AHMAD IBRAHIM SECONDARY SCHOOL
GCE O-LEVEL PRELIMINARY EXAMINATION 2018

PHYSICS
PAPER 2

6091/02

Sec 4 Express

Date: 14 August 2018
Duration: 1 h 45 min

Name: ……………………………………..(   )

Class: ……………

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.
Write down your name, class and register number on this page and on any additional writing papers.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.

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

Information for candidates:
Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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

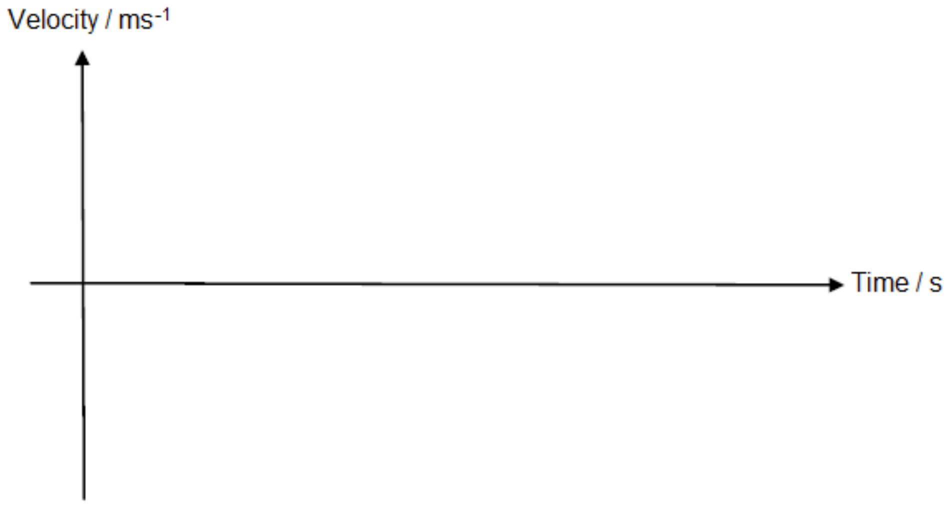
FOR EXAMINER'S USE	
Section A	**/ 50**
Section B	**/ 30**
TOTAL	**/ 80**

Section A

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

1 A rubber ball is dropped freely from a height of 20 m. The ball hits the ground at time t and rebounds vertically upwards with half its maximum velocity. The maximum velocity of the ball just before it hits the ground for the first time is V.

(a) In the axes below, sketch the velocity-time graph of the ball from the point of release to the time when it has rebounded to its new maximum height. (Ignore air resistance) [2]



(b) Using information from the graph, determine the velocity of the ball just before it hits the ground for the first time.

velocity = ………………………………. [2]

(c) Find the displacement of the ball after it has rebounded to its maximum height.

displacement = ………………………………. [2]

(d) State the change in velocity of the ball during its rebound.

change in velocity = ………………………………. [1]

2 Fig. 2.1 shows three cylinders **X**, **Y** and **Z** are supported by three ropes that passes through ring **R**.

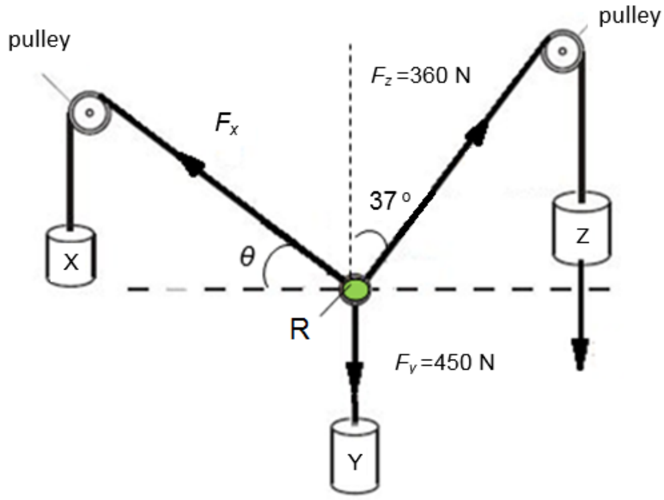


Fig. 2.1

Ring **R** is in equilibrium under the action of three forces F_x, F_y and F_z.

Draw a vector diagram to find F_x and angle θ.

F_x = ……………………………….

angle θ = ……………………….. [4]

3 A uniform rod **AB** of length 3 m weighs 10 N. It is suspended by two identical strings at points **X** and **Y** as shown in Fig. 3.1. T_1 and T_2 are the tension in the strings.

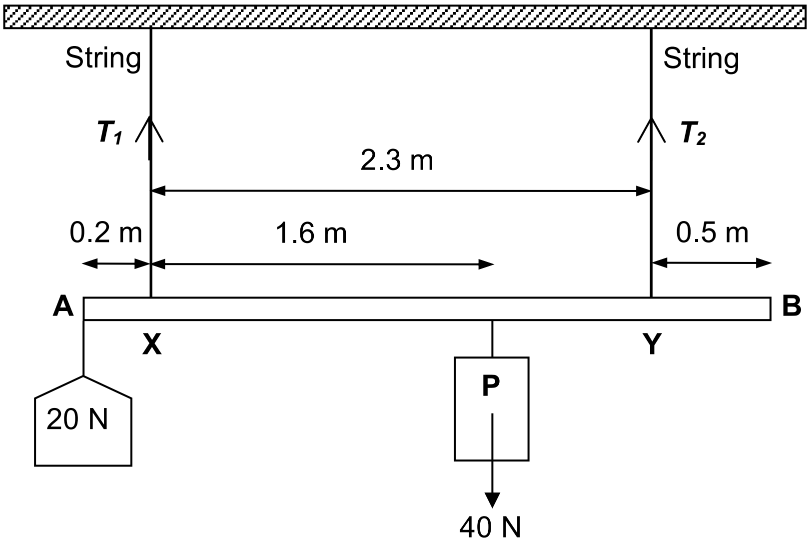


Fig. 3.1

Two weights, 20 N and **P**, are hung from the rod at point **A** and 1.6 m from **X** respectively.

(a) Draw the weight of the rod in Fig. 3.1 and label it **W**. [1]
Indicate clearly its distance from point **A**.

(b) Determine T_2, the tension of the string at **Y**.

T_2 = ………………………………… [2]

(c) Hence, or otherwise, determine T_1, the tension of the string at **X**.

T_1 = ………………………………… [1]

4 A small jet plane which can carry six people is shown in Fig. 4.1.

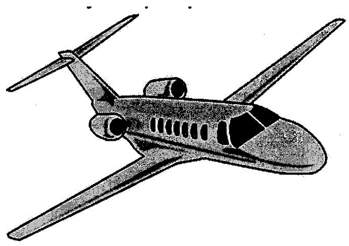


Fig. 4.1

The mass of the fully-loaded jet plane is 2560 kg. It is initially at rest. When the jet plane is taking off, the two jet engines can exert a total thrust force of 8000 N and the friction between the wheels and the ground is 340 N. Both forces remain constant at these values during take-off.

(a) Calculate the acceleration of the plane as it starts to move.

acceleration = ... [2]

(b) Explain what happens to this acceleration as the jet plane speeds up.

....

....

.... [2]

(c) The average acceleration during take-off is 2.2 m/s^2.

(i) Calculate the time that the jet plane will take to reach a take-off speed of 55 m/s.

time = ... [1]

(ii) Determine the minimum length of the runway that is required for the jet plane to take off.

minimum length = ... [2]

(d) Suggest why the wheels of the jet plane are folded into the body of the jet plane after take-off.

…………………………………………………………………………………………………

………………………………………………………………………………………………… [1]

5 Fig. 5.1 below shows a long vertical glass tube with one end immersed in mercury and the other connected to a vacuum pump at **A**. The tube fits tightly into a bell jar. With an opening at **B** and all air in the glass tube pumped out via **A**, the mercury rises to a maximum height of 76.0 cm above the dish.

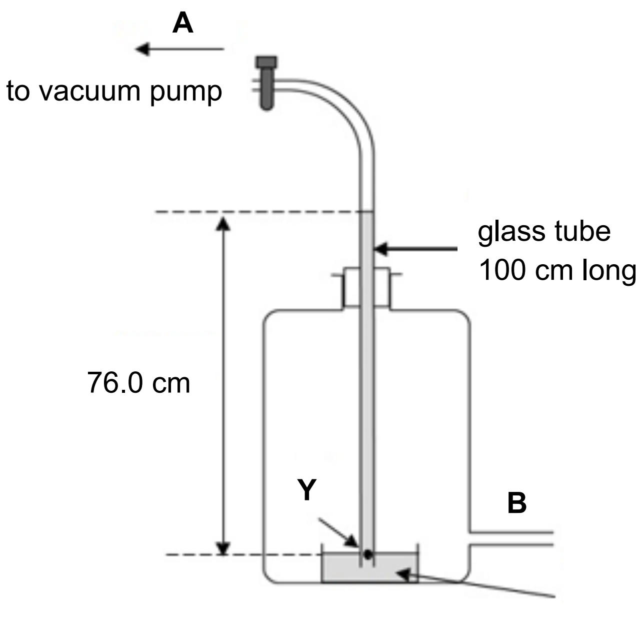


Fig. 5.1

(a) Explain why the mercury only can rise to a maximum height of 76.0 cm.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………... [2]

(b) If the density of mercury is 13600 kg/m^3, calculate the pressure at **Y** in pascals.

pressure = ………………………………. [2]

(c) A container of air initially at atmospheric pressure is connected to **B** and heated over a flame as shown in Fig. 5.2.

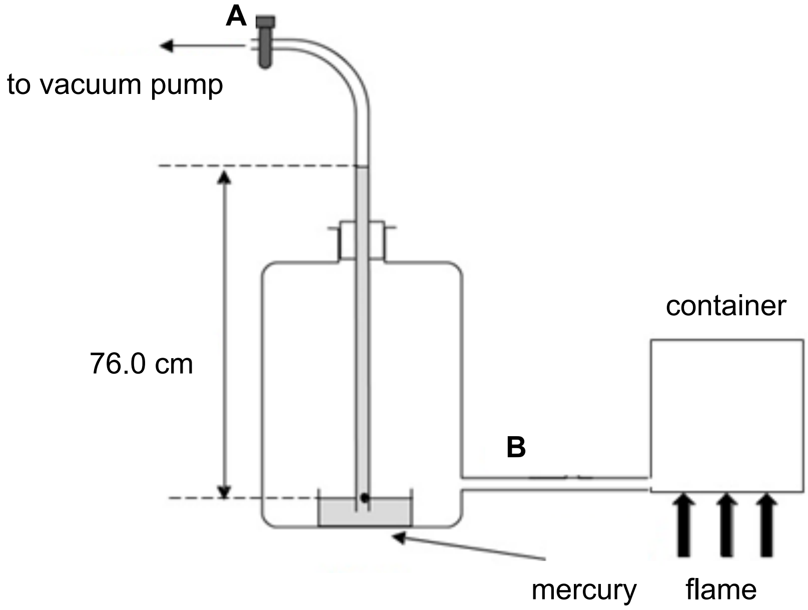


Fig. 5.2

Using kinetic theory of matter, explain whether the height of mercury column rises, falls or remains the same.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………… [3]

6 John conducts an experiment to determine the specific latent heat of vaporisation of water.

He places an immersion heater fully immersed in water in an open steel container. The voltage across the immersion heater is 240 V and the current which passes through the heating element is 1.6 A. John measures the mass of water after steady boiling is achieved, and again after another 8 minutes. He discovers that the mass of water in the container decreases by 0.075 kg during the 8 minutes.

(a) Calculate the specific latent heat of vaporisation of water.

specific latent heat of vaporisation = ……………………………… [2]

(b) Is the value calculated in (a) higher than the actual specific latent heat of vaporization of water? Explain why.

....

....

.... [2]

(c) John's friend Ali comments that it is better to use a vacuum flask to contain water rather than a steel container. Explain why this is so.

....

.... [1]

7 A collector views a postage stamp of height 1.5 cm through a lens. The lens is 2.0 cm from the stamp and the ratio of height of image to height of object is 3.0.

(a) In Fig. 7.1, complete the full scale ray diagram to determine the image of the stamp [3]

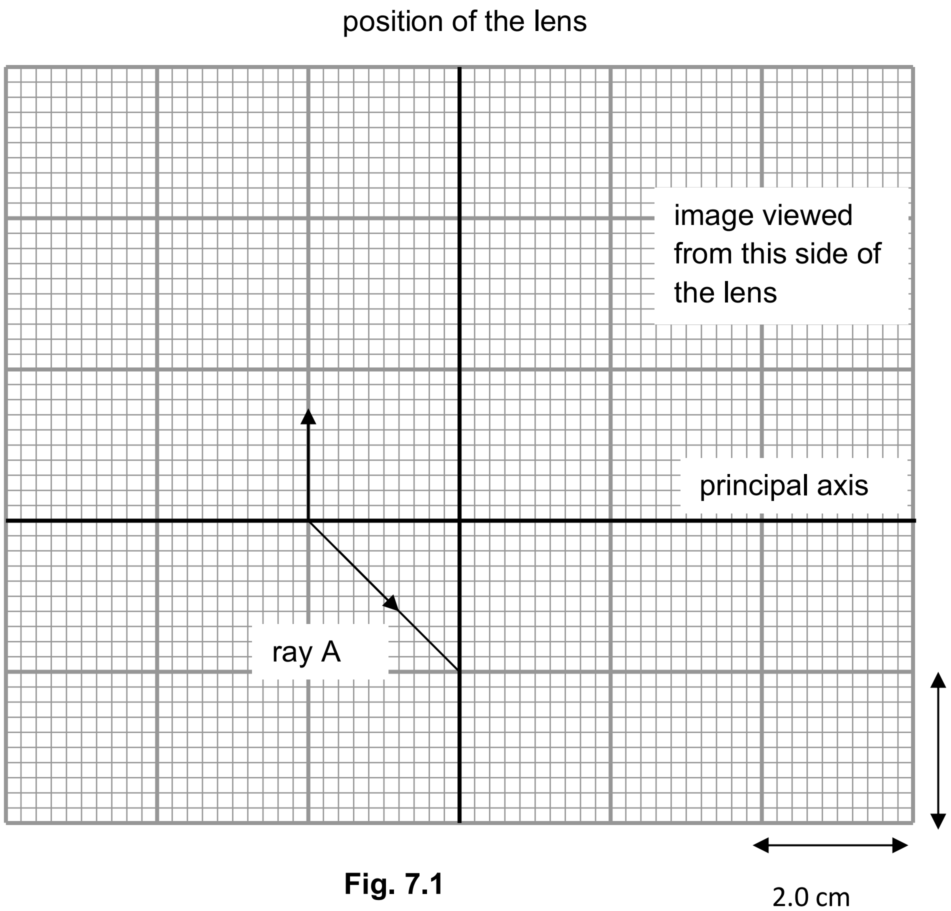


Fig. 7.1

(b) State what is meant by a virtual image.

....

.... [1]

(c) Use your drawing to determine the focal length of the lens.

focal length = ………………………………. [1]

(d) On Fig. 7.1, complete the path of ray A after passing through the lens. [1]

8 **(a)** An acetate rod held in the hand may be charged positively by rubbing it with a cloth, but a copper rod held in the hand cannot be charged this way.

(i) Explain how the acetate rod acquires positive charges when rub with a cloth.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………… [2]

(ii) Explain why a copper rod held in a hand cannot acquire charges by rubbing with a cloth.

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

(b) Fig. 8.1 shows a light positively charged acetate rod hung freely with an insulating thread. An earthed metal sphere is then brought near it.

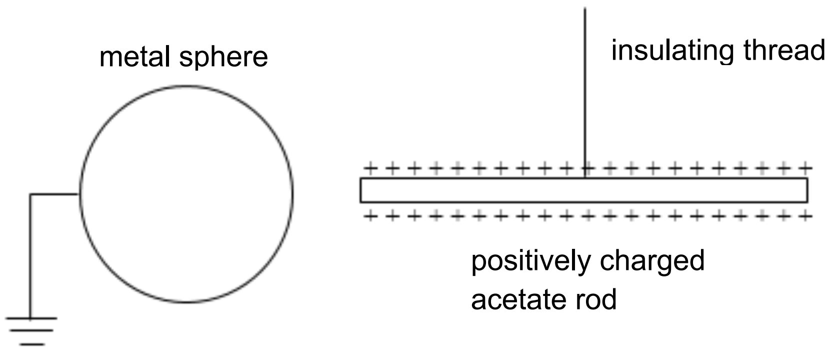


Fig. 8.1

(i) State what happens to the light acetate rod?

....

.... [1]

(ii) Draw the charges on the metal sphere in Fig. 8.1. [1]

9 Fig. 9.1 shows part of a power transmission system. Electricity from the power station is transmitted to end users via transmission cables.

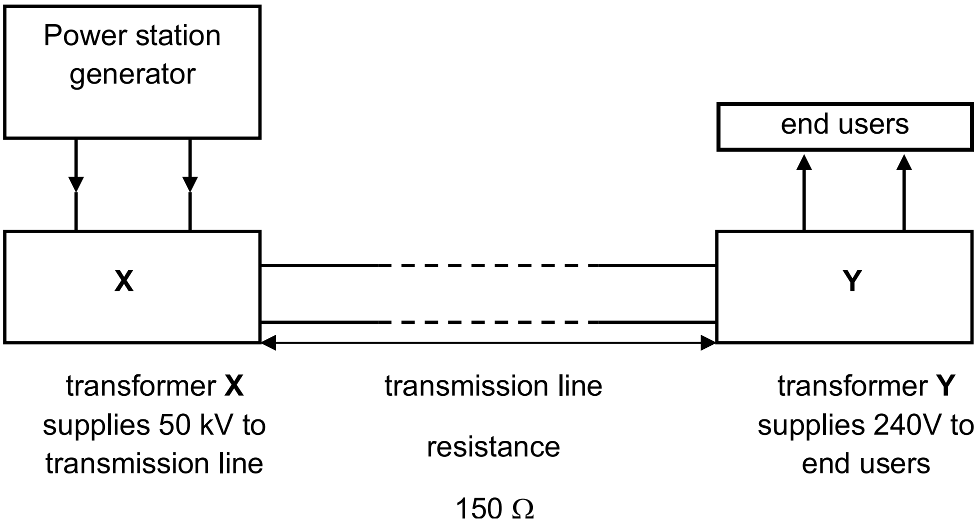


Fig. 9.1

(a) If the power station is transmitting a power of 3.0 kW at 50 kV from transformer **X** to transformer **Y**, calculate the current flowing through the transmission lines.

current = ………………………………. [1]

(b) Calculate the power loss in the transmission lines which has 150 Ω resistance.

power loss = ………………………………. [1]

(c) With reference to your answers from (a) and (b), explain why the power station does not transmit the same power to the houses at 240 V?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

………………………………………………………………………………………………... [2]

Section B

Answer **all** the questions from this section.
Answer only one of the two alternative questions in **Q12**.

10 Some countries do not have enough supply of water from rain or from rivers. The scientists in these countries are exploring new ways of getting water. In Canada, one scientist suggests making use of icebergs found in the Atlantic Ocean to obtain water. Icebergs, which are made from fresh water, can be towed to a port in the country. Once they arrive, they are allowed to melt either in the sun or by energy from a local power station.

Based on the Table 10.1, you are required to evaluate the feasibility of towing an iceberg to a port in Canada to obtain fresh water.

Distance between the iceberg and the port in Canada	1.2×10^4 km
Average towing speed	0.75 m/s
Effective surface area of iceberg exposed to the sun	4.5×10^5 m^2
Sun's radiation at the Earth's surface	700 W/m^2
Mass of iceberg	1.5×10^{11} kg
Specific latent heat of fusion of ice	3.4×10^5 J/kg
Electrical power output from local power station	550 MW

Table 10.1

(a) Explain what is meant by the statement *ice has a specific latent heat of fusion of 3.4×10^5 J/kg.*

……………………………………………………………………………………………………..

…………………………………………………………………………………………………….. [1]

(b) What is the time taken to tow the iceberg to the port in Canada?

time taken = ……………………………… [1]

(c) Calculate the total amount of solar energy absorbed by the iceberg while it is towed to the port.

solar energy = ………………………………. [2]

(d) **(i)** Estimate the mass of ice melted by the sun as the iceberg is towed to the port.

mass of ice = ………………………………. [2]

(ii) State an assumption that you have made in **(d)(i)**.

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

(e) Once the iceberg reaches the port, it can be melted either in the sun or by energy from a local power station. Which is a faster method to melt the ice? Support your answer with appropriate calculations.

…………………………………………………………………………………………...

…………………………………………………………………………………………...

…………………………………………………………………………………………... [2]

(f) Suggest a possible environmental problem of using this method to obtain fresh water.

……………………………………………………………………………………….. [1]

11 **(a)** Fig. 11.1 shows a simple setup that can be used to detect seismic waves from earthquakes. The setup consists of a bar magnet suspended from a spring hanging from a metal rod. The metal rod transmits vibrations from the Earth and the magnet moves in and out of the coil when there is an earthquake. The coil is connected to a cathode-ray oscilloscope (c.r.o.) that monitors the e.m.f across the coil.

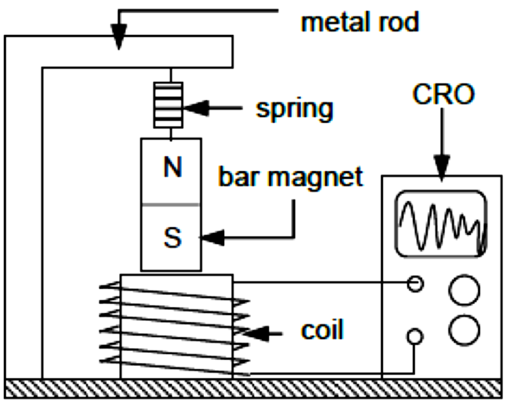


Fig. 11.1

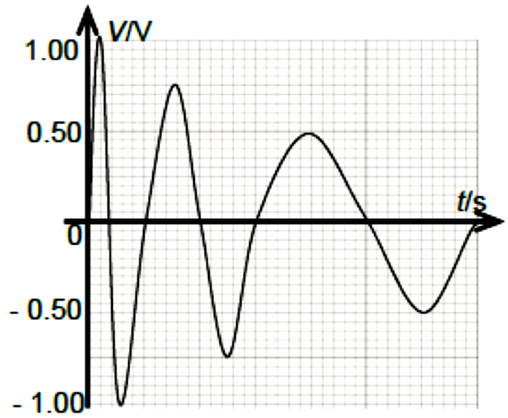


Fig. 11.2

Fig. 11.2 shows the trace that was displayed on the c.r.o. during a particular earthquake. Each complete oscillation of the same magnitude represents one tremor.

(i) Describe and explain how a trace shown on the c.r.o. in Fig. 11.2 is obtained when there is an earthquake.

....

....

....

....

.... [4]

(ii) On Fig. 11.1, indicate the direction of the current in the coil when the south pole of the magnet is moving into the coil. [1]

(b) An output voltage of 2.0 V from a generator is connected to the primary coil of a step-up transformer with a turns ratio of 1:50. The current in the secondary coil is 2.4 mA. The transformer is 75% efficient.

(i) State the metal used for the core of a transformer.

.... [1]

(ii) Calculate the current in the primary coil.

current = ………………………………. [2]

(iii) State two reasons why a typical transformer is not 100% efficient.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

12 EITHER

A student makes a 2.0 V battery by connecting two cells of electromotive force (e.m.f.) 2.0 V in parallel. The battery, an ammeter with different ranges and three different resistors are used to set up the circuit shown in Fig. 12.1.

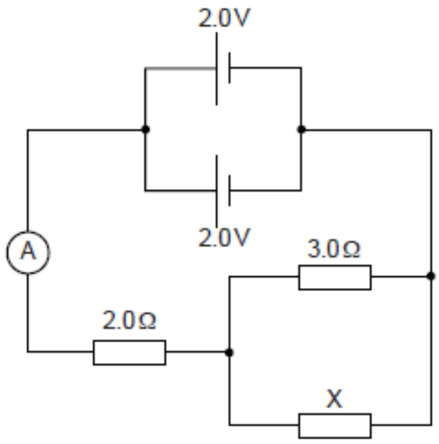


Fig. 12.1

(a) State and explain one advantage of using two cells in parallel rather than using a single 2.0 V cell.

....

....

.... [2]

(b) The total resistance of the circuit is 4.0 Ω.

Calculate the resistance of **X**.

resistance of **X** = ... [2]

(c) **(i)** Determine the reading of the ammeter.

reading = ... [1]

(ii) Suggest a suitable range for the ammeter.

.... [1]

(d) State the potential difference (p.d.) across the [1]

(i) 2.0 Ω resistor, and

p.d. = ...

(ii) 3.0 Ω resistor.

p.d. = ...

(e) The student sets up a second circuit using a variable d.c. power supply, an ammeter and a 12 V metal filament lamp. The circuit is shown in Fig. 12.2.

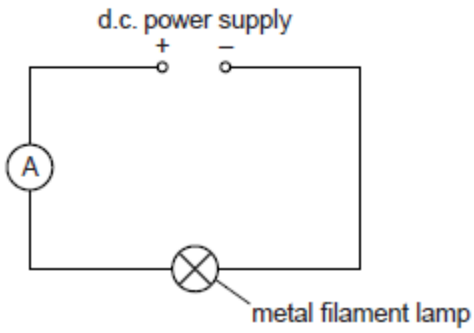


Fig. 12.2

The d.c. power supply is set to 12 V and the ammeter reading is 1.5 A. The student changes the e.m.f. of the d.c. power supply to 6.0 V. The lamp dims and the ammeter reading changes.

(i) State and explain what happens to the resistance of the filament lamp.

....

....

.... [2]

(ii) State whether the new ammeter reading is less than, equal to or greater than 0.75 A.

.... [1]

12 OR

(a) In a particular light experiment, a ray of light is passed through water into air as shown in Fig. 12.3.

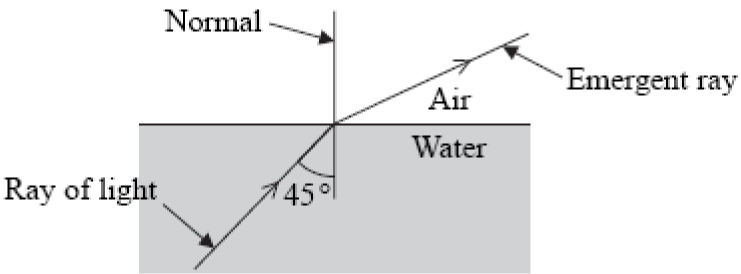


Fig. 12.3

Explain why the ray of light changes its direction when it emerges from water as shown.

