Geylang Methodist School (Secondary)
Preliminary Examination 2015

PHYSICS **5059/01**

Paper 1 **Sec 4 Express**

Additional materials : OAS **1 hour**

Setter : Mr Sng PH **31 July 2015**

READ THESE INSTRUCTIONS FIRST

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

Do not open this booklet until you are told to do so.

Answer **all** questions. Shade your answers on the OAS provided.

At the end of the examination, submit OAS and the question paper separately.

INFORMATION FOR CANDIDATES

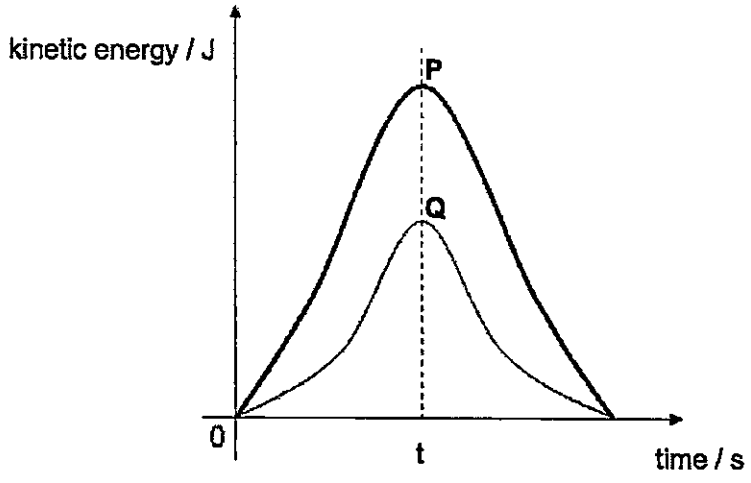
Each correct answer will score one mark.

Any rough work should be done in this booklet.

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 18 printed pages.

1 The diagram shows the kinetic energy – time graph of two pendulums oscillating.



Which of the statements made below is/are correct?

1 The graph shows both pendulums swinging through 1 complete oscillation.

2 The pendulum P's bob has a larger mass than pendulum Q's.

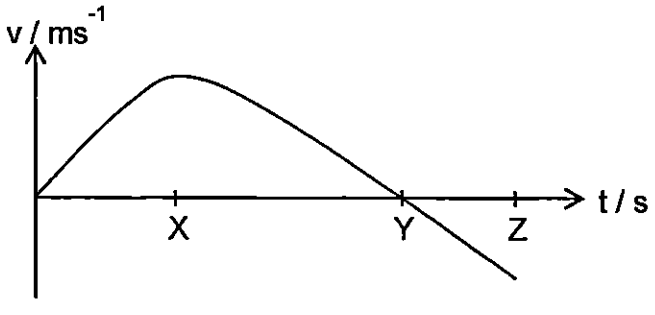
3 At instantaneous time *t*, both pendulums are at their lowest point of their oscillation.

4 Both pendulums have the same length.

A 3 only **B** 2 and 3 only

C 1, 2 and 3 only **D** 2, 3 and 4 only

2 A water rocket is launched vertically upwards. The velocity-time graph below shows the relationship between the velocity of the rocket and time.



Which of the following statements is/are correct?

1 The rocket reaches the highest position at instant X.

2 The resultant force acting on the rocket is zero at instant Y.

3 The rocket is still in the air at instant Z.

A 1 only **B** 3 only

C 1 and 2 only **D** 2 and 3 only

3 Which of the following represents the shortest length?

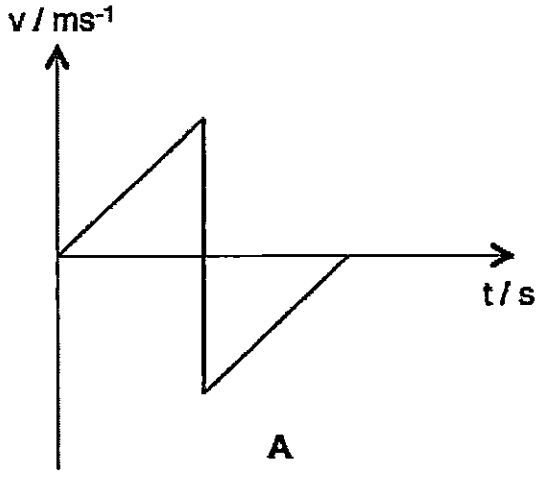
A 1.2×10^4 Mm

B 1.2×10^5 km

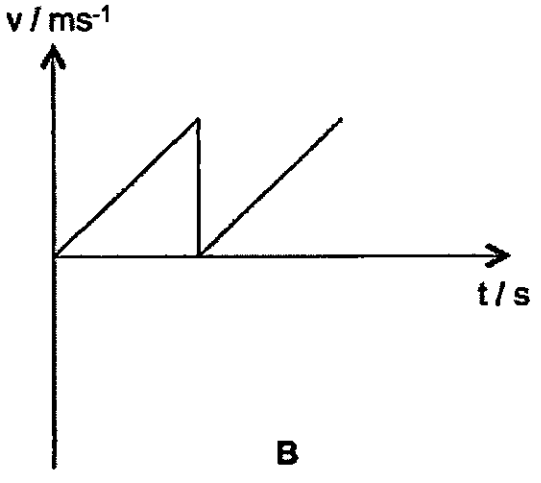
C 1.2×10^7 m

D 1.2×10^{11} mm

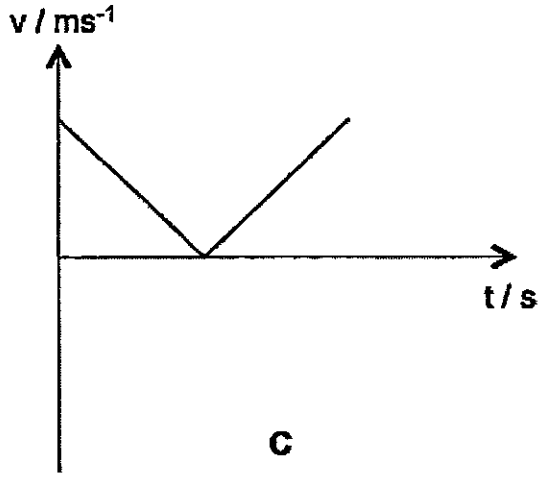
4 A ball is dropped from the top of a ladder. It falls vertically through air and rebounds in a vertical path upon hitting the ground. Assuming that no energy is lost during its impact with the ground and negligible air resistance, which of the following velocity-time graph best describes the motion of the ball?



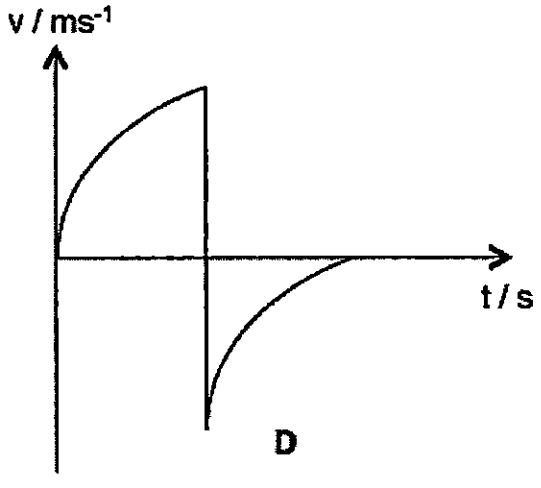
A



B

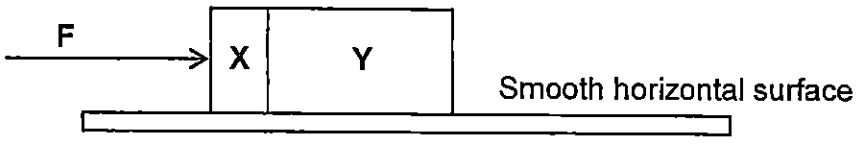


C



D

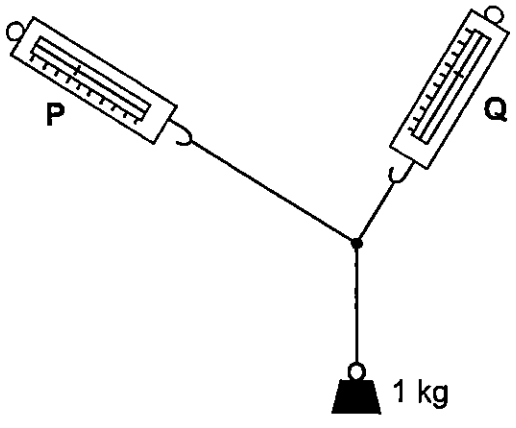
5 Two blocks X and Y, of masses *m* and *3m* respectively, are accelerated along a smooth horizontal surface by a force F applied to the block X as shown.



What is the magnitude of the force exerted by block Y on block X during this acceleration?

A 0.25 F **B** 0.33 F **C** 0.50 F **D** 0.75 F

6 The diagram below shows a 1 kg mass being supported by two strings, connected to spring balances, P and Q.



Which of the following statements is correct?

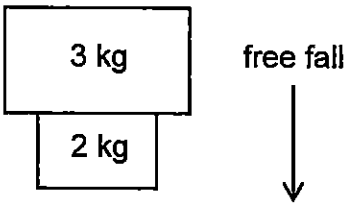
A The reading on the two spring balances will be the same.

B The reading on P will be greater than that of Q.

C If a 3 kg mass is used, both readings will triple.

D The sum of the two reading will be 10 N.

7 Two separate concrete blocks are falling freely from a building under construction.



What is the net force acting on the 2 kg block?

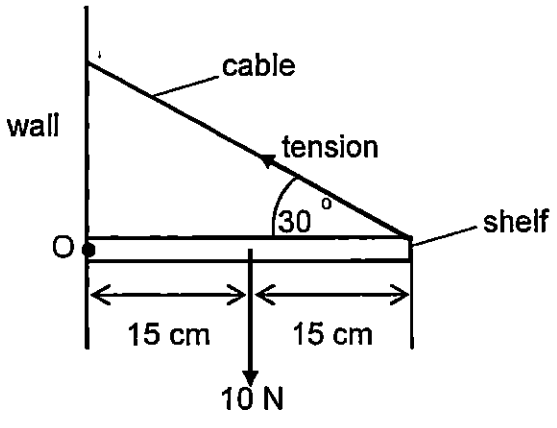
A 10 N **B** 20 N **C** 30 N **D** 50 N

8 Nichrome is an alloy that consists of 90 % Nickel and 10 % Chromium by mass. A piece of Nickel with a mass 90 g and volume of 10 cm^3, is mixed with a piece of Chromium. The Nichrome alloy formed has a density of 8.4 g/cm^3.

Calculate the density of Chromium used.

A 3.0 g/cm^3 **B** 5.3 g/cm^3 **C** 7.8 g/cm^3 **D** 9.6 g/cm^3

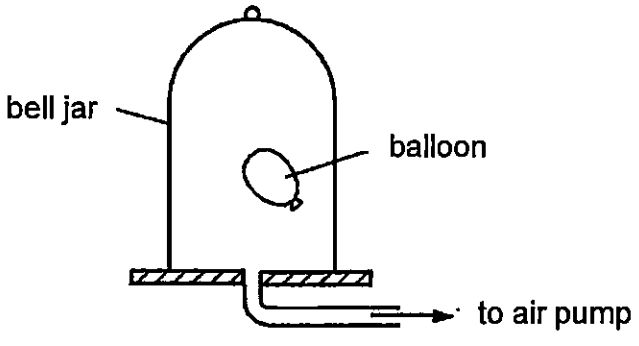
9 The diagram shows a horizontal, uniform bookshelf hinged to a vertical wall at point O and supported by a cable, which makes an angle of 30° with the shelf.



Given that the weight of the shelf is 10 N, what is the tension in the cable?

A 2.5 N **B** 5.0 N **C** 5.7 N **D** 10.0 N

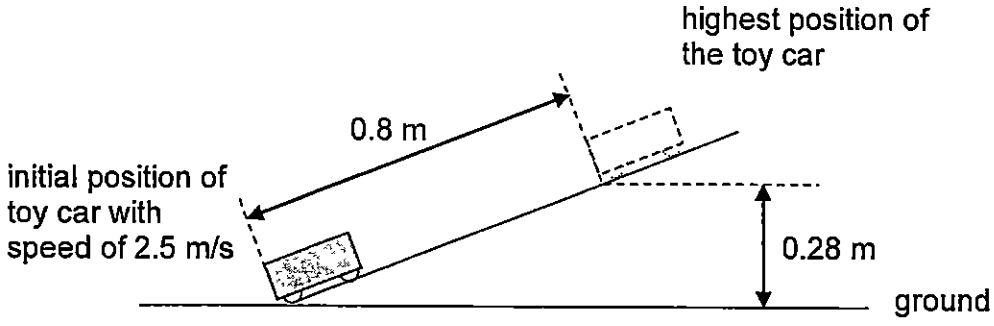
10 A partially-inflated balloon is placed inside a bell jar. The bell jar is connected to an air pump. The air pump is switched on and air is removed from the bell jar.



