

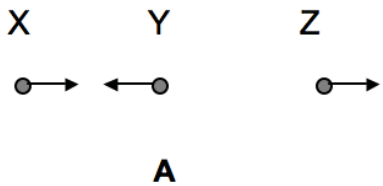
C It increases the average separation of the water molecules.

D It raises the temperature of the air near the water.

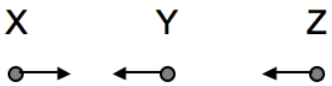
19 A transverse wave moves along a rope in the direction as shown in the diagram.



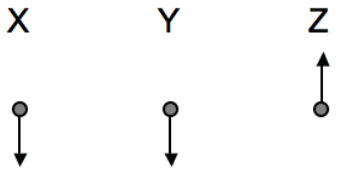
Which of the following shows the direction in which particles at points X, Y and Z are moving?



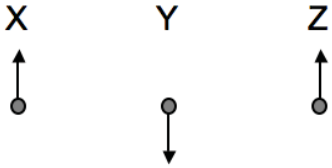
A



B

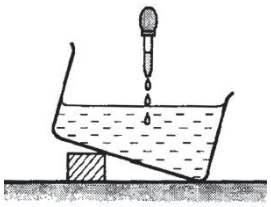


C

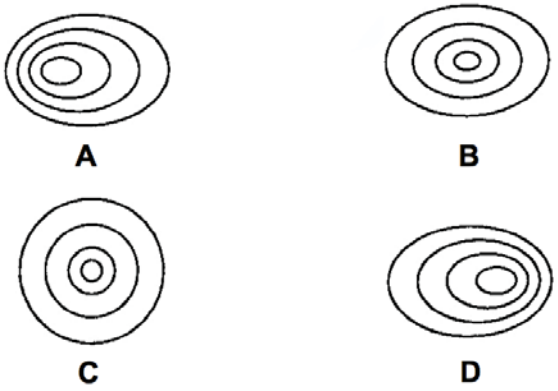


D

20 Water is dripped at a constant rate into a slanting basin which contains water as shown.



Which of the following patterns can be observed in the basin?



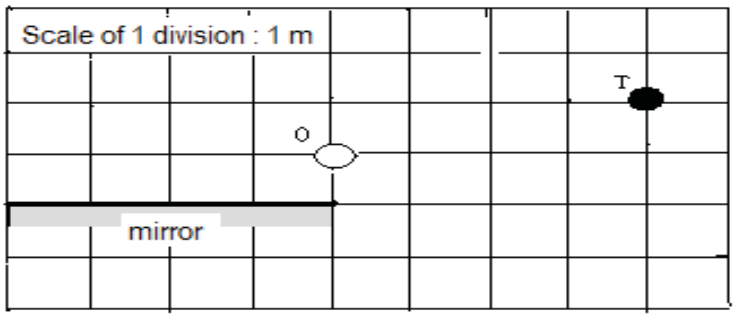
21 A musical instrument produces two notes. A note of frequency f has a velocity v and a wavelength 3 m in air. For the other note of frequency 3f, state its wavelength and velocity respectively.

	wavelength	velocity
A	1 m	v
B	1 m	3v
C	9 m	v
D	9 m	3v

22 A car, which is travelling towards a cliff at a speed of 50 m/s, sounds its horn when it is 0.7 km away from the cliff. Taking speed of sound in air to be 300 m/s, find the time taken for the driver to hear its echo.

A 0.004 s **B** 2.0 s **C** 4.0 s **D** 28.0 s

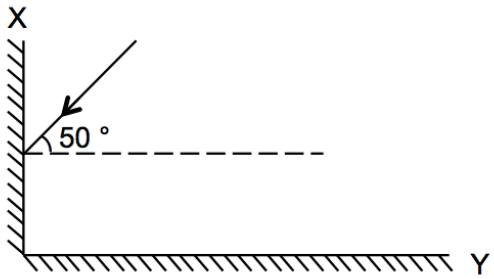
23 An observer O cannot see the image of target T through the mirror.



What is the minimum distance he should move to see the image of target T through the mirror?

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

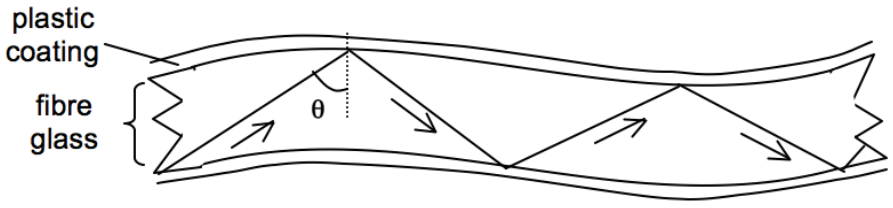
24 The diagram below shows two plane mirrors placed perpendicular to each other.



What is the angle of reflection in mirror Y?

A 40 ° **B** 50 ° **C** 80 ° **D** 100 °

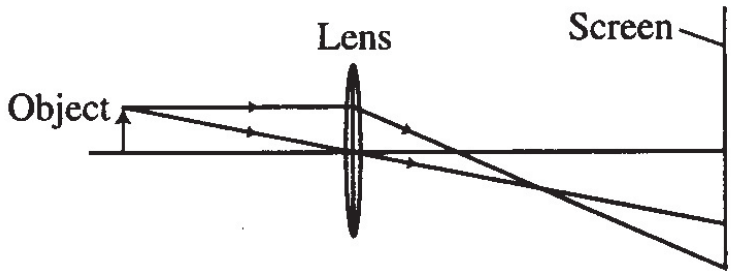
25 Fibreglass of refractive index 1.4, is sheathed in plastic coating of refractive index close to 1.3, to transmit data in the form of light packets.



What is the minimum angle, θ, for the light ray to be transmitted?

A 41.8 ° **B** 45.6 ° **C** 47.8 ° **D** 50.3 °

26 In the set up below, the image formed on the screen is blurred.



Which modification will produce a sharp image on the screen?

A Replace the lens with another convex lens of longer focal length.

B Replace the lens with another convex lens of shorter focal length.

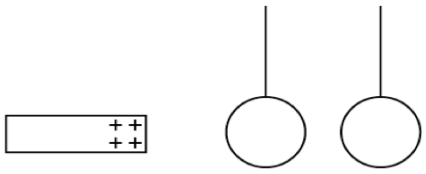
C Move the object further from the lens.

D Move the object until it is at the focal point of the lens.

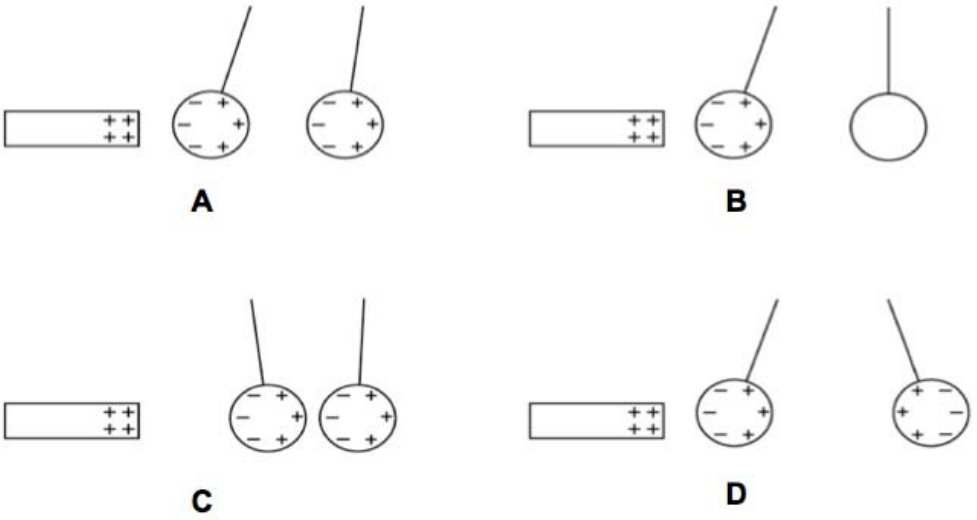
27 Which row shows parts of the electromagnetic spectrum in order of decreasing frequency?

	decreasing frequency →		
A	radio waves	X-rays	visible light
B	radio waves	visible light	X-rays
C	X-rays	radio waves	visible light
D	X-rays	visible light	radio waves

28 Two uncharged metal spheres, not touching one another, are suspended by means of cotton thread. A positively charged rod is brought near the spheres.



Which diagram shows what happens to the spheres?



29 Which of the following steps can make an isolated metallic sphere positively charged with a given negatively charged plastic ruler?

A Touch the ruler with a finger and use the same finger to touch the sphere.

B Touch the sphere momentarily with the ruler.

C Bring the ruler near the sphere and touch the sphere momentarily with a finger, then remove the ruler.

D Bring the ruler near the sphere and touch the sphere with a finger, remove the ruler and finally the finger.

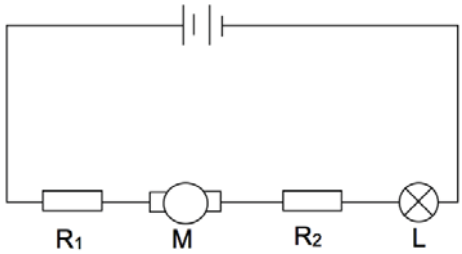
30 Which of the following changes to a wire will halve its resistance?

	cross-sectional area	length
A	double	double
B	double	no change
C	halve	no change
D	no change	double

31 What is the e.m.f. of the cell in an electrical circuit if it uses 1kJ of energy to send 3A of current around the circuit for 2 minutes?

A 2.78 V **B** 6 V **C** 25 V **D** 360 V

32 In the circuit shown below, two resistors R_1 and R_2, a motor M and lamp L are connected to a suitable voltage supply.



The potential difference across each of the circuit component is measured and recorded as shown in the table below.

circuit component	R_1	M	R_2	L
potential difference / V	6.0	10.0	3.0	1.0

Which of the following inference is **not** true?

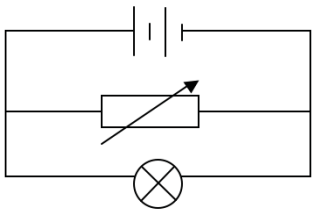
A The resistance of R_1 is twice the resistance of R_2.

B The lamp has the least amount of current passing through compared to other components.

C The motor uses the greatest amount of electrical energy per unit time

D If the motor is removed from the circuit and replaced with a wire, the current through each component would be 2 times the existing value.

33 A variable resistor and a light bulb are connected to a battery as shown.



What will happen to the bulb when the resistance of the variable resistor is halved?

A It will probably burn out.

B It will shine much less brightly.

C It will shine more brightly.

D It will hardly change in brightness.

34 In Singapore, power cords for electrical appliances usually come with a 3-pin plug or a 2-pin plug as shown below.

Which of the following statements are correct?

I. A fuse is found in both the 3-pin plug and 2-pin plug.
II. The extra pin is a design feature to ensure better connection.
III. The extra pin is to earth the appliance.
IV. The 2-pin plug is designed usually with double insulation.

A I and III only
B II and III only
C III and IV only
D I, III and IV only

35 The following specifications are found on an electric heater.

Operating voltage: 240 V / 50 or 60 Hz
Power: 1500 W
Fuse rating: 13 A

Which of the following statement(s) concerning this device is/are correct?