……………………………………………………………………………………………..

……………………………………………………………………………………………..

…………………………………………………………………………………………….. [2]

(b) The experiment in (a) is repeated using a semicircular glass block as shown in Fig. 12.4. The refractive index of glass is 1.60.

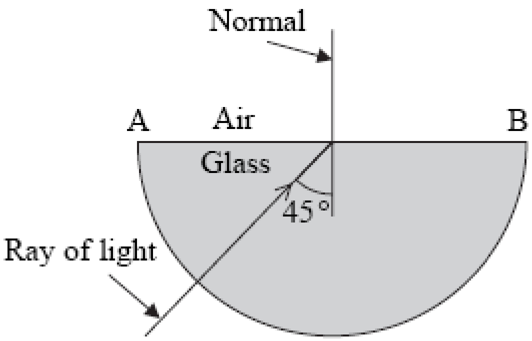


Fig. 12.4

(i) Explain why the ray of light does not change direction when it enters the glass.

……………………………………………………………………………………………

…………………………………………………………………………………………… [1]

(ii) Explain why the ray of light does not emerge from the straight edge **AB** of the glass block. Show relevant working.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………… [4]

(iii) On Fig. 12.4, draw accurately the complete path for the ray of light until it emerges from the glass block again. [1]

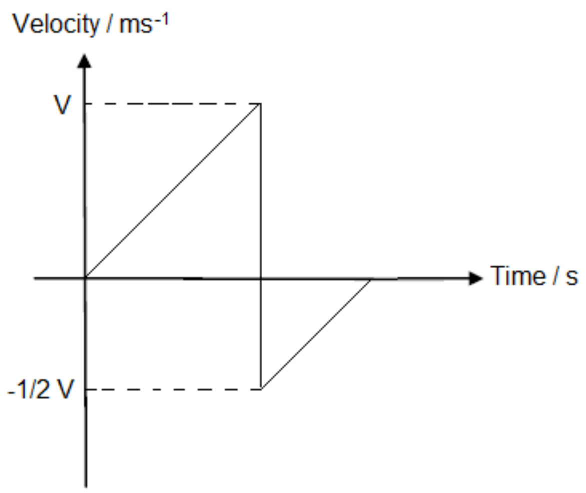
(iv) The speed of light in air is 3.00×10^8 m / s. Calculate the speed of light in the glass block.

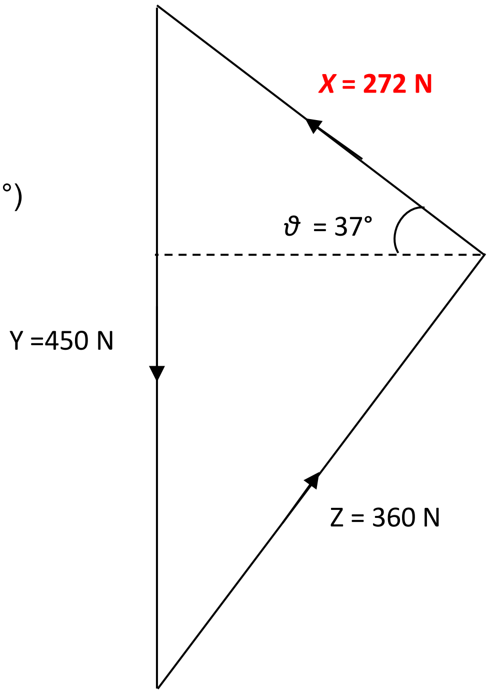
speed = ………………………………… [2]

END OF PAPER
Setter: Mr Luqman

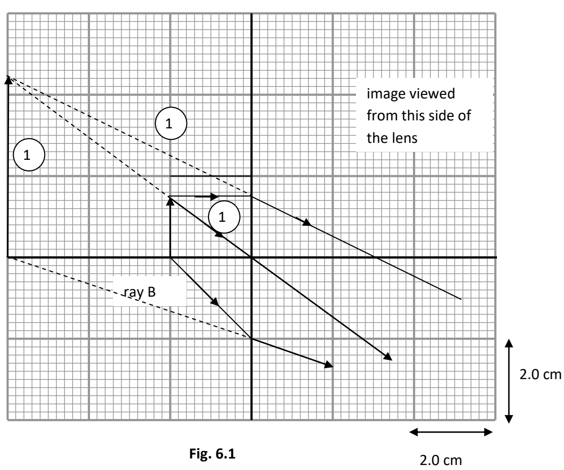
[AISS] Paper 2

Section A

QN		SOLUTION
1	(a)	Correct shape before rebound [1] Correct shape after rebound [1] 
	(b)	a = (v-u)/t 10 = (v-0)/t t = v/10 ½ x t x v = 20 ½ x (v/10) x v = 20 [1] v^2 = 400 v = 20 m/s [1]
	(c)	Rebound height = ½ x 1 x 10 = 5m [1] Displacement of the ball = 20 – 5 = 15 m [1]
	(d)	Changed in velocity = 20 – (-10) = 30 m/s [1]

2		θ = 37° [1] (accepts 36° to 38°) X = 272 N [1] (accepts X ranges from 250 to 290 N) All arrows points in the correct directions [1] Scale marks only given to students who give a scale **1:50 +/- 10N** only, provided the forces Y and Z are represented correctly and accurately. Else, no mark even if the scale is correct.[1] 
3	**(a)**	Downward arrow drawn in the middle of the rod. W indicated for weight. Must indicate distance (e.g. 1.5 m from point X) [1]
	(b)	Taking moments about X, at equilibrium (T_2 x 2.3) + (20 x 0.2) = (10 x 1.3) + (40 x 1.6) [1] [M1: award 1 mark if there are 2 correct calculation of moments] T_2 = 31.739 = 31.7 N [1] (3sf)
	(c)	Total Upwards Force = Total Downwards Force T1 = 70 N – 31.7 N =38.3N [1]

4	**(a)**	F = ma 8000 – 340 = 2560 x a [1] a = 2.99 m/s^2 [1]
	(b)	Acceleration will decrease till it becomes zero [1] Resultant force will decrease because air resistance has increased [1] Acceleration becomes zero when forward force equal air resistance.
	(ci)	a = (v – u)/ t 2.2 = (55 – 0)/ t t = 25 s [1]
	(cii)	Distance = Area under Speed Time Graph Dist = ½ (25)(55) [1] Dist = 688 m [1]
	(d)	To provide a streamline body In order to reduce air resistance [1]
5	**(a)**	At B, it is open to the atmosphere. Since atmospheric pressure is 76 cm Hg, the mercury can rise to a maximum height of 76 cm. [1] At A, the tube is connected to a vacuum, this means that there is no gas pressure acting on the top surface of liquid in the tube, therefore the mercury will rise to a maximum of 76 cm Hg. [1]
	(b)	P = hpg = 0.76 x 13600 x 10 [1] = 1.03 x 10^5 Pa [1]

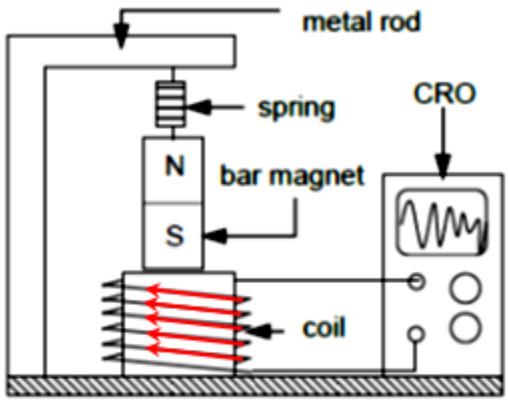
	(c)	Height <u>increases</u> as pressure on mercury surface increases. [1] When temperature increases, average k.e. of molecules increases. Molecules move faster and hit the mercury surface with <u>greater force</u> and at <u>higher frequency</u>. [1] causing <u>force per unit area</u> or <u>pressure to increase</u>. [1]
6	**(a)**	$Q = ml_v$ $VIt = ml_v$ $240 \times 1.6 \times 8 \times 60 = 0.075 \times l_v$ [1] $l_v = 2460\ J\ g^{-1}$ or $2{,}460{,}000\ J\ kg^{-1}$ [1]
	(b)	Yes, it is higher. [1] There is **heat lost** to the surroundings by conduction, convection and radiation. The amount of heat received by the water for boiling is thus **smaller** than the calculated value. [1]
	(c)	The use of vacuum flask reduces heat lost to the surroundings by conduction, convection and radiation. [1]
7	**(a)**	position of the lens  Fig. 6.1
	(b)	A virtual image is an image that cannot be formed on a screen. [1]
	(c)	f = 3.0 cm [1]
	(d)	correct drawing using concept ray from of bottom of object originate from bottom of image [1]

8	**(ai)**	The **electrons** are transferred from atoms of the acetate rod to the cloth due to friction of rubbing. [1] Acetate rod loses electrons and become positively charged. [1]
	(aii)	Copper is a **conductor**. The acquired charges by rubbing will be neutralized by the hand. [1]
	(bi)	The acetate rod is attracted to the sphere. It moves closer to the sphere. [1]
	(bii)	Negative charges on the right side of sphere [1]
9	**(a)**	Current = Power/Voltage = 3000/50000 = 0.06 A [1]
	(b)	Power loss = 0.06 x 0.06 x 150 = 0.54 W [1]
	(c)	If the voltage is 240 V, I = 3000/240, will be high. [1] When this current flows through the transmission cable of 150 Ω, the heat generated will be very high. This results in energy loss and monetary loss.[1]

Section B

QN		**SOLUTION**
10	**(a)**	3.4×10^5 J of thermal energy is required to change 1 kg of ice from solid to liquid state (or vice versa) without a change in temperature. [1]
	(b)	Time required = $(1.2 \times 10^4 \times 1000) / 0.75$ = 1.6×10^7 s [1]

	(c)	Effective solar power received = $(4.5 \times 10^5) \times 700$ = 3.15×10^8 W [1] From P = E / t, E = $3.15 \times 10^8 \times 1.6 \times 10^7$ = 5.04×10^{15} J [1]
	(di)	From $Q = ml_f$, m = $(5.04 \times 10^{15}) / 3.4 \times 10^5$ [1] = 1.48×10^{10} kg [1] ecf given
	(dii)	There is no heat gain by the surrounding / All the energy supplied by the sun is absorbed by the iceberg. [1]
	(e)	Rate of heating by the sun = $(4.5 \times 10^5) \times 700 = 3.15 \times 10^8$ W Rate of heating by the power station = 550 MW = 5×10^8 W [1] Using energy from the power station is a more efficient way to melt the ice. [1]
	(f)	The ice that melts during the towing process will contribute to rising sea levels which can cause flooding in low-lying areas./ Loss of habitats [1]
11	**(ai)**	During an earthquake, the magnet moves in and out of coil, producing a change in magnetic flux linking the coil, thus inducing an emf at the solenoid. By Lenz's Law, the direction of the emf changes when the

		magnet moves in and out of the coil, [1] hence an alternating trace is produced. [1] By Faraday's Law, the magnitude of the induced emf is proportional to the rate of change of magnetic flux linkage, [1] hence a larger tremor will produce a trace with a higher amplitude. [1]
	(aii)	[1] 
	(bi)	Soft iron [1]
	(bii)	$V_s = 50 \times 2.0$ $= 100$ V $0.75 \times V_pI_p = V_sI_s$ $0.75 \times 2.0 \times I_p = 100 \times 0.0024$ [1] $I_p = \underline{0.16\text{ A [1]}}$
	(biii)	Induced (eddy) currents are formed in the core of the transformer. / There is heat loss due to the resistance in the wires. / There is magnetic flux leakage between the primary and secondary coil. (any two) [2]
12E	**(a)**	Any one of: • The cells last longer Reason: Each cell supplies half the current needed. • The circuit continues to work if one cell is flat. Reason: The circuit is still a closed circuit.

		• A cell can be replaced without switching off. Reason: The circuit is still a closed circuit. [2]
	(b)	Total R of circuit= R of 2.0 + (Total R of 3.0 & X in parallel) $4.0 = 2.0 + (1/(3.0) + 1/R_X)^{-1}$ [1] $2.0 = (1/(3.0) + 1/R_X)^{-1}$ $1/(2.0) = 1/(3.0) + 1/R_x$ $1/R_X = 1/(6.0)$ $R_X = 6.0\ \Omega$ (2 s.f.) [1]
	(ci)	$I = V/R$ $= (2.0)/(4.0)$ $= 0.50$ A (2 s.f.) [1]
	(cii)	0 A to 0.50 A (accept till 5.0 A) [1] e.c.f given
	d(i) **d(ii)**	p.d.=1.0 V p.d.=1.0 V [1]
	(ei)	The resistance of the filament lamp decreases. [1] With less voltage across the filament lamp (and hence less current through the lamp), the temperature of the filament lamp decreases. [1]
	(eii)	The new ammeter reading is less than 0.75 A. [1]
12O	**(a)**	-Air is optically less dense than water. -Speed of light increases as it gets from water to air -Causing light to bend away from normal 2 marks for all 3 points 1 mark for ½ points
	(bi)	Angle of incidence is 0^{o}. / incident ray lies along the normal. [1]
	(bii)	$n = 1 / \sin c$ $c = \sin^{-1} (1 / 1.60)$ [1] $= 38.7\ ^{o}$ [1] Angle of incidence greater than critical angle AND total internal reflection occurs. [1]

		Light moving from optically denser medium (glass) to optically less dense medium (air). [1]
	(biii)	45 ^{o} at point of incidence AND Reflected ray straight out into air. [1]
	(c)	n = c / v 1.60 = 3.00×10^{8} / v [1] v = 1.88×10^{8} m / s [1]

Name of Candidate: ______________________ (   ) Class: _________ Calculator Model:

BUKIT PANJANG GOVERNMENT HIGH SCHOOL

Preliminary Examination 2018

SECONDARY 4 Express

Physics

Paper 2

6091/02

Date: 14 Aug, 2018

Duration: 1 hr 45 min

Time: 1115 – 1300 h

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

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

Answer **all** questions in the space provided

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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

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

Setter: Mr Lim Kangyu

[Turn over

Section A (50 marks)

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

1 A 20 kg mass is supported by two strings, inclined at angles 30° and 50° to the vertical respectively, as shown in Fig. 1.1. The weight of the mass is W, and the tensions in the strings are T_1 and T_2. Take the gravitational field strength to be 10 N/kg.

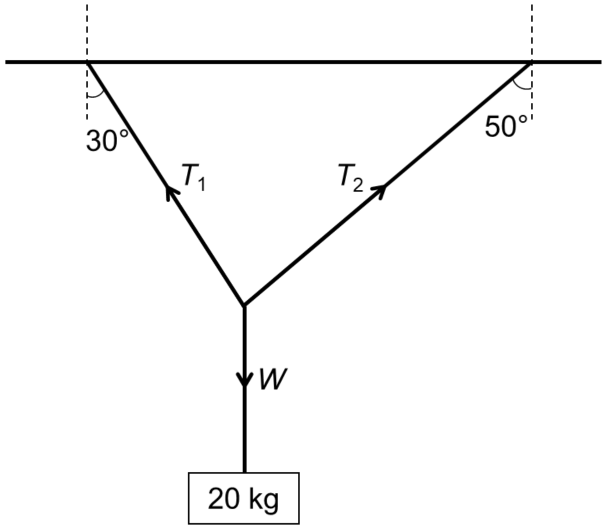


Fig. 1.1 (not to scale)

(a) By means of a scaled diagram, determine T_1 and T_2.

T_1 = ...

T_2 = ... [4]

(b) Suggest and explain one way that the forces in Fig. 1.1 are labelled wrongly.

....

.... [2]

2 **(a)** State the two conditions required for an object to be in equilibrium, when it is acted upon by a number of forces.

1 ....

....

2 ....

.... [2]

(b) Fig. 2.1 shows a roly-poly toy. In diagram A, it is shown at rest. When it is slightly displaced to one side (diagram B) and released, it returns to the upright position as shown in diagram C. The dot represents the centre of gravity of the roly-poly toy.

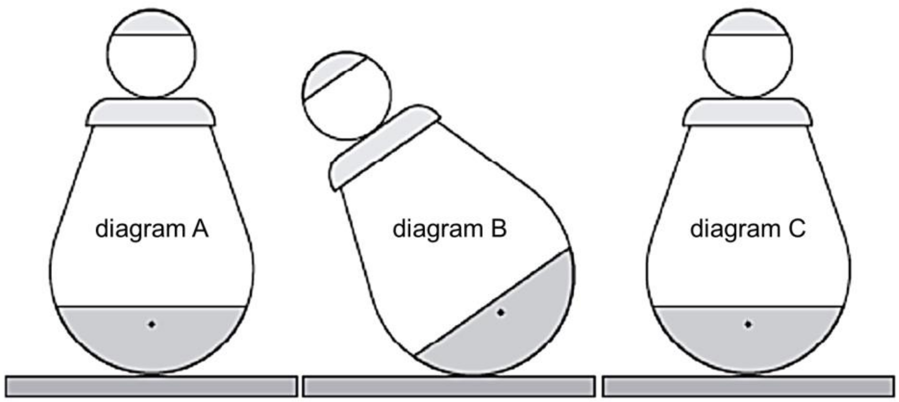


Fig. 2.1

(i) On diagram A, mark the pivot with an **X**. [1]

(ii) On diagram B, draw and label the weight of the toy. [1]

(iii) Explain why the toy returns to the upright position when it is released.

....

.... [1]

(iv) Without changing the structure of the toy, suggest how you would position the toy so that it will not return to its upright position.

....

.... [1]

3 Fig. 3.1 shows a hydraulic system. A force F is applied onto piston **X** to lift a heavier load of weight L at piston **Y**. The masses of the pistons are negligible.

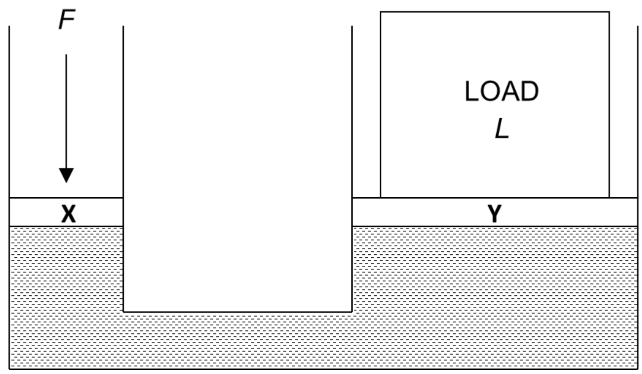


Fig. 3.1

(a) Given that the ratio of area **X** to area **Y** is 1:4, calculate

(i) the ratio of pressure at **X** to pressure at **Y**,

ratio = ... [1]

(ii) the ratio of $F : L$.

ratio = ... [1]

(b) Peter argued that, "Since the load moved upwards, it gained gravitational potential energy. Since energy cannot be created, this gravitational potential energy must have come from the loss in gravitational potential energy of piston **X**." Explain whether you agree with this argument.

....

....

.... [2]

(c) Given that piston **Y** moves upwards by 6.0 cm, calculate the distance moved by piston **X**.

distance moved = ... [2]

4 An uncalibrated thermometer is immersed in pure melting ice. When thermal equilibrium is reached, the length of the mercury thread is 3 cm, as shown in Fig. 4.1.

The thermometer is then placed in a flask and surrounded by steam from boiling water under normal atmospheric pressure. When the second thermal equilibrium is reached, the length of the mercury thread is 28 cm, as shown in Fig. 4.2.

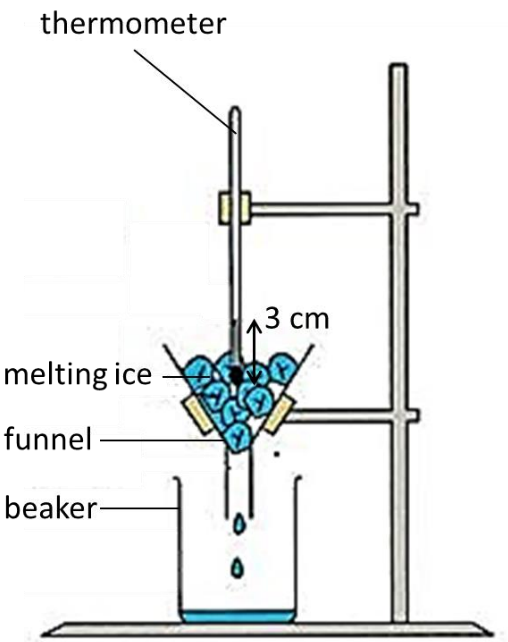


Fig. 4.1

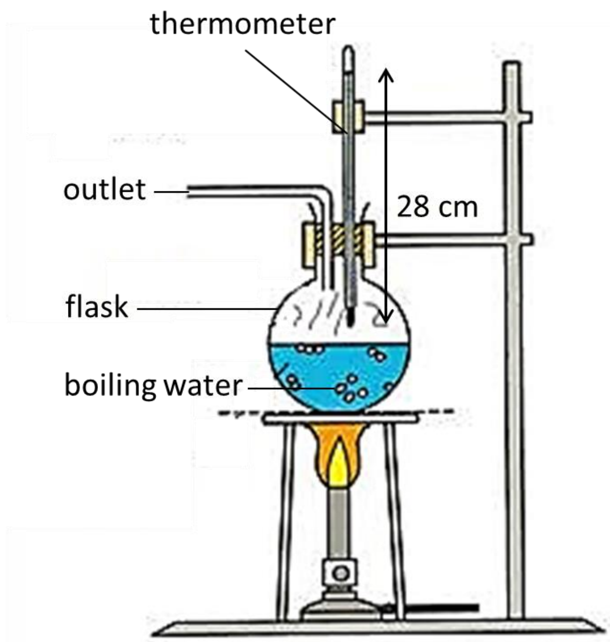


Fig. 4.2

(a) State the meaning of "thermal equilibrium", and the difference between the two thermal equilibria.

....

....

.... [2]

(b) With reference to Fig. 4.1, indicate the directions and state the modes by which thermal energy is transferred between the melting ice, thermometer and funnel, before thermal equilibrium is reached. [2]

Direction of thermal energy transfer (→ or ←)			Mode
melting ice		thermometer	
melting ice		funnel	

(c) With reference to Fig. 4.2, describe the function of the outlet.

....

.... [1]

(d) The thermometer is then placed in an unknown liquid of temperature T and the length of the mercury thread is 18 cm.

Calculate T.

T = ... [2]

(e) It is known that the boiling point of water increases when the surrounding pressure increases.

If the pressure in the flask in Fig. 4.2 is higher than normal atmospheric pressure,

(i) state whether the second thermal equilibrium will be reached at a *higher*, *lower* or *the same* temperature;

.... [1]

(ii) state whether the temperature of the unknown liquid will be calculated to be *higher than*, *lower than* or *the same as* your answer in **(d)**.

.... [1]

5 The earliest types of converging lenses were made of flint glass. Fig. 5.1 shows such a converging lens, and two light rays before entering and after leaving the lens. The diagram is drawn to scale.

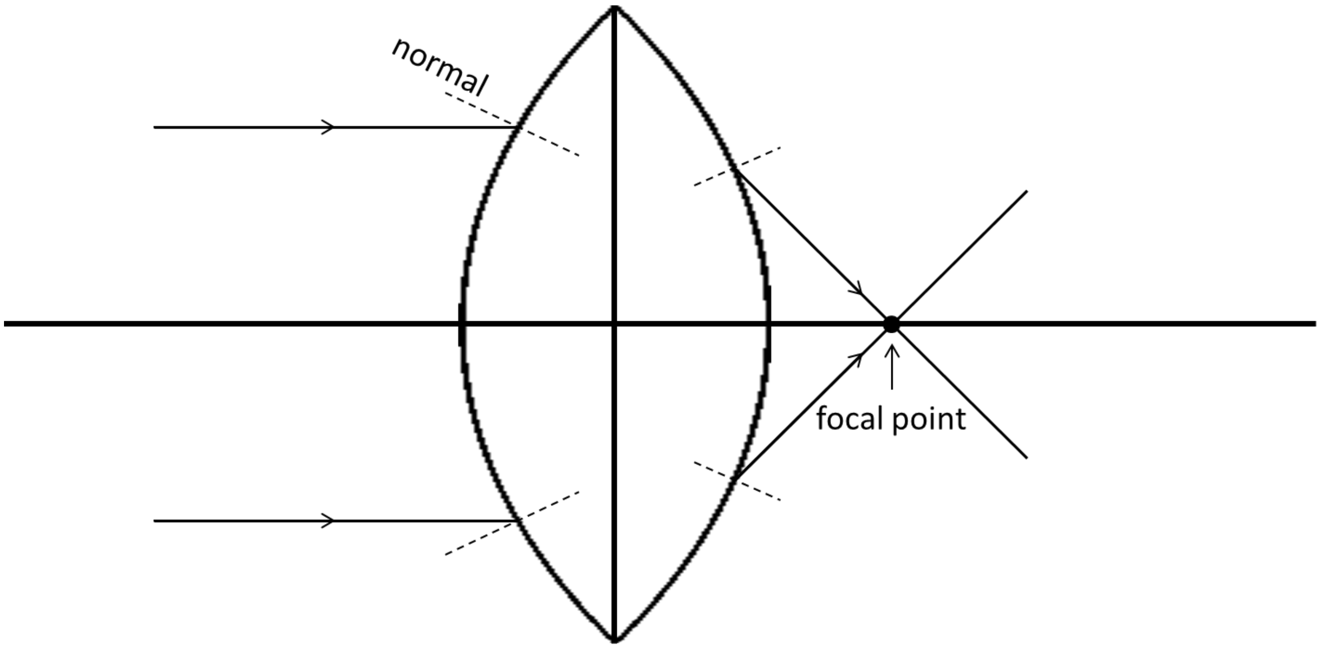


Fig. 5.1

(a) On Fig. 5.1 above,

(i) complete the paths of the two light rays in the lens; [1]

(ii) mark out and label the optical centre of the lens with the letter "**O**". [1]

(b) By accurate measurements,

(i) calculate the refractive index of flint glass,

refractive index = ... [1]

(ii) determine the focal length of the converging lens.

focal length = ... [1]

(c) With the aid of a sketch, describe where the image of a distant object will be formed by the converging lens.