What happens to the pressure and to the volume of the gas inside the balloon?

	pressure	volume
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	Increases	increases

11 The diagram below shows a 0.5 kg toy car being pushed from the base of a slope with an initial speed of 2.5 m/s. It is able to move a distance of 0.8 m up the slope to its highest point 0.28 m above the ground.



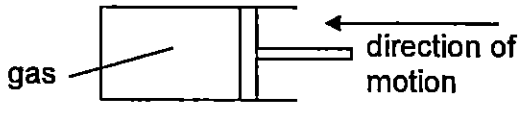
What would be the average frictional force acting on the toy car as it moves up the slope?

A 0.203 N **B** 1.400 N **C** 1.560 N **D** 1.950 N

12 A lift of mass 1000 kg rises 50 m in 2.0 minutes. If the efficiency of the lift is 80%, what is the power supplied to the motor?

A 3.33 kW **B** 5.00 kW **C** 5.21 kW **D** 250 kW

13 Gas inside a cylinder is cooled slowly to a lower temperature. The pressure inside the cylinder remains constant as the piston moves inwards.



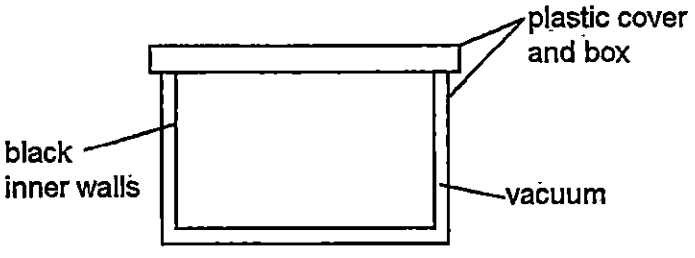
How do the speed of the particles and their rate of collisions with the cylinder and piston compare with their initial values at the higher temperature?

	average speed	rate of collision
A	lower	reduced
B	lower	increased
C	same	same
D	same	reduced

14 Which of the following correctly shows the changes, if any, in the potential energy and the kinetic energy of the particles as a solid melts?

	potential energy	kinetic energy
A	decreases	increases
B	decreases	stays the same
C	increases	stays the same
D	stays the same	increases

15 The diagram below shows the cross-section of a plastic container that a manufacturing company has created.



The company claims that the container can keep food warm for a duration that surpasses other brands of container. It offers the following explanations to justify their claims:

1 The plastic cover will reduce heat loss through conduction as plastic is a poor conductor of heat.

2 The black inner walls will absorb heat from the environment to keep food warm since black surfaces are good absorbers of heat.

3 The vacuum between the interior and exterior walls of the container will prevent heat losses to the surroundings through conduction, convection and radiation.

Which of the statements is/are correct?

A 1 only **B** 1 and 2 only

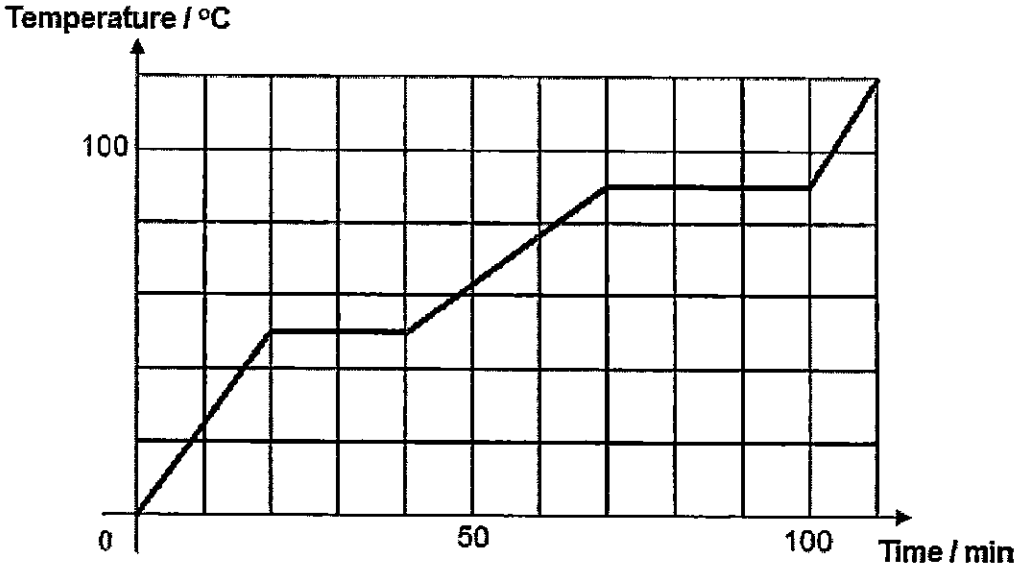
C 2 and 3 only **D** All of the above

16 A tungsten wire has a resistance of 30 Ω at -10 °C and 50 Ω at 90 °C.

What is the working temperature of the wire if its resistance is 70 Ω?

A 100 °C **B** 170 °C **C** 190 °C **D** 210 °C

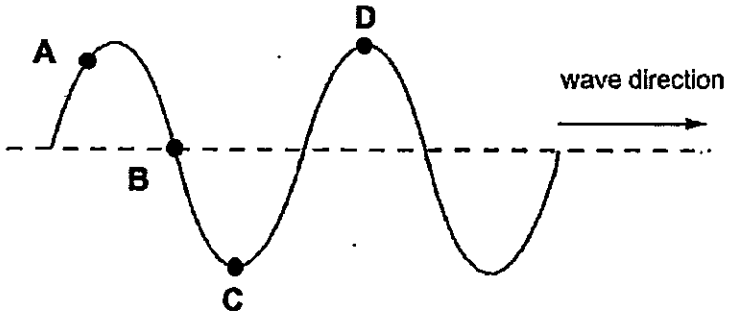
17 The graph shows the change in temperature when heat is supplied at 200 W to 1 kg of the substance.



The specific latent heat of vaporisation of the substance is _____.

A 4000 J/kg B 6000 J/kg C 240000 J/kg D 360000 J/kg

18 The diagram below shows an instantaneous position of a water wave travelling in the direction shown.



Which of the flowing statement is/are correct?

1 The particle B is momentarily at rest.

2 The particles A and D are vibrating in phase.

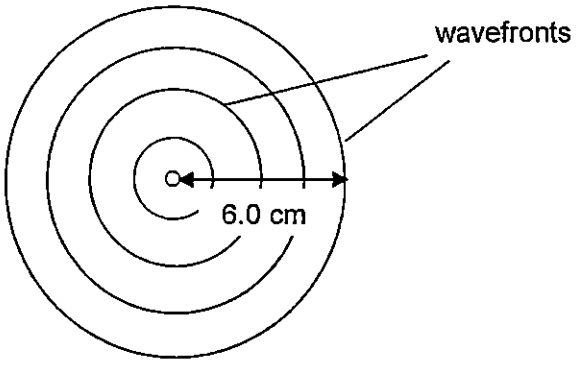
3 The particles C and D are vibrating at the highest speed.

4 All the particles in the string vibrate with same frequency.

A 1 only B 4 only

C 1 and 3 only D 1, 2 and 3 only

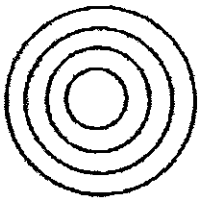
19 The diagram below shows circular wavefronts radiating from a point source **P**.



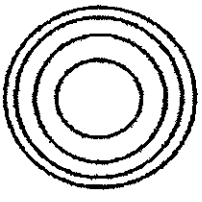
The point source is then set to vibrate with a gradually decreasing frequency.

Which of the following shows the possible resulting wavefronts?

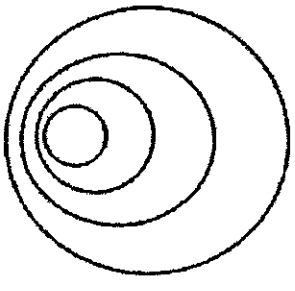
A



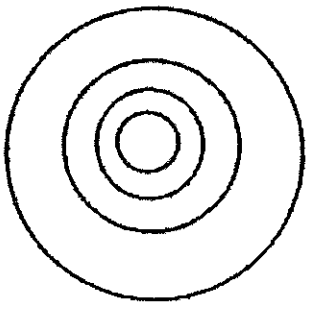
B



C



D



20 Which statement about the process of evaporation is **NOT** correct?

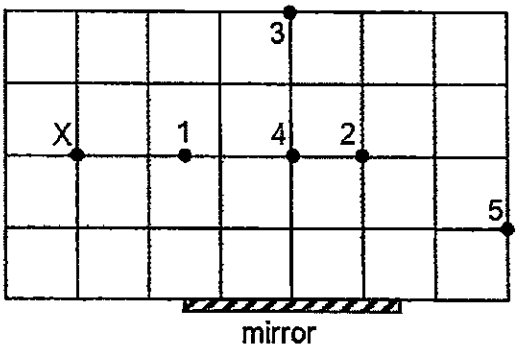
A A moist atmosphere decreases the rate of evaporation from a water surface.

B Evaporation can cause cooling.

C Liquids with lower boiling points evaporate more easily.

D The rate of evaporation increases with increased pressure.

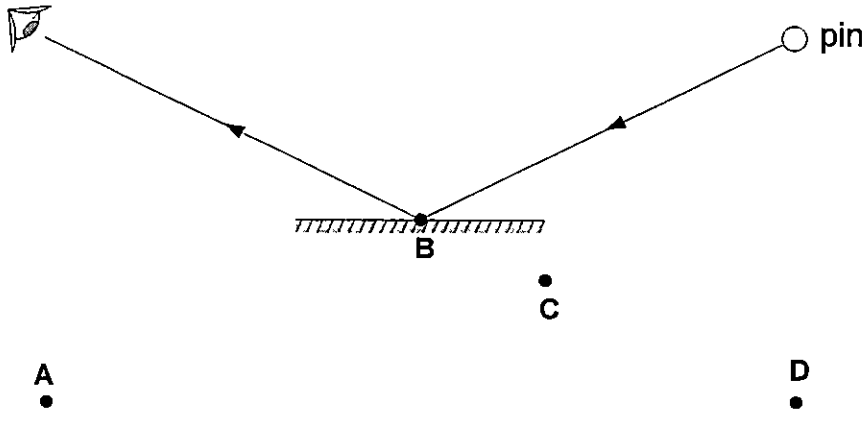
21 A person stands at point **X** as shown in the diagram below.



Which of the pins (1, 2, 3, 4, 5) will the person be able to see the image in the mirror?

A Pins 1 and 3 only
B Pins 2 and 4 only
C Pins 2, 3 and 4 only
D Pins 2, 4 and 5 only

22 A pin is placed in front of a plane mirror as shown.



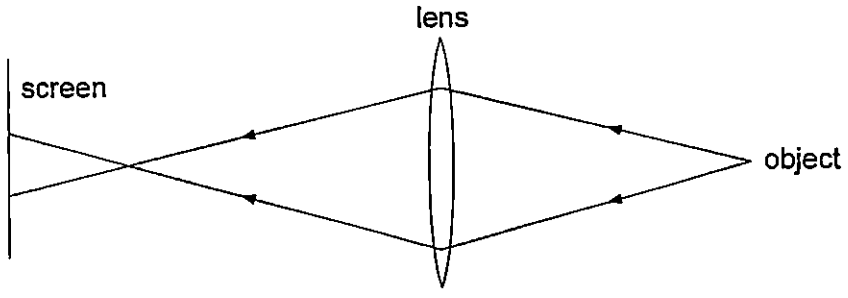
Where is the image of the pin?

23 The critical angle for a certain crystal is 41 °.

What is the speed of light in this crystal?

A 1.37×10^8 m/s
B 1.97×10^8 m/s
C 2.26×10^8 m/s
D 3.00×10^8 m/s

24 A lens forms a blurred image of an object on a screen.



How can the image be focused on the screen?

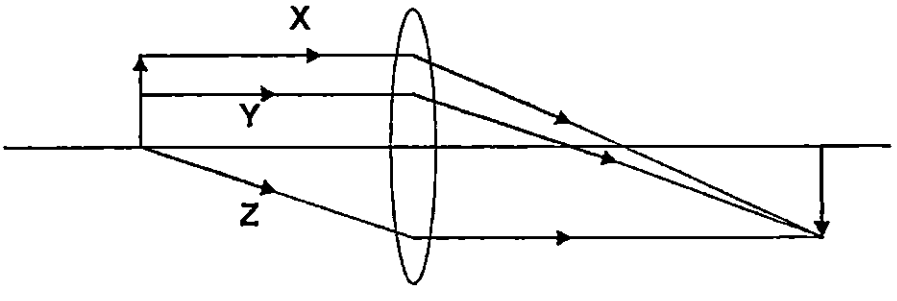
A Use a lens with a shorter focal length at the same position.

B Move the screen away from the lens.

C Move the object closer to the lens.

D Use a brighter object at the same position.