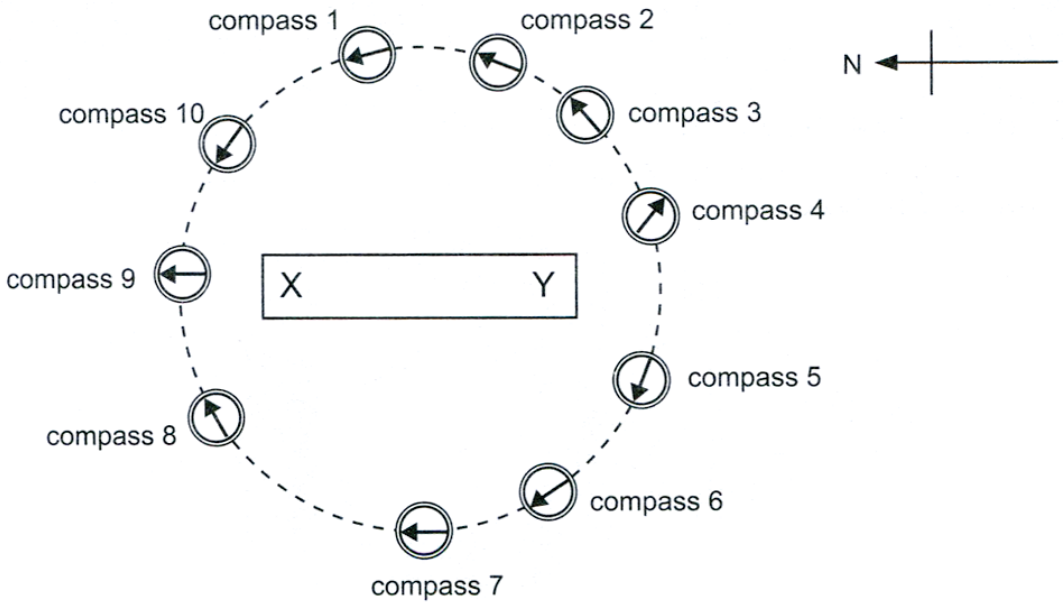
I. The electric heater generates 3000 J of electrical energy in 2 seconds.
II. The fuse rating is correctly marked.
III. The resistance of the heating element is 38.4 Ω.

A I only
B I and III only
C II and III only
D All of the above

36 Which of the following results can prove that an iron bar has magnetism?

A A wire is attracted to the iron bar.
B Both ends of a compass are attracted to the same end of the iron bar.
C One end of a compass is repelled by the iron bar.
D A bar magnet is attracted to the iron bar.

37 The diagram below shows the top view of a slab of permanent magnet with ten compasses arranged on a dotted circle around it. The poles of the magnet are unknown and are labelled as X and Y.



Which one of the following statements is correct?

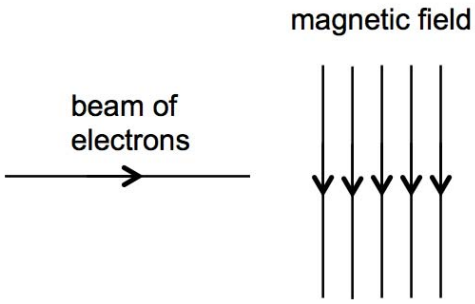
A Compass 1 is faulty.

B Compass 5 is faulty.

C Compass 9 is faulty.

D Pole X is the north-pole and pole Y is the south-pole.

38 The diagram shows a beam of electrons entering a magnetic field.



What is the effect of the magnetic field on the electrons?

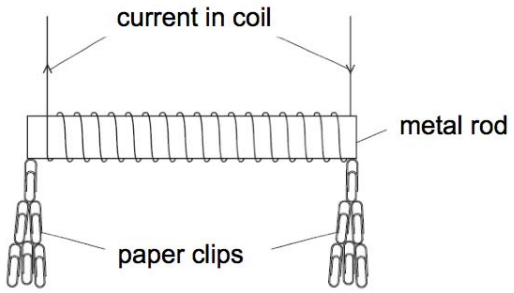
A They are deflected into the plane of the diagram.

B They are deflected out of the plane of the diagram.

C They are deflected towards the bottom of the diagram.

D They are deflected towards the top of the diagram.

39 Four metal rods are placed, in turn, inside a coil of copper wire.

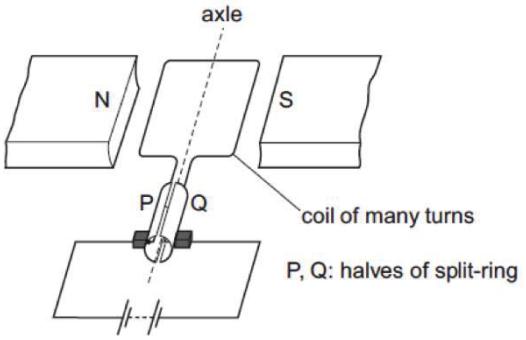


Each rod is used to pick up as many paper clips as possible. The current is then switched off. The table gives the results of the experiment.

Which rod is the most suitable core for a coil in a circuit breaker?

	number of paper clips picked up when there is a current in the coil	number of paper clips still attached after the current is switched off
A	1	0
B	20	2
C	35	0
D	35	30

40 A d.c. motor consists of a coil of many turns rotating in a fixed magnetic field. The coil is connected to a d.c. supply through a split-ring commutator.



Some changes are made, one at a time.

- The d.c. supply is reversed.
- The coil is turned before switching on, so that P starts on the right and Q on the left.
- The poles of the magnet are reversed.
- The turns on the coil are increased in number.

How many of these changes make the coil rotate in the opposite direction?

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

END OF PAPER

Geylang Methodist School (Secondary)
Preliminary Examination 2020

Candidate Name			
Class		Index Number	

PHYSICS **6091/02**

Paper 2 Physics **Sec 4 Express**

Additional materials : Writing Papers **1 hour 45 minutes**

Setter : Mr Yip Cheng Hou **25 August 2020**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
Write your answers to **Section A** in the spaces provided in the Question Paper.
Write your answers to **Section B** in writing papers provided unless stated otherwise.
Question 12 has a choice of parts to answer.

Candidates are reminded that all quantitative answers should include appropriate units. You are advised to show all your working in a clear, orderly manner.

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

Acceleration due to gravity, ***g***, is assumed to be 10 m/s^2 unless otherwise specified.

For Examiner's Use	
Section A	/50
Section B	/30
Total	/80

This document consists of **18** printed pages and 2 blank pages.

[Turn over

Section A

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

1 A man starts the engine of his boat. The engine produces a constant forward force of 1000 N. The total mass of the boat and man is 400 kg. Fig. 1.1 shows how the resistive force on his boat varies over time.

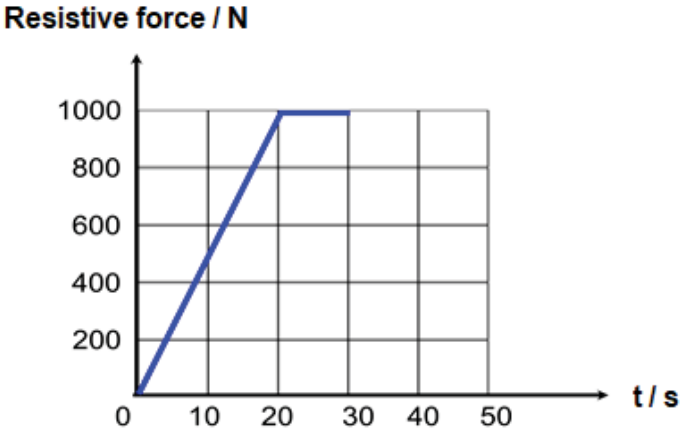


Fig. 1.1

He reaches a maximum velocity of 25 m/s at time t = 20 s.

(a) Calculate the acceleration at time t = 10 s.

acceleration = …….. [2]

(b) Explain why his velocity does not increase from t = 20 s.

……...

…… [1]

(c) At t = 30 s, he switches off the engine completely.
Assuming that the boat experiences a constant resistive force of 1000 N, calculate the time taken for him to come to a stop.

time = …….. [2]

(d) Sketch the speed-time graph for his entire journey till he comes to a stop in Fig. 1.2 below.

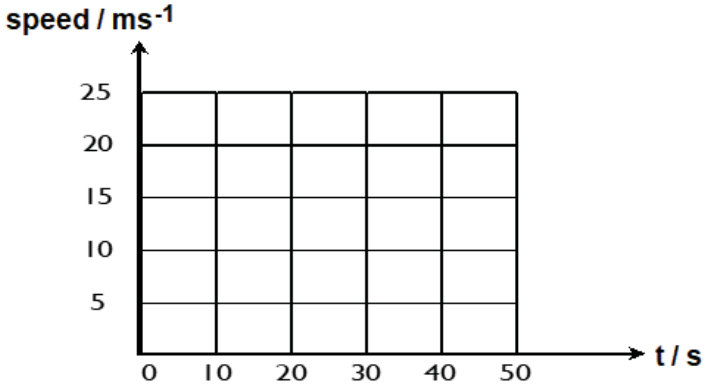


Fig. 1.2 [2]

2 An uniform ladder which is 5 m long and has a weight **W** of 400 N leans with its upper end against a smooth vertical wall and its lower end on a rough ground, as shown in Fig. 2.1.

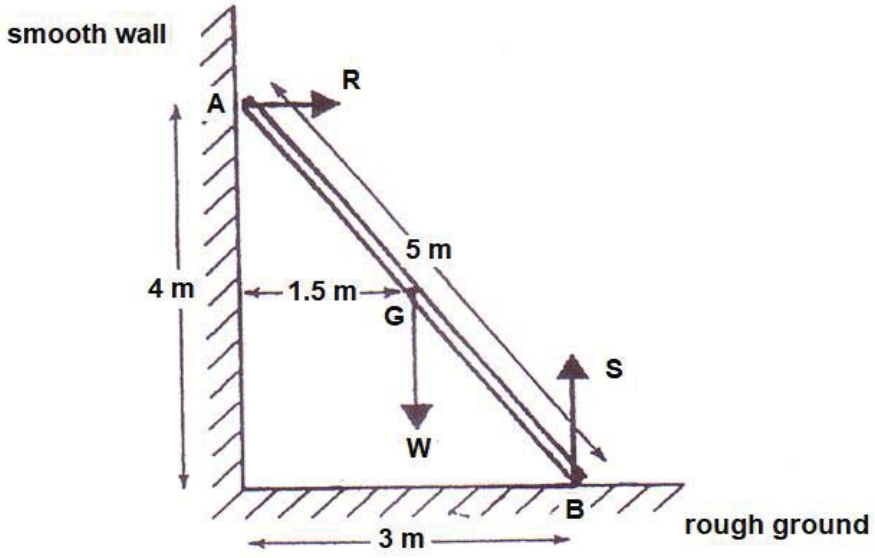


Fig. 2.1

R is the normal reaction force acting on the top of the ladder due to the wall and **S** is the normal reaction force acting on the bottom of the ladder due to the ground. A frictional force **f** (not shown on diagram) also acts at the bottom of the ladder due to the rough ground.

At this position, the ladder is in equilibrium.

(a) On the diagram, indicate where the frictional force **f** would be acting. [1]

(b) State the value of **S** and explain your answer.

…….