....

.... [3]

(d) Some identical flint glass was used to make a diverging lens of the same focal length. In Fig. 5.2 below, sketch the paths of the same two parallel light rays (as in Fig. 5.1) incident on the diverging lens.

Label the focal point of the diverging lens, and show clearly the paths of the light rays in the lens and after leaving the lens. [2]

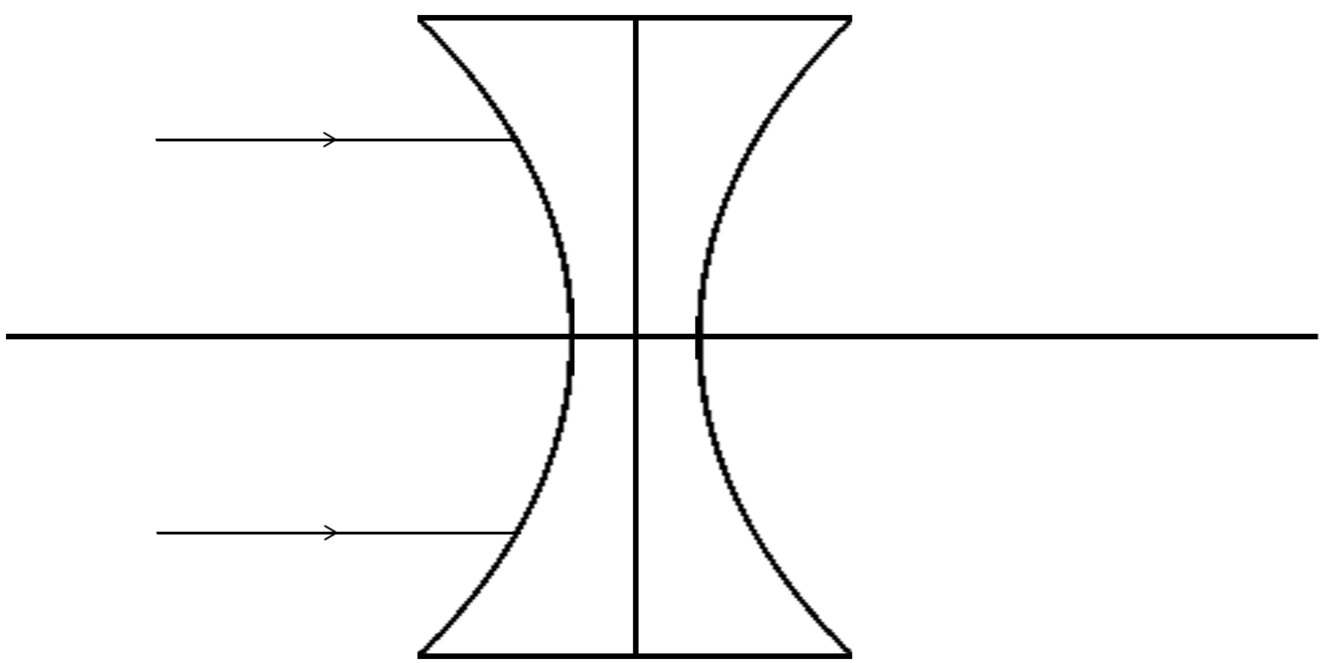


Fig. 5.2

6 A light-dependent resistor (LDR) is connected to a 150 V power supply and two resistors, 600 Ω and 1 kΩ respectively, as shown in Fig. 6.1. Under room lighting, the resistance of the LDR is 100 Ω. As the brightness increases, the resistance of the LDR gets closer and closer to 0 Ω.

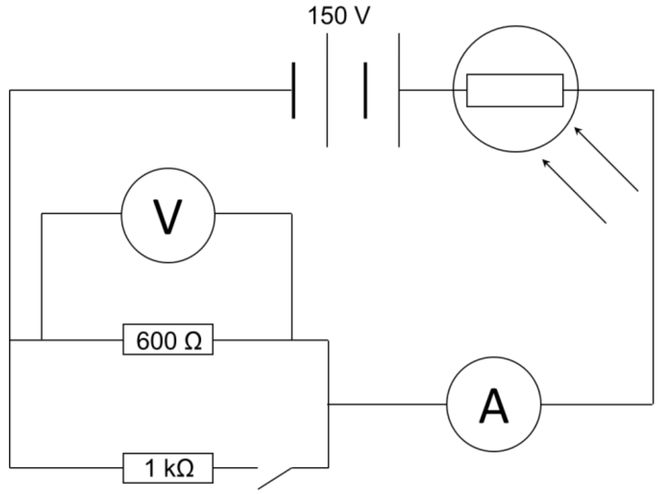
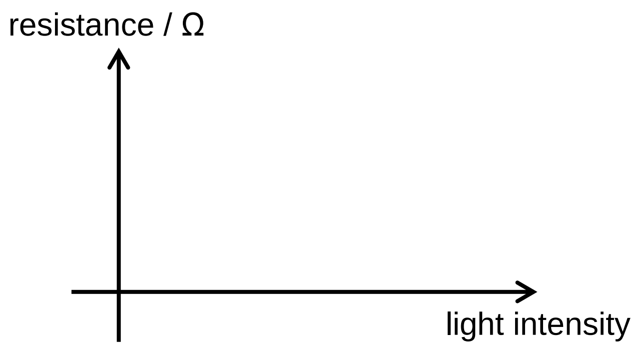


Fig. 6.1

(a) In the axes provided, sketch a graph to show how the resistance of the LDR varies with light intensity. Include any values that you have been provided with. [1]



(b) Calculate the ammeter and voltmeter readings, when the switch is closed, and the lighting is under room condition.

ammeter reading = ...

voltmeter reading = ... [3]

7 Fig. 7.1 shows a d.c. motor comprising of a coil, **ABCD**, with three turns of wire. When the current flows through the circuit, the coil rotates in the direction as indicated.

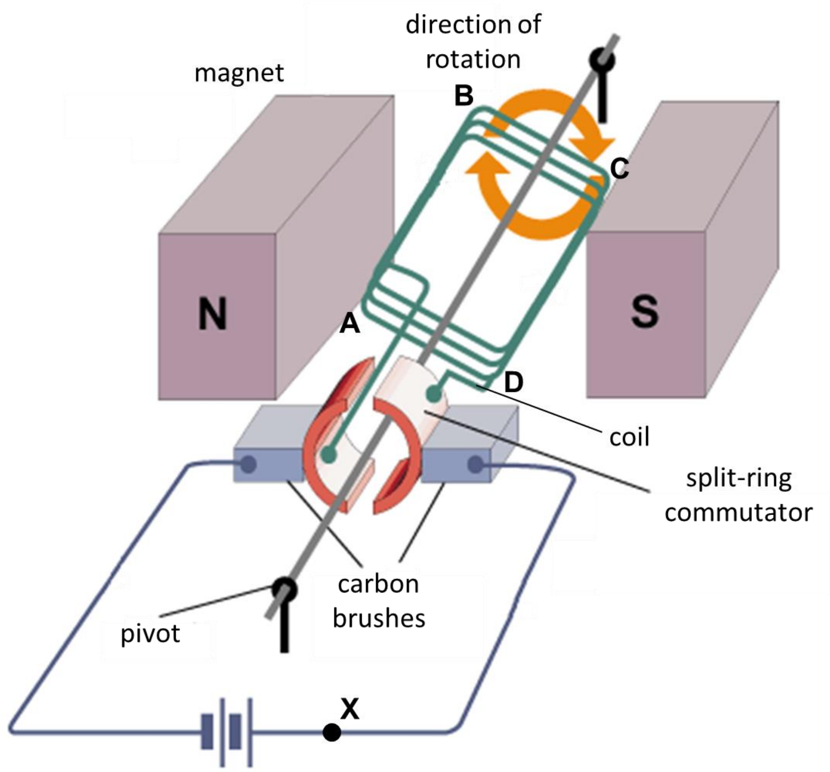


Fig. 7.1

(a) **(i)** On Fig. 7.1, indicate the direction of current flow in the external circuit and the coil. [1]

(ii) Hence explain how the direction of rotation of the coil can be deduced as indicated.

....

....

....

.... [3]

(b) State all possible observations on the motor if

(i) the number of turns of wire is two instead of three;

.... [1]

(ii) a light bulb is connected at the point **X**.

.... [1]

8 Fig. 8.1 shows the electrical power supplied to housing consumers from the National Grid System. The power lines transmit alternating current from the National Grid System at 120 000 V, as shown in Fig. 8.1. The device **X** converts the potential difference across the transmission wires, connected to housing, to 240 V.

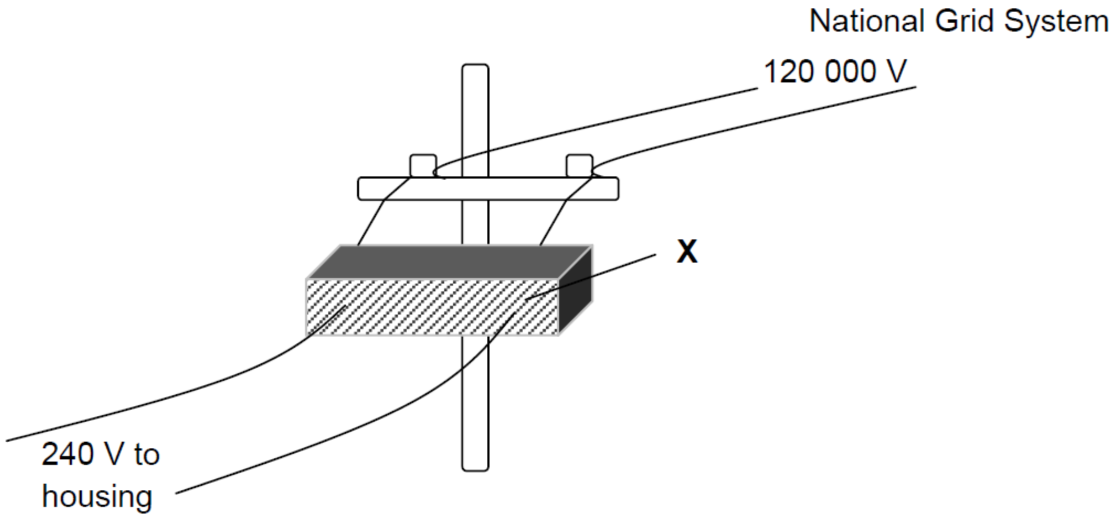


Fig. 8.1

(a) Identify device **X**.

.... [1]

(b) Explain why the supply from the National Grid System is not transmitted at 240 V.

....

....

.... [2]

(c) Explain why the potential difference across the wires, connected to housing, should not be kept at 120 000 V.

....

....

.... [1]

Section B (30 marks)
Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11**.

9 In a Biology experiment, student **B** wanted to determine his own human reaction time, with the assistance of student **A**.

Student **A** held a 30 cm ruler near the end, at the 0 cm mark, and let it hang downwards. Student **B** put his hand approximately an additional 15 cm away from the 30 cm mark of the ruler, as shown in Fig. 9.1.

Once the students were ready, student **A** dropped the ruler and student **B** had to catch the ruler as fast as possible after it dropped, as shown in Fig. 9.2.

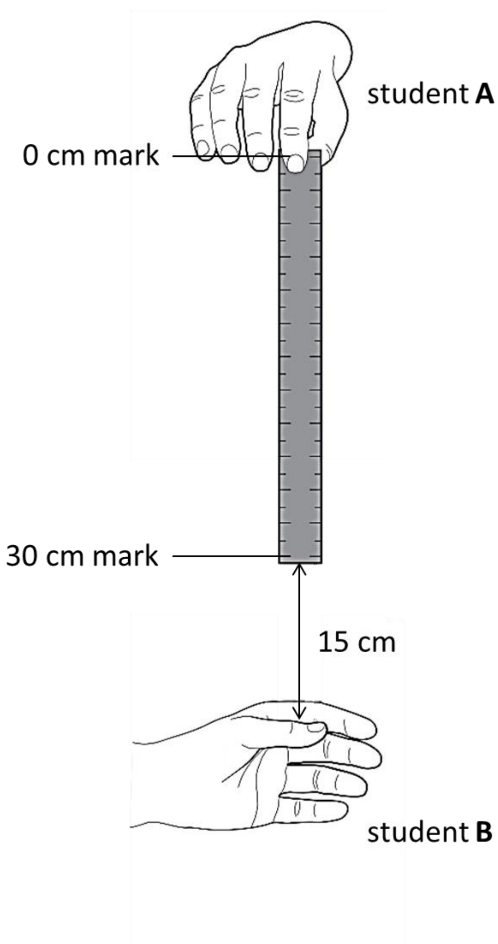


Fig. 9.1

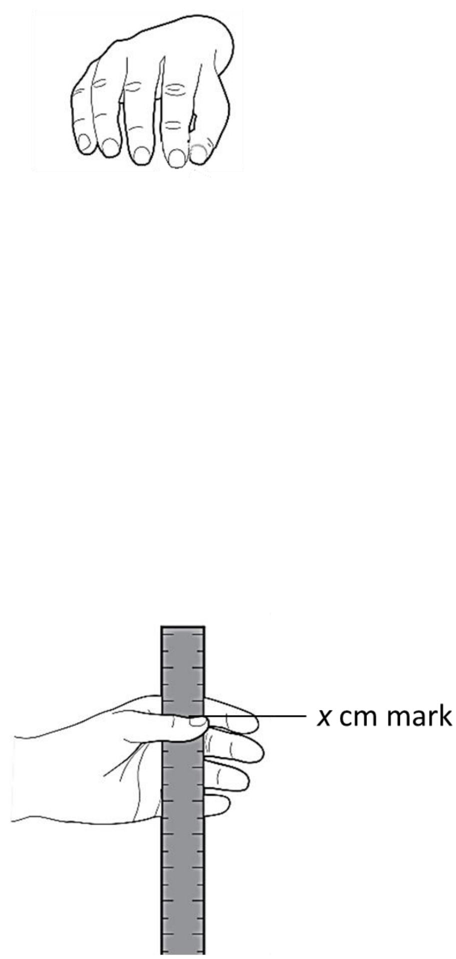


Fig. 9.2

They recorded the marking at which the ruler was caught, *x*, and calculated the distance travelled by the ruler, *d*.

(a) **(i)** Show that the ruler travelled a distance of 40.0 cm, if it was caught by student **B** at the 5.0 cm mark. [1]

(ii) Hence write down an expression for *d*, in terms of *x*.

.... [1]

(b) To improve the reliability of their results, the students conducted the experiment three times, and recorded their results in a table as shown in Table 9.3.

Experiment	***x* / cm**	***d* / cm**	***Estimated t / s***	***Calculated t / s***
1	5.0	40.0		
2	10.3			
3	12.1			

Table 9.3

For each value of *d* calculated, they referred to a chart from the internet, to estimate the human reaction time, *t*, of student **B**. The estimation chart is given in Fig. 9.4.

Estimation chart for human reaction time

Distance	**Time**
~5 cm	0.10 sec (100 ms)
~10 cm	0.14 sec (140 ms)
~15 cm	0.17 sec (170 ms)
~20 cm	0.20 sec (200 ms)
~25.5 cm	0.23 sec (230 ms)
~30.5 cm	0.25 sec (250 ms)
~43 cm	0.30 sec (300 ms)
~61 cm	0.35 sec (350 ms)
~79 cm	0.40 sec (400 ms)

Fig. 9.4

(i) Fill in the blanks in Table 9.3 for the column of ***d*** **/ cm**. [1]

(ii) Fill in the blanks in Table 9.3 for the column of ***Estimated t*** **/ s**. [1]

(c) Student **A** did not like the idea of estimating student **B**'s human reaction time, and decided to come up with a way to calculate it accurately.

(i) State the acceleration of the ruler after it is released by student **A**. State an assumption made.

....

.... [2]

(ii) Sketch the velocity-time graph of the ruler after it is released by student **A**, until it was caught by student **B**. [1]

(iii) Hence calculate the time taken between student **A** releasing the ruler and student **B** catching the ruler, if student **B** caught the ruler at the 5.0 cm mark.

time taken = ... [2]

(iv) Fill in the blanks in Table 9.3 for the column of ***Calculated t / s***. [1]

10 In a Chemistry textbook, Einstein read the descriptions about ionic bonds and metallic bonds.

(a) The textbook description of ionic bonds is shown in Fig. 10.1.

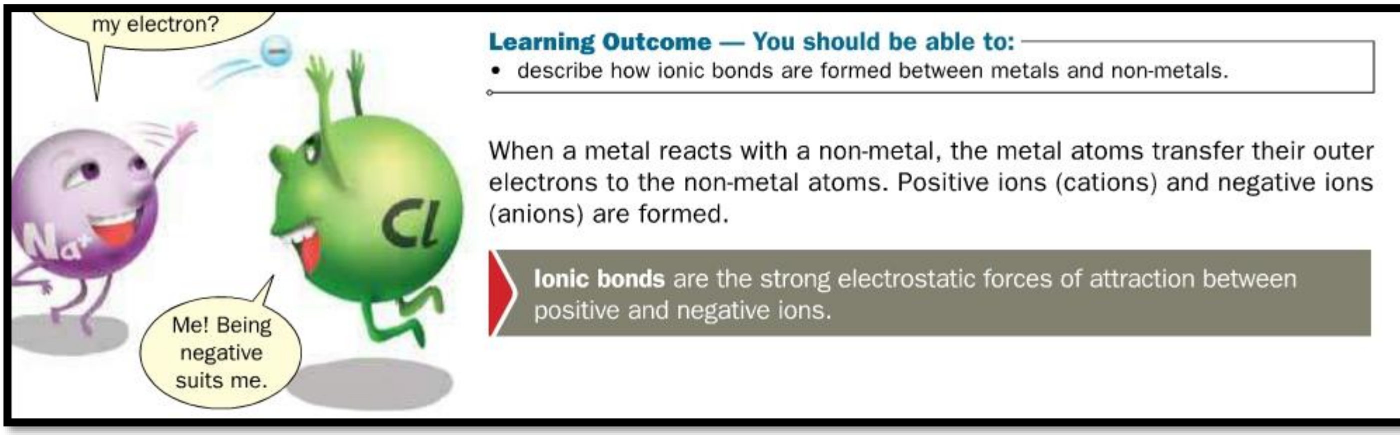


Fig. 10.1

A sodium (Na) atom loses an electron to become a positively-charged ion. A chlorine (C*l*) atom gains an electron to become negatively-charged ion. The magnitude of the charge of one electron is 1.60×10^{-19} C.

Fig. 10.2 shows the two charged particles next to each other, separated by a distance of 2.75×10^{-10} m.

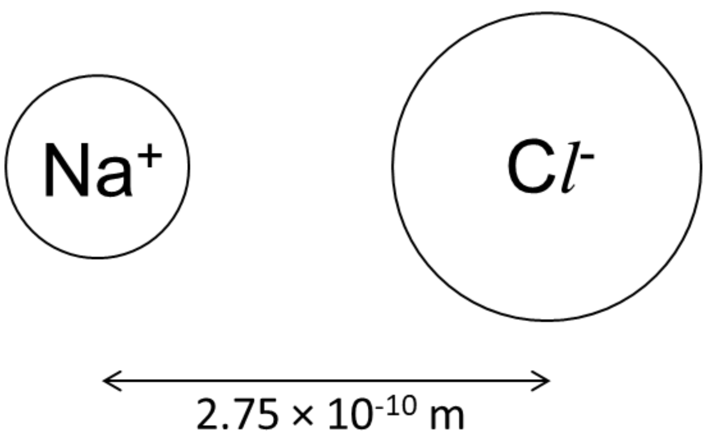


Fig. 10.2

(i) Sketch the electric field pattern around the negatively-charged Cl^- ion. Ignore the presence of the positively-charged Na^+ ion. [1]

(ii) Hence, using concepts of electric field, explain why the negatively-charged Cl^- ion exerts a force on the positively-charged Na^+ ion.

....

....

.... [2]

(iii) Given that the force in **(a)(ii)**, *F*, between two charged particles of charges q_1 and q_2, separated by a distance *r*, is given by

$$F = \frac{q_1 q_2}{(1.11\times10^{-10})r^2},$$

calculate the magnitude of the force, *F*.

F = ... [1]

(iv) "The force exerted by the negatively-charged Cl^- ion on the positively-charged Na^+ ion is equal in magnitude to the force exerted by the positively-charged Na^+ ion on the negatively-charged Cl^- ion," claims Einstein. Explain whether you agree with his statement.

....

....

.... [2]

(b) The textbook description of metallic bonds is shown in Fig. 10.3.

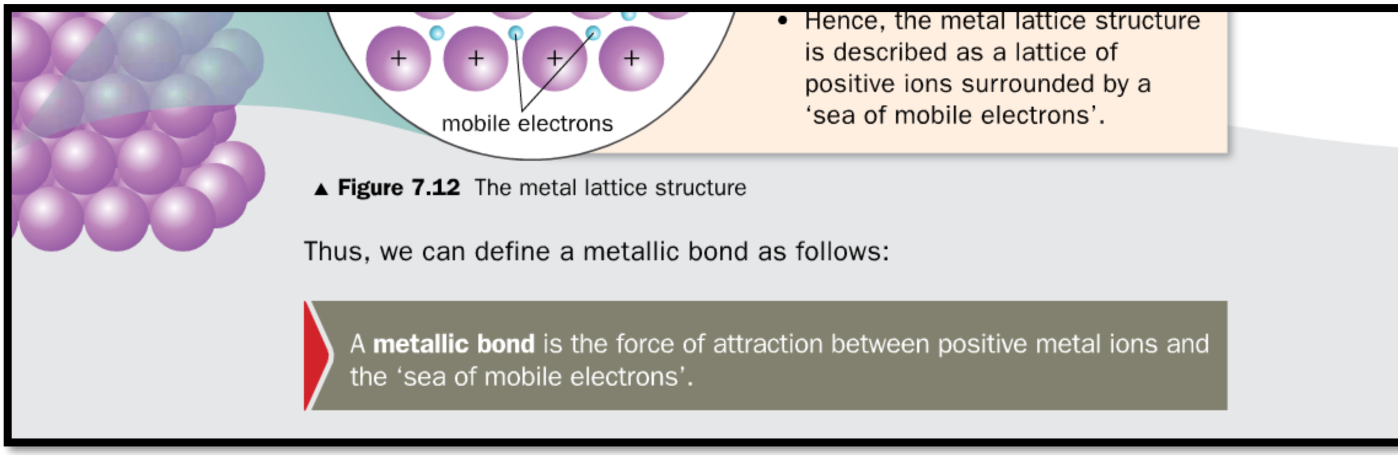


Fig. 10.3

Metallic bonds occur only in metals. Fig. 10.4 shows the positions of the positive metal ions and the mobile electrons in a metal sphere.

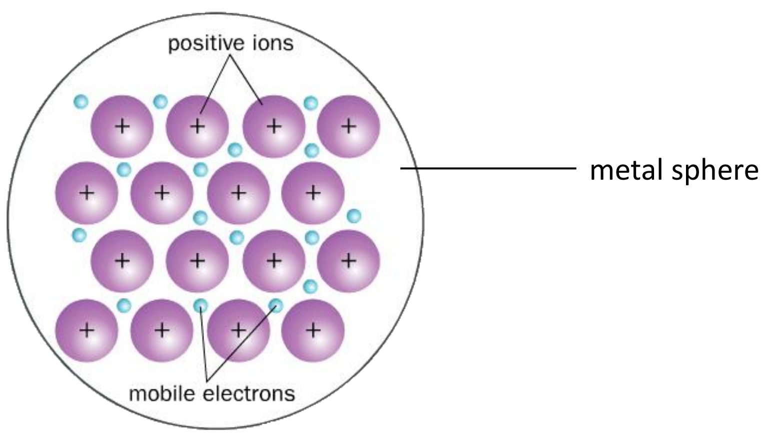


Fig. 10.4

(i) A negatively-charged metal rod is brought near the left side of metal sphere, as shown in Fig. 10.5. On the diagram, sketch the new positions of all the mobile electrons. [2]

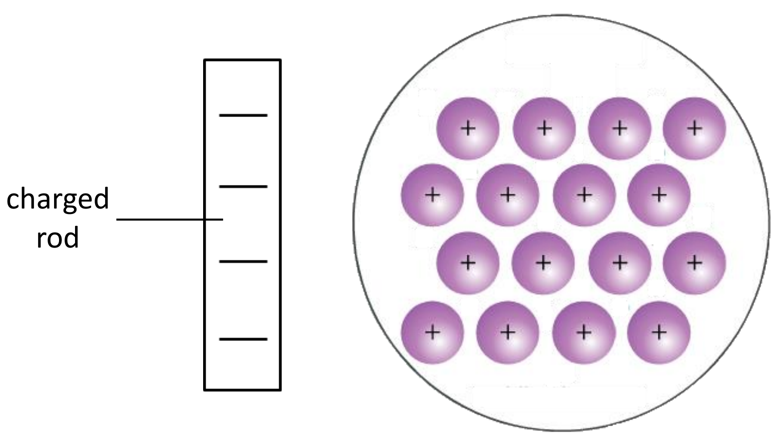


Fig. 10.5

(ii) With the aid of the negatively-charged metal rod in **(b)(i)**, describe a method to

1. make the metal sphere positively-charged;

....

.... [1]

2. make the metal sphere negatively-charged.

....

.... [1]

11 EITHER

(a) Steven throws a stone into a point **X** in a lake. He watches the waves move towards the edge of the lake, as shown in Fig. 11.1. The distance between each wavefront is 8.0 cm.