25 Which ray(s) is/are correctly drawn in the diagram below?



A Ray X only

B Ray Y only

C Ray X and Y only

D Rays X, Y and Z

26 Which of the following statements is/are **NOT** true about radio waves?

1 Radio waves can travel in vacuum.

2 Radio waves travel faster than ultrasound waves.

3 Radio waves from radio are within human audible range.

4 Radio waves cannot be reflected.

A 1 and 4 only

B 2 and 3 only

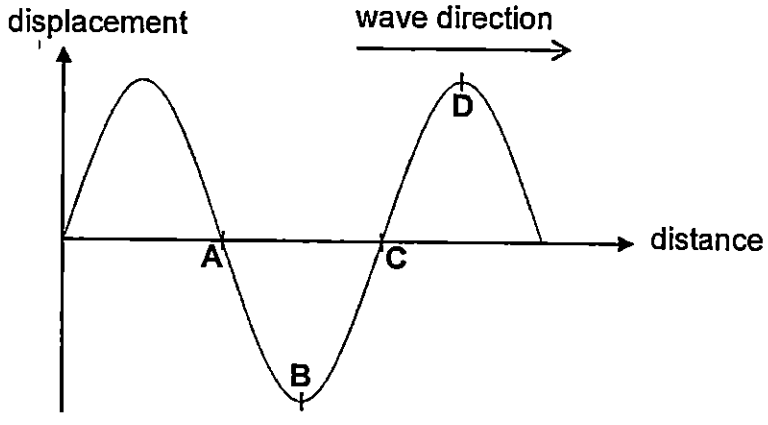
C 2 and 4 only

D 3 and 4 only

27 John attended a horse riding session at Gallop Stable at Punggol. During the ride, the horse heard something that John could not hear. Given that the wavelength of the sound heard by the horse is 1.1 cm, which of the following is a possible audible frequency range of the horse?

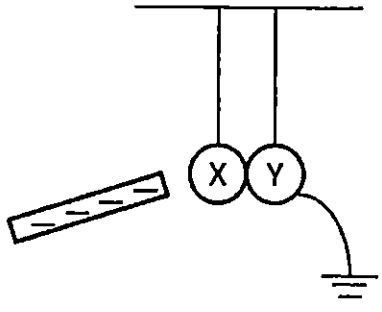
A 10 Hz to 10 000 Hz
B 15 Hz to 20 000 Hz
C 20 Hz to 20 000 Hz
D 50 Hz to 35 000 Hz

28 The diagram below shows a sound wave with the wave direction as shown.



Which point, A,B,C or D, corresponds with compression of the wave?

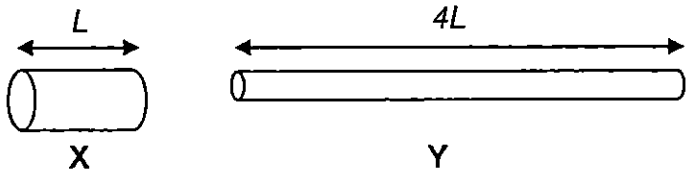
29 The diagram below shows two metal spheres X and Y in contact are suspended by insulating threads. Sphere Y is earthed.



A negatively charged plastic rod is held near to sphere X. What is the net charge on X and Y respectively?

	sphere X	sphere Y
A	positive	negative
B	positive	neutral
C	positive	positive
D	neutral	neutral

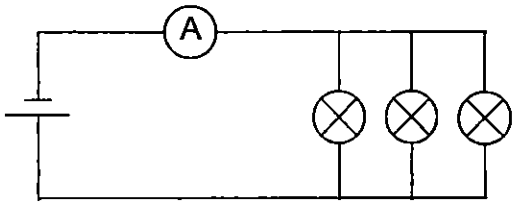
30 Two copper wires X and Y have the **same volume**. Wire Y is four times as long as wire X.



What is the ratio of the resistance of wire Y to resistance of wire X?

A 4 **B** 8 **C** 16 **D** 64

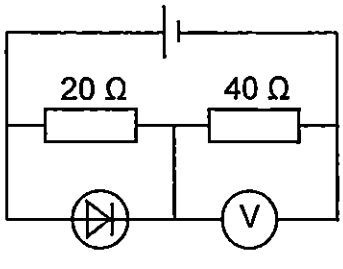
31 Three identical light bulbs are connected in parallel to a D.C. supply. Each bulb operates at normal brightness.



What will happen to the ammeter reading and brightness of the remaining bulbs if one of the bulb blows?

	ammeter reading	bulb brightness
A	increases	increases
B	increases	unchanged
C	decreases	unchanged
D	decreases	decreases

32 In the given circuit, the voltmeter reads 12V. If the diode is reversed, what is the reading of the voltmeter?



A 6 V **B** 8 V **C** 12 V **D** 16 V

33 Ben connects a fuse along the neutral wire of a fan. Which of the following statement(s) is/are correct?

1 The fan will be safe to touch after the fuse blows.

2 The fan will still be connected to the high voltage source when the fuse blows.

3 There is no current passing through the neutral wire after the fuse blows.

A 2 only **B** 1 and 2 only

C 1 and 3 only **D** 2 and 3 only

34 An electrical cable contains three wires: live, neutral and earth. The cable is correctly wired to a plug which contains a 3 A fuse. The insulation becomes damaged and bare metal wires are exposed. Five possible events can occur.

1 A person touches the earth wire.

2 A person touches the neutral wire.

3 A person touches the live wire.

4 The live wire touches the neutral wire.

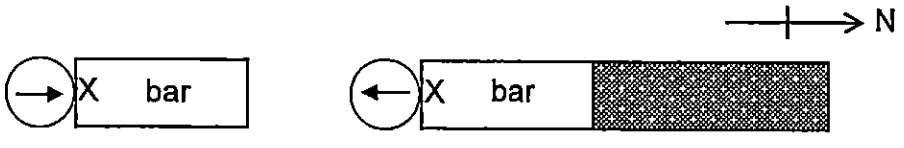
5 The live wire touches the earth wire.

Which of these events can cause the fuse to blow?

A 1 and 3 only **B** 2 and 3 only

C 4 and 5 only **D** 3, 4 and 5 only

35 The direction of a compass needle placed at one end of an unknown bar, is as shown below. When a magnet is brought near it, the compass direction is reversed.



Which of the following statements is/are possible conclusion/s?

1 The unknown bar is made of a material such as nickel.

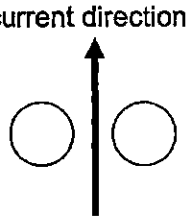
2 The unknown bar is made of a material such as aluminium.

3 The unknown bar is a magnet with X as the north pole.

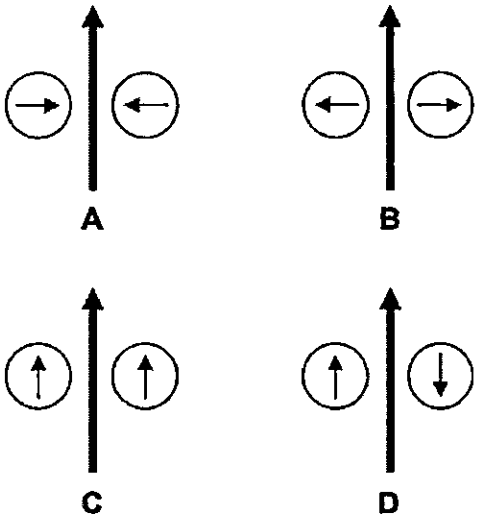
A 1 only **B** 2 only

C 1 and 2 only **D** 1 and 3 only

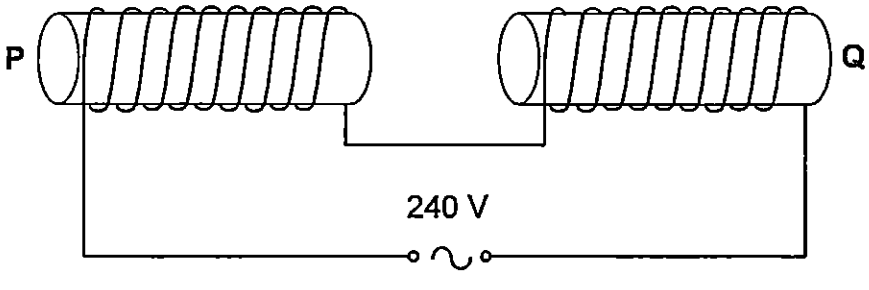
36 Two plotting compasses and a current carrying wire are placed on a table. The compasses are placed on either sides of the wire as shown below.



In which direction will the compass needles point?



37 Two iron bars P and Q are placed inside two solenoids as shown below.



When the solenoids are connected to an a.c power supply, P and Q will

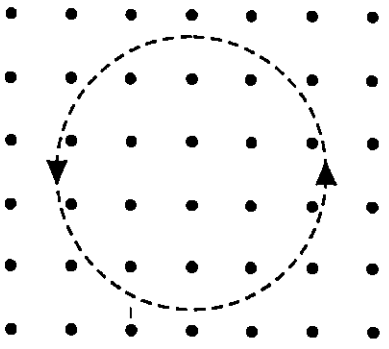
A repel each other.

B attract each other.

C oscillate towards and away from each other.

D oscillate upwards and downwards.

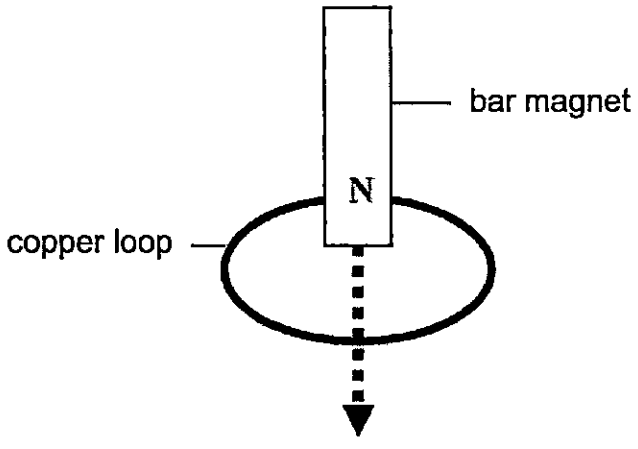
38 The diagram below shows the circular anti-clockwise path of a charged particle in a field. The direction of the field is out of the paper.



Ignoring the effect of gravity, which of the following correctly describes a possible state of charge of the particle and the nature of the field?

	charge	field
A	negative	magnetic
B	positive	electric
C	negative	electric
D	positive	magnetic

39 A bar magnet is dropped through a loop of copper wire as shown.



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

1 When the magnet approaches the copper loop, a current is induced in the loop that flows in clockwise as seen by the observer from the top of the loop.

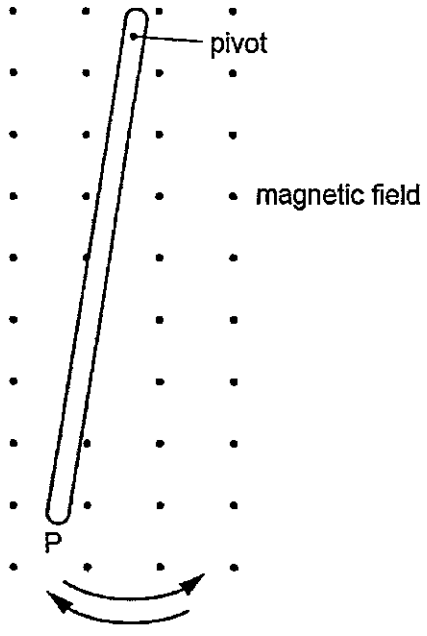
2 When the magnet moves through the copper loop, the current induced in the copper loop sets up a magnetic field that always repel the magnet.

3 Heat is produced in the copper loop.

4 The magnet falls through the copper loop with an acceleration that is lower than the acceleration of free fall due to gravity.

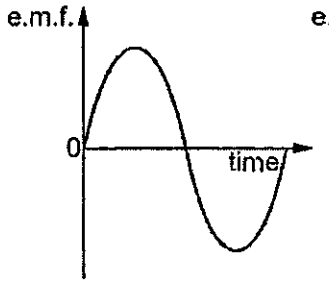
A 2 only
B 1 and 2 only
C 2 and 3 only
D 3 and 4 only

40 The diagram shows a metal bar swinging like a pendulum across a uniform magnetic field. The motion induces an e.m.f. between the ends of the bar.

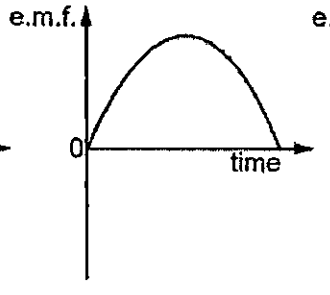


Which graph represents this e.m.f. during one complete oscillation of the bar, starting and finishing at P?

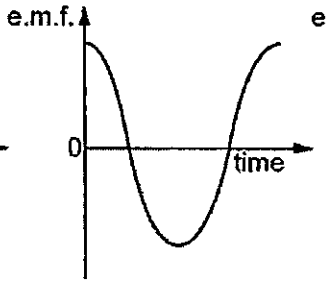
A



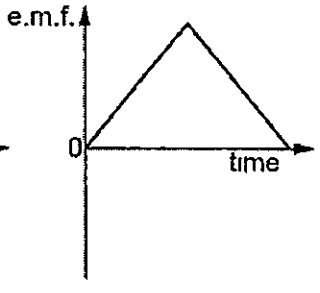
B



C



D



END OF PAPER

Geylang Methodist School (Secondary)
Preliminary Examination 2015

Candidate Name			
Class		Index Number	

PHYSICS **5059/02**

Paper 2 Physics **Sec 4 Express**

Additional materials : Nil **1 hour 45 minutes**

Setter : Mr Sng Peng Hock **31 July 2015**

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** on the writing papers provided.
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.