……... [2]

(c) By taking moments about **A**, calculate the anti-clockwise moment due to the normal reaction force **S**.

anti-clockwise moment = …….. [1]

(d) Hence, by considering the total clockwise moments due to the frictional force **f** and the weight **W** of the ladder about **A**, find the value of the frictional force **f**.

frictional force **f** = …….. [2]

3 Fig. 3.1 shows a gymnast on a trampoline.
At position **A** in Fig. 3.1a, the gymnast starts to rise.
She passes through **B** in Fig. 3.1b and reaches her maximum height at **C**.

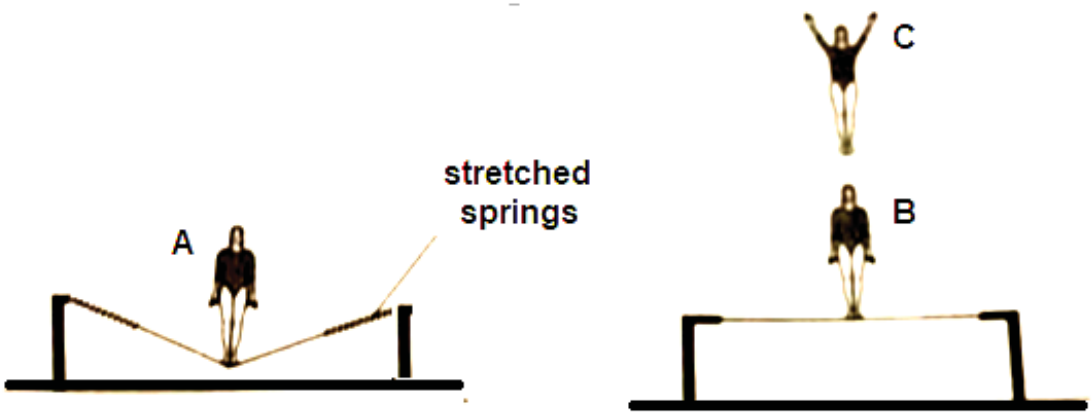


Fig. 3.1a **Fig. 3.1b**

(a) State the form of energy stored in the stretched springs in Fig. 3.1a.

…….……

……..... [1]

(b) State the form(s) of energy gained from **A** to **B**.

…….……

……..... [1]

(c) State the energy changes from **B** to **C**.

…….……

……..... [1]

4 Two different kettles are used to heat water, as shown in Fig. 4.1.

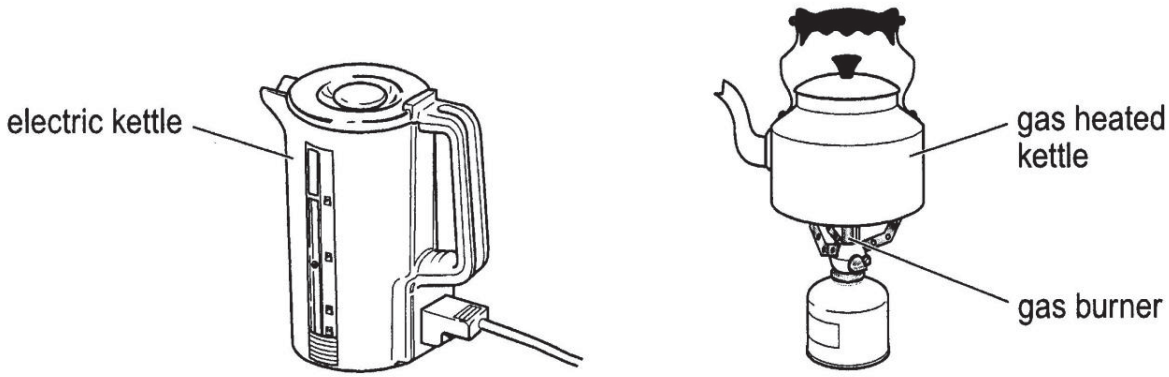


Fig. 4.1

Data for the two kettles is shown in Fig. 4.2.

type of kettle	energy supplied to the kettle in one minute / J	thermal energy supplied by the kettle to the water in one minute / J
electric kettle	120 000	95 000
gas heated kettle	130 000	90 000

Fig. 4.2

(a) **(i)** Calculate the efficiency of **both** electric kettles.

efficiency of electric kettle = ...

efficiency of gas heated kettle = ... [2]

(ii) Explain the difference in efficiency in terms of thermal transfer.

……

……

…… [2]

(b) A metal can and a plastic bottle, both containing liquid, are cooled by placing them in a jug of melting ice, as shown in Fig. 4.3.

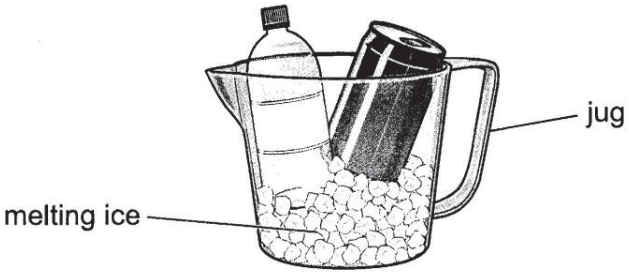


Fig. 4.3

The can and bottle each contains 330 g of the same liquid at 15 °C.
The specific heat capacity of the liquid is 4.2 J / (g °C).
The specific latent heat of fusion of ice is 336 J / g.

(i) Calculate the thermal energy released when 330 g of the liquid at 15 °C is cooled to 2 °C.

energy = ... [2]

(ii) When cold water at 0 °C is used in the jug, instead of the melting ice, the cooling is slower.

Explain why cooling is faster when melting ice is used in the jug rather than cold water at 0 °C.

.....

.....

.....

.....

..... [2]

(iii) Explain why the liquid in the metal can cools down faster than the liquid in the plastic bottle in terms of electrons.

.....

.....[1]

6 Fig. 6.1 traced the paths of three incident rays, AO, BO and CO, as they enter a semicircular slab of transparent plastic. One of the rays undergoes **total internal reflection.**

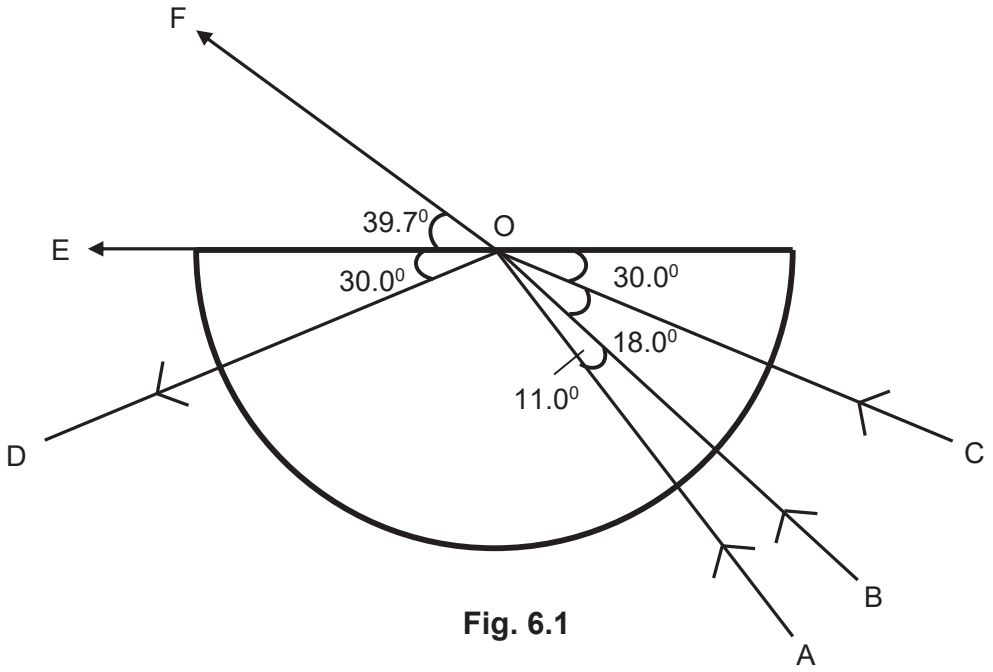


Fig. 6.1

(a) What do you understand by **total internal reflection**?

.....

.....

..... [2]

(b) State the ray that undergoes total internal reflection.

..... [1]

(c) What is the critical angle for the plastic material?

..... [1]

(d) Determine the refractive index of the plastic material.

refractive index = ... [2]

7 Fig. 7.1 represents the full scale diagram of the positions of particles of a medium at a particular instant when a sound wave passes through the medium. The dots represent the particles. The short lines represent the original undisturbed positions of the particles.

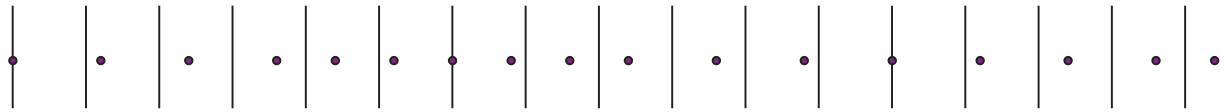


Fig. 7.1

(a) Mark on the diagram the [2]

(i) wavelength of the wave using $\leftrightarrow$, label the distance as λ.
(ii) amplitude of the wave using $\leftrightarrow$, label the distance as a.

(b) If each particle oscillates 3000 cycles per second, calculate the time taken to hear the echo of the sound reflected from a wall 2 km away.

time taken = ... [3]

(c) Explain which of the above answers in (a) and (b) will change if the sound becomes softer as it travels.

…… [1]

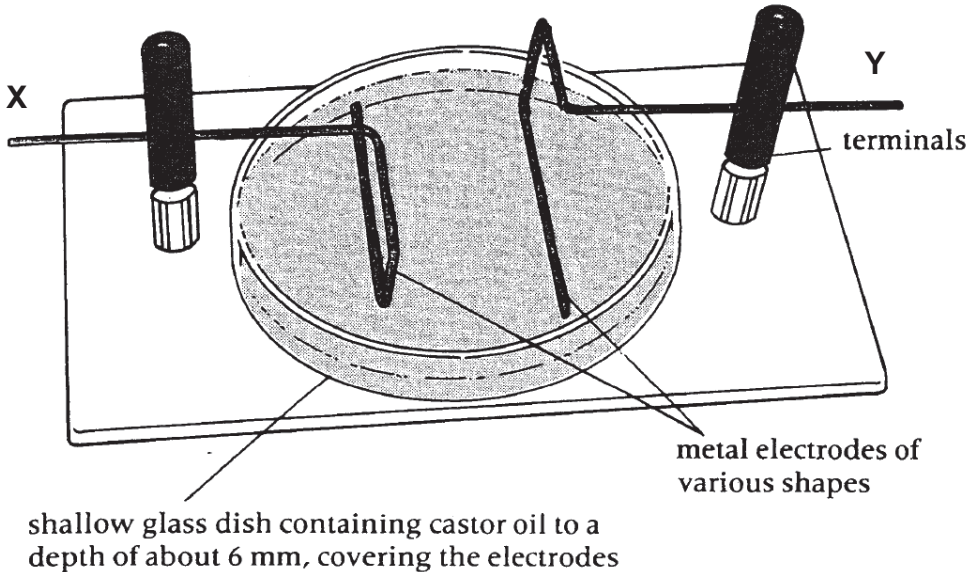
(d) This sound wave will be produced by a burglar alarm if a house is broken into by intruders at night. State another wave used by the burglar alarm to detect intruders and two differences of this wave from the sound wave.