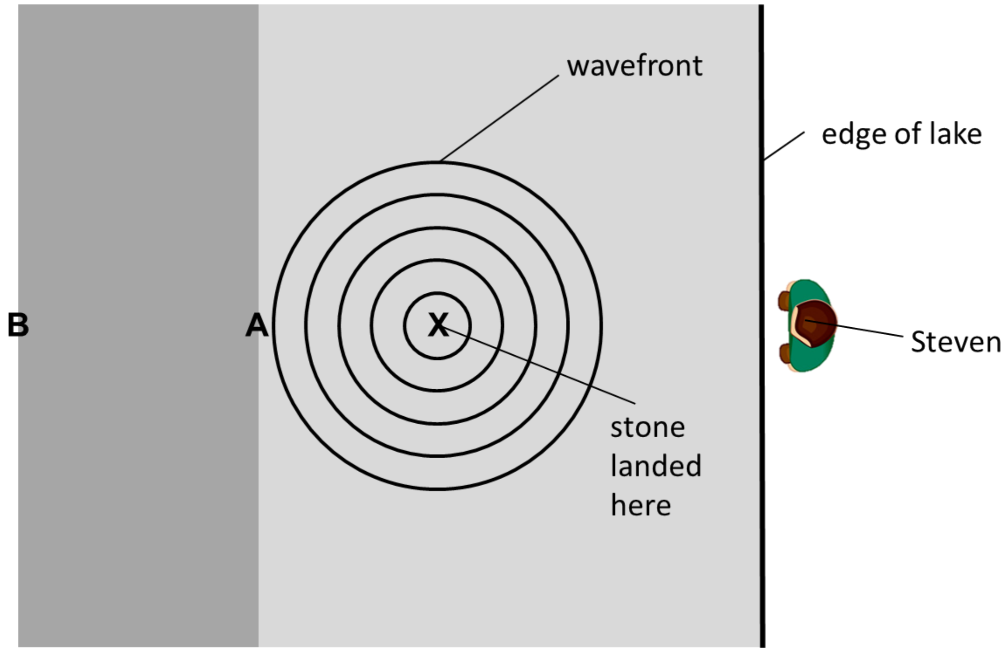


Fig. 11.1

(i) Explain what is meant by *distance between each wavefront is 8.0 cm*.

....

.... [1]

(ii) State the wavelength of the waves. Briefly explain how you obtained your answer.

....

.... [1]

(iii) Steven counts two complete waves reaching the edge of the lake in each second.

Determine the speed of the waves.

speed = ... [1]

(iv) From point **A** to point **B**, the depth of the lake increases. It is known that as the depth increases, the waves at the surface of the water travel faster.

Suggest a possible explanation for the phenomenon above.

....

.... [1]

(v) Hence, on Fig. 11.1, sketch further wavefronts to represent the waves as they travel further outwards from the point **X**.

Explain the shape of your sketch.

....

.... [3]

(b) When the stone falls into point **X** in the lake, Steven sees a hole created at the water surface with some water splashed upwards around the hole, as shown in Fig. 11.2. He also hears a small "*plomp*" sound when the stone hits the water surface.

"*plomp*"

Fig. 11.2

(i) State the two types of waves that allowed Steven to make the observations.

Wave 1: ....

Wave 2: .... [1]

(ii) "Since I see the splash and hear the "*plomp*" way before the waves on the lake reach me, the speed of Wave 1 and Wave 2 must be the same, and are much faster than the speed of water waves," Steven thinks in his head.

Explain whether you agree with Steven's thinking and reasoning.

....

....

....

.... [2]

OR

The Magnetic Levitation (Maglev) Train is still under development and many scientists are working on the project. The basic idea is to use magnets that either repel or attract each other, to suspend a train above the rail.

(a) Explain how suspending a train above the rail makes the train move more efficiently.

....

.... [2]

(b) Fig. 11.3 shows one magnet repelling another into the air, making the latter levitate.

Fig. 11.3

(i) On Fig. 11.3, sketch the magnetic field lines between the North poles of the two magnets. [1]

(ii) In reality, it is difficult to levitate one magnet above the other, as the one on the top will fall down to the sides easily.

If one magnet can be levitated above the other as in Fig. 11.3, state the type of equilibrium that the system is in.

.... [1]

(c) To resolve the issue of a suspended magnet falling over, a German scientist designed the Electromagnetic Suspension (EMS) system. EMS systems use the attractive property of magnets, as shown in Fig. 11.4, to suspend a train above its track, also called a guideway.

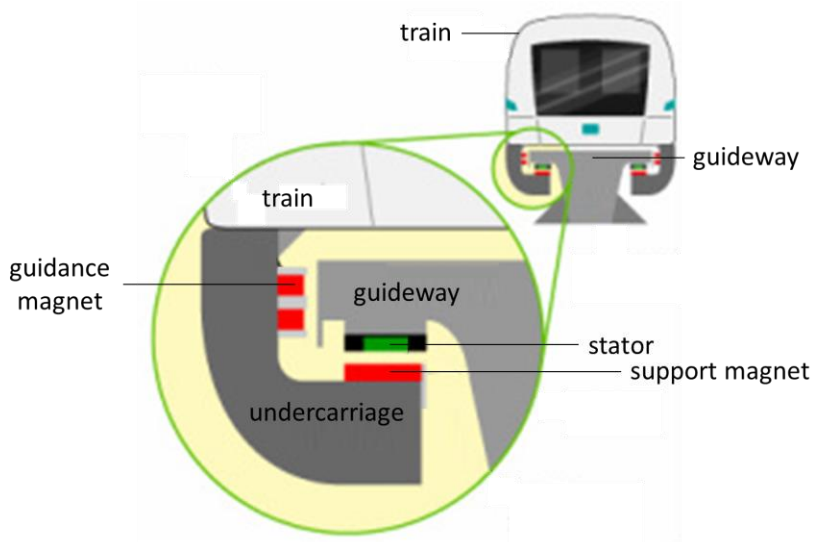


Fig. 11.4

The stator and support magnet are electromagnets of opposite polarities and hence are attracted to each other. It causes the train to not land on the guideway. The strength of the stator and support magnet can be electronically adjusted to keep the train levitated.

There is a guidance magnet on the side of the track that generates the magnetic force that prevents the train from moving side to side. The levitating train cannot touch any side of the track because of the magnetic force pushing the train to the middle.

(i) Explain why iron is a suitable material to make the stator and support magnet.

....

.... [1]

(ii) On Fig. 11.5, draw a free-body diagram of the train, when it is levitated and at rest. [2]

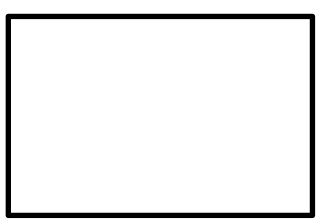


Fig. 11.5

(d) On the other hand, some Japanese scientists use the technology of Electrodynamics Suspension (EDS) to levitate a train. The method of EDS utilises the principle of electromagnetic induction.

The train travels in a guideway which has a series of "8"-shaped coils on each side. When the train travels by with a high speed, the permanent magnets on each side of the train will induce a current in the coils. Both halves of the "8"-shaped coils generate an upward component of magnetic force on the permanent magnet and levitate the train. This is illustrated in Fig. 11.6a and 11.6b.

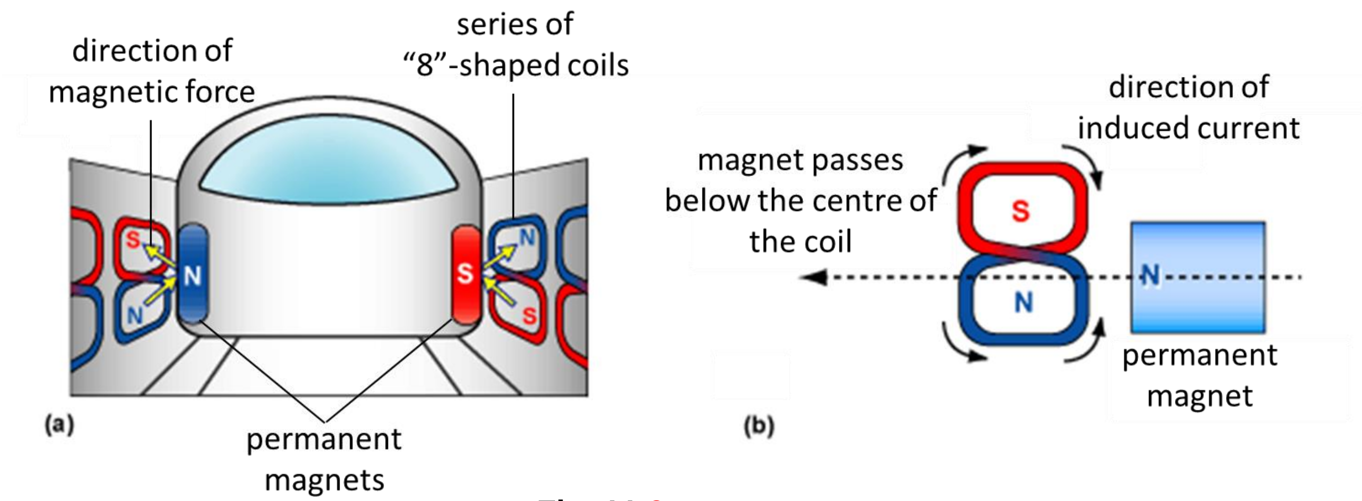


Fig. 11.6

(i) One drawback of the EDS is that the train cannot be levitated when it is at rest. Explain why this is the case.

....

.... [1]

(ii) The magnet passes below the centre of the "8"-shaped coils, as shown in Fig. 11.6b, so that the magnetic flux change in the lower half of the "8"-shaped coils is greater than that in the upper half, and a current is induced.

Explain what will happen if the magnet passes through the centre of the coils instead.

....

....

....

.... [2]

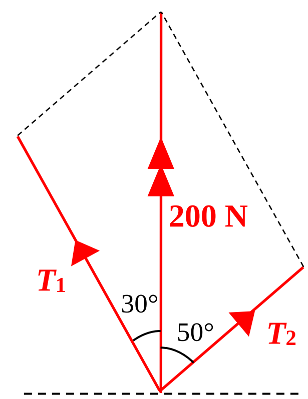
END OF PAPER

Sec 4 Express Physics Preliminary Examination 2018 – Marking Scheme

Paper 2 Section A (50 marks)

Deduct 1 m for s.f.
Deduct 1 m for omission or wrong units

<table>
<tr><th>Qn</th><th>Solutions</th><th>Mark Allocation</th></tr>
<tr><td>1(a)</td><td>$$W = mg = (20\ \text{kg})(10\ \text{N kg}^{-1}) = 200\ \text{N downwards}$$
For the system to be in equilibrium, the resultant force on the mass is zero. Thus the sum of the tensions must be exactly 200 N upwards to balance the downward W.

<u>Scale</u>
1 cm : 40 N

$T_1 = 3.9 \times 40 = 156$ N (accept 148 N – 164 N)
$T_2 = 2.6 \times 40 = 104$ N (accept 98 N – 110 N)</td><td>B1

B1

A1
A1</td></tr>
<tr><td>1(b)</td><td>The weight of the mass should be labelled from the centre of gravity of the 20 kg mass downwards, instead of being drawn from the ends of the two strings.

OR

The 20 kg mass should be drawn at the centre of the three strings, instead of being drawn at the end of the vertical string.

OR

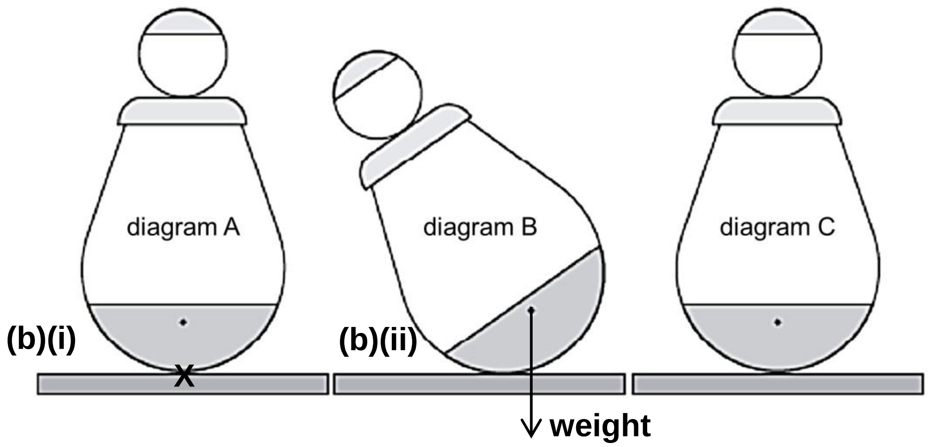
The force in the vertical string should be drawn as a downward tension in the vertical string, instead of the weight of the mass.</td><td>B1
B1

OR

B1
B1

OR

B1
B1</td></tr>
</table>

Qn	Solutions	Mark Allocation
2(a)	**1** The **resultant force** on the object is **zero.** **2** The **resultant moment** about any pivot is **zero**.	B1 B1
2(b)(i) 2(b)(ii)		B1 B1
2(b)(iii)	The **weight of the toy** results in **a clockwise moment about the pivot**, that rotates the toy clockwise back to its original position.	B1
2(b)(iv)	Balance the toy on the tip of its **head.**	B1
3(a)(i)	By Pascal's Principle, $$P_X = P_Y$$ Therefore ratio of pressure at **X** to pressure at **Y** is 1 : 1.	A1
3(a)(ii)	$$\frac{F_X}{A_X} = \frac{F_Y}{A_Y}$$ $$\frac{F_X}{F_Y} = \frac{A_X}{A_Y}$$ $$\frac{F}{L} = \frac{1}{4}$$ Therefore ratio of F : L is 1 : 4.	A1
3(b)	Peter is correct that the **load gained gravitational potential energy**, however it did not come from the loss in gravitational energy of piston **X**, because the piston has negligible mass and negligible energy. Instead, the increase in gravitational potential energy of the load was due to the **work done by the force *F*.**	B1 B1

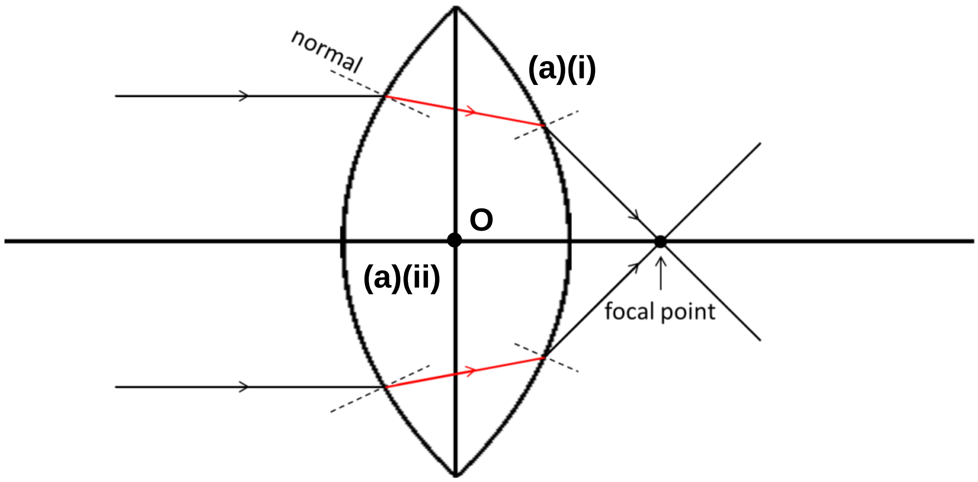
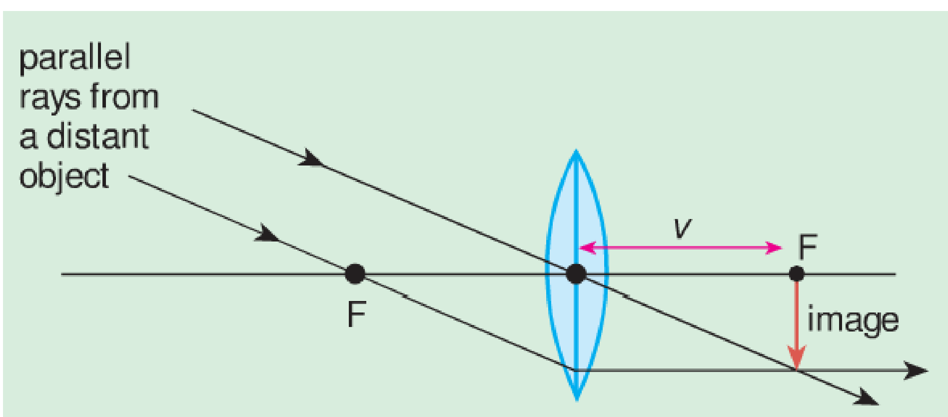
<table>
<tr><th>Qn</th><th>Solutions</th><th>Mark Allocation</th></tr>
<tr><td>3(c)</td><td>$$\begin{aligned}\text{WD by } F &= \text{gain in GPE of load}\\ F \times d_X &= L \times 0.06\text{ m}\\ d_X &= \frac{L}{F} \times 0.06\text{ m}\\ &= \frac{4}{1} \times 0.06\text{ m}\\ &= 0.24\text{ m}\end{aligned}$$</td><td>M1

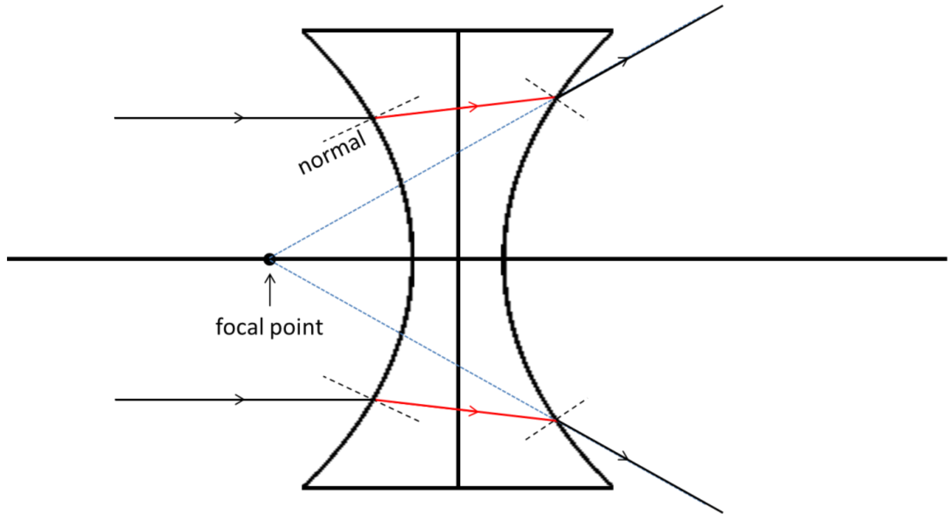
A1</td></tr>
<tr><td>4(a)</td><td>Thermal equilibrium is the state when two objects reach the same temperature <u>or</u> when there is no net transfer of thermal energy between the two objects.

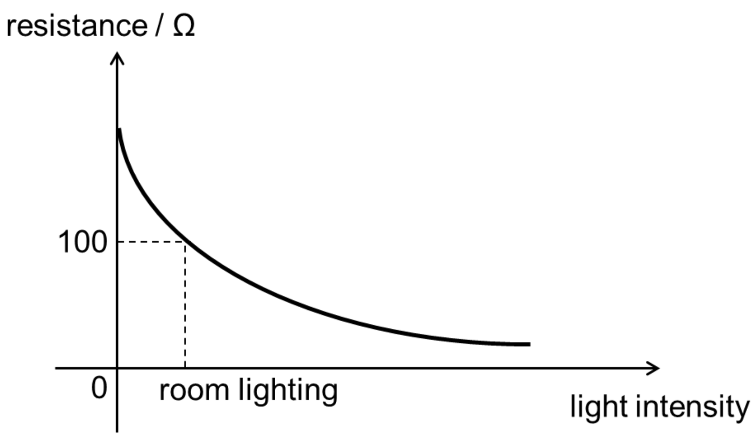
The thermal equilibrium in Fig. 4.2 occurs at a higher temperature than that in Fig. 4.1.</td><td>B1

B1</td></tr>
<tr><td>4(b)</td><td><table><tr><th colspan="3">Direction of thermal energy transfer (→ or ←)</th><th>Mode</th></tr><tr><td>melting ice</td><td>←</td><td>thermometer</td><td>Conduction</td></tr><tr><td>melting ice</td><td>←</td><td>funnel</td><td>Conduction</td></tr></table></td><td>B1
B1</td></tr>
<tr><td>4(c)</td><td>It is to release the water vapour in the flask in order to maintain the pressure in the flask at atmospheric pressure. Otherwise, the boiling point of water becomes affected.</td><td>B1</td></tr>
<tr><td>4(d)</td><td>$$\begin{aligned}T &= \frac{l_\theta - l_0}{l_{100} - l_0} \times 100\ {}^\circ\text{C}\\ &= \frac{18\text{ cm} - 3\text{ cm}}{28\text{ cm} - 3\text{ cm}} \times 100\ {}^\circ\text{C}\\ &= 60\ {}^\circ\text{C}\end{aligned}$$</td><td>C1

A1</td></tr>
<tr><td>4(e)(i)</td><td>Higher</td><td>B1</td></tr>
<tr><td>4(e)(i)</td><td>Lower than</td><td>B1</td></tr>
</table>

Qn	Solutions	Mark Allocation
5(a)(i) 5(a)(ii)		B1 B1
5(b)(i)	By measurement, $$i = 25°, r = 15°$$ $$n = \frac{\sin i}{\sin r} = \frac{\sin 25°}{\sin 15°} = 1.63$$ *[Accept answers from 1.5 to 1.8]*	A1
5(b)(ii)	By measurement, $$f = 3.6 \text{ cm}$$ *[Accept answers from 3.5 cm to 3.7 cm]*	A1
5(c)	 The image will be formed on the **focal plane** of the lens.	B1 for light rays B1 for image B1

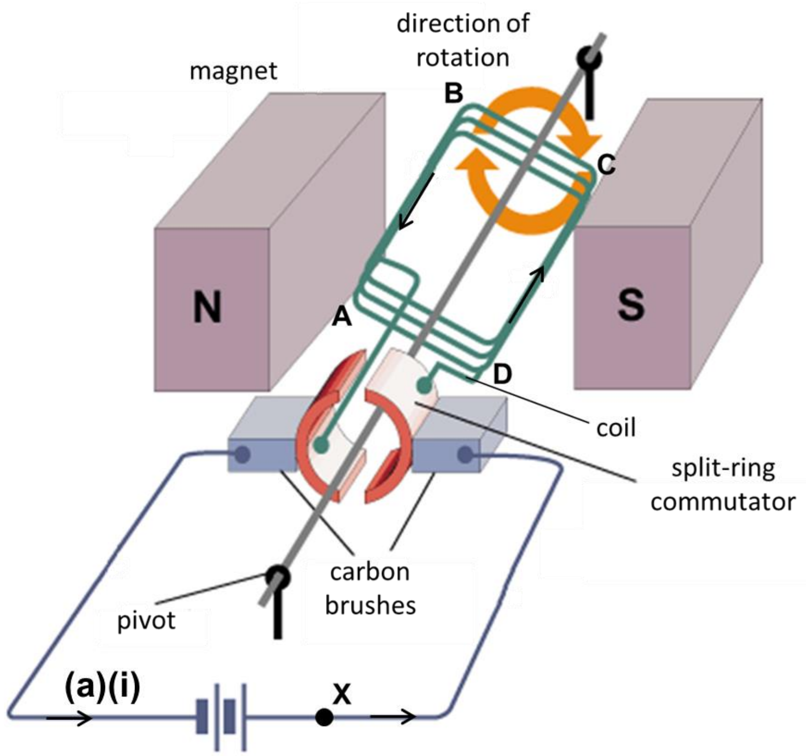
<table>
<tr><th>Qn</th><th>Solutions</th><th>Mark Allocation</th></tr>
<tr><td>5(d)</td><td>
</td><td>B1
for correct refraction

B1
for focal point</td></tr>
<tr><td>6(a)</td><td>
</td><td>B1</td></tr>
<tr><td>6(b)</td><td>When the switch is closed,

$$R_{eff} = \left(\frac{1}{600\ \Omega} + \frac{1}{1000\ \Omega}\right)^{-1} + 100\ \Omega$$ $$= 375\ \Omega + 100\ \Omega$$ $$= 475\ \Omega$$
$$I_{total} = \frac{\varepsilon}{R_{eff}} = \frac{150\ \text{V}}{475\ \Omega} = 0.316\ \text{A}$$
$$V_{600\ \Omega} = \frac{375\ \Omega}{375\ \Omega + 100\ \Omega} \times 150\ \text{V} = 118\ \text{V}$$</td><td>C1

A1

A1</td></tr>
</table>

Qn	Solutions	Mark Allocation
7(a)(i)		B1
7(a)(ii)	Apply the **Fleming's left-hand rule** on the side DC, with the thumb, index finger and middle finger at right angles to one another. Point the **index finger** in the direction of magnetic field, from **left to right**. Point the **middle finger** in the direction of current, into the plane of the paper **from D to C**. The **thumb** gives the direction of the force on DC, **vertically downwards**. Hence the coil rotates clockwise as indicated.	B1 B1 B1
7(b)(i)	The speed of rotation of the coil decreases.	B1
7(b)(ii)	The speed of rotation of the coil decreases and the light bulb lights up.	B1
8(a)	Step-down transformer	B1
8(b)	Since $\boldsymbol{P_{out}} = \boldsymbol{IV}$, if power is transmitted at a low voltage, the **current flowing through the transmission wires will be high**. Since $\boldsymbol{P_{loss}} = \boldsymbol{I^2R}$, large amount of power will be dissipated and **energy will be lost** as thermal energy.	B1 B1

Qn	Solutions	Mark Allocation
8(c)	The **potential difference across household appliances will be too large** at 120 000 V, resulting in very large currents flowing through the appliances that will cause **overheating.**	B1

Paper 2 Section B (30 marks)

Deduct 1 m for s.f.
Deduct 1 m for omission or wrong units
If both questions in **11** are attempted, only the first question is marked

<table>
<tr><th>Qn</th><th>Solutions</th><th>Mark Allocation</th></tr>
<tr><td>9(a)(i)</td><td>Student B’s hand is 45.0 cm below student A’s hand.