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.

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.

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

This document consists of **15** printed pages and 1 blank page.

[Turn over

SECTION A

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

1 Fig. 1.1 shows the variation of the resultant force acting on a moving object in the direction of motion. The object moves along a horizontal surface in a straight path.

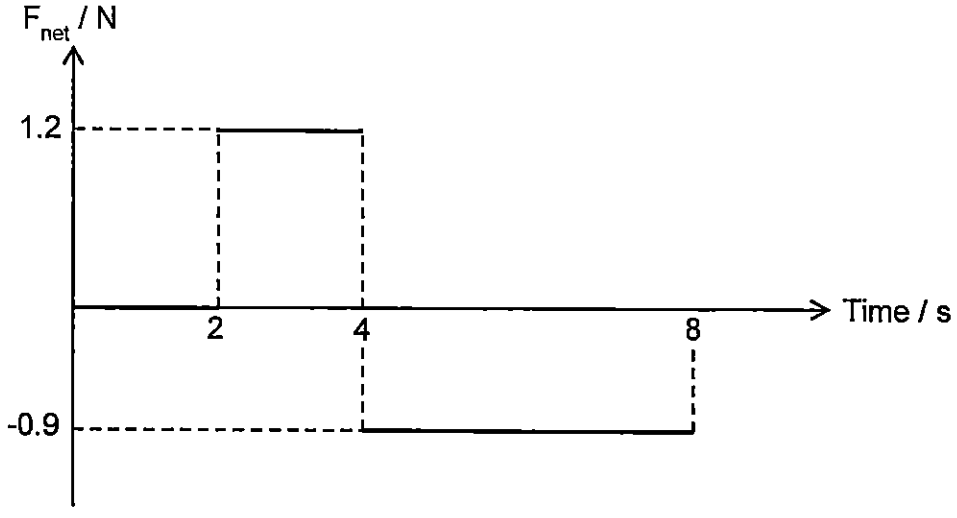


Fig 1.1

The object has a mass of 0.3 kg and a velocity of 6 m/s at t = 0.

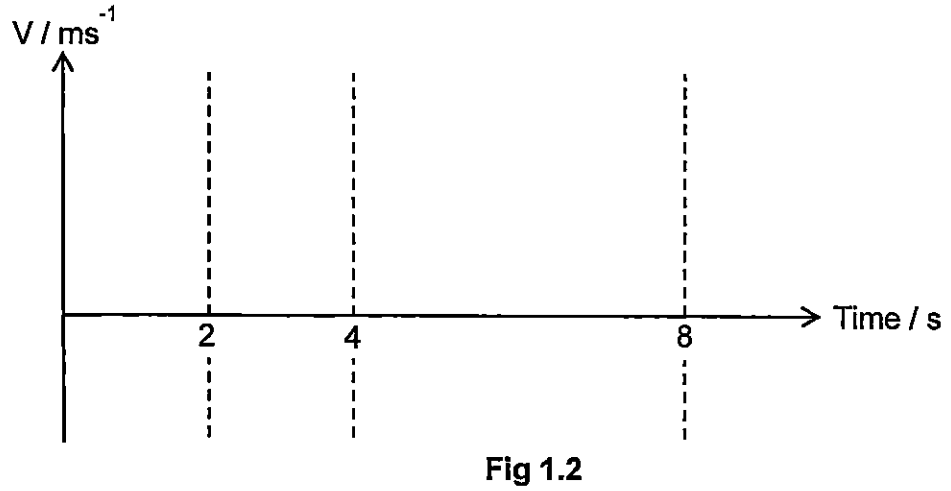
(a) State the object's acceleration at t = 1.

acceleration = ... [1]

(b) Calculate the velocity of the object at t = 4.

velocity = ... [2]

(c) On Fig.1.2, draw the velocity-time graph of the object, showing all values clearly.



[3]

Fig 1.2

2 A uniform plank of length 4.0 m and weight 500 N is suspended by two strings at X and Y. A box of mass 3.5 kg is placed as shown in Fig. 2.1.

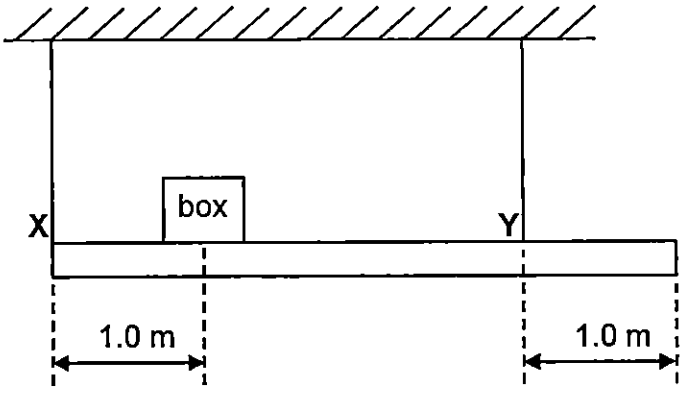


Fig. 2.1

(a) On Fig. 2.1, draw arrows to represent **all** the forces acting on the plank. [2]

(b) The plank is balanced. Calculate the force in the string at X by taking moments about Y.

force at X = ... [2]

(c) Hence or otherwise, calculate the force in the string at Y.

force at Y = ... [1]

(d) An additional weight is suspended from the plank directly below point Y.

State and explain how this will affect the force in the string at X.

.....

.....

..... [2]

3 Fig. 3.1 shows a diver working below the surface of a lake. The density of the water in the lake is 1000 kg/m^3, the atmospheric pressure at the surface is 1.0×10^5 Pa.

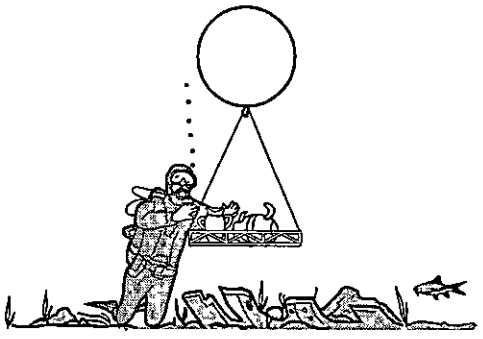


Fig. 3.1

The diver inflates a balloon with air at a depth of 15 m and attaches the balloon to a tray of objects.

(a) Calculate the total pressure acting on the balloon, at 15 m below the surface of the lake.

pressure = ... [2]

(b) The diver releases the tray and the balloon, and they begin to rise. The temperature of the air in the balloon does not change. The volume of the balloon is 0.3 m^3 at 15 m depth.

Calculate the volume of the balloon when it reaches the surface.

volume = ... [2]

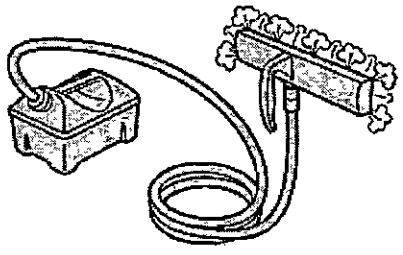
(c) Explain, in terms of the air molecules inside the balloon, why the air pressure in the balloon is less at the surface.

.....

.....

..... [2]

4 Arnold uses the steam wallpaper stripper, as shown in Fig. 4.1, to help him remove wallpaper in his living room.



Machine Specifications
Power rating = 2.5 kW
Voltage = 240 V
Capacity = 5.0 litres

Fig. 4.1

The water in the machine is heated until it boils and produces steam. The steam nozzle is held against the wall and the steam will soften the wallpaper, making it easy for Arnold to scrape it off.

Given that:
Specific heat capacity of water = 4200 J/kg °C
Specific latent heat of vaporization of water = 2260 x 10^3 J/kg
One litre of water has a mass of one kilogram.

(a) Arnold fills the machine to its full capacity using tap water at 20 °C and turns on the switch.
Calculate the time he needs to wait before the machine starts producing steam.

time = ... [3]

(b) Arnold uses the machine continuously for one hour since the time he turns on the switch.
Calculate the mass of the water left in the machine.

mass = ... [3]

5 Fig. 5.1 below shows circular wavefronts produced at the centre of a circular ripple tank.

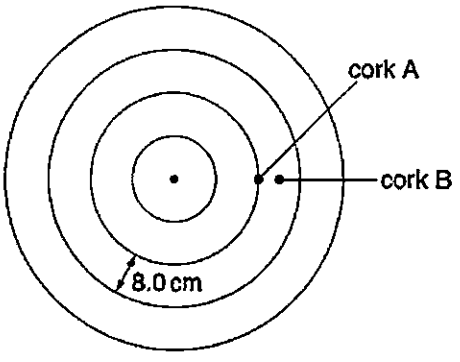


Fig 5.1

Two corks, A and B, float on the water in the ripple tank. The distance between successive wavefronts is 8.0 cm. Fig. 5.2 shows how the displacement of cork A varies with time.

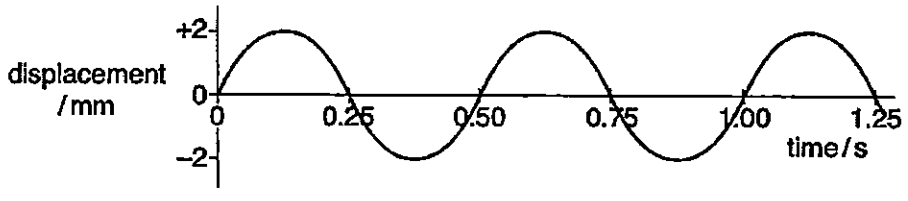


Fig 5.2

(a) State the displacement of cork B, when the displacement of cork A is 2 mm.

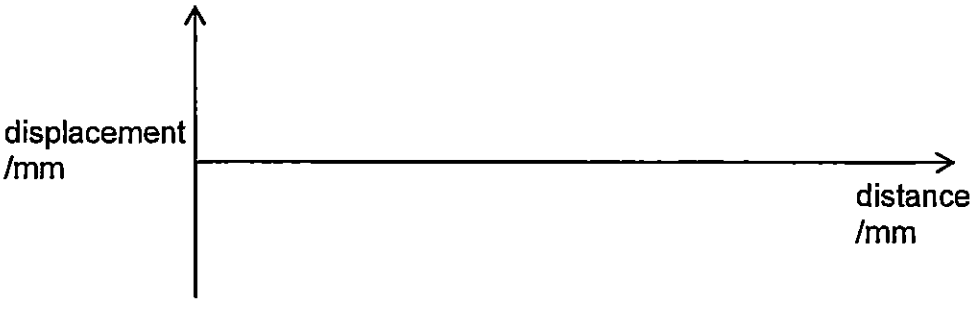
displacement = ... [1]

(b) The diameter of the ripple tank is 80 cm.

Determine the time taken by a wavefront to travel from the centre of the tank to the edge.

time = ... [2]

(c) Sketch the displacement-distance graph of the wave, for one complete wave.



[2]

6 A ray of light from an under water laser pointer, is incident upon a spherical air bubble as shown in Fig. 6.1. The refractive index of water is 1.33.

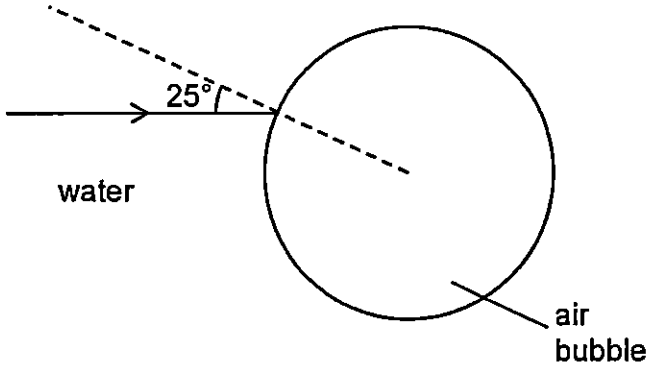


Fig 6.1

Complete the path of the ray until it exits the air bubble, showing clearly all angles at the boundaries. Show the workings to calculate these angles in the space below. [3]

7 Fig. 7.1 shows a positively charged sphere held with an insulating handle. When the sphere is brought near the metal plate, the galvanometer needle deflects momentarily.

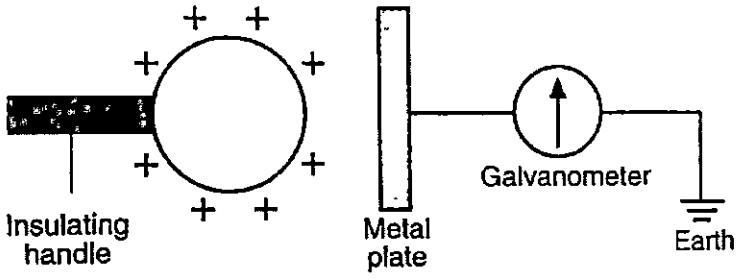


Fig 7.1

(a) Explain clearly why there is momentary deflection in the galvanometer needle?

.....

.....