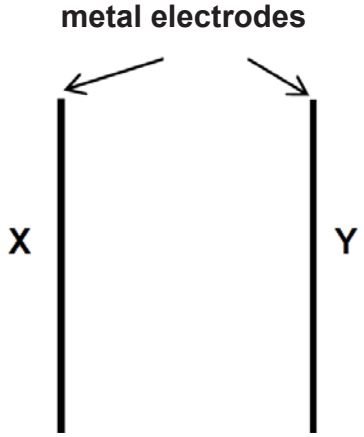
……

……

…… [3]

8 In an electrostatic experiment, two parallel metal electrodes are placed in castor oil in a petri dish as shown. The two metal electrodes X and Y are then connected to a battery; with X being connected to the positive terminal and Y connected to the negative terminal of the battery. Some light grass seeds are scattered on the castor oil.





(a) On the figure above, mark the signs of charges formed on the two metal electrodes when they are connected to the battery. Hence draw the electric field pattern between the electrodes. [2]

(b) Explain why the light grass seeds will line up in between the metal electrodes to reveal the shape of the electric field lines.

.....

.....

.....

..... [2]

9 A student has made a battery tester shown in Fig. 9.1. It uses a magnet, wire that is flexible and springy, and a pointer. With it, she can check whether a battery is "live" or "dead". When she connects a battery to the tester, the pointer moves to the right.

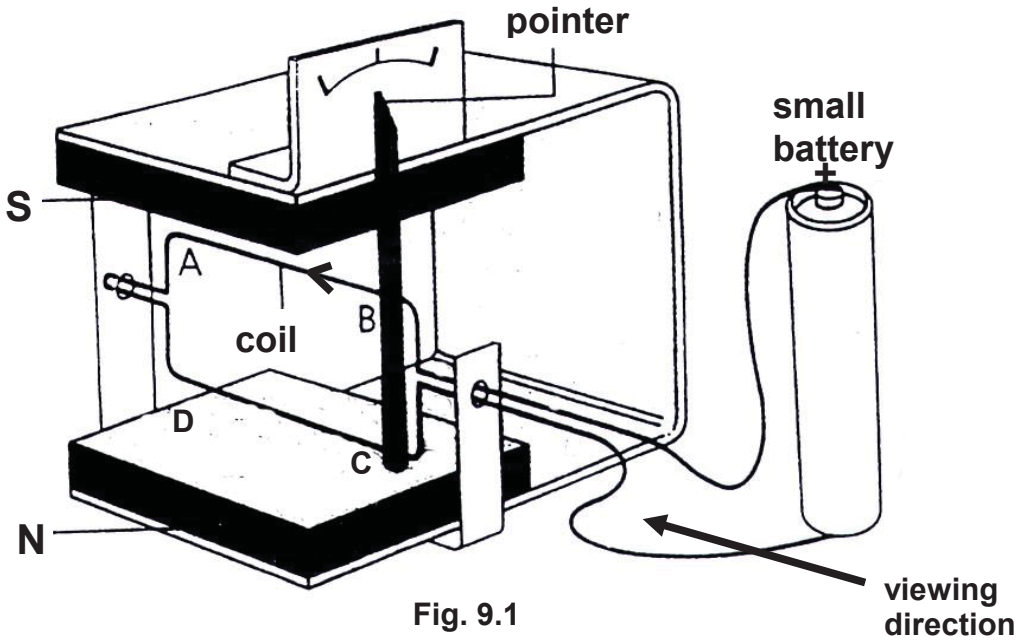
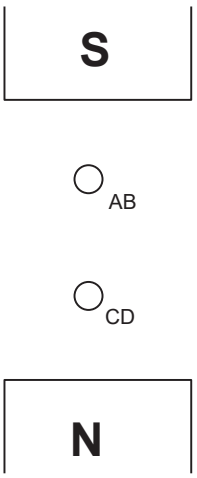


Fig. 9.1

(a) Explain, by drawing the magnetic field around the wires in the diagram below, to show why the pointer deflect. (The circles represent the cross-section of the wires **AB** and **CD** viewed in the direction shown) [3]



.....

.....

.....

(b) State what would be observed on the pointer if the battery she connected delivered less current?

.....

..... [1]

(c) The student wants to make the tester more sensitive so that the pointer can move through a greater distance when the battery is connected. State **two ways** that she needs to change the design to make this happen?

.....

..... [2]

END OF SECTION A

Section B

Answer **all** the questions from this section in writing papers provided unless stated otherwise.
Answer only one of the two alternative questions in **Question 12**.

10 Hand phones - the mobile approach

The last decade has seen an explosion in the use of mobile telephones. Before hand phones were invented, those who needed mobile communications installed a radio telephone in their car. In the radio-telephone system there was one central antenna tower per city and perhaps 25 channels available on that tower. The radio telephone in the car was a powerful transmitter.

In the modern system the city is divided into small cells and millions of people can use hand phones at the same time. The base station contains a fixed receiver and transmitter, connected to the normal telephone system. The hand phone and the base system use low power transmitters of 1-3W, which cannot be detected far outside each cell.

In one of the first systems, each hand phone works on two different frequencies at the same time, as a transmitter and as a receiver. A frequency band between 890 MHz and 915 MHz is allocated for hand phones to transmit to the nearest base station and another band from 935 MHz to 960MHz for the phones to receive a transmission from the base station to the mobile. To transmit good quality signals, each complete signal is about 20 kHz wide. Within the band available for transmission or reception, individual channels are set 25 kHz apart to avoid overlap.

The implementation of mobile phones needed the development of small, efficient rechargeable batteries. Typically a battery may be able to supply 72000J of electrical energy before it needs to be recharged.

(a) Explain what is meant by a frequency of 20 kHz. [2]

(b) Calculate the maximum wavelength that a hand phone uses to transmit a signal to the nearest base station. [2]

(c) Calculate the number of individual hand phones that one base station can support. [2]

(d) Estimate the minimum time that a battery will last if the hand phone is used for continuous transmission. [2]

(e) State one similarity and one difference between visible light rays and radio waves. [2]

11 Fig. 11.1 shows an object O, placed at a distance from a thin converging lens L. An image I is formed. P and Q are light rays incident on the converging lens.

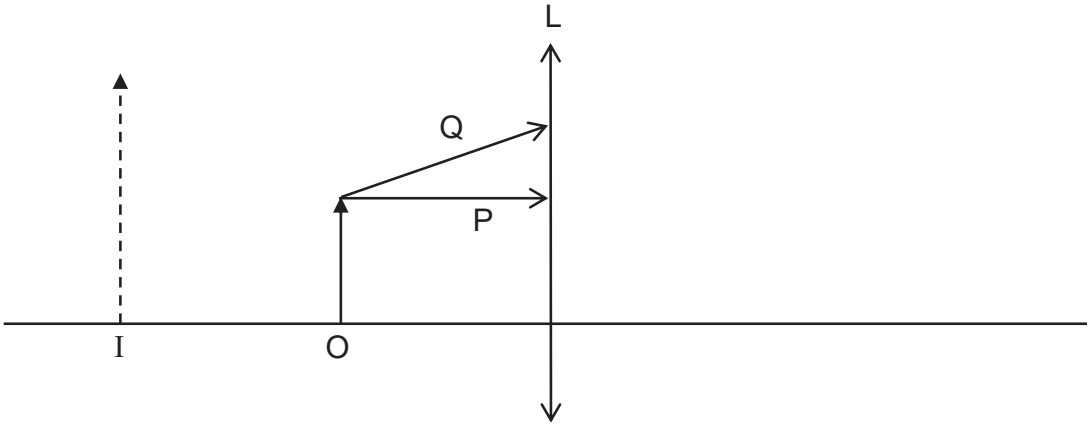


Fig. 11.1

(a) On Fig. 11.1,

(i) complete the ray diagram to show the paths of rays P and Q, [2]

(ii) locate the position of the focal point and label it as F. [1]

(b) State three characteristics of the image formed. [2]

(c) State an application for such lens arrangement. [1]

(d) The object is moved closer to the lens. State two changes of the image formed. [2]

(e) The lens is now moved away from the object for more than twice its focal length.

State

(i) one change of the image formed, and [1]

(ii) one application for such lens arrangement. [1]

12 EITHER

Two containers, X and Y, filled with the same liquid are connected as shown in Fig. 12.1. The pressure at A is 100 000 Pa and the pressure at B is 160 000 Pa.

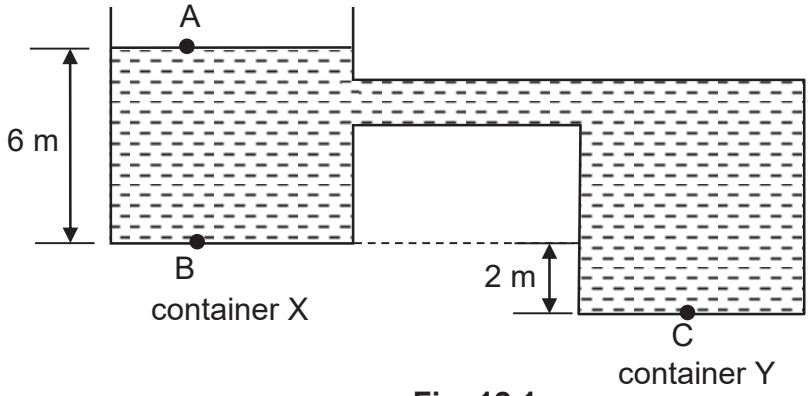


Fig. 12.1

(a) Determine the density of the liquid. [2]

(b) Calculate the pressure at C. [2]

(c) A syringe contains trapped air, as shown in Fig. 12.2. The piston inside the syringe is free to move up and down in the syringe. When the syringe is placed in hot water, the piston is pushed upwards.

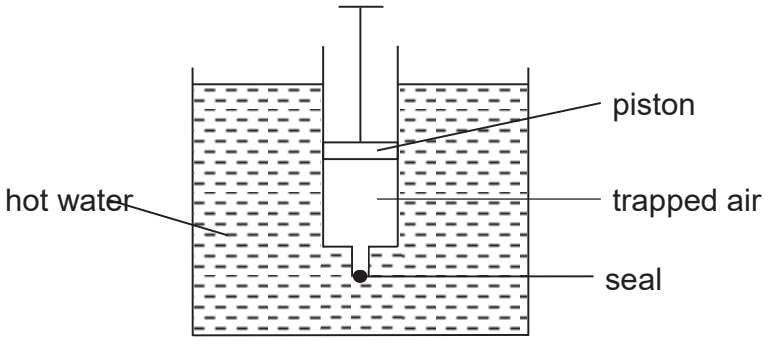


Fig. 12.2

Explain, in terms of the motion of the molecules, why the piston is pushed upwards. [2]

(d) Another syringe contains 60 cm^3 of trapped air at room temperature. The piston is slowly pushed inwards, compressing the air. Some information about the air inside the syringe is given in Fig. 12.3.

	before compression	after compression
volume of air	60 cm^3	15 cm^3
temperature of air	25 °C	25 °C
pressure of air	1.0×10^5 Pa	p

Fig. 12.3

(i) Calculate the pressure p of the air after compression. [2]

(ii) Sketch a graph to show the variation of the pressure of the air against volume at temperature T = 25 °C. Label your graph as T_1. [1]

(iii) On the same axes, sketch the graph if the temperature of the air is kept constant at T ' = 50 °C. Label your graph as T_2. [1]

12 OR

In the potential divider circuit shown in Fig. 12.4 below, the battery has negligible internal resistance.