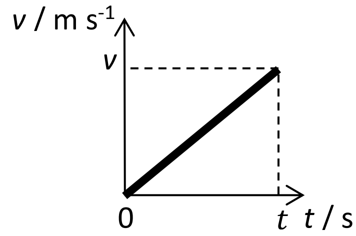
If the ruler was caught at the 0.0 cm mark,
$$\begin{aligned}\text{distance travelled by ruler} &= 30.0\text{ cm} + 15.0\text{ cm}\\ &= 45.0\text{ cm}\end{aligned}$$
If the ruler was caught at the 5.0 cm mark,
$$\begin{aligned}\text{distance travelled by ruler} &= \mathbf{45.0\ cm - 5.0\ cm}\\ &= 40.0\text{ cm}\end{aligned}$$</td><td>M1</td></tr>
<tr><td>9(a)(ii)</td><td>$$\boldsymbol{d = 45 - x}$$</td><td>B1</td></tr>
<tr><td>9(b)(i)</td><td><table><tr><th>Experiment</th><th>x / cm</th><th>d / cm</th></tr><tr><td>1</td><td>5.0</td><td>40.0</td></tr><tr><td>2</td><td>10.3</td><td>34.7</td></tr><tr><td>3</td><td>12.1</td><td>32.9</td></tr></table></td><td>B1</td></tr>
<tr><td>9(b)(ii)</td><td><table><tr><th>Experiment</th><th>x / cm</th><th>d / cm</th><th>Estimated t / s</th></tr><tr><td>1</td><td>5.0</td><td>40.0</td><td>0.30</td></tr><tr><td>2</td><td>10.3</td><td>34.7</td><td>0.25</td></tr><tr><td>3</td><td>12.1</td><td>32.9</td><td>0.25</td></tr></table><u>or</u><table><tr><th>Experiment</th><th>x / cm</th><th>d / cm</th><th>Estimated t / s</th></tr><tr><td>1</td><td>5.0</td><td>40.0</td><td>0.29</td></tr><tr><td>2</td><td>10.3</td><td>34.7</td><td>0.27</td></tr><tr><td>3</td><td>12.1</td><td>32.9</td><td>0.26</td></tr></table><u>or</u><table><tr><th>Experiment</th><th>x / cm</th><th>d / cm</th><th>Estimated t / s</th></tr><tr><td>1</td><td>5.0</td><td>40.0</td><td>0.288</td></tr><tr><td>2</td><td>10.3</td><td>34.7</td><td>0.267</td></tr><tr><td>3</td><td>12.1</td><td>32.9</td><td>0.260</td></tr></table></td><td>A1

a1

a1</td></tr>
<tr><td>9(c)(i)</td><td>The acceleration of the ruler is 10 m s^{-2} downwards, assuming there is no air resistance.</td><td>B1
B1</td></tr>
</table>

Qn	Solutions	Mark Allocation

9(c)(ii)



B1

9(c)(iii)

If student B caught the ruler at the 5.0 cm mark, then the area under the *v*-*t* graph is 40.0 cm (0.40 m):

$$\boldsymbol{\frac{1}{2}(v)(t) = 0.40}$$

Since acceleration of free fall of the ruler is 10 m/s², then

$$\boldsymbol{\frac{v}{t} = 10}$$

C1

Solving the equations simultaneously by eliminating *v*,

$$\frac{1}{2}(10t)(t) = 0.40$$

$$t^2 = \frac{0.4}{5}$$

$$t = \sqrt{0.08}$$

$$t = \mathbf{0.283\ s}$$

A1

or

$$s = ut + \frac{1}{2}at^2$$

$$\boldsymbol{0.40 = (0)(t) + \left(\frac{1}{2}\right)(10)(t^2)}$$

c1

$$0.40 = 5t^2$$

$$t^2 = \frac{0.40}{5}$$

$$t = \sqrt{0.08}$$

$$= \mathbf{0.283\ s}$$

a1

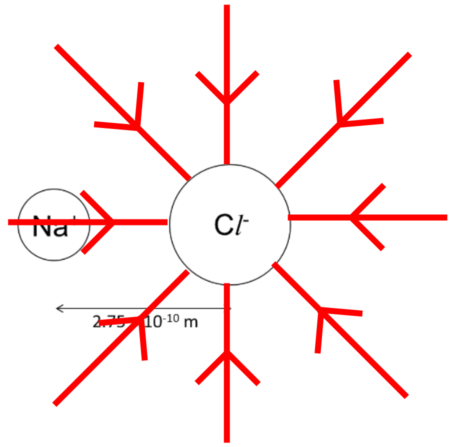
9(c)(iv)

Experiment	*x* / cm	*d* / cm	*Calculated t / s*
1	5.0	40.0	**0.28**
2	10.3	34.7	**0.26**
3	12.1	32.9	**0.26**

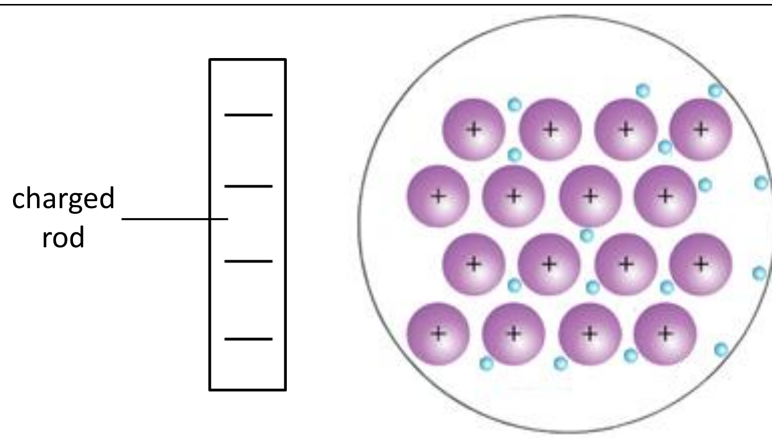
or

Experiment	*x* / cm	*d* / cm	*Calculated t / s*
1	5.0	40.0	**0.283**

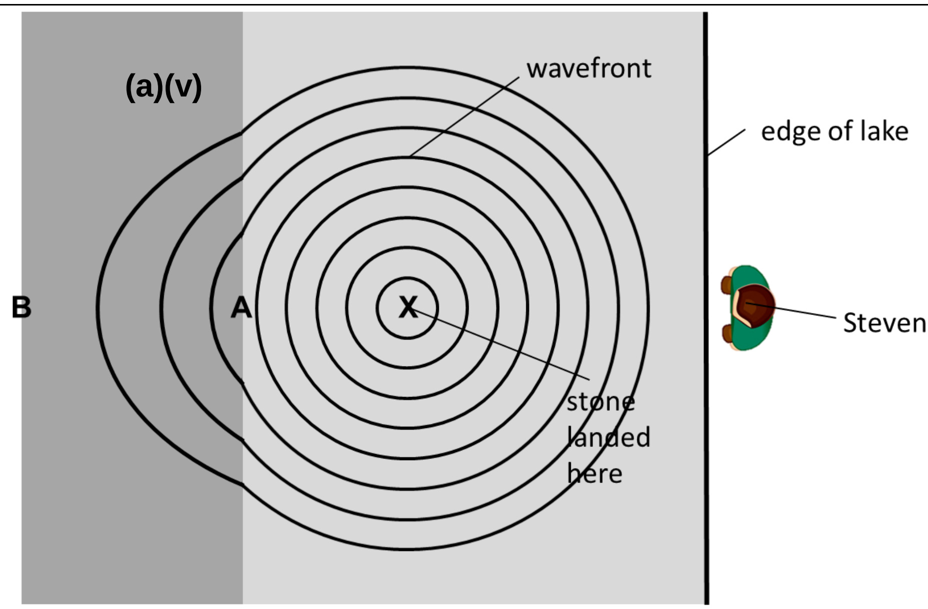
A1

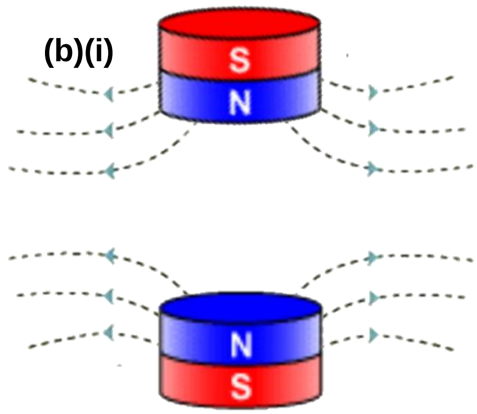
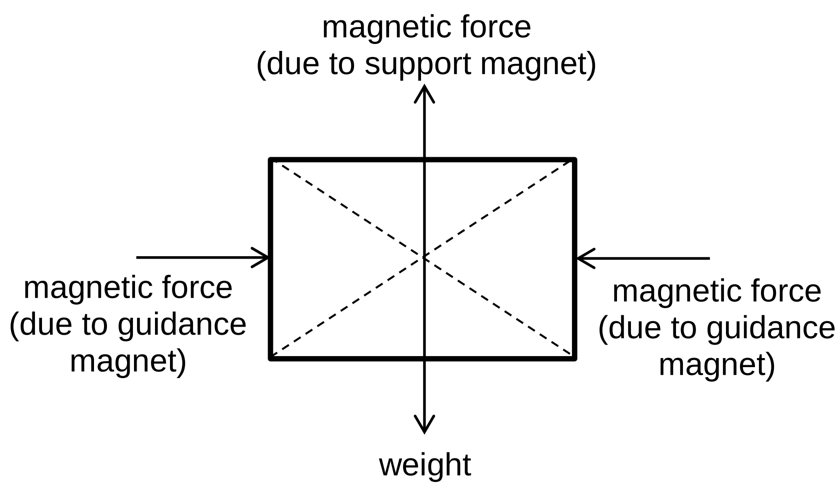
<table>
<tr><th>Qn</th><th>Solutions</th><th>Mark Allocation</th></tr>
<tr><td></td><td><table><tr><td>2</td><td>10.3</td><td>34.7</td><td>0.263</td></tr><tr><td>3</td><td>12.1</td><td>32.9</td><td>0.257</td></tr></table></td><td>a1</td></tr>
<tr><td>10(a)(i)</td><td>
</td><td>B1</td></tr>
<tr><td>10(a)(ii)</td><td>As the positively-charged Na⁺ ion lies within the influence of the electric field of the negatively-charged Cl⁻ ion, it experiences an electric force that attracts it towards the Cl⁻ ion.</td><td>B1
B1</td></tr>
<tr><td>10(a)(iii)</td><td>$$F = \frac{q_1 q_2}{(1.11\times10^{-10})r^2}$$ $$= \frac{(1.60\times10^{-19}\ \mathrm{C})(1.60\times10^{-19}\ \mathrm{C})}{(1.11\times10^{-10})(2.75\times10^{-10}\ \mathrm{m})^2}$$ $$= \mathbf{3.05\times10^{-9}\ N}$$</td><td>A1</td></tr>
<tr><td>10(a)(iv)</td><td>I agree with his statement.

By Newton's 3rd Law, these two forces are equal in magnitude and opposite in direction <u>or</u> these two forces form an action-reaction pair.</td><td>B1

B1</td></tr>
<tr><td>10(b)(i)</td><td>
</td><td>B1
for four excess electrons on the right

B1
for sixteen total electrons throughout sphere</td></tr>
<tr><td>10(b)(ii)</td><td>1. With the negatively-charged rod placed near to the metal sphere, earth the sphere.</td><td>B1</td></tr>
</table>

Qn	Solutions	Mark Allocation
	2. Touch the sphere with the negatively-charged rod.	B1
EITHER 11(a)(i)	The distance between each **imaginary line on a wave that joins all adjacent points that are in phase** is 8.0 cm.	B1
EITHER 11(a)(ii)	The wavelength is **8.0 cm**, because the wavelength is the **shortest distance between any two points in phase**, represented by the distance between two wavefronts.	B1
EITHER 11(a)(iii)	$v = f\lambda$ $= (2\text{ Hz})(0.08\text{ m})$ $= 0.16\text{ m s}^{-1}$	A1
EITHER 11(a)(iv)	As depth increases, the waves at the surface of the water experience **less friction** with the lakebed.	B1
EITHER 11(a)(v)	 As the **wave speed increases** and **frequency remains unchanged**, the **wavelength of the waves increases**, resulting in longer distances between wavefronts from A to B.	B1 for same wavelength region B1 for increased wavelength region B1
EITHER 11(b)(i)	Wave 1: Visible light / Electromagnetic waves / Transverse Wave 2: Sound waves / Longitudinal	B1 for both correct
EITHER 11(b)(ii)	Since he hears the splash and hears the sound way before the waves on the lake reach him, he can only conclude that the **speeds of Wave 1 and Wave 2 are much faster than the speed of water waves**.	B1

Qn	Solutions	Mark Allocation
	However, among waves 1 and 2, one is an electromagnetic wave which travels at a speed of light, and the other is a **sound wave which travels much slower**. Therefore Steven is incorrect in that waves 1 and 2 have the same speed.	B1
OR 11(a)	Suspending a train above the rail **reduces friction** between the train and the rail. This results in **less energy loss as thermal energy** and improves efficiency.	B1 B1
OR 11(b)(i)	 	B1
OR 11(b)(ii)	Unstable equilibrium	B1
OR 11(c)(i)	Iron is a soft magnetic material which is **easily magnetised and demagnetised**, therefore suitable as its **magnetic strength can be easily adjusted**.	B1
OR 11(c)(ii)	 	B1 for vertical forces B1 for horizontal forces

Qn	Solutions	Mark Allocation
OR 11(d)(i)	The magnets on the sides of the train need to move in order to create a **change in magnetic flux linking the coils**, to obtain an induced emf and induced current in the coils.	B1
OR 11(d)(ii)	If the magnet passes through the centre of the coils, **both the upper and lower halves of the "8"-shaped coils will be induced North poles** as both experience the same change in magnetic flux linkage. The induced emf and the induced current in both halves will cancel each other out, and there will be **no current flowing through the coil** and no magnetic force.	B1 B1

Section A (50 marks)

Answer all the questions in the space provided.

1. A car describes a linear motion represented by the graph shown in Fig.1.1.

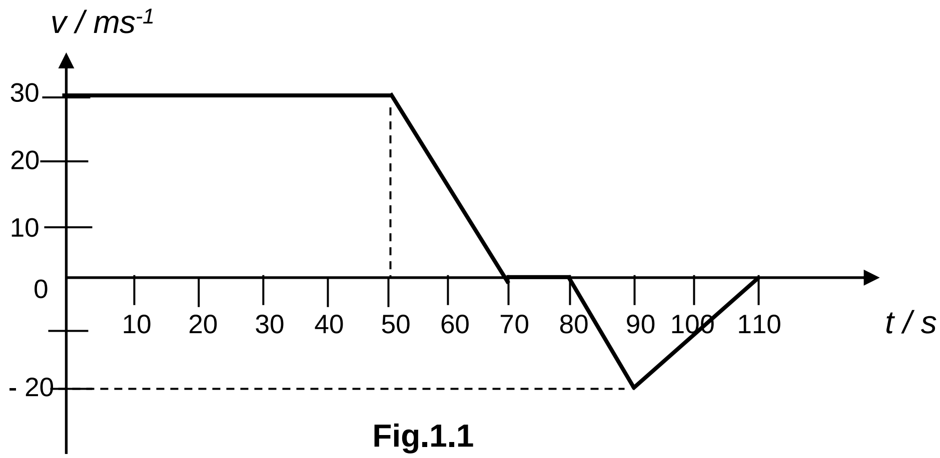


Fig.1.1

(a) **(i)** Describe the motion of the car from t = 0 to 110 s. [2]

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(ii) What is the value of the retardation of the car from t = 50 to 70 s? [1]

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……………………………………………………………………………………

(b) Find the total displacement travelled by the car for the whole journey. [2]

(c) Sketch the displacement-time graph for the car's motion.
Indicate all relevant values. [2]

2. A uniform rod **PQ** of length 80.0 cm and weight 2.0 N is placed on the pivot as shown in Fig. 2.1 below. A spring balance is attached to the other end of the rod. A load of 8.0 N is placed 20.0 cm from the spring balance.

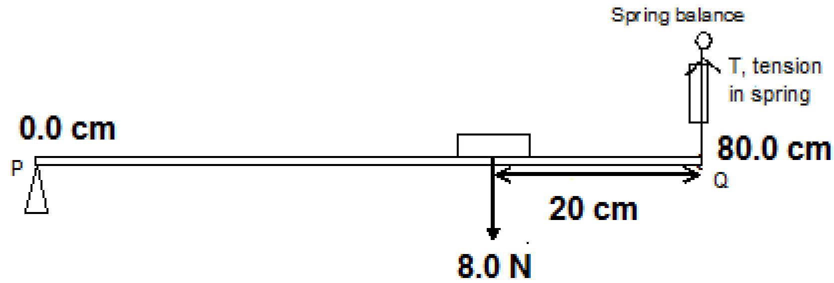


Fig. 2.1

(a) What is the reading on the spring balance in order for the rod to balance horizontally? [2]

(b) Determine the magnitude and direction of the reaction (force) on the pivot. [2]

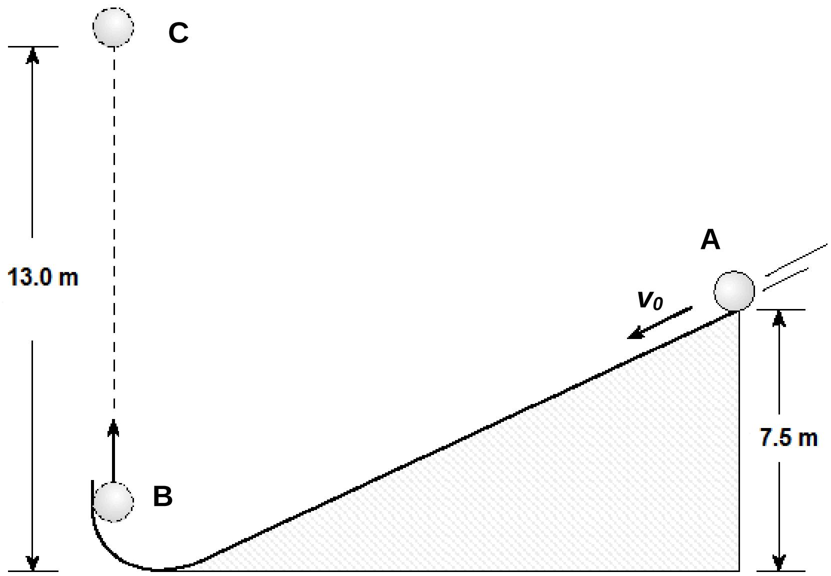
(c) If the 8.0 N weight is gradually moved along the rod towards **P**, the rod being kept horizontal, state and explain the change in the magnitude of **T**. [2]

....

....

....

3. A 0.50 kg ball starting from position **A** which is 7.5 m above the ground, slides down from an incline with an initial speed of v_o m/s as shown. Friction on the rough incline produces 10.7 J of heat energy. The ball leaves the incline at position **B** travelling vertically upward and reaches a height of 13.0 m above the floor (position **C**) before Falling vertically down.



(a) State the Principle of Conservation of Energy. [1]

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

(b) What is/are the energy/energies that the ball possesses at position **A**? [1]

……………………………………………………………………………………………

(c) Calculate the gravitational potential energy at position **C**. [1]

(d) Calculate the initial speed, $\boldsymbol{v_0}$, at position **A**. [2]

(e) State one assumption for your calculation in **(d)**. [1]

……………………………………………………………………………………………

4. Fig.4.1 shows the plan view of a fish tank containing one goldfish.
The diagram is drawn **full scale**.

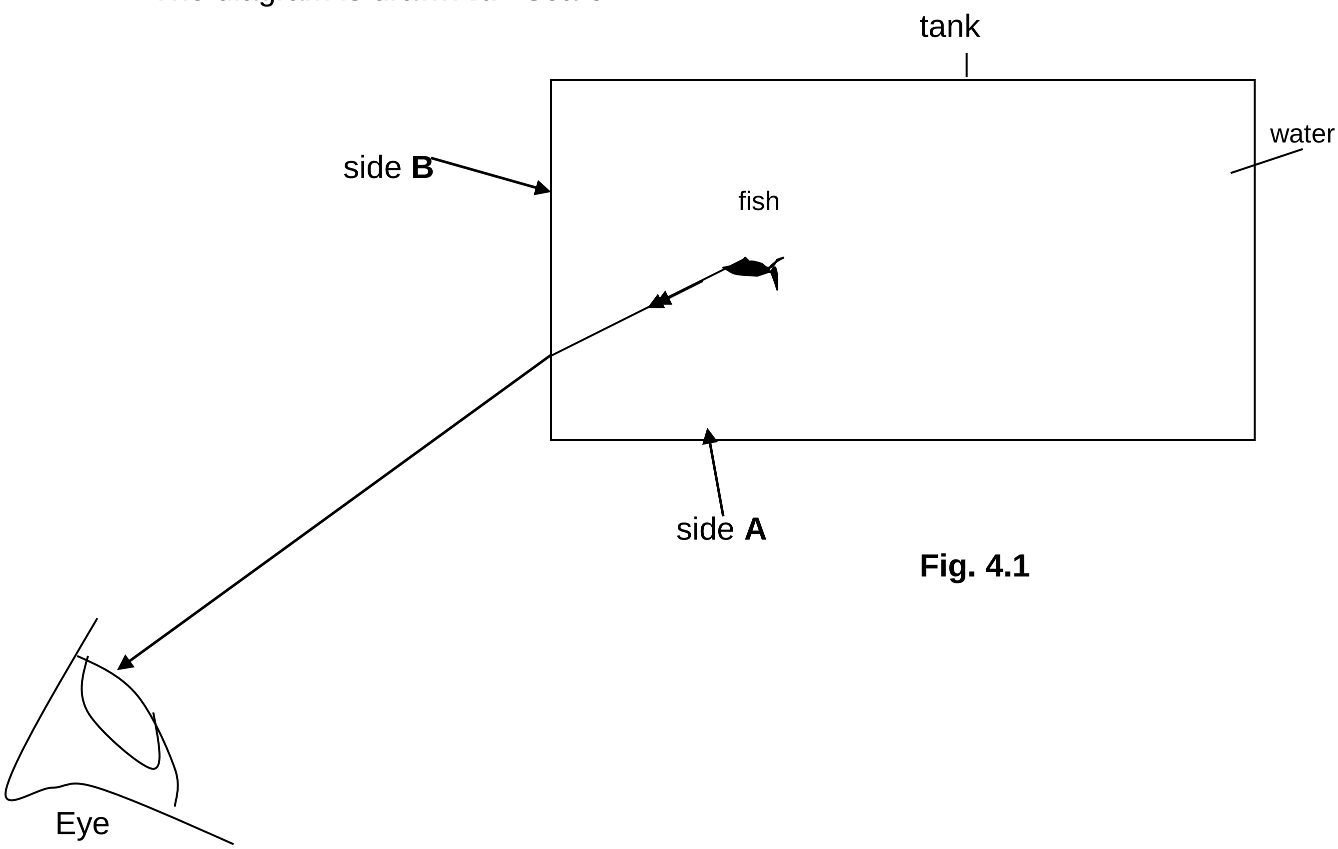


Fig. 4.1

A boy can see two images of the fish when he looks from the position shown.
Fig. 4.1 shows a ray of light, from the fish, that is refracted at side **B** of the tank.
The ray enters the eye as shown.

(a) **Measure** the angle of incidence and refraction and use the angles to determine the refractive index of the water in the tank. [2]

On Fig.4.1,

(b) **(i)** sketch a second **ray** (no need to draw to scale) from the fish to the eye that is refracted at side **A** of the tank,

(ii) show the positions of the **two images** of the fish. [3]

5. **(a)** Explain, by writing about molecules, how the air inside a car tyre exerts a pressure on the walls of the tyre. [2]

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

(b) A vessel closed by a piston contained a constant mass of gas. Keeping the temperature of the gas constant, weights are placed on top of the piston which reduces the volume of the gas.

Complete the table below, using the words **increases, decreases** or **no effect** to describe the changes that have occurred. [1]

Property of the gas	**Change that has occurred**
Number of molecules in every cm^3	
Frequency of collisions of the gas molecules with the piston	
Average kinetic energy of the gas molecules	
Pressure of the gas	

6. A light perspex ball is placed near a highly positively charged metal dome in a Van de Graaff generator. The ball swings away from the positively charged metal dome and remains stationary at position **X.** (Fig. 6.1)

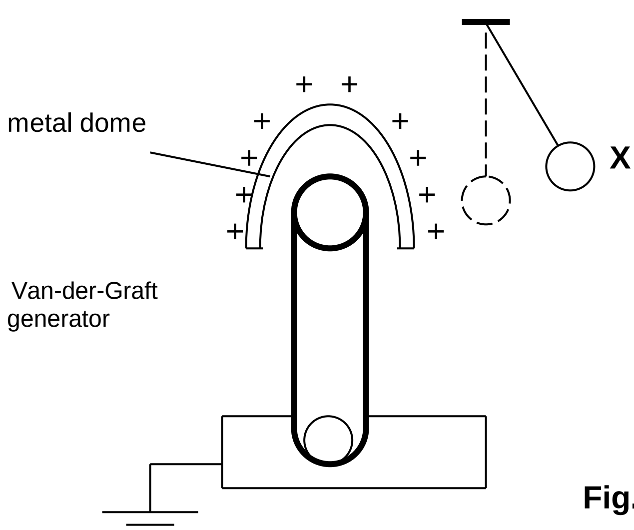


Fig. 6.1

(a) Explain why the perspex ball moves away from the metal dome. [2]

………………………………………………………………………………………

………………………………………………………………………………………

(b) The perspex ball has a mass of 5.0 g.

At the instant where the ball is stationary at **X**, there is a horizontal electric force, F_E = 0.15 N acting to the right, a tension **T** in the string and the weight **W**, (Fig. 6.2)

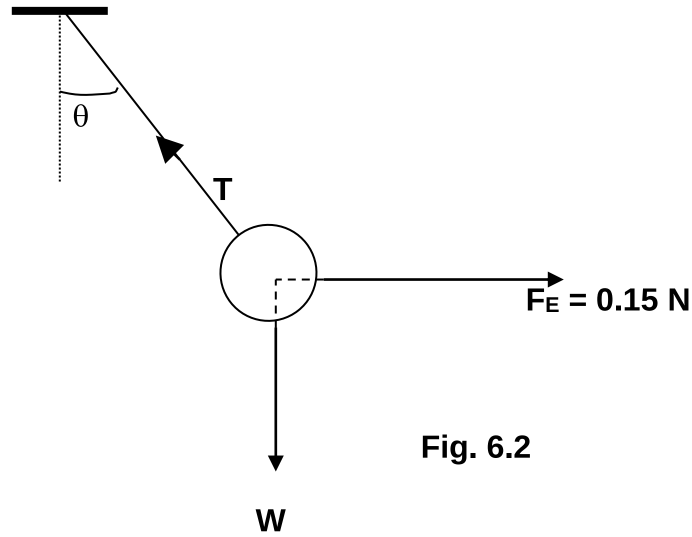


Fig. 6.2

By using a scale drawing, determine the tension **T** and the angle **θ** that the string makes with the vertical. (Take g = 0.01 N / g) [4]

7. **(a)** Fig. 7.1 shows an electric circuit powered by a 12.0 V battery of negligible internal resistance.