.....

.....

.....

..... [3]

(b) Suggest a method that would increase the magnitude of the deflection.

.....

..... [1]

(c) State clearly what can be observed when the positively charged sphere is removed quickly.

.....

..... [1]

8 Fig. 8.1 below shows a circuit connected to a battery of unknown e.m.f.

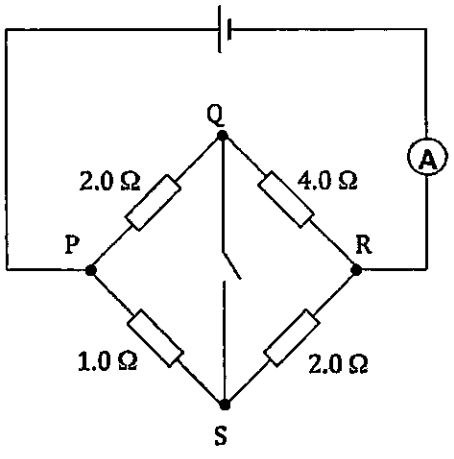


Fig. 8.1

(a) When the switch is opened, the ammeter reads 3.0 A.

(i) Calculate the e.m.f of the battery.

e.m.f = ... [3]

(ii) Calculate the current passing through PSR.

current = ... [1]

(b) The switch is now closed.

Explain if a current will flow through QS. If yes, how much is the current.

.....

.....

.....

..... [3]

9 If small cracks in steel pipes can be detected before they become larger, the cost of repairing the damage can be greatly reduced. Fig. 9.1 shows a method to detect cracks using a coil of insulated copper wire carrying a current. Iron filings are sprinkled over the pipe and will cluster around any crack that is perpendicular to the axis of the pipe.

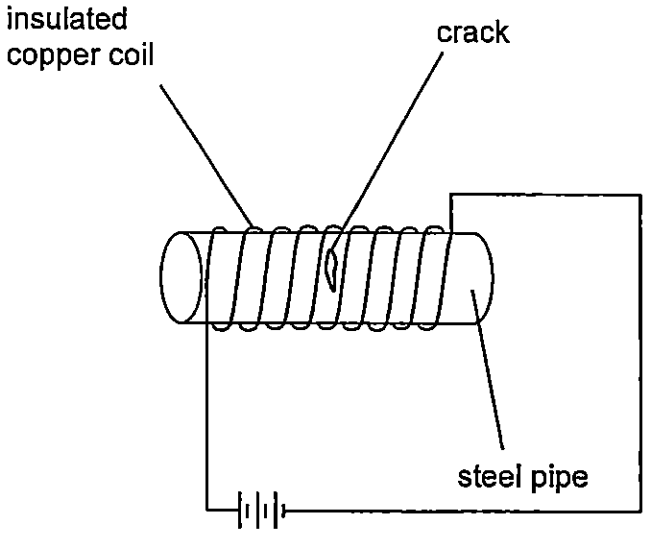


Fig. 9.1

(a) Draw on Fig. 9.1, the magnetic field lines generated by the current carrying coil if there is no crack and state clearly the magnetic poles formed. [2]

(b) Explain why iron filings cluster around the crack when there is a current in the coil.

.....

.....

.....

.....

..... [2]

(c) Explain why this method will not work on copper pipes.

.....

..... [1]

SECTION B

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

10 A 40 kg mass is initially at rest on a rough bench and a 20 kg mass is attached to it via an inextensible string, as shown in Fig 10.1. The string goes over a smooth pulley with negligible friction.

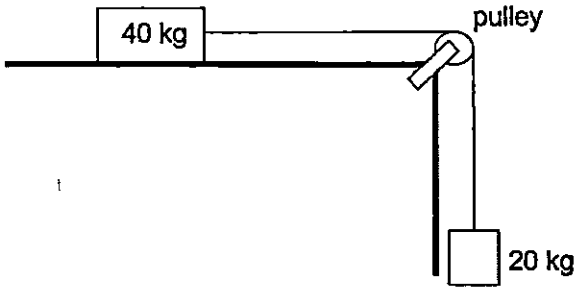


Fig. 10.1

When the 20 kg mass is released, the masses start to move together. The friction between the 40 kg mass and the bench is 20 N.

(a) Using Newton's Third Law of motion, state the action reaction pair of the weight of the 40 kg mass. [1]

(b) Calculate the acceleration of the masses when they start to move. [3]

(c) Calculate the tension in the string when the masses start to move. [2]

(d) Fig. 10.2 shows a car brake system.

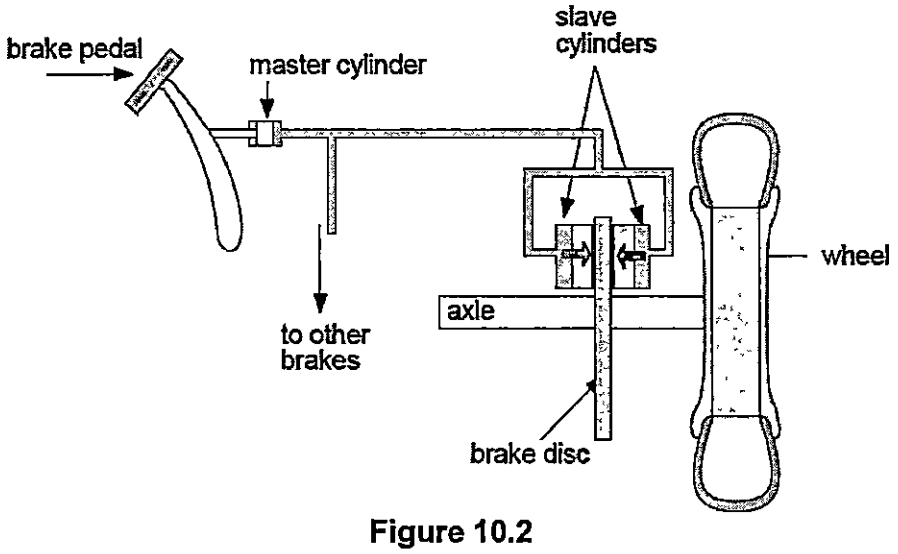


Figure 10.2

The pipes between the master cylinders and the slave cylinders are filled with incompressible brake fluid, forming a closed system. The diameter of the master cylinder is 10 cm and that of the each slave cylinder is 20 cm.

Calculate the ratio of the master cylinder area to the slave cylinder area. [1]

(e) The car requires a braking force of 4500 N on each brake disc to stop.

How much force should be applied to the master cylinder in order to achieve this? [3]

11 The issue of haze generated from forest fire has become a yearly problem for many countries. This is not only an expensive problem but has become a critical health hazard for many who are exposed to its effect. Moreover the generation of greenhouse gases from these fires has caused alarm as it will most likely further contribute to changes in the world's climate and weather pattern. One way in which the regional government has sought to combat this problem of forest fire is through the use of infra-red thermal imaging. Satellites equipped with infra-red sensors are used to detect problem spots. With this information, the local authorities are then mobilised to put out the fire before it spreads and worsens.

Visible light is unable to pass through clouds and haze, but infra-red radiation can.

How does the infrared (IR) sensor work?

The infra-red (IR) sensors mounted on satellites detect the relative thermal energies emitted by objects like burning trees, fields and streams. With the aid of a signal processor, this information is converted into a colour coded visual presentation showing regions with varying range of temperature. The IR band is often subdivided into smaller sections, coded as shown in the table below:

Section Code	**NIR**	**SWIR**	**MWIR**	**LWIR**	**FIR**
Wavelength/μm	0.75 – 1.4	1.3 – 3	3 – 8	8 – 15	15 – 1000

IR radiations that fall into individual sections are assigned colour codes by the signal processor. Forest fires which are normally detected in the range of 3 to 4.5 μm and hence falls under the MWIR section may be assigned the colour red.

Bodies of water which are cooler like rivers fall in the range of 10+ μm and as such the LWIR section may be assigned the colour blue.

As a result, a coloured image of red for hot and blue for cold objects can be constructed and used to detect hot spots.

(a) Which IR radiation, MWIR or LWIR, travels at a higher speed to the sensors on the satellites? [1]

(b) State the IR section code that is nearest to the electromagnetic band of visible light. [1]

(c) Calculate the range of the IR frequencies for the MWIR section code. [4]

(d) Deduce from the information above, if the method of IR imaging is more useful in detecting exact spots of forest fire compared to a normal coloured photograph taken from a satellite. Explain your deduction. [2]

(e) Besides the application above, state two other applications of infra-red radiation. [2]

EITHER

12 Fig. 12.1 shows a flowmeter that measures the volume of oil passing through a pipe.

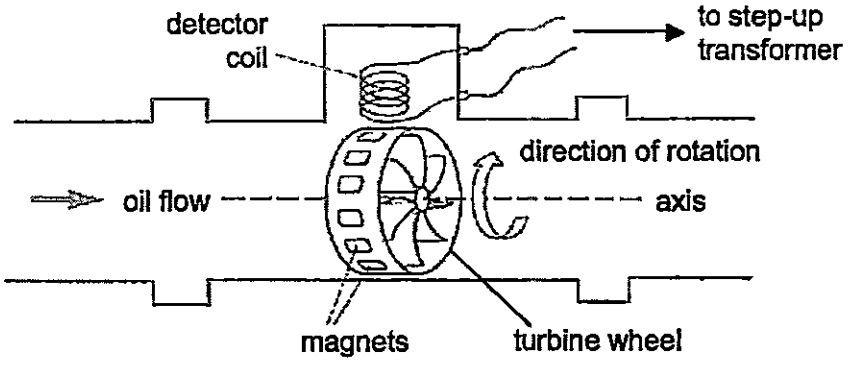


Fig.12.1

Twenty identical magnets are spaced equally around a turbine wheel. As oil flows, the turbine wheel rotates about the axis as shown. The detector coil is connected to the primary coil of a step-up transformer (Fig. 12.2) to amplify the voltage signal, which is then displayed on a cathode ray oscilloscope.

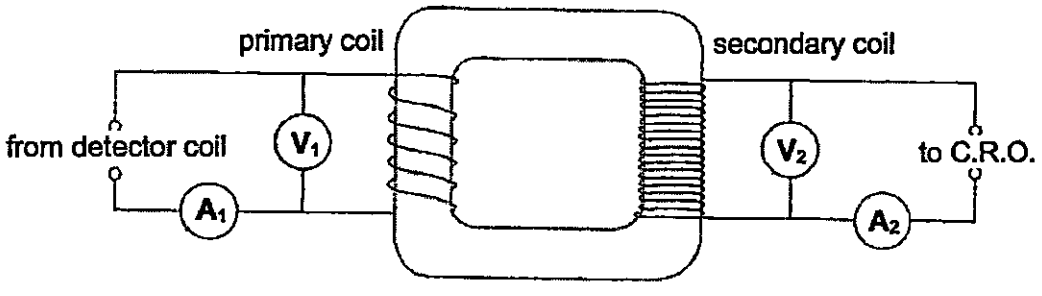


Fig. 12.2

Fig. 12.3 shows the data for two different oil flow rates. Some values are missing from the table.

oil flow rate/ $cm^3 s^{-1}$	period of turbine spin / s	transformer			
		A_1 / A	V_1 / V	A_2 / A	V_2 / V
15	2	1.8	6	0.8	12
30	1	1.8		0.8	

Fig. 12.3

(a) Explain why an alternating e.m.f. is induced in the detector coil. [3]

(b) Sketch a graph below to show how the induced e.m.f. in the primary coil varies with time for a flow rate of 15 cm^3/s. [2]

(c) State if the transformer is 100% efficient. Explain by showing your working clearly. [2]

(d) Calculate the ratio of the number of turns in the secondary coil to the number of turns in the primary coil. [2]

(e) Calculate the missing values for V_1 and V_2. [1]

OR

12 Fig. 12.1 shows a simple experimental set-up to study the motion of a motor. AB and CD are solenoids connected to a battery. F and G are connected to an external voltage supply. The graph of the external voltage supplied is as shown in Fig. 12.2 (Positive voltage indicates that the potential of F is higher than of G).

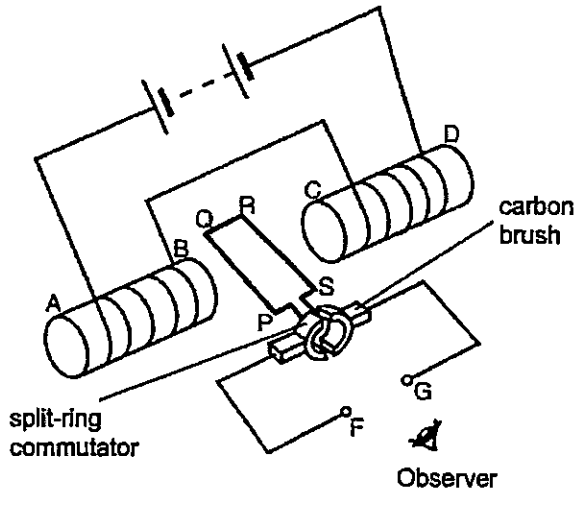


Fig. 12.1

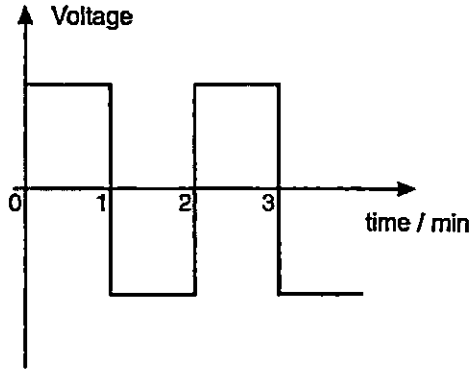


Fig. 12.2

It is observed that the coil makes 5 rotations in one minute.