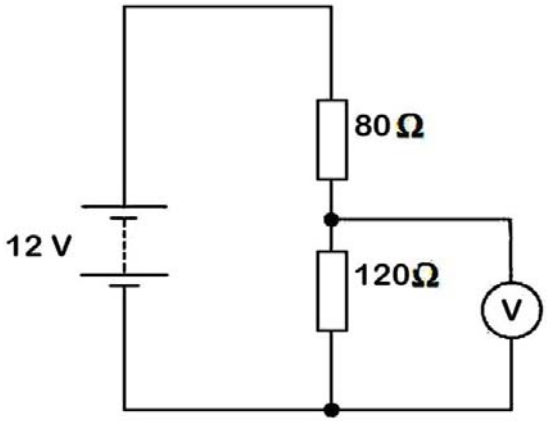


Fig. 12.4

(a) Calculate the reading on the voltmeter. [1]

(b) The **voltmeter** in Fig. 12.4 above, is replaced by a **thermistor**, giving the circuit shown in Fig. 12.5 below.

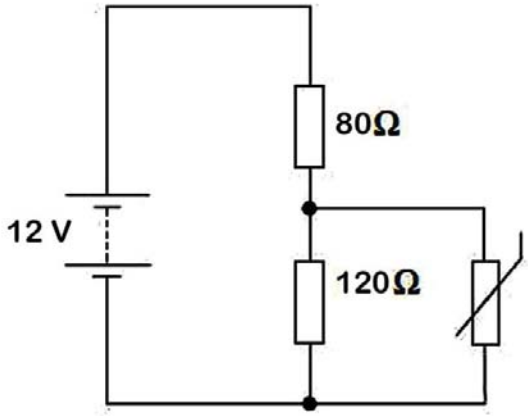


Fig.12.5

The resistance of the thermistor at 0°C is 120 Ω. As the temperature increases, its resistance decreases. Explain, without calculation, whether the current through the battery increases or decreases as the temperature of the thermistor is increased from 0 °C. [2]

(c) A square sheet of carbon-reinforced plastic, measuring 90 mm x 90 mm and 1 mm thick, has its two large surfaces coated with a highly conducting metal film. When a p.d. of 210 V is applied between the metal films a current of 1.4 mA passes through the plastic sheet. Calculate the resistivity of the plastic. [2]

(d) Three resistors, each of resistance 3.0 Ω, are connected as shown in Fig. 12.6 below.

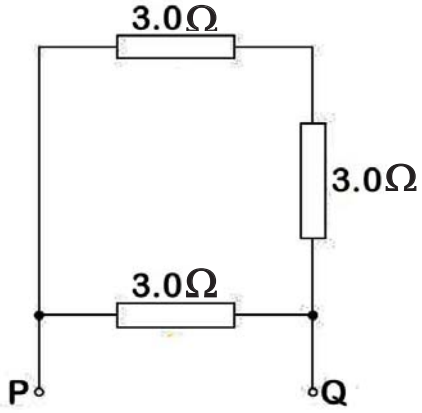


Fig. 12.6

(i) Calculate the total resistance between point **P** and point **Q** of this circuit. [1]

(ii) The circuit in **(d)(i)** is now connected to two more resistors each of resistance 3.0 Ω, as shown in Fig. 12.7 below.

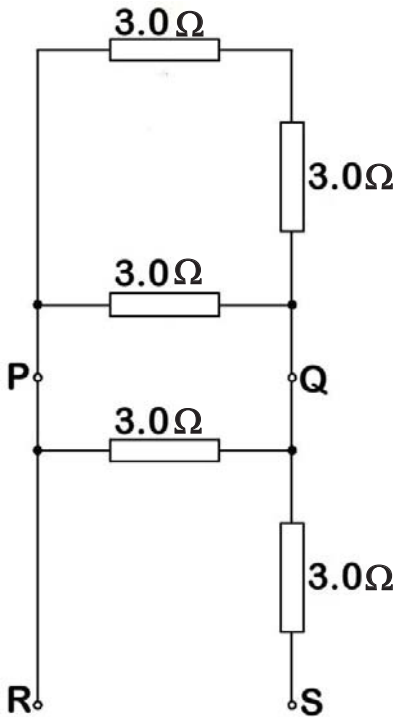


Fig.12.7

Using your answer in **(d)(i),** show that the total resistance between **R** and **S** is **4.2Ω.** [2]

(iii) One of the resistors in the circuit shown in Fig. 12.7 becomes faulty. The resistance between **R** and **S** is found to be **5.0 Ω.** On the diagram in Fig. 12.7 above, identify the faulty resistor by drawing a circle around it and state the nature of the fault. [2]

END OF PAPER 2

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Geylang Methodist School (Secondary)
Preliminary Examination 2020

PHYSICS **6091/01**

Paper 1 **Sec 4 Express**

Answers

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

Geylang Methodist School (Secondary)
Preliminary Examination 2020

Candidate Name			
Class		Index Number	

PHYSICS **6091/02**

Paper 2 Physics **Sec 4 Express**

Additional materials : Writing Papers **1 hour 45 minutes**

Setter : Mr Yip Cheng Hou **25 September 2020**

READ THESE INSTRUCTIONS FIRST

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For Examiner's Use	
Section A	/50
Section B	/30
Total	/80

This document consists of **20** printed pages and 1 blank page.

[Turn over

Section A

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

1 A man starts the engine of his boat. The engine produces a constant forward force of 1000 N. The total mass of the boat and man is 400 kg. Fig. 1.1 shows how the resistive force on his boat varies over time.

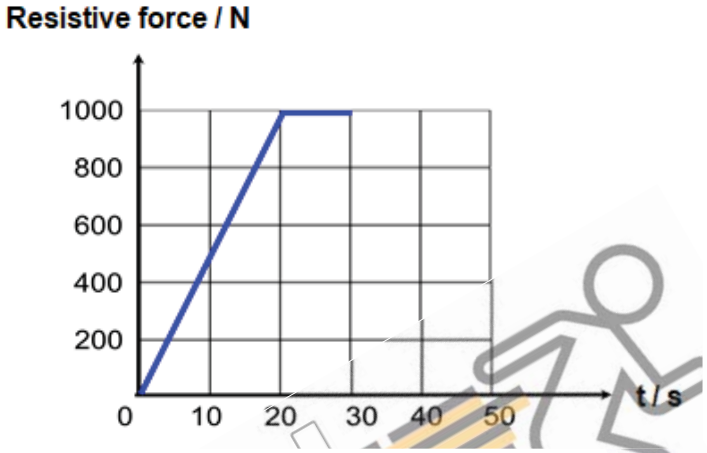


Fig. 1.1

He reaches a maximum velocity of 25 m/s at time t = 20 s.

(a) Calculate the acceleration at time t = 10 s.

$F_R = ma$ OR $a = (v-u)/t$
$1000 - 500 = 400a$ $= (25 - 0) / 20$
$a = 1.25\ m/s^2$ $= 1.25\ m/s^2$

acceleration = …….. [2]

(b) Explain why his velocity does not increase from t = 20 s.

forward force = resistive force, and hence resultant force = 0 or acc = 0

……[1]

(c) At t = 30 s, he switches off the engine completely.
Assuming that the boat experiences a constant resistive force 1000 N, calculate the time taken for him to come to a stop.

$F_R = ma$ $a = (v-u)/t$
$-1000 = 400a$ $-2.5 = (0-25)/t$
$a = -2.50\ m/s^2$ (1) $t = 25/2.5$
$= 10.0\ s$ (1)

time = …….. [2]

(d) Sketch the speed-time graph for his entire journey till he comes to a stop in Fig. 1.2 below. [2]

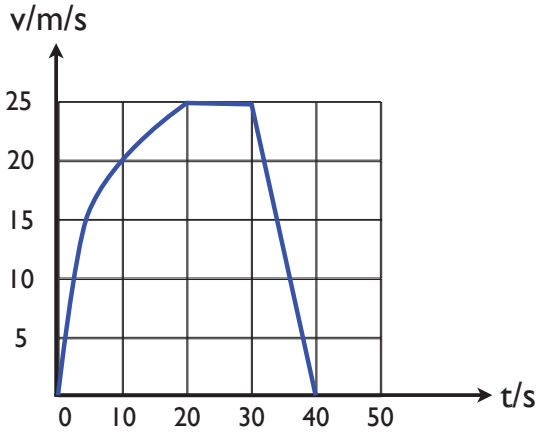


Fig. 1.2

2 An uniform ladder which is 5 m long and has a weight **W** of 400 N leans with its upper end against a smooth vertical wall and its lower end on a rough ground, as shown in Fig. 2.1.

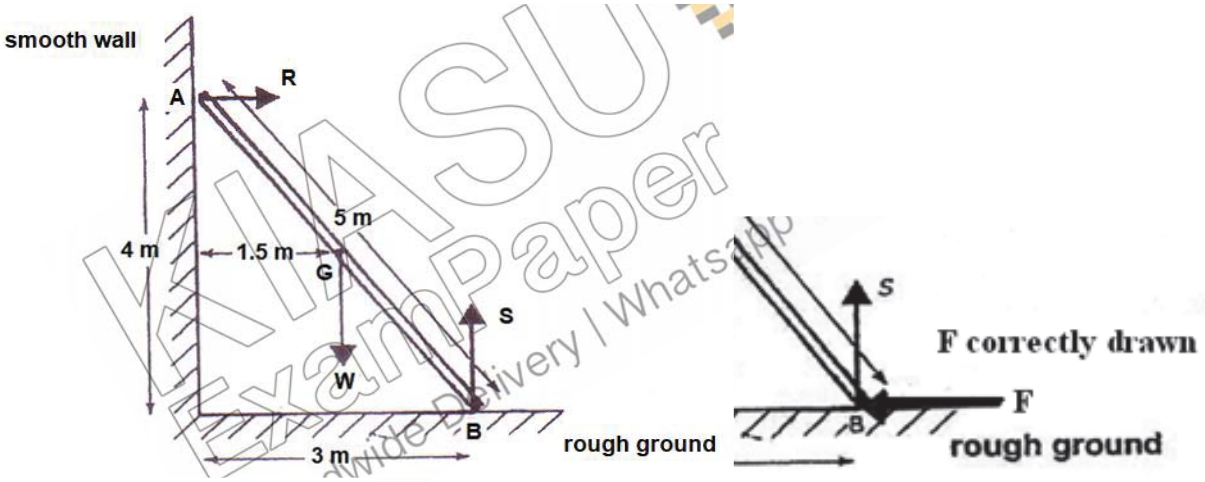


Fig. 2.1

R is the normal reaction force acting on the top of the ladder due to the wall and **S** is the normal reaction force acting on the bottom of the ladder due to the ground. A frictional force **f** (not shown on diagram) also acts at the bottom of the ladder due to the rough ground.

At this position, the ladder is in equilibrium.

(i) On the diagram, indicate where the frictional force **f** would be acting. [1]

(ii) State the value of **S** and explain your answer.