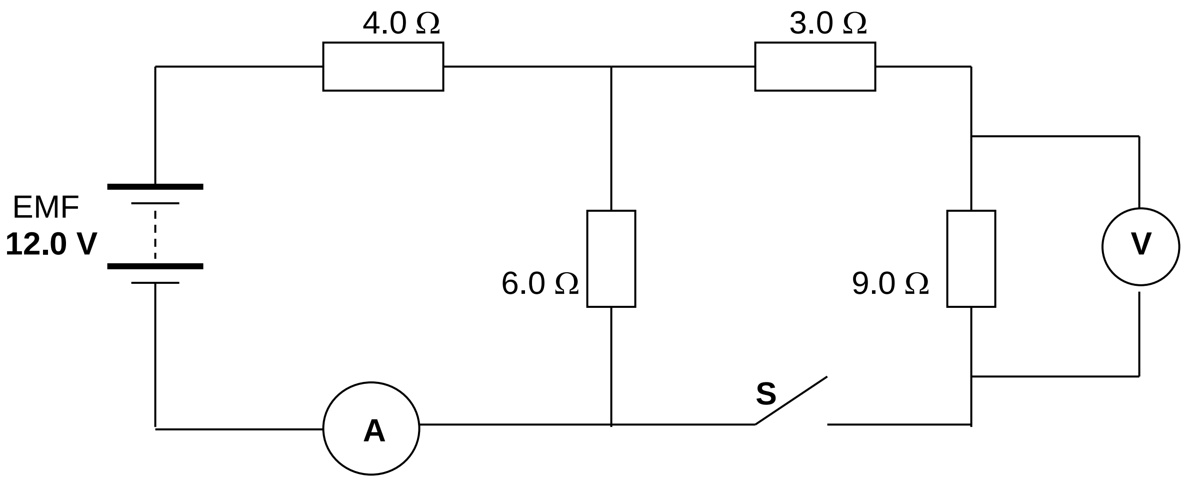


Fig. 7.1

Determine the ammeter and the voltmeter readings when

(i) the switch **S,** is open; [2]

(ii) the switch **S,** is closed. [2]

(b) The same power source is now connected to a potential divider consisting of an LDR and a resistor. (Fig. 7.2).

An LDR (light-emitting diode) is an *input transducer* whose resistance can change according to the amount of light falling on it.

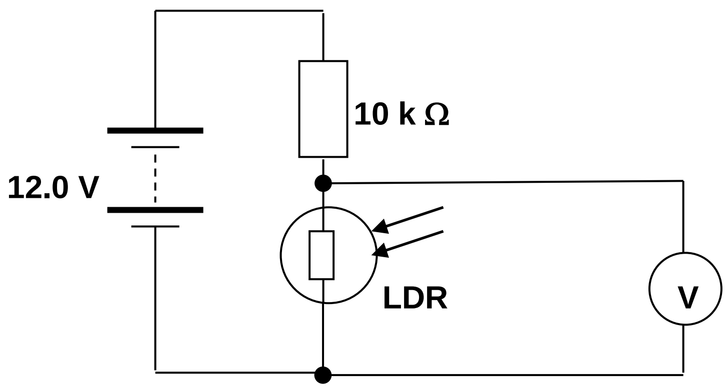


Fig. 7.2

(i) Explain the word '*input transducer'.* [1]

……………………………………………………………………………………

……………………………………………………………………………………

(ii) What is the resistance of the LDR when the voltmeter reads 2.0 V? [1]

8. A pupil makes a simple d.c motor as shown in Fig. 8.1 using some common materials and connected to a 6.0 V battery.

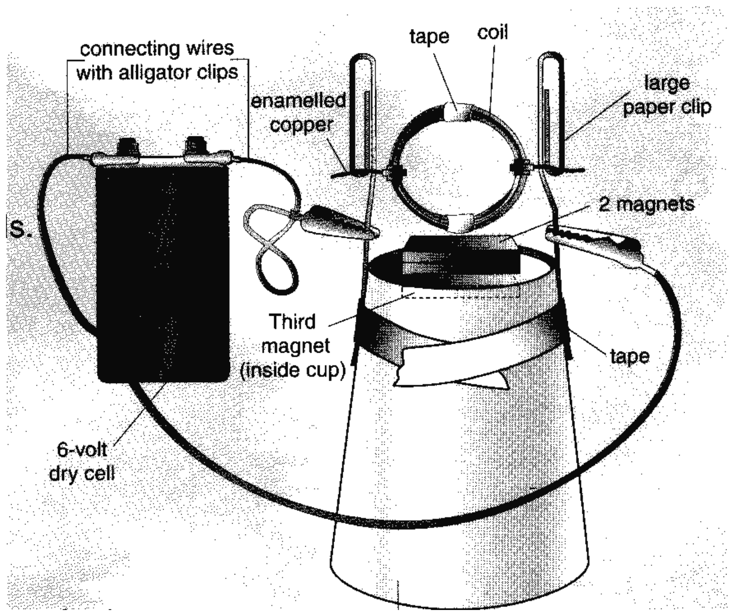


Fig. 8.1

The enamelled copper wire is an insulated wire with **part of its insulation** removed. The ends of the coil are placed on the large paper clip.

When the power source is turned on, the coil is given a *slight push* and the coil begins to *spin*.

(a)(i) Why is the coil given a *slight push*? [1]

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(ii) Explain why the coil starts to rotate continuously. [3]

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(b) If a stronger power source is used, state its effect on the rotation of the coil. [1]

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(c) What is the purpose of the third magnet inside the cup? [1]

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9. Fig. 9.1 shows the structure of a transformer which is used in the transmission of electrical power through the cables.

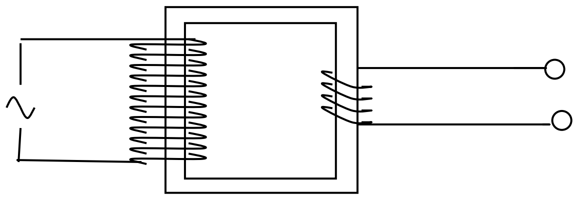

Fig. 9.1

Coil	Number of turns
J	50
K	100
L	1 000
M	1 500

Table 1

An engineer is assigned to build a step-down transformer for stepping down the voltage from 3.3 kV to 220 V in the substation of a housing estate. He has the choice of using four types of coils with different number of turns as shown in Table 1 above.

(a) Based on Table 1, select the most suitable pair of coils for making the primary coil and secondary coil of the transformer. Explain your choice. [2]

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(b) Assume that the transformer is 75 % efficient and the power output is 15 kW, determine the current flowing in the primary coil. [2]

(c) State and explain **one** feature that can improve the efficiency of this transformer. [1]

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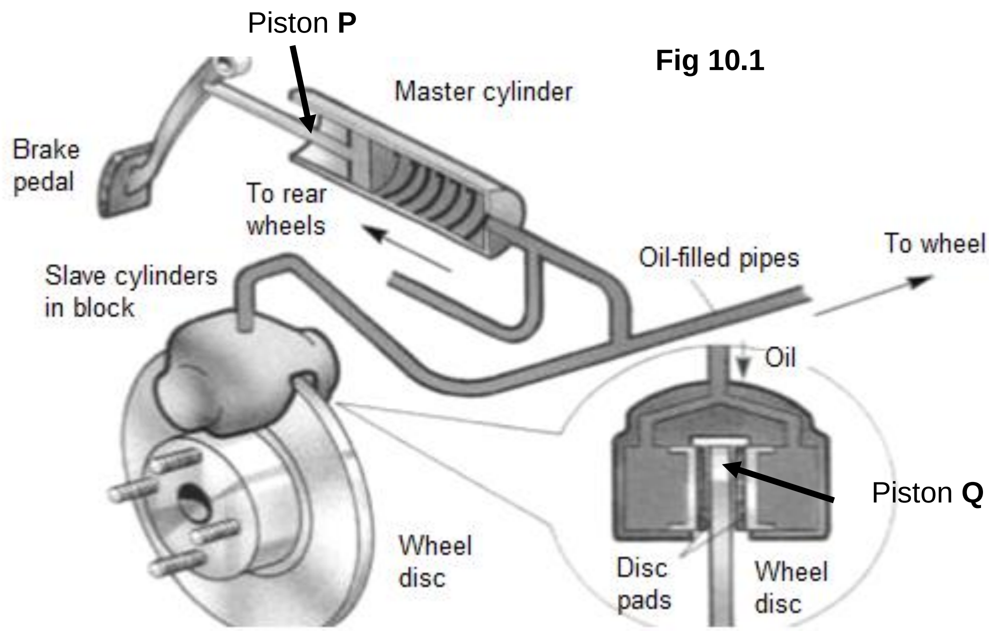
-**END OF SECTION A-**

Section B [30 marks]

Answer all the questions from this section. Question 12 has a choice of section to answer.

10. **Fig. 10.1** shows the hydraulic braking system for a car from the brake pedal to the braking discs of the wheel.

Fig 10.1



A force is applied downwards on the brake pedal in order to slow down the wheels of the car.

(a) Using **Fig. 10.1**, explain clearly how a force applied on the brake pedal can slow down a moving car. [2]

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(b) The surface area of piston **P** in contact with the brake fluid at the master cylinder is 5.0×10^{-4} m^2 and the area of piston **Q** of the slave cylinder is 7.5×10^{-3} m^2.

(i) Explain why the area of piston **P** has to be smaller than piston **Q**. [1]

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(ii) Find the force exerted on Piston **Q** when a force of 120 N is exerted on the brake pedal. [2]

(iii) If piston **P** moves down by 6 cm when the brake pedal is depressed, calculate the distance moved by piston **Q**. [1]

(c) In order to ensure that the braking system functions properly, air cannot be trapped in the brake fluid. Explain clearly how trapped air in the braking fluid can affect the performance of the hydraulic braking system. [1]

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(d) When the road is wet, a sudden hard braking when the car is moving at a high speed can cause the wheels to stop rotating instantly and the car will skid (slide uncontrollably).

(i) Explain why a fast moving car skids on the wet road when the brake is suddenly pressed very hard and the wheels stop rotating. [2]

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(ii) To reduce the possibility of a car skidding on a wet surface, the wheels of the car have specially designed threads as shown in **Fig.10.2**. Suggest how these threads are able to reduce the chances of the car skidding on a wet surface. [1]

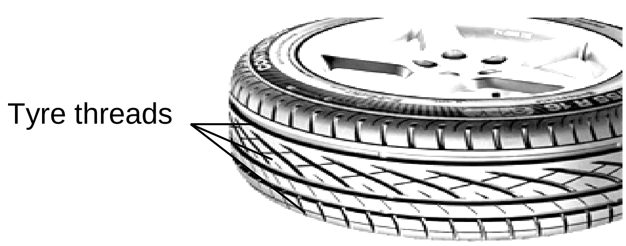

Fig. 10.2

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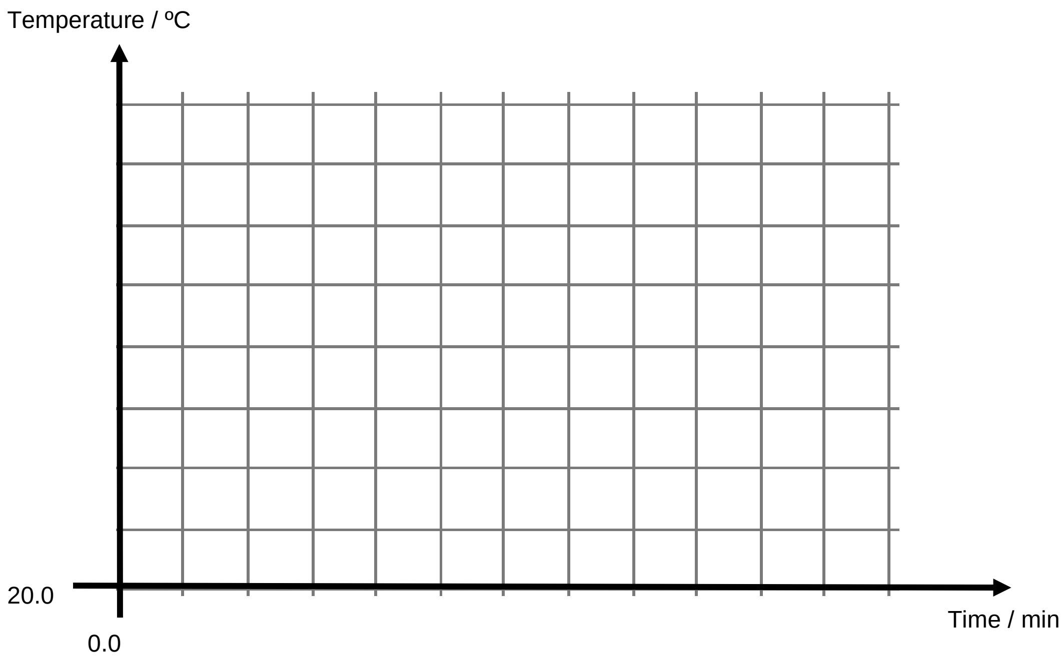
11. (a) 2 kg of pure substance **X** was heated uniformly from its solid state until it reaches the gaseous state. The temperature of **X** was taken in intervals of 5.0 minutes and are tabulated as shown in **Fig.11.1**. Assume that the heat supplied was constant and no heat was lost during the heating process.

Melting point of pure **X** = 40.0 ºC
Boiling point of pure **X** = 70.0 ºC
Time when **X** began melting = 2.5 minutes
Time taken for all of solid **X** to melt = 5.0 minutes
Time when **X** began boiling = 10.0 minutes
Specific latent heat of vaporization of **X** = 30.0 kJ/kg
Power = 100 W

Time / min	**Temperature / ºC**
0.0	25.0
5.0	40.0
10.0	70.0
15.0	70.0
20.0	70.0
25.0	85.0

Fig. 11.1

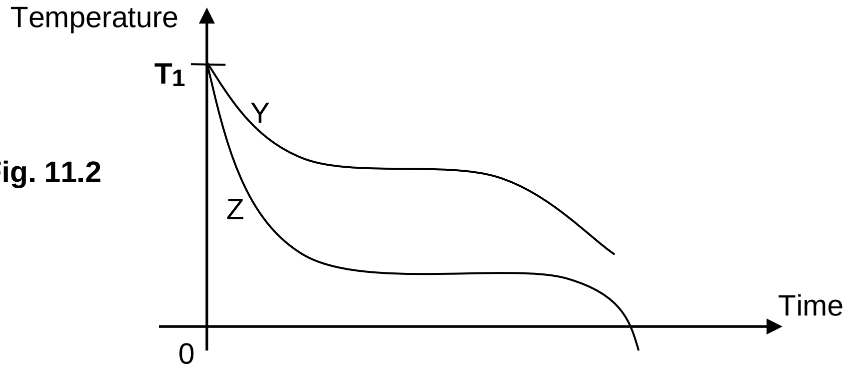


(i) By analyzing the data obtained and using the given information, plot the heating curve of pure substance **X** in the grid lines provided. [3]

(ii) Calculate the specific heat capacity of the solid **X**. [2]

(b) **Fig. 11.2** below shows the cooling curve graphs of two pure liquids, **Y** and **Z,** of the same mass.

Fig. 11.2



(i) Which substance (**Y** or **Z**) has a lower melting point? [1]

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(ii) Which substance (**Y** or **Z**) has a greater specific heat capacity in the liquid state? Explain your answer clearly. [2]

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(iii) Which substance (**Y** or **Z**) has a greater specific latent heat of fusion? Explain your answer clearly. [2]

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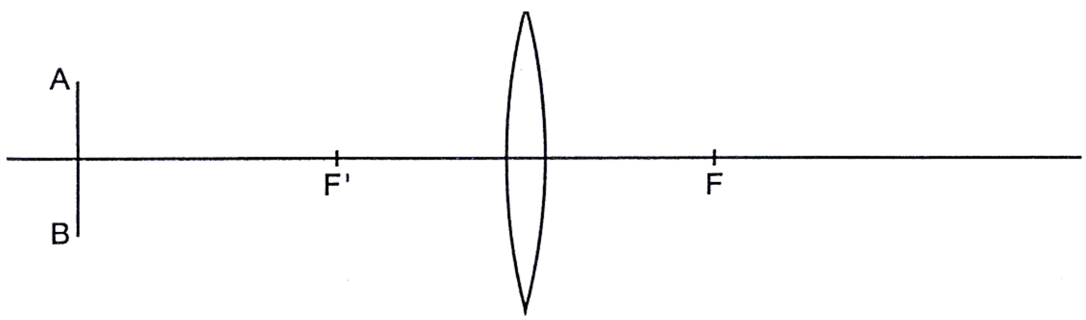
EITHER

12A.(a) **Fig. 12.1** shows an object **AB** near a thin converging lens. The principal foci of the lens are at **F** and **F'**

Fig. 12.1



(i) By means of an accurate drawing, draw rays to find the positions of the images of the points **A** and **B**. [2]

(ii) If object **AB** is brought closer and closer to the converging lens until a distance less than one focal length, describe clearly the changes to the image of **AB**. [2]

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(b) **Fig. 12.2** shows a scaled drawing of an object **PQ** and its image **P'Q'** after passing through a thin converging lens. By locating the position of the converging lens and drawing rays on the diagram, find the focal length of the converging lens. [2]

Fig. 12.2

Focal length = ………………………..

(c) Light rays passing into an eyeball undergo two refractions; once as they pass through the cornea and another as they pass through the lens of the eye. **Fig.12.3** shows how light rays pass through the eyeball and the image of an object is formed at the back of the eye (retina) for an individual with perfect eyesight. For a short-sighted person, the image of a distant object is formed in front of the retina.

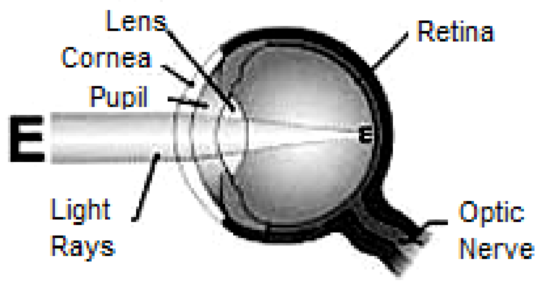

Fig. 12.3

(i) One way to correct short-sightedness is to use a pair of spectacles. Which type of spectacle lens (converging or diverging) would be suitable to correct short-sightedness? Explain your answer clearly. [2]

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(ii) Another method to correct short-sightedness is by performing a 'lasik surgery' which removes a small portion of tissue in the cornea to make the cornea less rounded. Suggest how the less-rounded cornea in front of the eye's lens can help to correct short-sightedness. [2]

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OR

12B. (a) **Fig. 12.4** shows a solenoid with an alternating current (a.c) supply coiled around a soft iron core. An aluminium ring is placed through the soft iron and rests on the solenoid. When the a.c supply is turned on, the ring 'floats' above the solenoid as shown in **Fig. 12.5**.

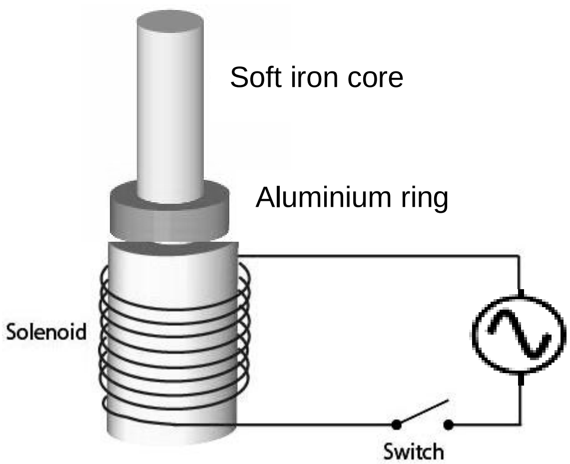

Fig. 12.4

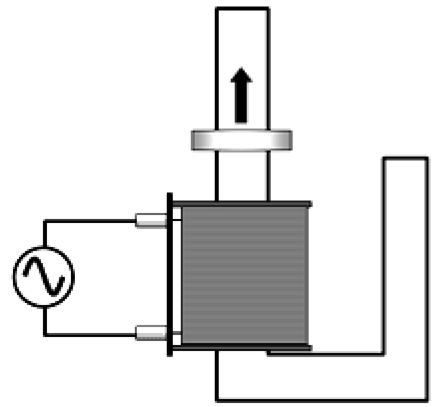

Fig. 12.5

(i) Explain clearly why the aluminium ring 'floats' when the a.c supply is turned on. [3]

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(ii) If the a.c supply is now replaced by a d.c supply, what will be observed after the supply is turned on? [1]

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(iii) The solenoid has an a.c supply but the aluminium ring is replaced with a 'C'-shaped ring instead as shown in **Fig. 12.6.** When the supply is turned on, the C-shaped ring does not 'float' upwards but continued to remain at rest on the solenoid instead. Explain the reason why this happens. [2]

Fig. 12.6

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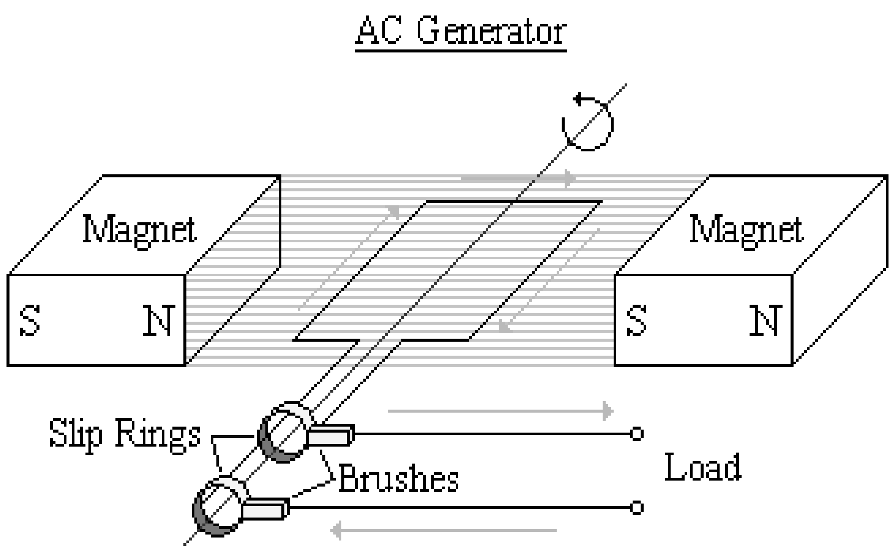
(b) **Fig.12.7** shows a simple a.c generator which has a frequency of 60 Hz and peak voltage 12 V.

Fig. 12.7



(i) Sketch the graph of the voltage produced against time for two complete cycles below. Take the position of the coil to be that in **Fig. 12.7** when time = 0 s. [1]

(ii) If the speed of rotation is **<u>reduced by</u>** ¼ times the original speed, sketch the new graph of the voltage produced on the same axis above. Label this new graph with **(ii)**. [2]

(iii) Explain clearly the differences between the graph for **b(i)** and **b(ii)**. [1]

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--**End of Section B**—

CCHY 2018 Pure Physics Prelim Exam Mark Scheme

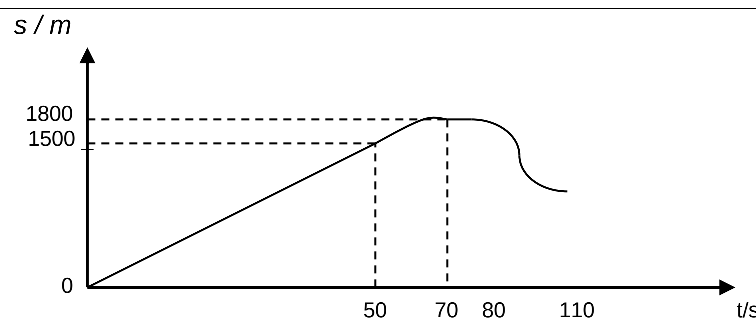
Paper 1

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

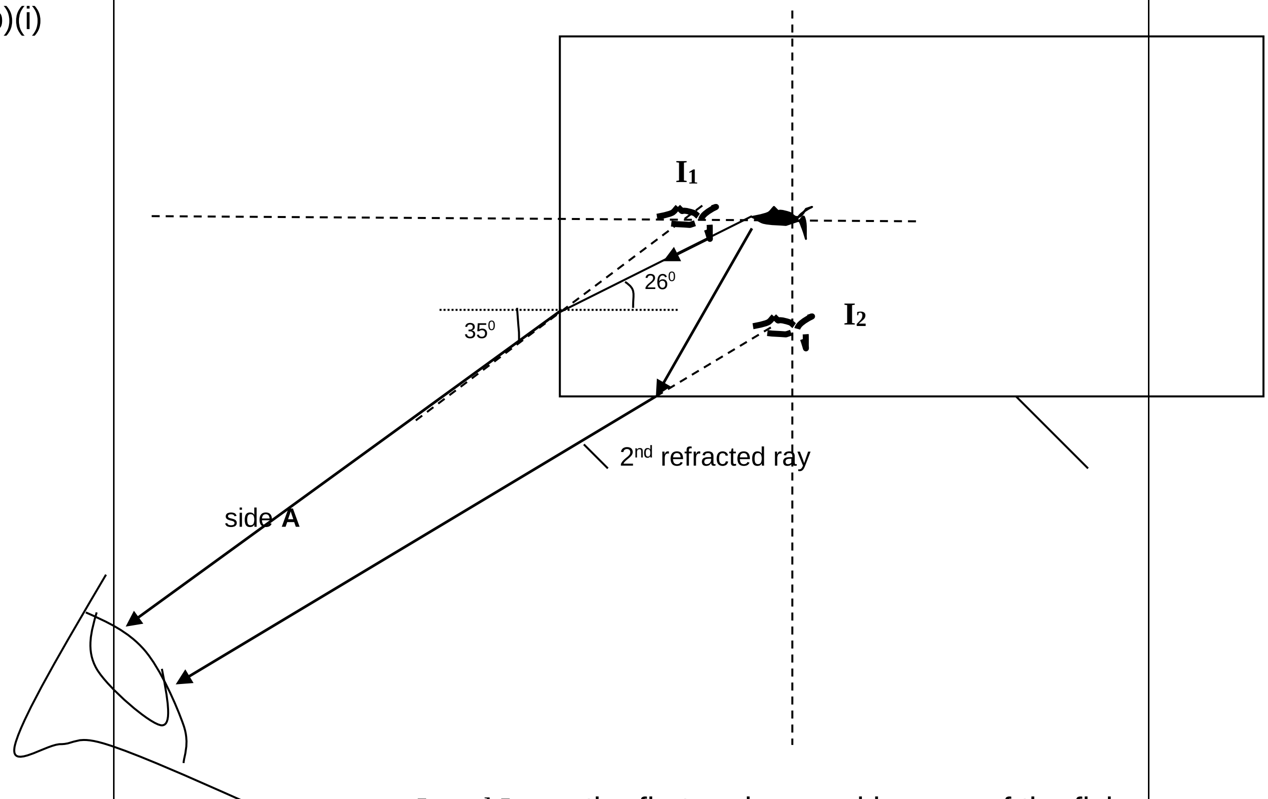
Paper 2

Note: ***1*** *mark will be deducted for not expressing numerical value to 2/3 sig. fig on 1 occasion. 2 marks to be deducted for more than 1 occasion.*
50% mark for each part of qn will be deducted for missing or wrong "unit".