(a) Identify the magnetic poles at B and C. [1]

(b) How would the coil PQRS turn (clockwise or anticlockwise direction) during the first minute? [1]

(c) Explain how you arrived to the answer in **(c)**. [2]

(d) Fig. 12.3 shows the solenoids and the coil PQRS from the observer's point of view.

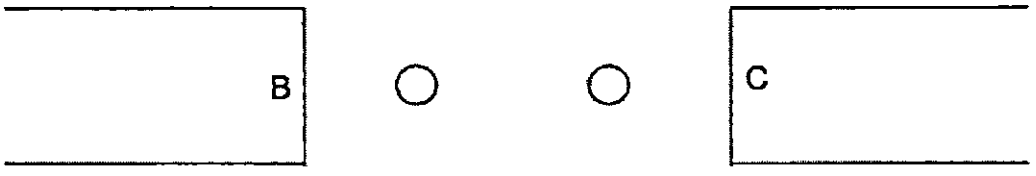


Fig. 12.3

Copy Fig. 12.3 and draw the magnetic field pattern between the two solenoids. The two circles represent PQ and RS. Indicate the direction of the current using dot and cross notation. [2]

(e) State what would happen to the coil during the 1-2 minute interval. [1]

(f) State the purpose of the split-ring commutators. [1]

(g) A longer wire of the same material and cross-sectional area as the one used in PQRS is used to make a coil with greater number of turns. This coil is used to replace PQRS.

State and explain what can be observed of the movement of the new coil. [2]

END OF PAPER

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Geylang Methodist School (Secondary)
Preliminary Examination 2015

Candidate Name			
Class		Index Number	

PHYSICS **5059/02**

Paper 2 Physics **Sec 4 Express**

Additional materials : Nil **1 hour 45 minutes**

Setter : Mr Sng Peng Hock **31 July 2015**

READ THESE INSTRUCTIONS FIRST

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

This document consists of **15** printed pages.

[Turn over

SECTION A

Answer **all** questions in this section.
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1 Fig. 1.1 shows the variation of the resultant force acting on a moving object in the direction of motion. The object moves along a horizontal surface in a straight path.

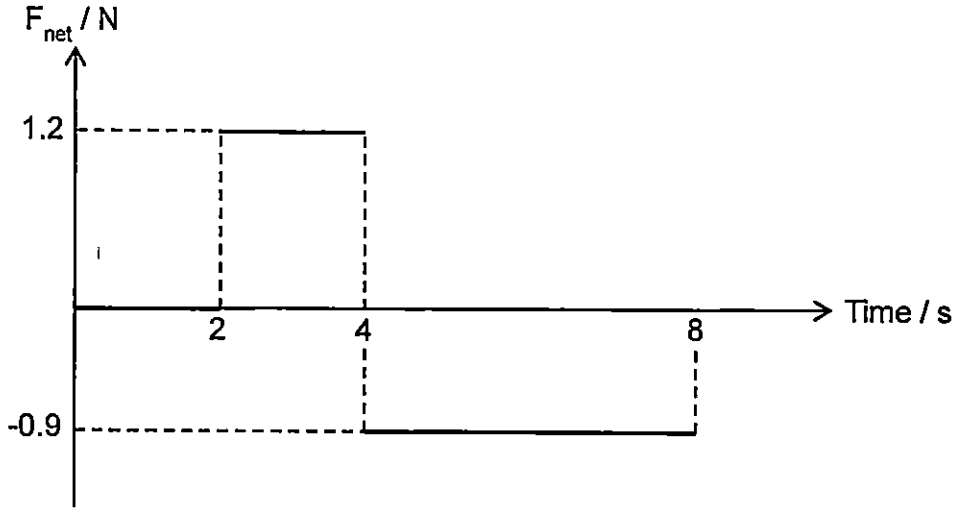


Fig 1.1

The object has a mass of 0.3 kg and a velocity of 6 m/s at t = 0.

(a) State the object's acceleration at t = 1.

acceleration = ...0 m/s^2..... [1]

(b) Calculate the velocity of the object at t = 4.
a = 1.2 / 0.3 = 4 m/s^2 [1]
(v – u) / t = a
(v – 6) / 2 = 4
v = 14 m/s [1]

velocity = ... [2]

(c) On fig.1.2, draw the velocity-time graph of the object, showing all values clearly.

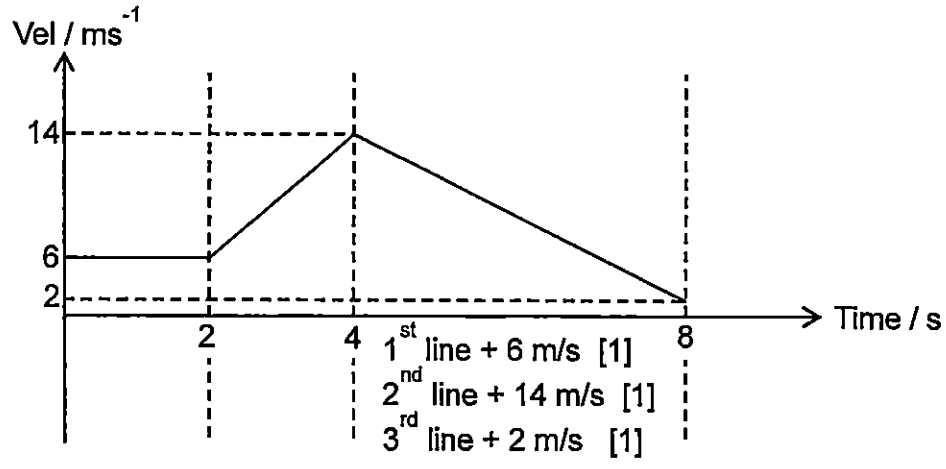


Fig 1.2

[3]

2 A uniform plank of length 4.0 m and weight 500 N is suspended by two strings at **X** and **Y**. A box of mass 3.5 kg is placed as shown in Fig. 2.1. Take g = 10 N/kg.

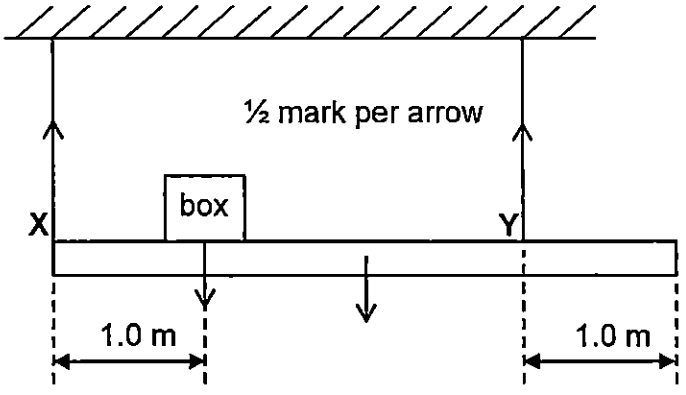


Fig. 2.1

(a) On Fig. 2.1, draw arrows to represent **all** the forces acting on the plank. [2]

(b) The plank is balanced. Calculate the force in the string at **X** by taking moments about **Y**.

Since the plank is balanced, taking moment about Y,
sum of clockwise moments = sum of anticlockwise moments.
$F_x \times 3 = 500 \times 1 + 35 \times 2$ [1]
$F_x = 190$ N [1]

force at **X** = ... [2]

(c) Hence or otherwise, calculate the force in the string at Y.
$500 + 35 = 190 + F_y$
$F_y = 345$ N [1]

force at **Y** = ... [1]

(d) An additional weight is suspended from the plank directly below point **Y**.

State and explain how this will affect the force in the string at **X**.

This will not affect the force at X. [1]
Taking moments about Y, the calculation of the force at X is the same as per part (b). [1]

[2]

3 Fig. 3.1 shows a diver working below the surface of a lake. The density of the water in the lake is 1000 kg/m^3, the atmospheric pressure at the surface is 1.0×10^5 Pa and the gravitational field strength is 10 N/kg.

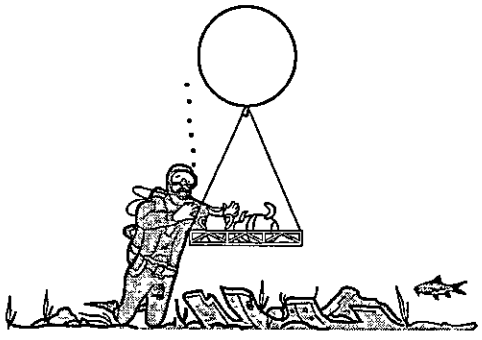


Fig. 3.1

The diver inflates a balloon with air at a depth of 15 m and attaches the balloon to a tray of objects.

(a) Calculate the total pressure acting on the balloon, at 15 m below the surface of the lake.

Total pressure = $1.0 \times 10^5 + 1000 \times 10 \times 15$ [1]
= 2.5×10^5 Pa [1]

pressure = ... [2]

(b) The diver releases the tray and the balloon, and they begin to rise. The temperature of the air in the balloon does not change. The volume of the balloon is 0.3 m^3 at 15 m depth.

Calculate the volume of the balloon when it reaches the surface.

$P_1V_1 = P_2V_2$
$2.5 \times 10^5 \times 0.3 = 1.0 \times 10^5 \times V_2$ [1]
$V_2 = 0.75$ m^3 [1]

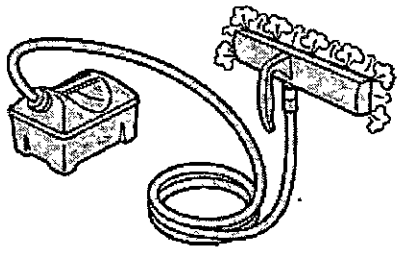
volume = ... [2]

(c) Explain, in terms of the air molecules inside the balloon, why the air pressure in the balloon is less at the surface.

As the balloon rises, its volume increases. The rate of air molecules colliding with the wall of the balloon is lower. [1] This leads to a lower average force per unit area acting on the wall of the balloon, thus the pressure is reduced. [1]

[2]

4 Arnold uses the steam wallpaper stripper, as shown in Fig. 4.1, to help him remove wallpaper in his living room.



Machine Specifications
Power rating = 2.5 kW
Voltage = 240 V
Capacity = 5.0 litres

Fig. 4.1

The water in the machine is heated until it boils and produces steam. The steam nozzle is held against the wall and the steam will soften the wallpaper, making it easy for Arnold to scrape it off.

Given that:
Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$
Specific latent heat of vaporization of water = 2260 x 10^3 J kg^{-1}
One litre of water has a mass of one kilogram.

(a) Arnold fills the machine to its full capacity using tap water at 20 °C and turns on the switch.
Calculate the time he needs to wait before the machine starts producing steam.

$mc\Delta\theta = 5 \times 4200 \times (100 - 20)$ [1]
$= 1.68 \times 10^6$ J [1]
time = energy / power = $1.68 \times 10^6 / 2.5 \times 10^3 = 672$ s [1]

time = ... [3]

(b) Arnold uses the machine continuously for one hour since the time he turns on the switch.
Calculate the mass of the water left in the machine.

Total energy supplied $2.5 \times 10^3 \times 60 \times 60 = 9.0 \times 10^6$ J

9.0×10^6 J - 1.68×10^6 J = 7.32×10^6 J [1]

$Q = ml$
$7.32 \times 10^6 = m \times 2260 \times 10^3$
$m = 3.24$ kg [1]
mass left = 5 – 3.24 = 1.76 kg [1]

mass = ... [3]

5 Fig. 5.1 below shows circular wavefronts produced at the centre of a circular ripple tank.

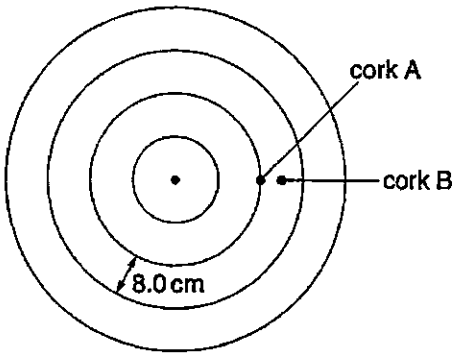


Fig 5.1

Two corks, A and B, float on the water in the ripple tank. The distance between successive wavefronts is 8.0 cm. Fig. 5.2 shows how the displacement of cork A varies with time.