S = W = 400 N (1) ladder is in (vertical) equilibrium, the total upward forces equal total down forces [2]

(iii) By taking moments about **A**, calculate the anti-clockwise moment due to the normal reaction force **S**.

ACW Moment due to S = 400 x 3 = 1200 Nm

Anti-clockwise moment = …….. [1]

(iv) Hence, by considering the total clockwise moments due to the frictional force **f** and the weight **W** of the ladder about **A**, find the value of the frictional force **f**.

According to Principle of Moments
Taking A as the pivot
Total CW moments = Total ACW moments
(400)(1.5) + (F)(4) = 1200
F = 150 N

frictional force **f** = …….. [2]

3 Fig. 3.1 shows a gymnast on a trampoline.
At position **A** in Fig. 3.1a, the gymnast starts to rise.
She passes through **B** in Fig. 3.1b and reaches her maximum height at **C**.

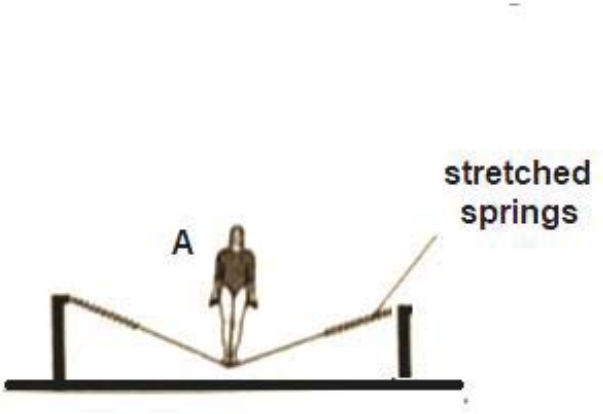


Fig. 3.1a

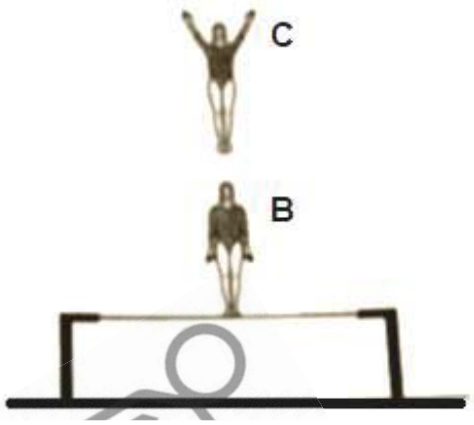


Fig. 3.1b

(a) State the form of energy stored in the stretched springs in Fig. 3.1a.

Elastic Potential Energy [1/2 mark for E.P.E]

..... [1]

(b) State the form(s) of energy gained from **A** to **B**.

Gravitational Potential Energy + Kinetic Energy
[1/2 mark for Potential Energy] [1]

(c) State the energy changes from **B** to **C**.

Kinetic Energy to Gravitational Potential Energy
[1/2 mark for abbreviations] [1]

4 Two different kettles are used to heat water, as shown in Fig. 4.1.

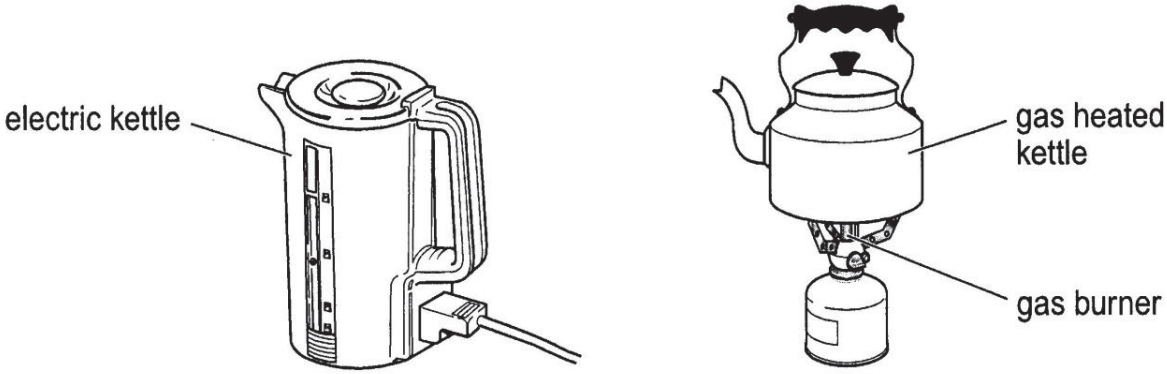


Fig. 4.1

Data for the two kettles is shown in Fig. 4.2.

type of kettle	energy supplied to the kettle in one minute / J	thermal energy supplied by the kettle to the water in one minute / J
electric kettle	120 000	95 000
gas heated kettle	130 000	90 000

Fig. 4.2

(a) (i) Calculate the efficiency of **both** electric kettles.

Efficiency = $\frac{useful energy}{input energy}$ **x 100%**

Electric kettle = $\frac{95000}{120000}$ **x 100% = 79.2 %**

Gas heated kettle = 69.2 %

efficiency of electric kettle = ...

efficiency of gas heated kettle = ... [2]

(ii) Explain the difference in efficiency in terms of thermal transfer.

Heat energy in the electric kettle is in direct contact with water (1)

However heat energy from the gas burner need to pass through the kettle by conduction before reaching water so energy is lost (1). [2]

(b) A metal can and a plastic bottle, both containing liquid, are cooled by placing them in a jug of melting ice, as shown in Fig. 4.3.

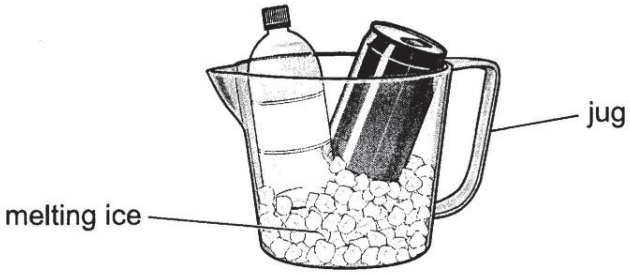


Fig. 4.3

The can and bottle each contains 330 g of the same liquid at 15 °C.
The specific heat capacity of the liquid is 4.2 J / (g °C).
The specific latent heat of fusion of ice is 336 J / g.

(i) Calculate the thermal energy released when 330 g of the liquid at 15 °C is cooled to 2 °C.

$Q = m\,c\,\Delta\theta = 330 \times 4.2 \times (15 - 2)$
$= 18018$ J
$= 18000$ J (3sf)

energy = ... [2]

(ii) When cold water at 0 °C is used in the jug, instead of the melting ice, the cooling is slower.

Explain why cooling is faster when melting ice is used in the jug rather than cold water at 0 °C.

Specific latent heat of fusion of ice is 336 J / g at 0 °C whereas the specific heat capacity of water is 4.2 J / (g °C). So ice absorbs more latent heat in order to break the intermolecular bonds and change from its solid state to liquid state at 0 °C. Hence cooling is faster when using melting ice rather than water at 0 °C. [2]

(iii) Explain why the liquid in the metal can cools down faster than the liquid in the plastic bottle in terms of electrons.

Metals has free moving electrons to conduct heat faster while plastics do not have. So heat loss is faster in metal. [1]

6 Fig. 6.1 traced the paths of three incident rays, AO, BO and CO, as they enter a semicircular slab of transparent plastic. One of the rays undergoes **total internal reflection.**

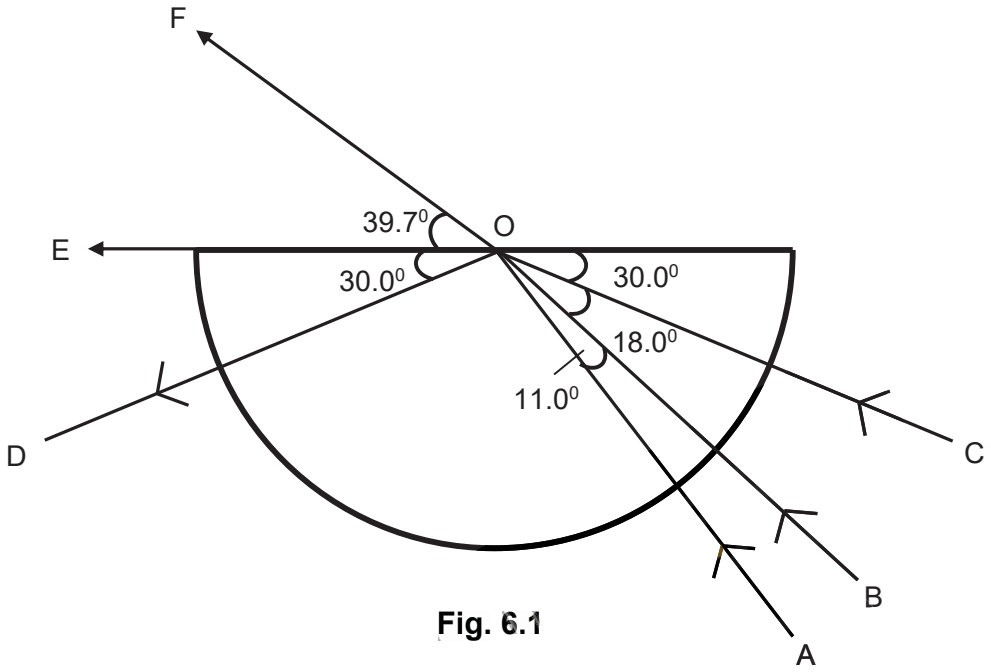


Fig. 6.1

(a) What do you understand by **total internal reflection**?

Total Internal Reflection occurs when light travels from an optically denser medium to an optically less dense medium and the angle of incidence is greater than the critical angle.

[2]

(b) State the ray that undergoes total internal reflection.

Ray COD

[1]

(c) What is the critical angle for the plastic material?

42°

[1]

(d) Determine the refractive index of the plastic material. [2]

$$n = \frac{1}{\sin 42^0}$$

n = 1.49

7 Fig. 7.1 represents the full scale diagram of the positions of particles of a medium at a particular instant when a sound wave passes through the medium. The dots represent the particles. The short lines represent the original undisturbed positions of the particles.

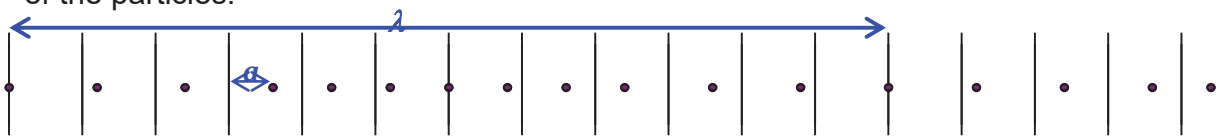


Fig. 7.1

(a) Mark on the diagram the [2]

(i) wavelength of the wave using ↔, label the distance as λ.
(ii) amplitude of the wave using ↔, label the distance as a.