Section A

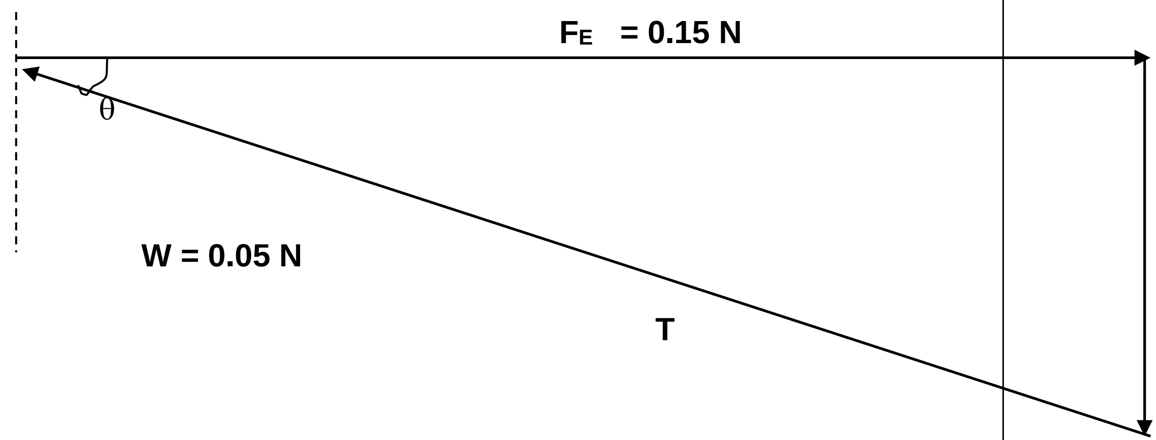
Qn no.	Suggested Solution	Marks
1(a)(i)	The car travelled at constant speed at 30 m/s from t = 0 to 50 s, then decelerates uniformly to stop from t = 50 s to 70 s, and remain stationary / at rest for a further 10 s, It reverses / change direction and accelerates uniformly	1 1
(ii)	Either, by graphical method Retardation (r) = gradient = 30/ (70-50) = 1.5 ms^{-2} Or, using formula $a = (v - u) / t = (0 - 30) / 20 = -1.5\ ms^{-2}$ or, $r = 1.5\ ms^{-2}$ (No mark awarded if working is not shown)	1
(b)	Total displacement = distance moved during the first 70 s - distance moved during t=80 - 110s = ½ (50 + 70) x 30 - { ½ x 30 x 20} = 1500 m	1 1
(c)	 ➢ Show a **constant slope** for first 50 s up to 1500 m; ➢ a **reducing gradient** for the next 20 s to 1800 m, ➢ a **horizontal line graph** between t = 70 – 80 s at 1800 m ➢ an (increasing and decreasing) **curve** for showing the last 30 s *1 mark will be deducted for not stating / labeling the axes.*	1 1

2(a)	*Let the spring balance reading (or tension) be T* *To balance about (pivot) P,* Net moment about P = 0 Total anticlockwise moment = Total clockwise moment T x 80 = (2 x 40) + (8 x 60) T = **7.0 N**	 1 1
(b)	**Either,** Let the reaction force at the pivot be R. Since net force = 0 (not moving / at balance) Hence, Total upward force = Total downward force T + R = 2 + 8 7 + R = 10 R = **3.0 N** Direction of R is (vertically) **upward** **OR , using POM and take moment about the spring position**	 1 1
(c)	Magnitude (size) of the spring balance reading **decreases** The total clockwise moment has <u>decreased</u> as the clockwise moment by the 8 N weight about P has decreased with the reduction in the (perpendicular) distance. To maintain equilibrium, <u>the anticlockwise moment by spring must also decrease proportionately.</u> As moment = force x perpendicular distance (and the distance is constant), the spring force must decrease to <u>compensate the reduction in the moment.</u>	1 1
3(a)	Total energy is always conserved (remain unchanged) Energy cannot be created or destroyed; They can only be converted from one form to other form(s)	1
(b)	kinetic and gravitational potential energy	1
(c)	Ep = mgh = 0.5 x 10 x 13 = **65 J**	 1
(d)	Assume no energy is loss and total energy is conserved, EP (at C) + $W_{friction}$ = total energy at A (PE + KE) 65 + 10.7 = ½ (0.5) (v_0^2) + (0.5 x 10 x 7.5) v_0 = **12.4 m/s** **OR** **E_K** (at A) = Work done against friction + Ep gain ½ (0.5)v_0^2 = 10.7 + (0.5 x 10 x {13 – 7.5}) v_0 = **12.4 m/s**	 1 1
(e)	There is <u>negligible loss of energy</u> due to <u>sound/heat energy</u> (on base)	1
4(a)	Using the Principle of Reversibility of Light **By measurement**	

	$\angle i$ (in air) = 35^0 $\angle r$ (in water) = 26^0 ($\pm 1^0$) n_{water} = sin i / sin r = sin 35 / sin 26 = **1.31** (or between 1.28 to 1.39)	1 1
(b)(i)	 I_1 and I_2 are the first and second images of the fish Show correct 2^{nd} refracted ray from side A to eye	1
(ii)	show correct positions of the 2 images, I_1 and I_2	2
5(a)	air molecules moving randomly and <u>bombarding / colliding with the (tyre) walls and rebounding off.</u> exert a <u>force on the unit area</u> of wall's surface. This produces a pressure (as pressure is force per unit area)	1 1
(b)	**Increase , increases, no effect , increases** All 4 are correct	1
6(a)	perspex ball has been charged with induced positive charges on its surface atoms near to the Van de Graaff generator As **like charges repel**, the (+) charged ball will be repelled off by the (+) charged metal dome.	1 1

<table>
<tr>
<td>(b)</td>
<td>5 g has a weight (W) of 5 x 0.01 = 0.05 N

Scale : 1 cm to 0.01 N (or less)



F_E and W are correctly shown (both magnitude and direction)

Correct triangle shown (or parallelogram showing the resultant of F and W)

Correct T and θ values (T = 0.16 N , $\theta = 72^0$)

(Deduct 1 mark each for not expressing T to 2 or 3 sf / not labeling the forces on the scale drawing/ not indicating the direction of the force(s)</td>
<td>1

1

1

1</td>
</tr>
<tr>
<td>7(a)(i)</td>
<td>S open, voltmeter reading is <u>0</u> as there is no current.
Combined resistance = 4 + 6 = 10 Ω
I = V / R = 12 / 10 = 1.2 A
Ammeter reads 1.2 A</td>
<td>1

1</td>
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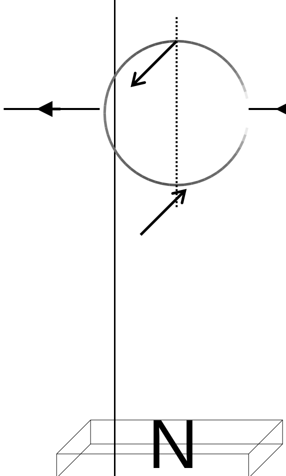
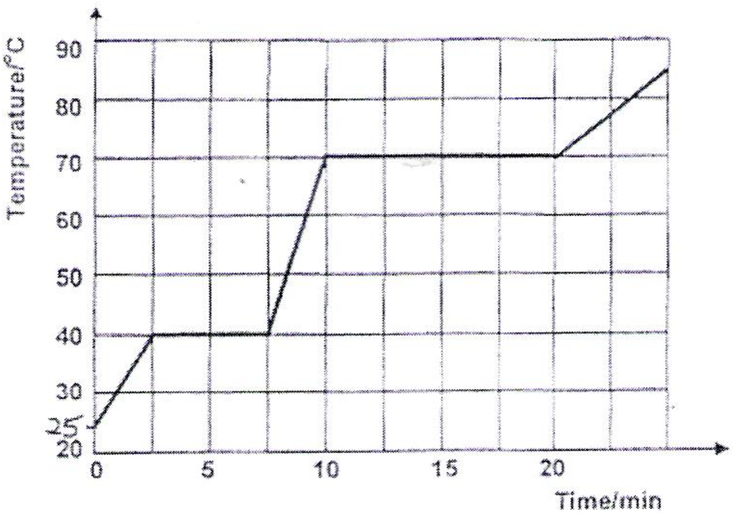
<tr>
<td>(ii)</td>
<td>S closed, combined resistance = 4 + {(6 x 12) / (6 + 12)} = 8 Ω
I = V / R = 12 / 8 = 1.5 A
Ammeter now reads 1.5 A

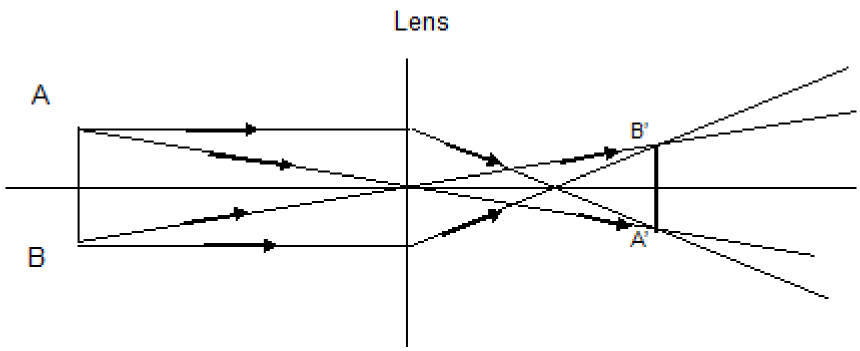
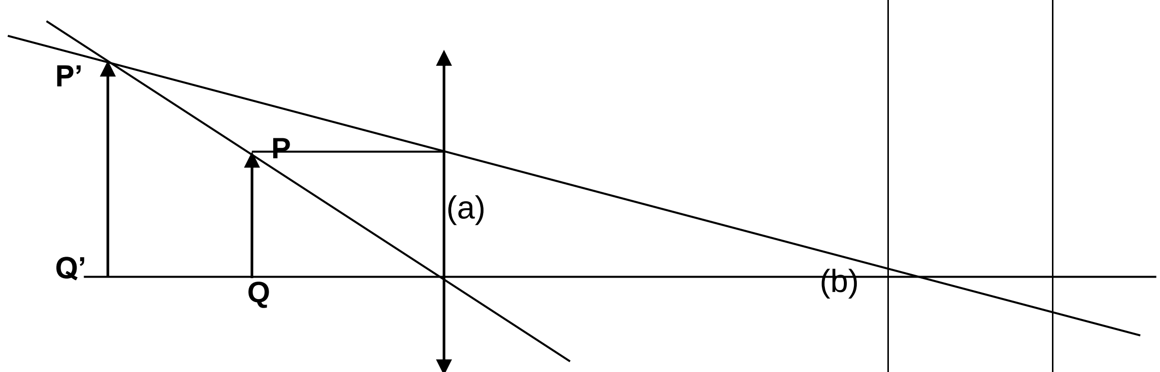
p.d across 4 Ω = IR = 1.5 x 4 = 6.0 V
hence, p.d across parallel network = 12 – 6 = 6 V
Current through 9 Ω = V / R = 6 / 12 = ½ A
P.d across 9 Ω = IR = ½ x 9 = 4.5 V
Voltmeter now reads 4.5 V</td>
<td>1

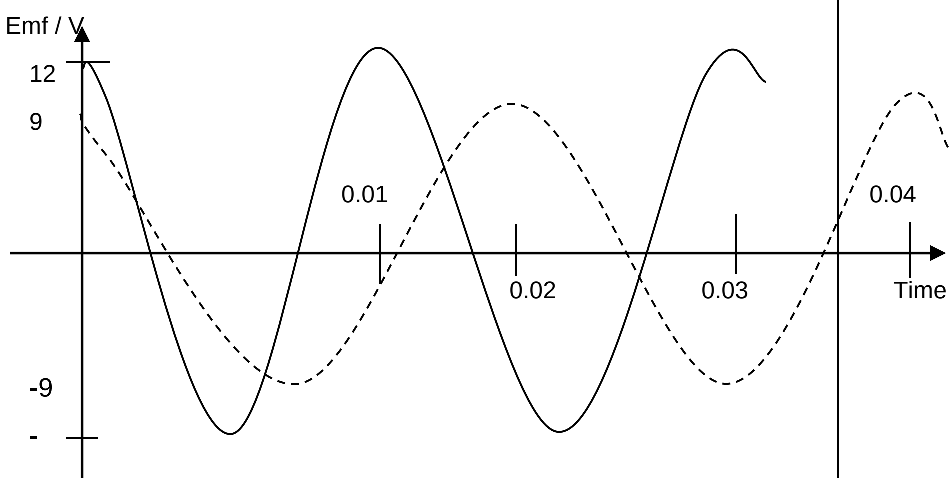
1</td>
</tr>
<tr>
<td>(b)(i)</td>
<td>A device that converts <u>other form of energy(s) to electrical energy</u>.</td>
<td>1</td>
</tr>
<tr>
<td>(ii)</td>
<td>Using potential divider,
As p.d α R at constant I
hence R_{LDR} / 10 kΩ = 2 V / 10 V
R_{LDR} = 2.0 kΩ</td>
<td>1</td>
</tr>
</table>

	Alternatively let $x = R_{LDR}$ $x / (x + 10) = 2 / 12$ $6x = x + 10$ $5x = 10$ $x =$ **2.0 kΩ**	
8(a)(i)	To overcome inertia of the coil so that it can start to turn / enable the conducting (enameled) part of the wire to be in contact with paper clip to allow current to pass into the coil.	1
(ii)	When electric current flows into the coil via the paper clip say from right to left, (assume the coil is vertical, as shown in the diagram) *Explanation of the force set up* it sets up a magnetic field at the bottom coil which interact with the magnetic field of the permanent magnets below (with a north pole up) The net resultant field produces a force pushing the bottom coil (using Fleming's LHR) near the bottom tape which turns the coil. This causes the conducting enameled copper wire to rotate. (Alternatively, when the coil is slightly displaced to one side, the current produces a magnetic pole in the coil which will cause the coil to turn as it is repel by the magnet pole. If it is attracted, the coil will not turn and you have to displace coil on the other side)  *Explanation for continuous rotation* No current flows into the coil when the insulated part of enameled wire is in contact with the paper clip, and hence no more magnetic force. But, inertia will continue to rotate the coil until the conducting enameled copper wire connects up the circuit again. This again set up a force pushing the coil in again, repeating the cycle and causing the coil to continue to turn.	1 1 1
(b)	The rotation speed will increase. *Mention ' increased rotation' – zero mark*	1
(c)	To secure the 2 magnets strongly in the same position on top of the base of holder by attracting them /prevent magnet attracting the coil above it.	1

9(a)	Coils **M**.: Primary coils and coil **K : secondary coil** Comparing the voltages of primary coil to secondary coil: Step down ratio = 3 300 : 220 = 15 : 1 Hence the coils must be step down to the same ratio of 15 : 1 Comparing the turn ratio i.e Coil M : Coil K = 1 500 : 100 = 15 : 1 (*If working is not clearly shown, award maximum 1 mark)*	 1 1
(b)	Input power = 100 / 75 x 15 kW = 20 kW Using I = P / V = 20 000 / 3 300 = **6.1 A**	1 1
(c)	Any one of the following….. <u>Laminating the iron core</u> will reduce the <u>power loss due to heat produced by induced current (known as eddy current) in the core</u> itself. Using <u>low resistance</u> (primary and secondary) <u>coils</u> will <u>minimize the amount of heat</u> produced in the coils. To increase the magnetic flux linkage between the primary and secondary coils by using a soft magnetic material (iron core) to link them up…	1
	Section B	
10(a)	A force exerted on the brake pedal **<u>acts on the surface area of Piston P in contact with the oil</u>** in the master cylinder **<u>to create a pressure</u>** This **<u>pressure in the oil is transmitted to all parts of the oil</u>** Since **<u>oil is incompressible, t</u>**his **<u>creates a force pressing on the disc pads</u>** of the wheels. **<u>Friction between the disc pads and the wheels</u>** slows the car down.	1 1
(b)(i)	Since the **<u>pressure acting in the liquid is the same throughout</u>**, A **<u>small area at Piston P would require a smaller force</u>** exerted **<u>to produce a larger force at Piston Q</u>**.	1
(ii)	Force exerted on piston Q = $(F_P \times A_Q)/A_P$ $= (120 \times 7.5 \times 10^{-3})/ 5.0 \times 10^{-4}$ = **1800 N** (Pressure on piston P = $120 / 5.0 \times 10^{-4}$ = 240 000 Pa if got the above wrong) [1]	1 1
(iii)	Assuming no energy loss, $F_P \times d_P = F_Q \times d_Q$ $d_Q = (120 \times 6)/ 1800$ = **0.4 cm**	1
(c)	Since **<u>air is compressible</u>** **<u>Pressure exerted at the master cylinder will not be fully transmitted</u>** to the disc brakes Resulting in a **<u>greater force required at brake pedal to obtain the same force on the disc brake</u>** for the ideal system **<u>Force on Piston Q is smaller</u>**	1
(d)(i)	The fast moving car has **<u>high inertia</u>** On a **<u>wet road, there is less friction between the wheels and the road</u>**	 1

	When wheels suddenly stops turning, the **<u>forward force is greater than the resistive force</u>**	1
(ii)	The threads **<u>allows water to pass through</u>** the surface of the tyre This **<u>increases the friction between the car and the road surface</u>** to prevent skidding.	1
11(a)(i)	 each correct part/shape of the graph with correctly labeled values for axes (total 5 parts) 0 to 2.5 min 2.5 min to 7.5 min 7.5 min to 10 min 10 min to 20 min 20 min to 25 min	2 correct - 1 mark 4 correct - 2 marks All 5 correct - 3 marks
(ii)	Heat energy supplied = power x time = 100 x 2.5 x 60 = **15 kJ** Temperature change = 40 – 25 = **15 ºC** Heat capacity of solid Z = Heat energy supplied / (mass x temperature change) = 15 000 / (2 x 15) = **500 J/kgºC**	1 1
(b)(i)	Substance Z	1
(ii)	Substance **<u>Y</u>** When subjected to the **<u>same cooling condition</u>**, the **<u>fall in temperature for substance Y is slower than substance Z</u>** This indicates that a **<u>higher amount of energy needs to be lost</u>** by substance Y compared to Z for the **<u>same amount of fall in temperature</u>**.	1 1
(iii)	Substance **<u>Z</u>** For the **<u>same mass</u>**, **<u>same period of time</u>**, Substance Z takes a **<u>longer time to change state</u>** Indicating that **<u>higher amount of latent heat needs to be lost</u>** by Z compared to Y to change from liquid to solid state	1 1

Either		
12A(a)(i)	 Correct **pair of rays** from A, one refracted through the lens and passing F, the other straight through optical centre Correct **pair of rays** from B, one refracted through the lens and passing F, the other straight through optical centre Correct **smaller straight image** drawn **Arrowheads drawn** for every light ray and **image labelled** with A' and B' (no arrowheads or incomplete arrow heads – minus 1 mark) (image is not straight – minus 1 mark)	1 1
(ii)	As the object is brought nearer to the lens <u>towards one focal length distance</u>, image becomes **magnified** but **remain inverted and real** When the object is <u>less that one focal length distance</u> from the lens, the image becomes magnified, **Upright** and **virtual**.	1 1
(b)	 Correct line passing through top of object and image to locate position of lens, (a) Correct line from object to lens, combined with line (b) Focal length between 5.9 to 6.2 cm	1 1
(c)(i)	**Diverging** lens. Diverging lens will **spread the incoming rays** before it reaches the lens The more diverged rays entering the lens will be **focused at a further distance in the eye** onto the retina	1 1
(ii)	When rays enter the less rounded cornea, it **undergoes lesser refraction/less converging** This causes the lesser refracted rays to be **focused at a further distance in**	1

	the eye after passing through the lens.	1
12B(a)(i)	When the supply is turned on, a **changing magnetic field** is produced around the solenoid The changing magnetic flux/magnetic field lines cutting the aluminium **ring induces an emf on the ring** By **Lenz's law**, the induced emf on the ring is such that the **magnetic field induced around the aluminum ring opposes the magnetic field of the solenoid** that produced it **Like poles** will exist between the aluminium ring and the solenoid And repel the ring upwards since **like poles repel**	1 1 1
(ii)	The ring will **move upwards momentarily** and subsequently **falls back down and rest** on top of the solenoid.	1
(iii)	The C-shaped ring **does not allow current to pass around the aluminium continuously**. This **does not allow any induced current, magnetic force/field to be produced** around the c-shaped ring. Hence the ring will remain at rest on the top part of the solenoid.	1 1
(b)(i)	 Correct sine curve starting from max Correct max. emf, min emf and period	1
(ii)	Correct sine curve (dotted) starting from max Correct max. emf = 9 V min emf = -9 V period = 0.022 s	1 1
(iii)	A rotation 1/4 times slower would result in a) **Output e.m.f = 9.0 V** which is 1/4 times lesser than initial b) **Period becomes 0.022 s** since frequency becomes 45 Hz c) A **slower rotation causes lesser e.m.f to be induced** in the generator **and it the period for each oscillation is longer.**	1

O

CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2018

CANDIDATE NAME	

CLASS

INDEX NUMBER

PHYSICS

6091/02

Paper 2 Theory

11 September 2018

1 hour 45 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black ink.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 11 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of physics than for correct answers.

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

Section A

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

1 The resistive forces that act backwards on a car are air resistance and friction, as illustrated in Fig. 1.1.

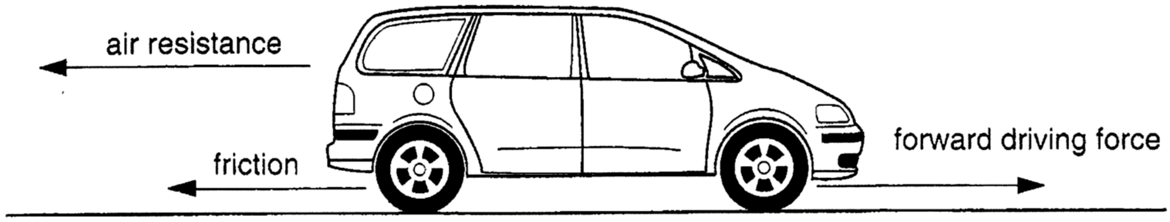


Fig. 1.1

Fig. 1.2 shows a graph of the total resistive force that acts on the car plotted against time t.

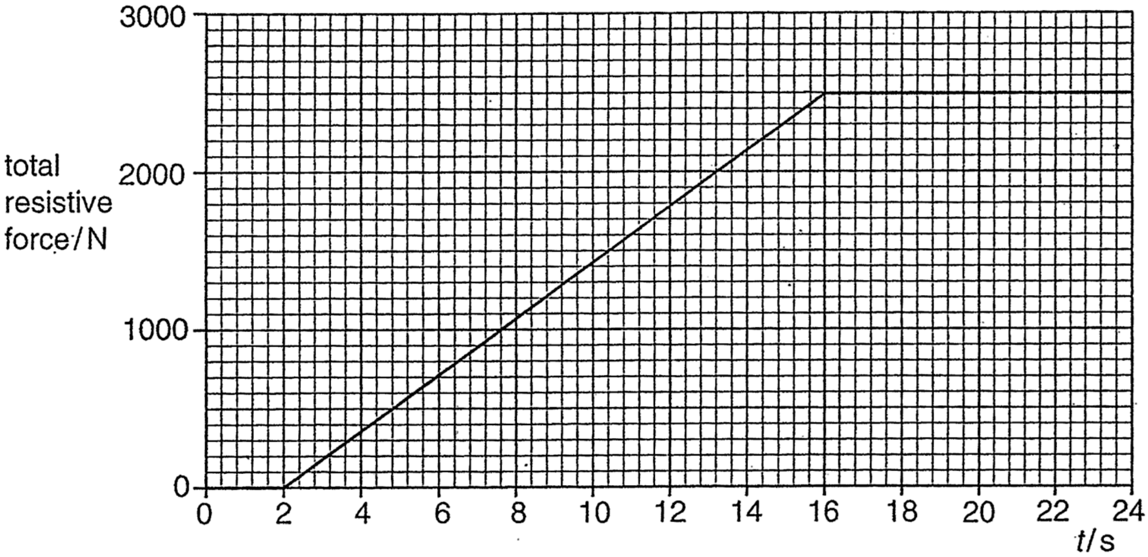


Fig. 1.2

The car is at rest at t = 0 s. The forward driving force acting on the car is zero until t = 2 s. From t = 2 s until t = 24 s, the driving force has a constant value of 2500 N.

(a) **(i)** State the two time intervals where the forces acting on the car are balanced.

....

....[2]

(ii) Describe the motion of the car during these intervals as stated in part **(a)(i)**.

....

....[2]

(b) The car has a mass of 900 kg. Calculate

(i) the acceleration of the car at t = 2 s,

acceleration = ……………………..[2]

(ii) the value of t when the acceleration of the car is 2.0 m/s^2.

t = ………………[3]

[Turn over

2 A rope suspends a steel ball of mass 20.0 kg. A horizontal force of 100.0 N is then applied to maintain the ball in the position shown in the Fig. 2.1.
Draw a diagram using an appropriate scale and indicate clearly the direction of the tension in the rope. Hence, determine the magnitude of the tension in the rope, and the value of the angle **X**.