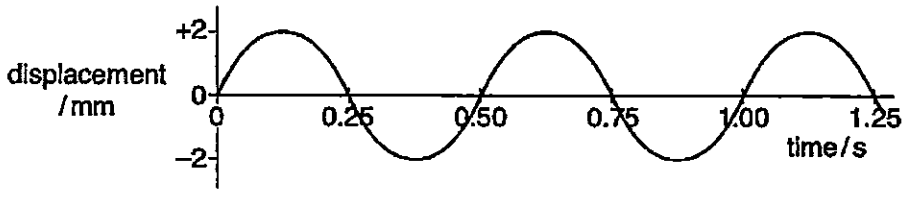


Fig 5.2

(a) State the displacement of cork B, when the displacement of cork A is 2 mm.

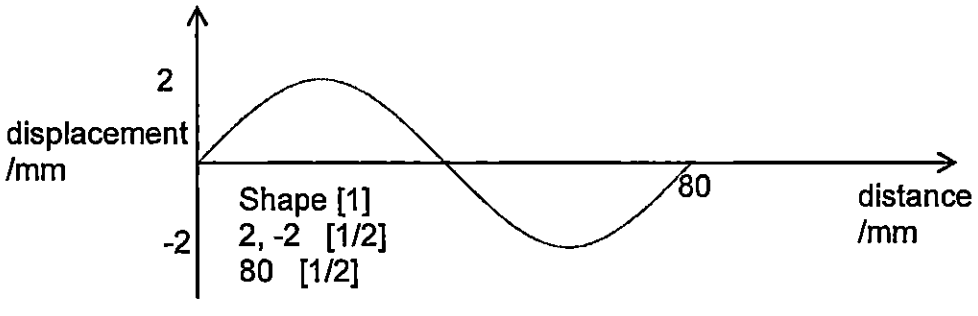
displacement = ...-2 mm..... [1]

(b) The diameter of the ripple tank is 80 cm.

Determine the time taken by a wavefront to travel from the centre of the tank to the edge.
T = 0.5 s
v = f λ
= 1/0.5 x 8 = 16 cm/s [1]
Distance from centre to edge = 80 / 2 = 40 cm [1]
time taken = 40 / 16 = 2.5 s [1]

time = ... [3]

(c) Sketch the displacement-distance graph of the wave, for one complete wave.



[2]

6 A ray of light from an under water laser pointer, is incident upon a spherical air bubble as shown in Fig. 6.1. The refractive index of water is 1.33.

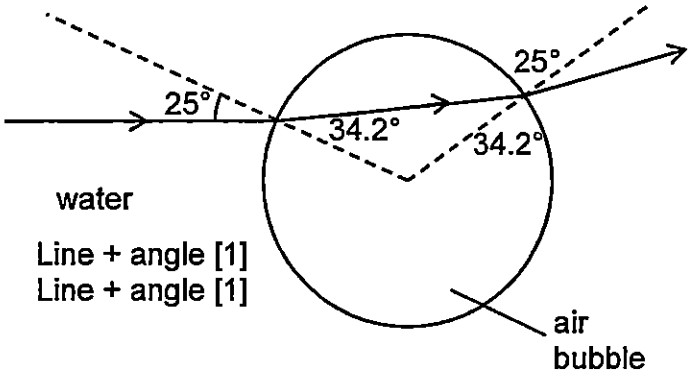


Fig 6.1

Complete the path of the ray until it exits the air bubble, showing clearly all angles at the boundaries. Show the workings to calculate these angles in the space below. [3]

(sin r) / (sin i) = n = 1.33

$r = \sin^{-1}(1.33 \times \sin 25)$

= 34.2° [1]

n = 1/(sin c)

$c = \sin^{-1}(1 / 1.33)$

= 48.8° (optional)

7 Fig. 7.1 shows a positively charged sphere held with an insulating handle. When the sphere is brought near the metal plate, the galvanometer needle deflects momentarily.

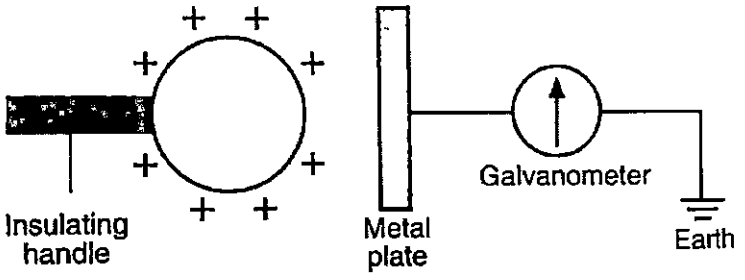


Fig 7.1

(a) Explain clearly why there is momentary deflection in the galvanometer needle?

When the sphere is brought near, electrons from the earth are attracted to the sphere and flowed to the surface of the plate. [1] This flow of electrons causes a current in the wire, deflecting the needle of the galvanometer. [1] When sufficient electrons are concentrated at the plate, the current stops and the deflection in the galvanometer stops. [1]

[3]

(b) Suggest a method that would increase the magnitude of the deflection.

Increase the positive charge of the sphere / Move sphere nearer to the plate [1]

[1]

(c) State clearly what can be observed when the positively charged sphere is removed quickly.

The needle of the galvanometer deflects momentarily in the opposite direction. [1]

[1]

8 Fig. 8.1 below shows a circuit connected to a battery of unknown e.m.f.

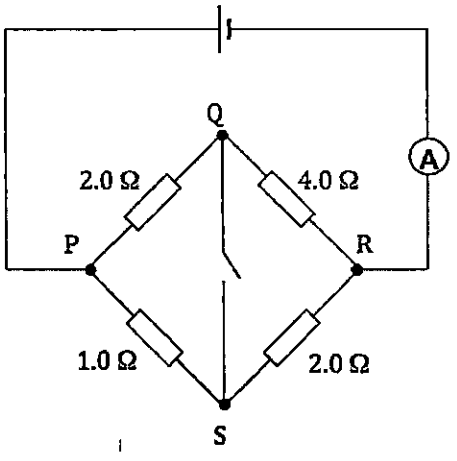


Fig. 8.1

(a) When the switch is opened, the ammeter reads 3.0 A.

(i) Calculate the e.m.f of the battery.

$1 / R_T = 1/6 + 1/3$ [1]
$R_T = 2\ \Omega$ [1]
$V = IR = 3 \times 2 = 6\ V$ [1]

e.m.f = ... [3]

(ii) Calculate the current passing through PSR.

$I = V/R = 6/3 = 2\ A$ [1]

current = ... [1]

(b) The switch is now closed.

Explain if a current will flow through QS. If yes, how much is the current.

No current flows through QS. [1]
Potential at Q = 2/6 x 6 = 2 V [1/2]
Potential at S = 1/3 x 6 = 2 V [1/2]
Since there is no potential difference between Q and S, no current will flow. [1]

[3]

9 If small cracks in steel pipes can be detected before they become larger, the cost of repairing the damage can be greatly reduced. Fig. 9.1 shows a method to detect cracks using a coil of insulated copper wire carrying a current. Iron filings are sprinkled over the pipe and will cluster around any crack that is perpendicular to the axis of the pipe.

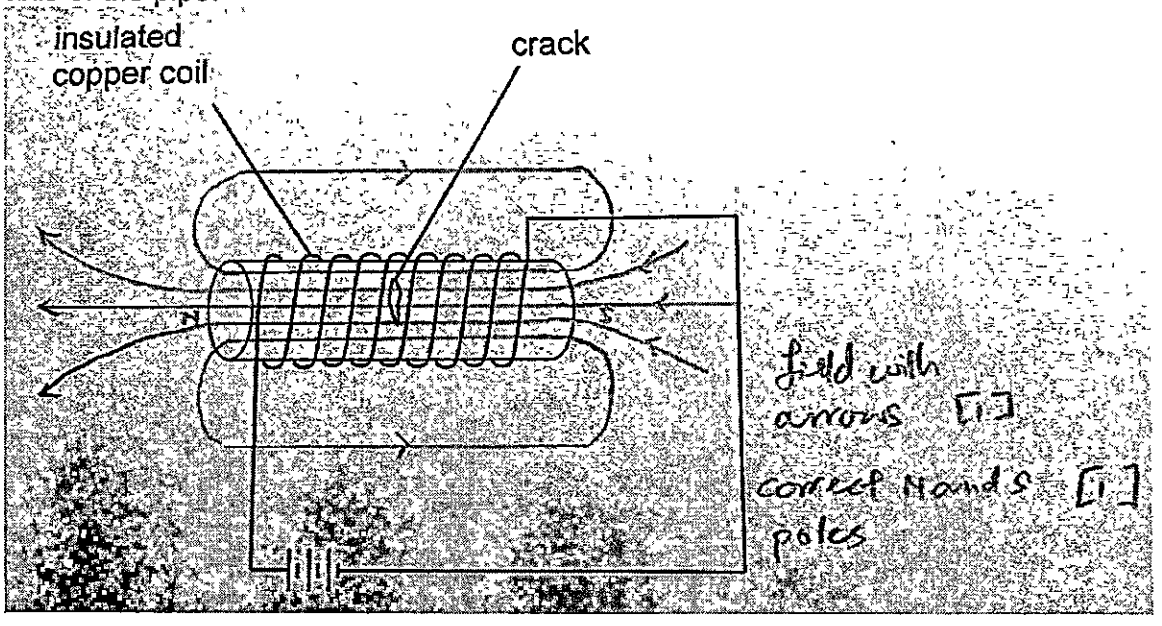


Fig. 9.1

(a) Draw on Fig. 9.1, the magnetic field lines generated by the current carrying coil if there is no crack and state clearly the magnetic poles formed. [2]

(b) Explain why iron filings cluster around the crack when there is a current in the coil.

When a current passes through the coil, a magnetic field is induced in the pipe. [1]
The edges of the crack acts like magnetic poles, attracting more iron filings. [1]
OR
The crack causes magnetic field leakage, attracting more iron filings. [2]

(c) Explain why this method will not work on copper pipes.

Since copper is not a magnetic material, it will not affect the magnetic field formed with or without cracks. [1]

[1]

SECTION B

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

10 A 40 kg mass is initially at rest on a rough bench and a 20 kg mass is attached to it via an inextensible string, as shown in Fig 10.1. The string goes over a smooth pulley with negligible friction.

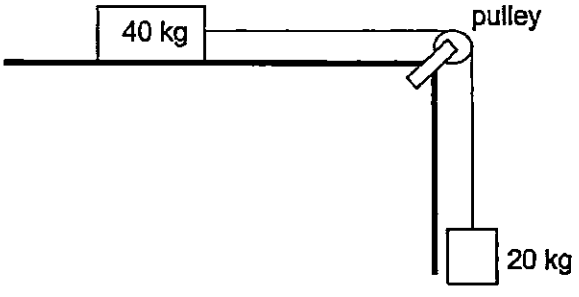


Fig. 10.1

When the 20 kg mass is released, the masses start to move together. The friction between the 40 kg mass and the bench is 20 N.

(a) Using Newton's Third Law of motion, state the action reaction pair of the weight of the 40 kg mass. [1]

The Earth pulls the 40 kg mass with a force of 400 N and the 40 kg mass pulls the Earth with a force of 400 N in the opposite direction.

(b) Calculate the acceleration of the masses when they start to move. [3]

$F_{net} = ma$ [1]
$200 - 20 = (20 + 40)a$ [1]
$a = 3\ m/s^2$ [1]

(c) Calculate the tension in the string when the masses start to move. [2]

$T - 20 = 40 \times 3$ [1]
$T = 140$ N [1]

(d) Fig. 10.2 shows a car brake system.

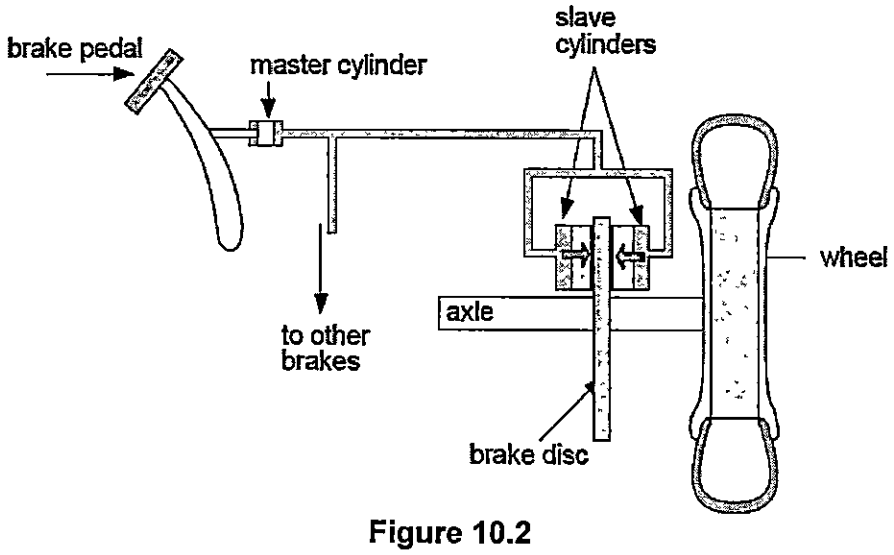


Figure 10.2

The pipes between the master cylinders and the slave cylinders are filled with incompressible brake fluid, forming a closed system. The diameter of the

master cylinder is 10 cm and that of the each slave cylinder is 20 cm.