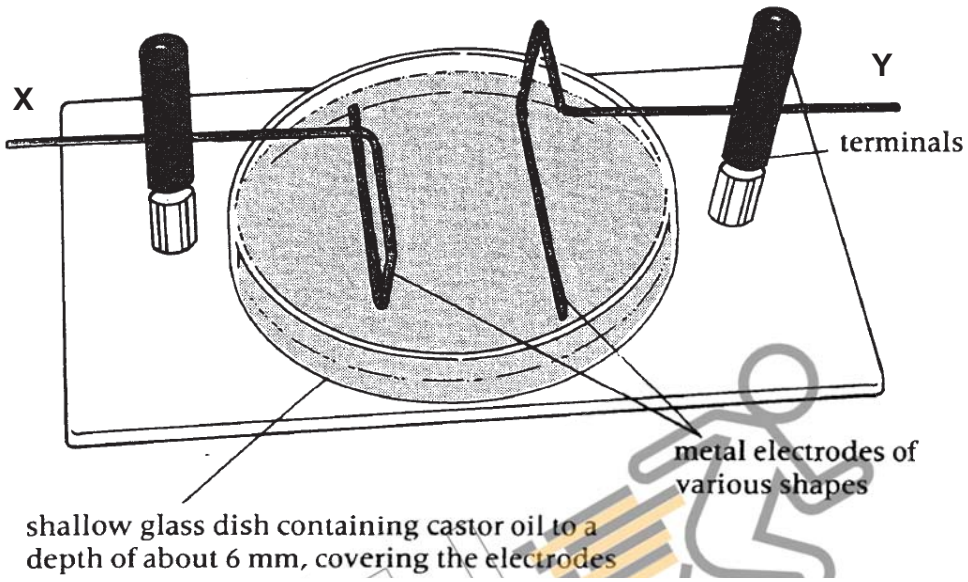
(b) If each particle oscillates 3000 cycles per second, calculate the time taken to hear the echo of the sound reflected from a wall 2 km away. [3]

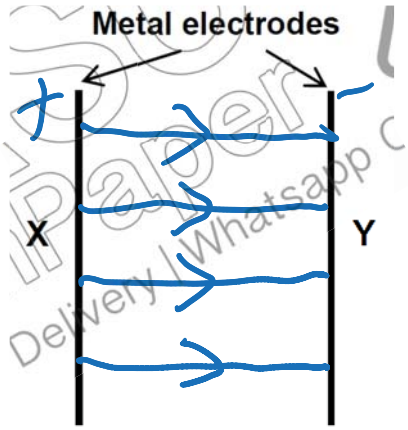
$V = f \times \lambda$
$= 3000\ Hz \times 11.8\ cm$ **[1]**
$= 3.54 \times 10^3\ cm/s$ or $354\ m/s$ **[1]**
Time taken = 2 (2000m) / 354 m/s = 11.3 s [1]

(c) Explain which of the above answers in (a) and (b) will change if the sound becomes softer as it travels.
Only the amplitude will become smaller.
..... [1]

(d) This sound wave will be produced by a burglar alarm if a house is broken into by intruders at night. State another wave used by the burglar alarm to detect intruders and two differences of this wave from the sound wave.
Infra-red wave
.....
Infra-red is a transverse wave while sound wave is longitudinal.
.....
Infra-red do not need a medium to travel but sound needs.
..... [3]

8 In an electrostatic experiment, two parallel metal electrodes are placed in castor oil in a petri dish as shown. The two metal electrodes X and Y are then connected to a battery; with X being connected to the positive terminal and Y connected to the negative terminal of the battery. Some light grass seeds are scattered on the castor oil.





(a) On the figure above, mark the signs of charges formed on the two metal electrodes when they are connected to the battery. Hence draw the electric field pattern between the electrodes. [2]

(b) Explain why the light grass seeds will line up in between the metal electrodes to reveal the shape of the electric field lines.

The end of the light grass seed nearer to X will be negatively charged
.....
while the opposite end will be positively charged due to induction. [1]
.....
Thus the light grass seed attracts each other in a line as unlike charges
.....
attract according to the electric field [1].
..... [2]

9 A student has made a battery tester shown in Fig. 9.1. It uses a magnet, wire that is flexible and springy, and a pointer. With it, she can check whether a battery is "live" or "dead". When she connects a battery to the tester, the pointer moves to the right.

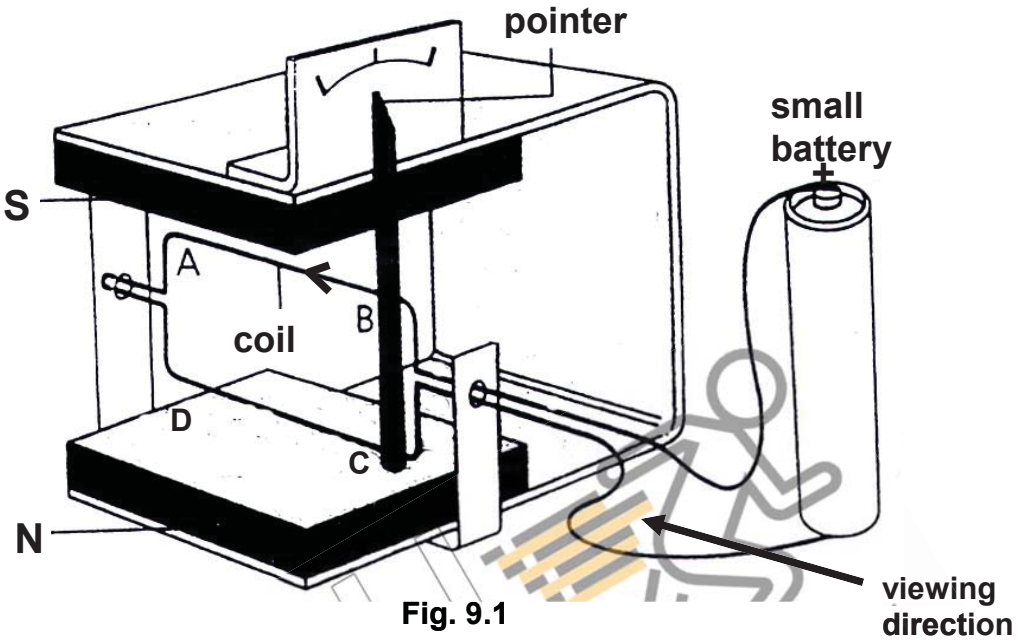
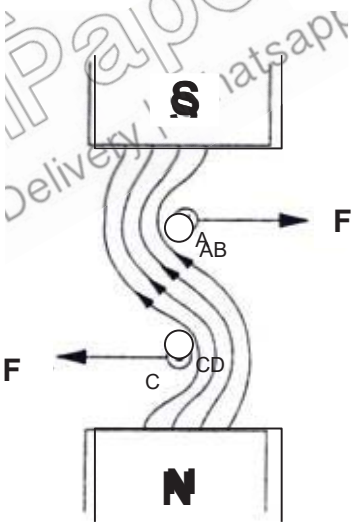


Fig. 9.1

(a) Explain, by drawing the magnetic field around the wires in the diagram below, to show why the pointer deflect. (The circles represent the cross-section of the wires **AB** and **CD** viewed in the direction shown) [3]



When current flows in the coil, the magnetic field of the coil and that of
.....
the magnet will combine in such a way that it gives rise to the forces as
.....
shown by the diagram. This makes the coil and the pointer deflects.
.....

(b) State what would be observed on the pointer if the battery she connected delivered less current?

The pointer turns through smaller angle of deflection (1).

.....

..... [1]

(c) The student wants to make the tester more sensitive so that the pointer can move through a greater distance when the battery is connected. State **two ways** that she change the design to make this happen?

(1) Increase the number of turns in the coil

.....

(2) use stronger magnet

..... [2]

END OF SECTION A

Section B

Answer **all** the questions from this section in writing papers provided unless stated otherwise.
Answer only one of the two alternative questions in **Question 12**.

10 Hand phones - the mobile approach

The last decade has seen an explosion in the use of mobile telephones. Before hand phones were invented, those who needed mobile communications installed a radio telephone in their car. In the radio-telephone system there was one central antenna tower per city and perhaps 25 channels available on that tower. The radio telephone in the car was a powerful transmitter.

In the modern system the city is divided into small cells and millions of people can use hand phones at the same time. The base station contains a fixed receiver and transmitter, connected to the normal telephone system. The hand phone and the base system use low power transmitters of 1-3W, which cannot be detected far outside each cell.

In one of the first systems, each hand phone works on two different frequencies at the same time, as a transmitter and as a receiver. A frequency band between 890MHz and 915 MHz is allocated for hand phones to transmit to the nearest base station and another band from 935 MHz to 960MHz for the phones to receive a transmission from the base station to the mobile. To transmit good quality signals, each complete signal is about 20kHz wide. Within the band available for transmission or reception, individual channels are set 25kHz apart to avoid overlap.

The implementation of mobile phones needed the development of small, efficient rechargeable batteries. Typically a battery may be able to supply 72000J of electrical energy before it needs to be recharged.

(a) Explain what is meant by a frequency of 20 kHz. [2]

Frequency of 20 kHz means that within a unit time (1), there's 20 000 (1) waves/oscillation created.

(b) Calculate the maximum wavelength that a hand phone uses to transmit a signal to the nearest base station. [2]

Speed = 3×10^8 m/s
$v = f\lambda$
$3 \times 10^8 = 890 \times 10^6 (\lambda)$ (max λ = lowest frequency) [1]
$\lambda = 0.337$ m [1]

(c) Calculate the number of individual hand phones that one base station can support. [2]

Bandwidth = $915 \times 10^6 - 890 \times 10^6 = 25 \times 10^6$ Hz [1]

Each channel is 25×10^3 Hz
Number of channels = 1000 [1]

(d) Estimate the minimum time that a battery will last if the hand phone is used for continuous transmission. [2]

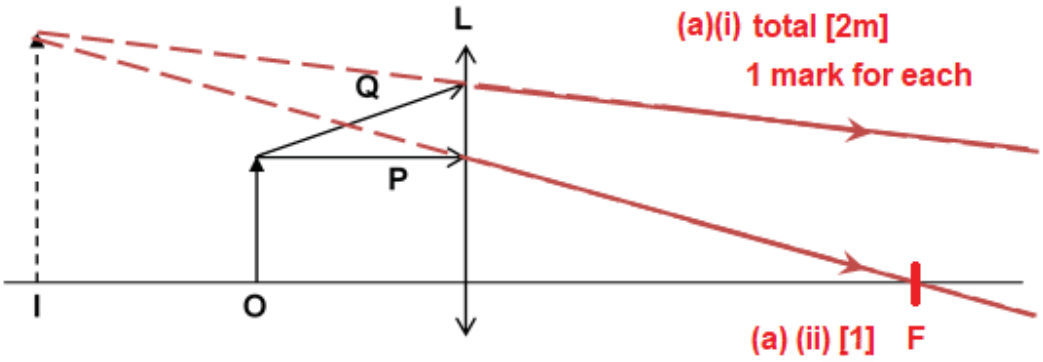
Minimum time will use the highest power ie 3 W

Power = Energy / time
Time = Energy / Power
= 72 000 / 1 [1]
= 72 000 s [1]

(e) State one similarity and one difference between visible light rays and radio waves. [2]

Similarity: Both are transverse waves. [1]
difference: Visible light has a higher frequency than radio wave [1]

11 Fig. 11.1 shows an object O, placed at a distance from a thin converging lens L. An image I is formed. P and Q are light rays incident on the converging lens.



(a)(i) total [2m]
1 mark for each

(a) (ii) [1]

Fig. 11.1

(a) On Fig. 11.1,

(i) complete the ray diagram to show the paths of rays P and Q, [2]

(ii) locate the position of the focal point and label it as F. [1]

(b) State three characteristics of the image formed. [2]
Virtual, upright and magnified

(c) State an application for such lens arrangement. [1]
Magnifying glass

(d) The object is moved closer to the lens. State two changes of the image formed. [2]
Image is smaller and nearer to lens

(e) The lens is now moved away from the lens for more than twice its focal length.

(i) State one change of the image formed, [1]
Image is smaller / real / inverted / formed at the other side of the lens

(ii) and one application for such lens arrangement. [1]
telescope / camera / eye

12 EITHER

Two containers, X and Y, filled with the same liquid are connected as shown in Fig. 12.1. The pressure at A is 100 000 Pa and the pressure at B is 160 000 Pa.

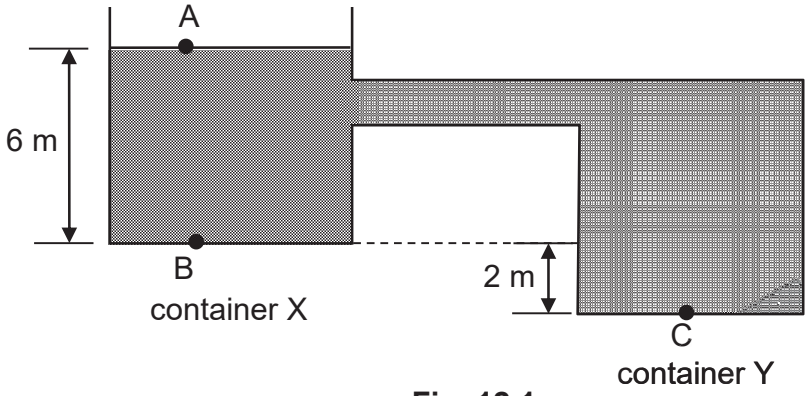


Fig. 12.1

(a) Determine the density of the liquid. [2]

Pressure = h ρ g
160 000 – 100 000 = 6 x ρ x 10
ρ = 1000 kg/m^3

(b) Calculate the pressure at C. [2]

Pressure at C = 160 000 + (2 x 1000 x 10)
= 160 000 + 20 000
= 180 000 Pa

(c) A syringe contains trapped air, as shown in Fig. 12.2. The piston inside the syringe is free to move up and down in the syringe. When the syringe is placed in hot water, the piston is pushed upwards.

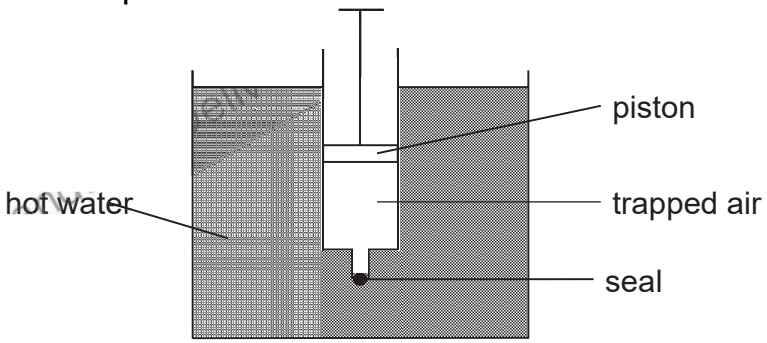


Fig. 12.2

Explain, in terms of the motion of the molecules, why the piston is pushed upwards. [2]

Heat is absorbed by the air and the air molecules move with a greater average kinetic energy and at higher speed. The force of collision and the rate of collision increases, and so the pressure inside the syringe increases / becomes greater than atmospheric pressure, causing the piston to move upwards.

(d) Another syringe contains 60 cm^3 of trapped air at room temperature. The piston is slowly pushed inwards, compressing the air. Some information about the air inside the syringe is given in Fig. 12.3.

	before compression	after compression
volume of air	60 cm^3	15 cm^3
temperature of air	25 °C	25 °C
pressure of air	1.0×10^5 Pa	p

Fig. 12.3

(i) Calculate the pressure p of the air after compression. [2]

Since temperature is kept constant, $p \propto \frac{1}{V}$.

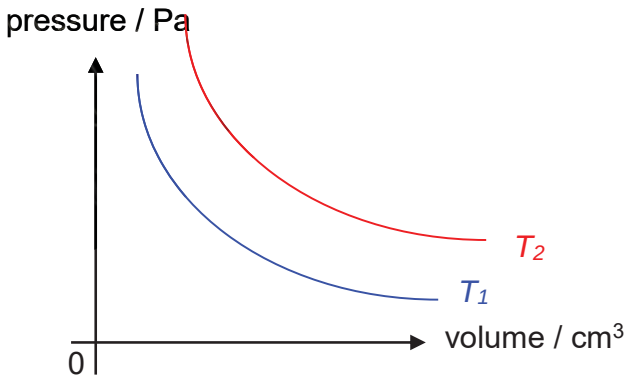
$$\frac{p_1}{p_2} = \frac{V_2}{V_1}$$

$$\frac{1.0 \times 10^5}{p} = \frac{15}{60}$$

$$p = 4.0 \times 10^5 \text{ Pa}$$

(ii) Sketch a graph to show the variation of the pressure of the air against volume at temperature T = 25 °C. Label your graph as T_1. [1]

(iii) On the same axes, sketch the graph if the temperature of the air is kept constant at T' = 50 °C. Label your graph as T_2. [1]



12 OR

In the potential divider circuit shown in **Figure 12.4** below, the battery has negligible internal resis

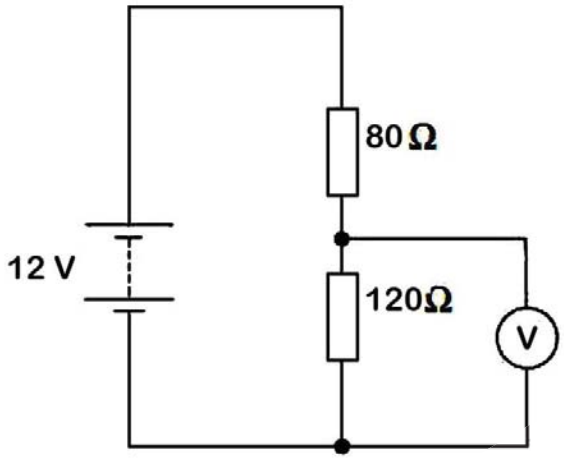


Fig. 12.4

(a) Calculate the reading on the voltmeter. [1]

The reading on the voltmeter = $\frac{120}{200}$ x 12 = 7.2 V

(b) The **voltmeter** in **Figure 12.4** above, is replaced by a **thermistor**, giving the circuit shown in **Figure 12.5** below.

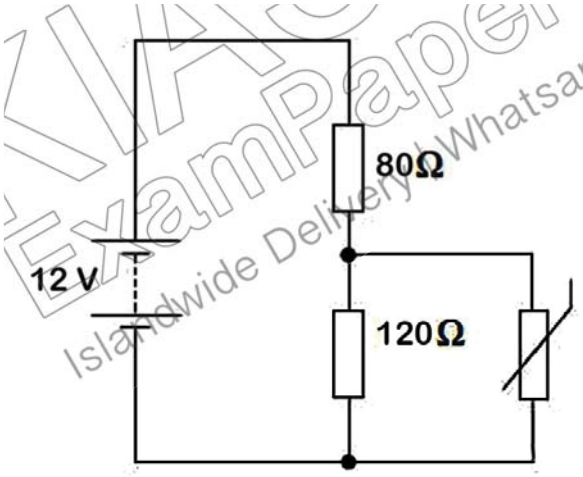


Fig.12.5

The resistance of the thermistor at 0 °C is 120 Ω. As the temperature increases, its resistance decreases. Explain, without calculation, whether the current through the battery increases or decreases as the temperature of the thermistor is increased from 0 °C. [2]

The current increases(1), since the total resistance decreases(1).

(c) A square sheet of carbon-reinforced plastic, measuring 90 mm x 90 mm and 1 mm thick, has its two large surfaces coated with a highly conducting metal film. When a p.d. of 210 V is applied between the metal films a current of 1.4 mA passes through the plastic sheet. Calculate the resistivity of the plastic. [2]

Resistance of the plastic = V/I = 210/0.0014 = 150 000 Ω ***[1]***

$$R = \frac{\rho L}{A}$$

$$\rho = \frac{RA}{L} = \frac{150000\ x90\,x90\,x1000}{1x1000\,x1000} = 1{,}200{,}000\ \Omega m \quad [1]$$

(d) Three resistors, each of resistance 3.0 Ω, are connected as shown in the **Figure 12.6** below.

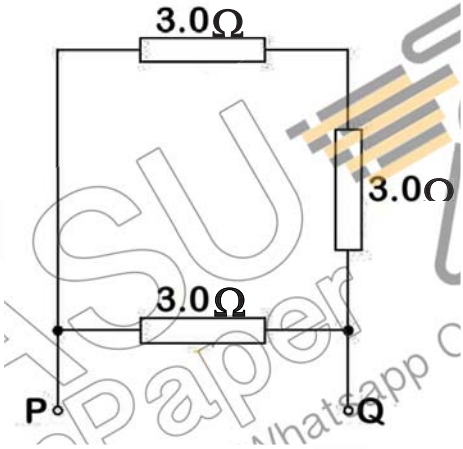


Fig. 12.6

(i) Calculate the total resistance between point **P** and point **Q** of this circuit. [1]

combined resistance = (3.0 x 6.0)/(3.0+6.0) = 2.0 Ω

(ii) The circuit in **(d)(i)** is now connected to two more resistors each of resistance 3.0 Ω, as shown in **Fig. 12.7** below. [2]

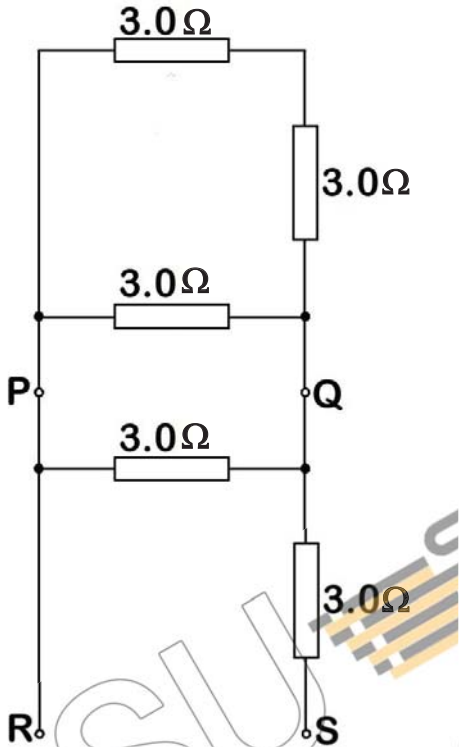


Fig.12.7

Using your answer in **(d)(i),** show that the total resistance between **R** and **S** is **4.2Ω.**

Total resistance between R and S
= (2.0 x 3.0)/(2.0+3.0) + 3.0 Ω ***[1]***
= 4.2Ω ***[1]***

(iii) One of the resistors in the circuit shown in **Fig. 12.7** becomes faulty. The resistance between **R** and **S** is found to be **5.0 Ω.** On the diagram in **Fig. 12.7** above, identify the faulty resistor by drawing a circle around it and state the nature of the fault. [2]

The horizontal resistor just above or below the terminals PQ.
The resistor has shorted / became zero resistance.

END OF PAPER 2