Calculate the ratio of the master cylinder area to the slave cylinder area. [1]
master cylinder area : slave cylinder area
$(10/2)^2 : (20/2)^2 = 1 : 4$ [1]

(e) The car requires a braking force of 4500 N on each brake disc to stop.

How much force should be applied to the master cylinder in order to achieve this? [3]
force at each slave cylinder = 4500/2 = 2250 N [1]
$F_m/A_m = F_s/A_s$ [1]
$F_m/1 = F_s/4$
$F_m = 2250/4 = 562.5$ N [1]

11 The issue of haze generated from forest fire has become a yearly problem for many countries. This is not only an expensive problem but has become a critical health hazard for many who are exposed to its effect. Moreover the generation of greenhouse gases from these fires has caused alarm as it will most likely further contribute to changes in the world's climate and weather pattern. One way in which the regional government has sought to combat this problem of forest fire is through the use of infra-red thermal imaging. Satellites equipped with infra-red sensors are used to detect problem spots. With this information, the local authorities are then mobilised to put out the fire before it spreads and worsens.

Visible light is unable to pass through clouds and haze, but infra-red radiation can.

How does the infrared (IR) sensor work?

The infra-red (IR) sensors mounted on satellites detect the relative thermal energies emitted by objects like burning trees, fields and streams. With the aid of a signal processor, this information is converted into a colour coded visual presentation showing regions with varying range of temperature. The IR band is often subdivided into smaller sections, coded as shown in the table below:

Section Code	**NIR**	**SWIR**	**MWIR**	**LWIR**	**FIR**
Wavelength/μm	0.75 – 1.4	1.3 – 3	3 – 8	8 – 15	15 – 1000

IR radiations that fall into individual sections are assigned colour codes by the signal processor. Forest fires which are normally detected in the range of 3 to 4.5 μm and hence falls under the MWIR section may be assigned the colour red.

Bodies of water which are cooler like rivers fall in the range of 10+ μm and as such the LWIR section may be assigned the colour blue.

As a result, a coloured image of red for hot and blue for cold objects can be constructed and used to detect hot spots.

(a) Which IR radiation, MWIR or LWIR, travels at a higher speed to the sensors on the satellites? [1]
Both travel at the same speed of 3.0×10^8 m/s [1]

(b) State the IR section code that is nearest to the electromagnetic band of visible light. [1]

NIR, shortest wave length. [1]

(c) Calculate the range of the IR frequencies for the MWIR section code. [4]

For 3 μm,

$f = 3.0 \times 10^{8} / 3.0 \times 10^{-6}$ [1]

$= 1.0 \times 10^{14}$ Hz [1]

For 8 μm,

$f = 3.0 \times 10^{8} / 8.0 \times 10^{-6}$ [1]

$= 3.75 \times 10^{13}$ Hz [1]

Range: 3.75×10^{13} Hz to 1.0×10^{14} Hz

(d) Deduce from the information above, if the method of IR imaging is more useful in detecting exact spots of forest fire compared to a normal coloured photograph taken from a satellite. Explain your deduction. [2]

An IR image is more useful [1] than a photograph.

If clouds or haze is present, they will block out the spots [1] which are on fire, rendering a photograph useless.

(e) Besides the application above, state two other applications of infra-red radiation. [2]

Heat treatment for illnesses / intruder alarm / remote control / thermometer [any 2 correct answers]

EITHER

12 Fig. 12.1 shows a flowmeter that measures the volume of oil passing through a pipe.

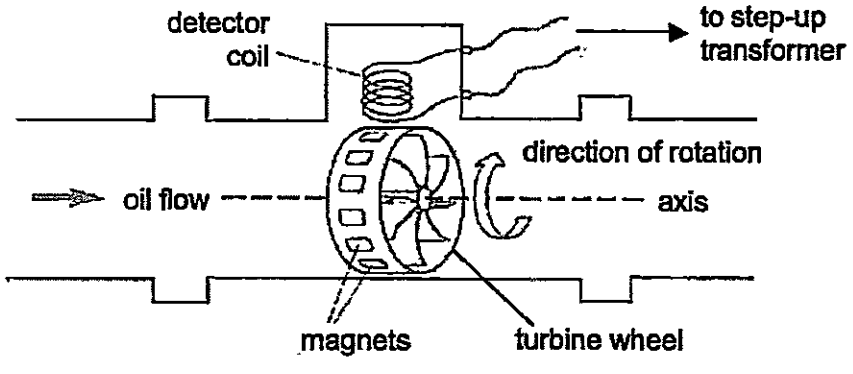


Fig.12.1

Twenty identical magnets are spaced equally around a turbine wheel. As oil flows, the turbine wheel rotates about the axis as shown. The detector coil is connected to the primary coil of a step-up transformer (Fig. 12.2) to amplify the voltage signal, which is then displayed on a cathode ray oscilloscope.

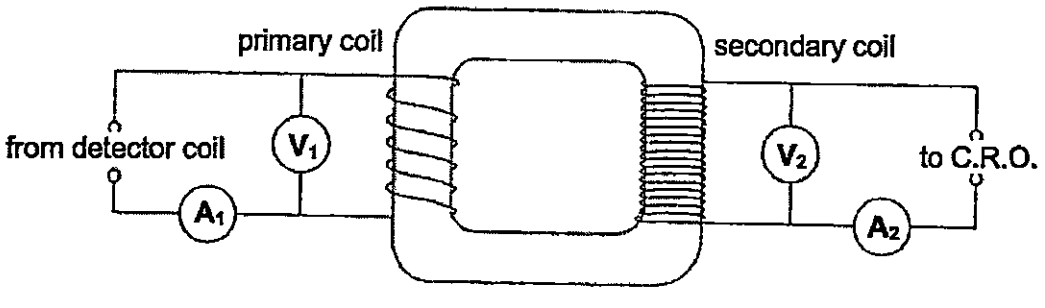


Fig. 12.2

Fig. 12.3 shows the data for two different oil flow rates. Some values are missing from the table.

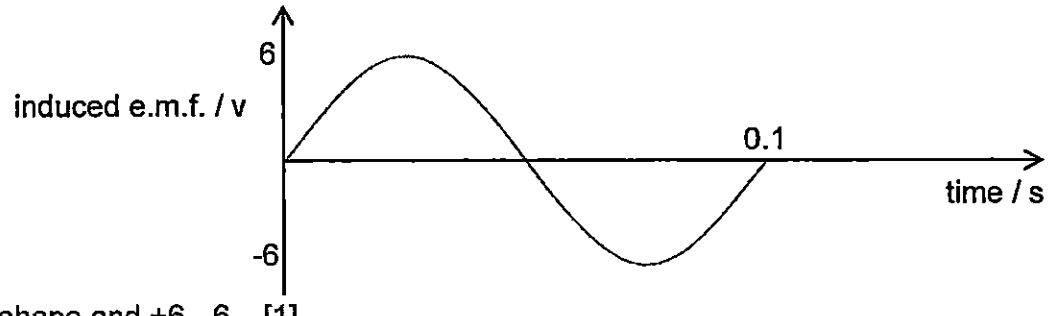
oil flow rate/ $cm^3 s^{-1}$	period of turbine spin / s	transformer			
		A_1 / A	V_1 / V	A_2 / A	V_2 / V
15	2	1.8	6	0.8	12
30	1	1.8		0.8	

Fig. 12.3

(a) Explain why an alternating e.m.f. is induced in the detector coil. [3]

As the turbine wheel turns, the magnets move with respect to the detector coil. When a magnet approaches the coil, the change in magnetic flux linking the coil generates an induced e.m.f. in the coil. [1] As the same magnet leaves the coil, it generates an induced e.m.f. of the opposite polarity. [1] The cycle repeats with each approaching magnet, inducing an alternating e.m.f. in the detector coil. [1]

(b) Sketch a graph below to show how the induced e.m.f. in the primary coil varies with time for a flow rate of 15 $cm^3 s^{-1}$. [2]



shape and +6, -6 [1]
0.1 for period [1]

(c) State if the transformer is 100% efficient. Explain by showing your working clearly. [2]

input power = 1.8 x 6 = 10.8 W, output power = 0.8 x 12 = 9.6 W [1]
since output power lower than input power, efficiency is lower than 100%. [1]

(d) Calculate the ratio of the number of turns in the secondary coil to the number of turns in the primary coil. [2]

$V_s/V_p = N_s/N_p$
$N_s/N_p = 12 / 6$ [1]
$= 2 : 1$ [1]

(e) Calculate the missing values for V_1 and V_2. [1]

$V_1 = 12$ V and $V_2 = 24$ V [1]

OR

12 Fig. 12.1 shows a simple experimental set-up to study the motion of a motor. AB and CD are solenoids connected to a battery. F and G are connected to an external voltage supply. The graph of the external voltage supplied is as shown in Fig. 12.2 (Positive voltage indicates that the potential of F is higher than of G).

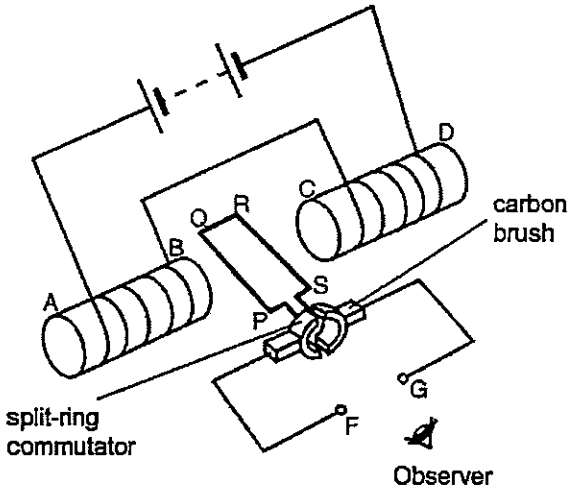


Fig. 12.1

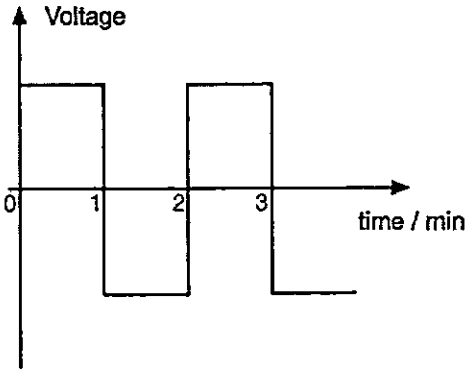


Fig. 12.2

It is observed that the coil makes 5 rotations in one minute.

(a) Identify the magnetic poles at B and C. [1]
B north, C south [1]

(b) How would the coil PQRS turn (clockwise or anticlockwise direction) during the first minute? [1]
anticlockwise [1]

(c) Explain how you arrived to the answer in **(c)**. [2]
With the magnetic field pointing from B to C and the current moving from P to Q, [1]
using Fleming's Left Hand rule, where the index finger is pointing in the N-S direction and the middle finger in the direction of the current, the thumb will show the direction of the force, in which the coil will turn. [1]

(d) Fig. 12.3 shows the solenoids and the coil PQRS from the observer's point of view.

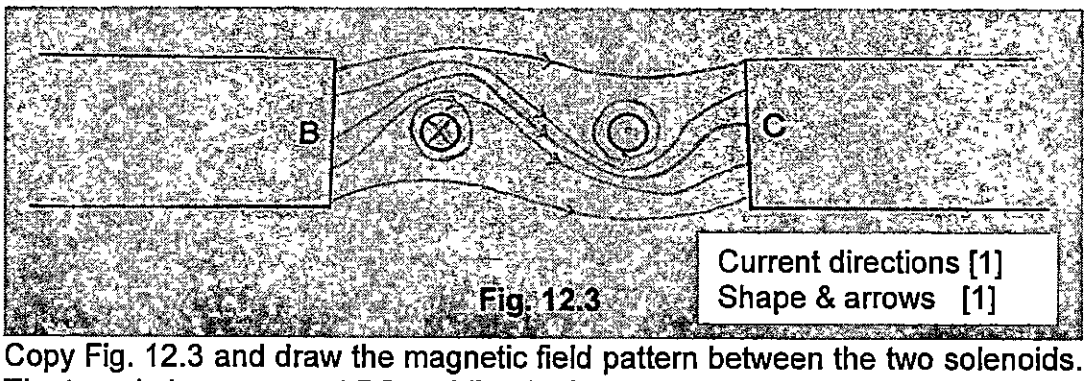


Fig. 12.3

Copy Fig. 12.3 and draw the magnetic field pattern between the two solenoids. The two circles represent PQ and RS. Indicate the direction of the current using dot and cross notation. [2]

(e) State what would happen to the coil during the 1-2 minute interval. [1]
The coil will begin to change direction of rotation. [1]

(f) State the purpose of the split-ring commutators. [1]
The split-ring commutators reverse the direction of the current in the coil after every half revolution. [1]

(g) A longer wire of the same material and cross-sectional area as the one used in PQRS is used to make a coil with greater number of turns. This coil is used to replace PQRS.

State and explain what can be observed of the movement of the new coil. [2]
The coil will spin faster. [1]
The turning effect of the DC motor can be increased by increasing the number of turns of the coil [1]
OR
There is now a longer length of current carrying conductor within the permanent magnets' magnetic field, causing a stronger turning effect.

END OF PAPER

Paper 1 answers

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