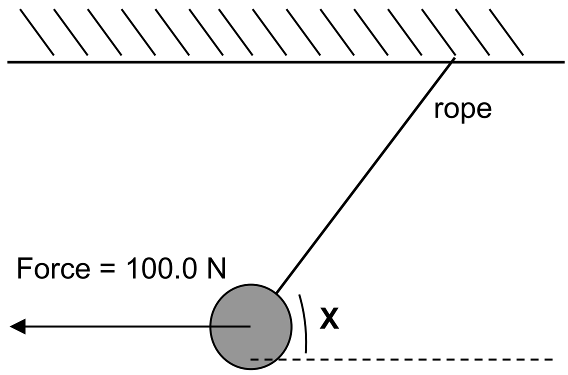


Fig. 2.1

scale = ……………………….……..

magnitude of tension in rope = ………………..…………….

angle **X** = ……………..……………

[5]

3 Fig. 3.1 shows six men on a ship trying to raise the anchor. Each men pushes against a handle with a force of 100 N at a distance of 1.2 m from the axis of rotation. The chain, which supports the anchor, wraps around the axle at a radius of 0.5 m.

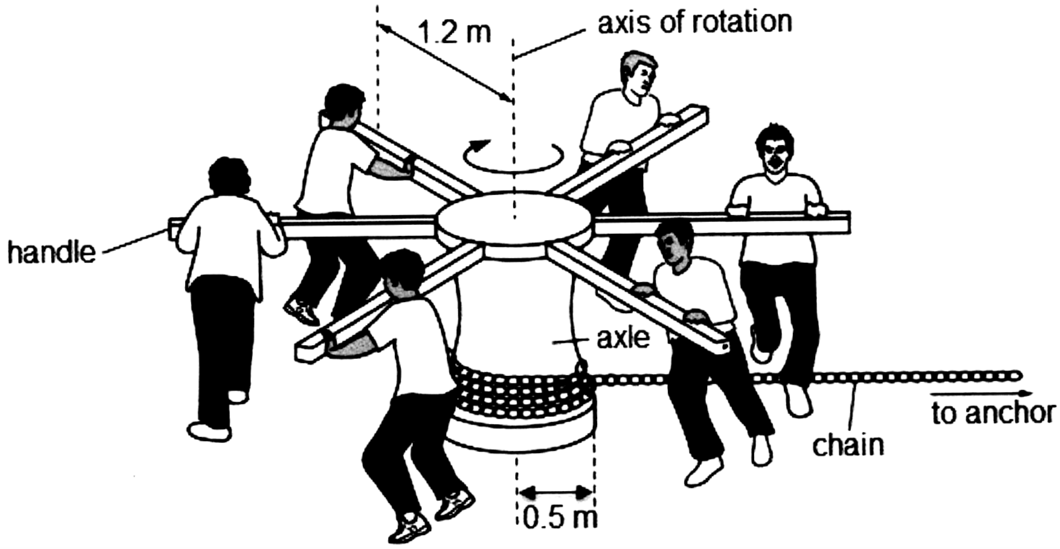


Fig. 3.1

(a) State the principle of moments.

....

....

....

....[1]

(b) Calculate the total moment produced by the six men about the axis of rotation.

total moment = ………………….[2]

(c) The anchor is raised steadily at a constant speed of 0.1 m/s.
Using the principle of moments, determine the weight of the anchor.

weight = …………………[2]

[Turn over

4 A U-tube initially contains water. Alcohol which floats on water is carefully poured into the right hand side of the U-tube until there is 60 mm height of alcohol in the tube as shown in Fig. 4.1. The water level on the right hand side of the U-tube is now 80 mm from the base. The density of water and alcohol is 1.0 g/cm^3 and 0.8 g/cm^3 respectively.

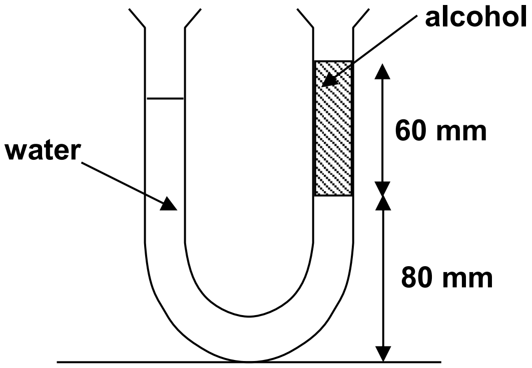


Fig. 4.1

(a) Calculate the difference in height between the water levels in the left and right side of the U-tube, after the alcohol was poured into the tube.

rise in height of water = …………………...[3]

(b) If the density of the alcohol is less than 0.8 g/cm^3, state the difference in the water level of both sides of the arm of the U-tube. Support your answer with reason.

....

....

....[2]

5 Describe, with the aid of a diagram, how the refractive index of a piece of glass block can be determined as accurately as possible.

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....[7]

[Turn over

6 Fig. 6.1 shows the top view of a person at **X** standing between a plane mirror and a wall mural behind him.

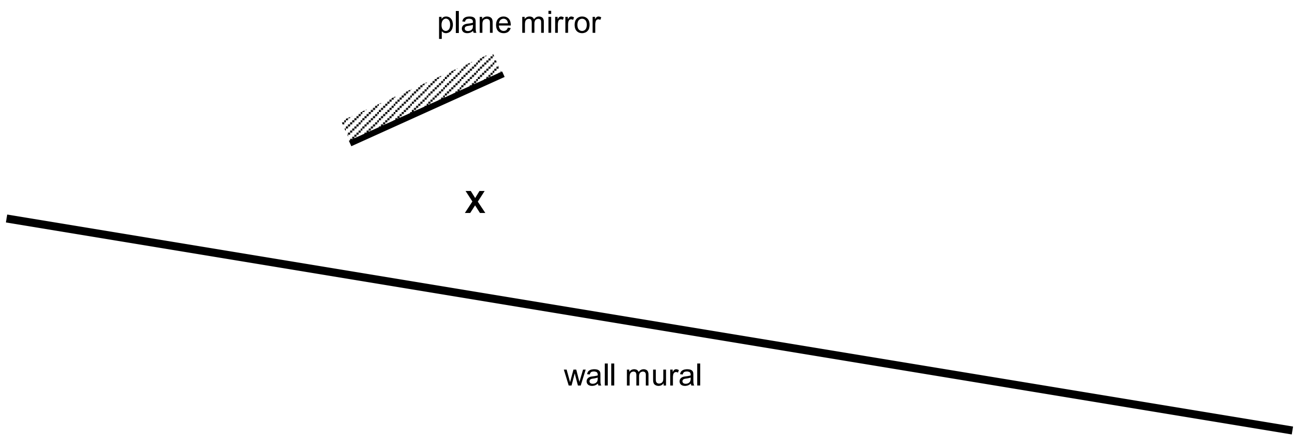

Fig. 6.1

(a) On Fig. 6.1, construct as accurately as possible, two light rays to show the two ends along the mural that are visible to the person standing at **X** in the plane mirror. Label the two ends as '**A**' and '**B**'. [2]

Fig. 6.2 shows an ornamental glass ball mounted on a rectangular glass base. The centre of the part circular glass ball has been marked '**O**'. An object **C** is embedded inside the glass ball.

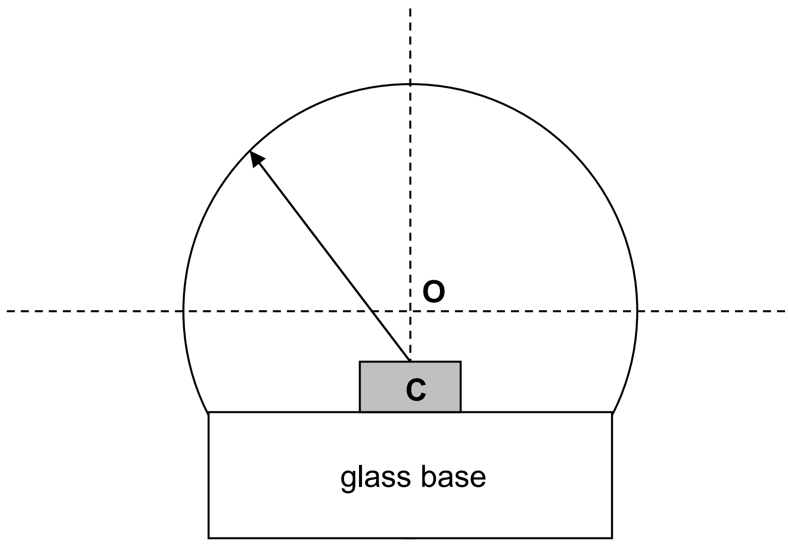

Fig. 6.2

A ray of light from object **C** is incident at the glass-air boundary.

(b) On Fig. 6.2, draw the normal at the glass-air boundary and measure the angle of incidence. Hint: The normal to any circular surface is the radius of the spherical surface.

angle of incidence = ...
[2]

(c) Given that the refractive index of glass is 1.50, calculate the angle of refraction.
On Fig. 6.2, complete the path of the ray as it leaves the glass ball.

angle of refraction = …………………………...
[2]

(d) Total internal reflection will not take place for this particular ray in Fig. 6.2. Explain why is this so. You may show numerical calculations to support your answer.

....

....

....

....[2]

[Turn over

7 Fig. 7.1 shows a circuit containing **A** and **B** which are lengths of different resistance wire while **P** and **Q** are two fixed resistors of 10 Ω and 20 Ω respectively.

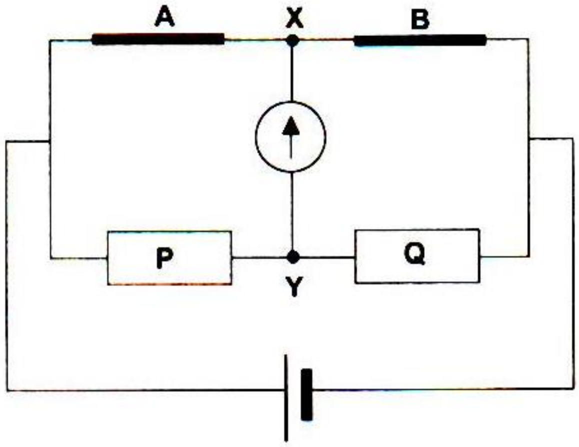

Fig. 7.1

(a) What is the ratio of resistance of **A** to resistance of **B** for the galvanometer to register a zero deflection?

ratio of resistance of **A** to resistance of **B** = ……………….……..[1]

(b) Explain why there is no current flow through the galvanometer.

....

....[1]

Wire **A** has a resistivity of 9.0×10^{-7} Ωm and its cross sectional area is four times that of **B**. In order for the galvanometer to show zero deflection, the length of **A** is three times that of **B**.

(c) Using your answer to part **(a)** or otherwise, determine the resistivity of wire **B**

resistivity of wire **B** = ……………………..[3]

(d) Resistors **P** and **Q** are ohmic devices. Hence, they both obey Ohm's Law.
State Ohm's Law.

....

....[2]

8 Fig. 8.1 shows a circuit containing a 12 V filament lamp and a 12 V power supply.

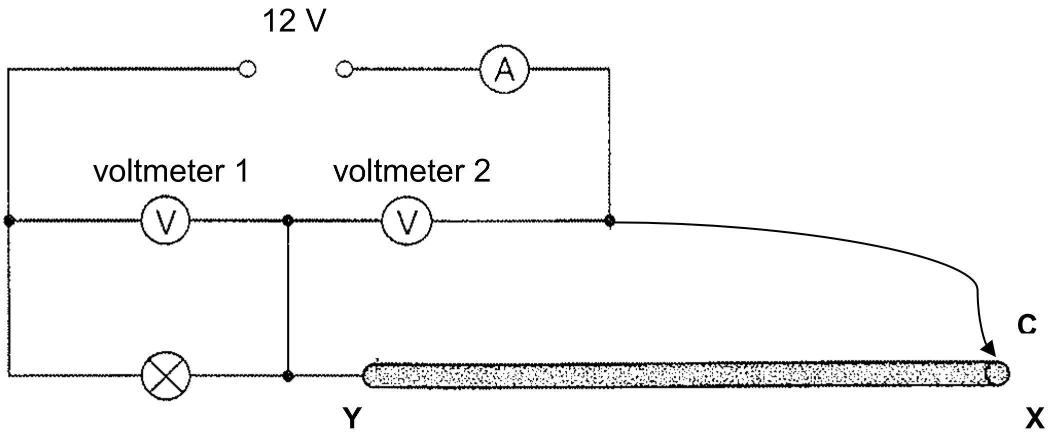

Fig. 8.1

The variable resistor **XY** is made from a long resistance wire and it has twice the resistance as the filament lamp. The sliding contact **C** moves along the wire from **X to Y**.

State what happens to the readings of the three meters as **C** moves from **X to Y**. Give numerical values where possible.

Voltmeter 1: ……………………………………………………………………………………………

………

………

Voltmeter 2: ……………………………………………………………………………………………

………

………

Ammeter: ………………………………………………………………………………………………

………

……… [4]

[Turn over

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Name:	Index number:	Class:

Section B

Answer **all** the questions from this section.
Answer only one of the two alternative questions in **Question 11**.

9 Fig. 9.1 shows a simple setup that can be used to investigate the loss of energy when the ball hits the ground.

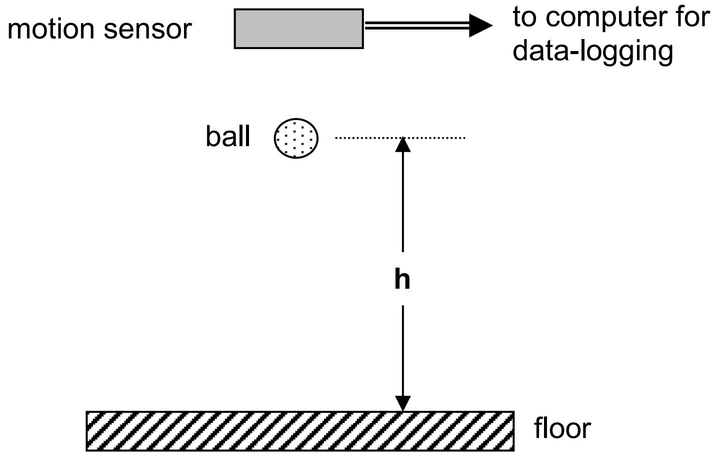

Fig. 9.1

The ball, which has a mass of 1.5 kg, was released at a certain height, **h**, above the floor. The motion sensor tracks the position of the ball and the following graph was obtained.

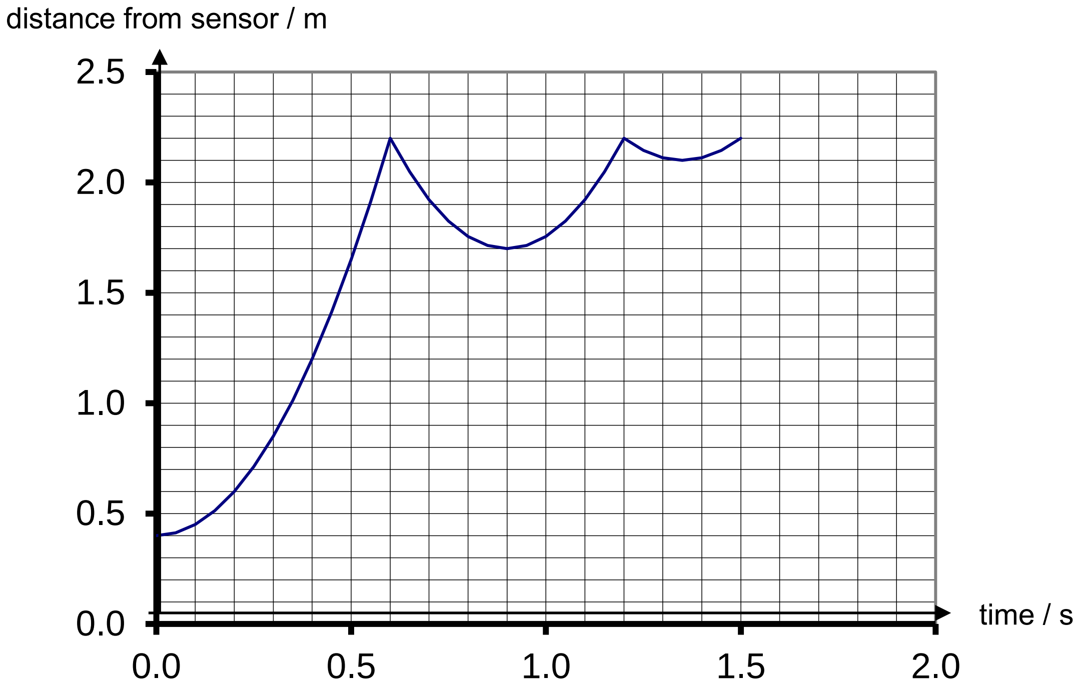

Fig. 9.2

[Turn over

(a) Explain why datalogging is suitable for this experiment.

……………………………………………………………………………..……………………………

…………………………………………………………………………………………..……………..….[1]

(b) From Fig. 9.2, determine

(i) the initial height of the ball above the ground.

initial height = ……………………….[1]

(ii) the maximum height attained by the ball after the first rebound.

maximum height = ……………………[1]

(iii) the speed of the ball at 0.5 s.

speed = ……………………..[2]

(iv) the speed of the ball at 0.9 s.

speed = …………………….[1]

(c) By making use of your answers to part **(b)** or otherwise, calculate the loss in energy of the ball upon the first impact with the floor.

loss of energy = …………………..[2]

(d) A second ball, which is made of the same material, has double the radius of the ball used in the experiment. Calculate the mass of second ball.

(Volume of sphere = $\frac{4}{3}\pi r^3$)

mass of second ball = ………………[2]

10 Fig. 10.1 shows an electric kettle.

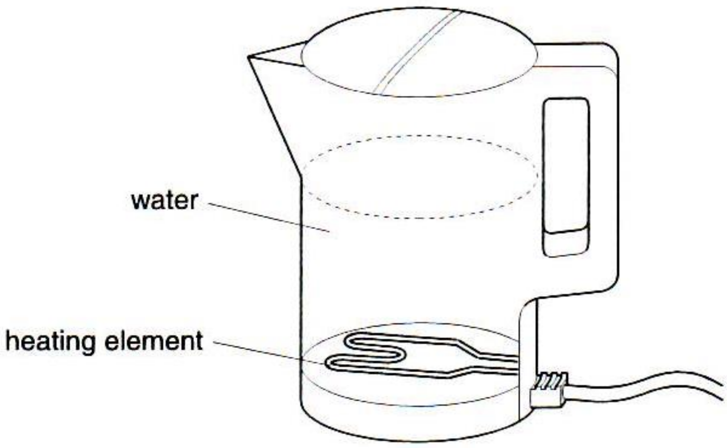

Fig. 10.1

(a) The specific latent heat of vaporisation of water is 2.36 x 10^6 J/kg.

Using this value for the specific latent heat of vaporisation of water, describe an experiment to determine the electrical power input to the kettle. You should state clearly how the readings are obtained and how the power is calculated.

Suggested apparatus: kettle, electronic balance, stopwatch, thermometer

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....[4]

[Turn over

10 **(b)** The kettle has an electrical power input of 1.5 kW and is used for 3 minutes.

(i) Calculate the electrical energy, in joules (J), supplied to the kettle.

electrical energy = ………………. [2]

(ii) Calculate the electrical energy, in kilowatt hours (kWh), supplied to the kettle.

electrical energy = ………………….[1]

(iii) Using your answers to part **(b)(i)** and **(b)(ii)**, calculate the number of joules that is equivalent to 1.0 kWh.

number of joules = ……………………[1]

(c) When the kettle is switched off, the water cools down. Explain, in molecular terms, how evaporation causes a loss of energy from the water.

....

....

....

....

....[2]

11 **EITHER**

(a) What is the difference between input transducers and output transducers?

……………………………………………………………………………………………...…

……………..……………..………………………………………………………..………….[1]

(b) Fig. 11.1 shows how the resistance of the temperature sensor changes with temperature.

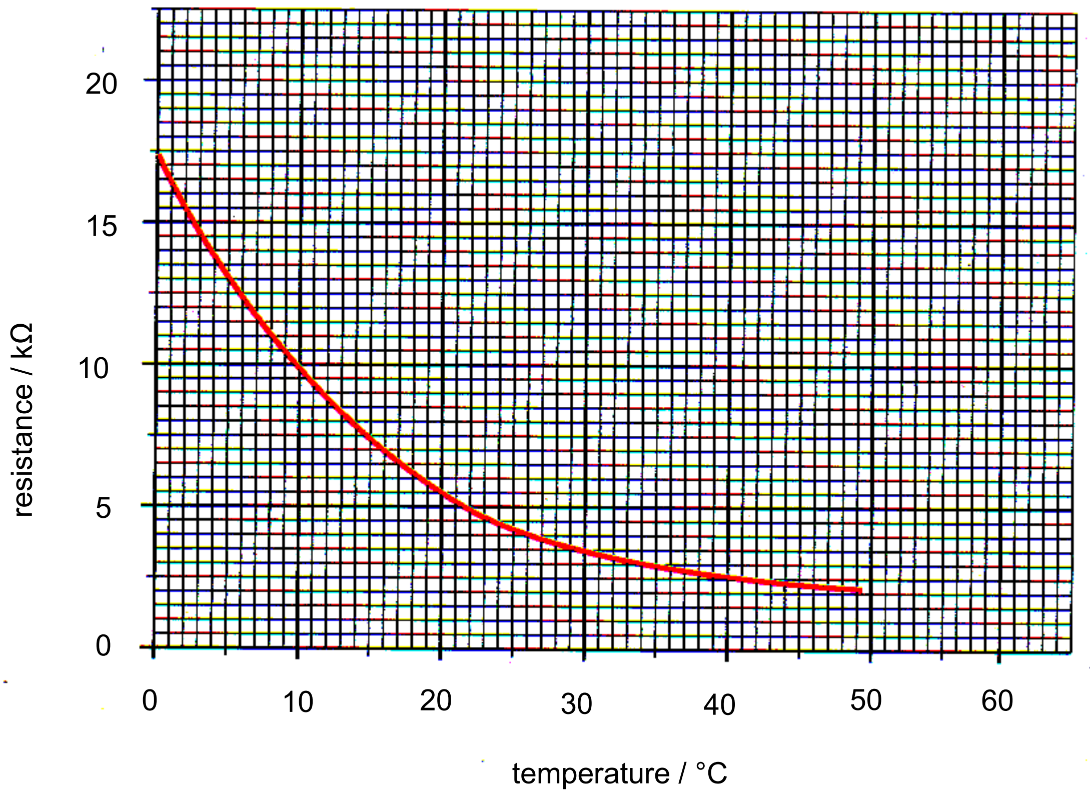

Fig. 11.1

(i) From the graph, determine the resistance of the temperature sensor at 40 °C.

resistance of sensor = ………………….[1]

(ii) Explain why the graph shows that the temperature sensor is a non-ohmic device.

……………………..…………………………………………………………………………..

..……………..……………………………………………………………….……………[1]

[Turn over

(c) The temperature sensor is connected to a circuit in Fig. 11.2. The variable resistor is set at 7.5 kΩ and the battery has an e.m.f of 20.0 V with negligible internal resistance.

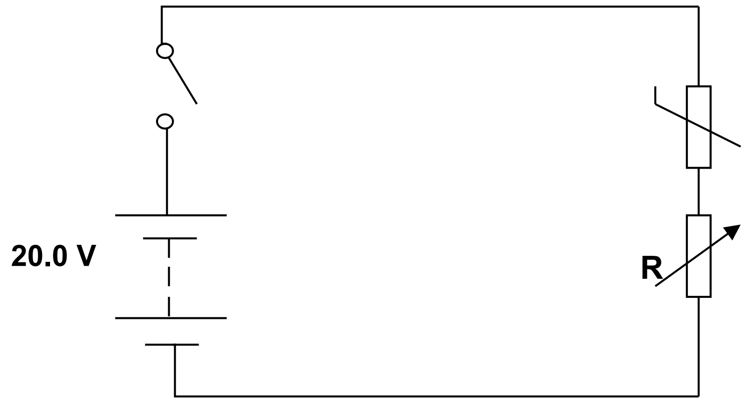

Fig 11.2

When the switch is closed, determine the current (in mA) flowing in the circuit at 40 °C.

current = ………………….[2]

(d) The resistor **R** is connected to an electronic circuit as shown in Fig. 11.3. The electronic circuit is switched on when the potential difference across **R** is between 6.0 V to 10.0 V. Assume the resistance of the variable resistor is still set at 7.5 kΩ.

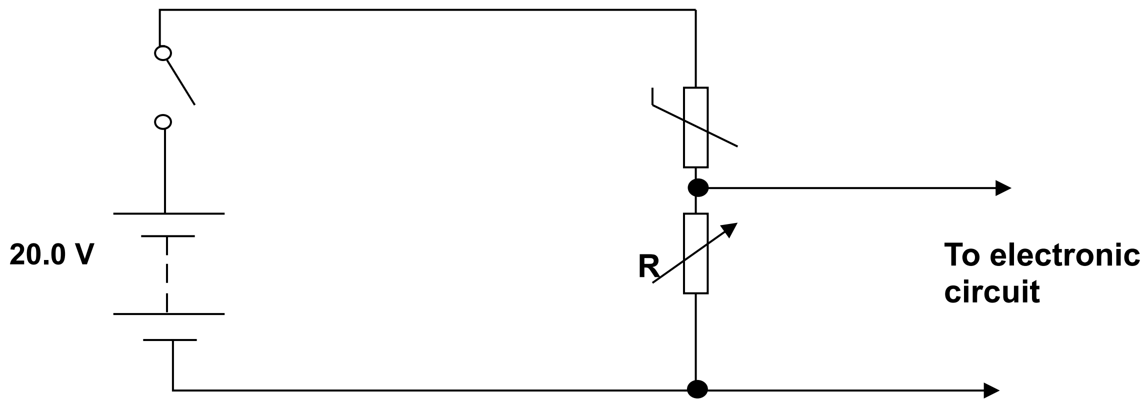

Fig. 11.3

(i) Calculate the output voltage across **R** when the temperature is 40 °C.

Output voltage = ……………………[1]

(ii) Calculate the maximum and minimum temperature for electric circuit to be switched on.

maximum temperature = ……………………….

minimum temperature = ……………………….

[3]

(iii) Suggest a use for this circuit.

……………………………………………………………………………………...

……………………………………………………………………………………[1]

[Turn over

OR

A basic microscope is usually made up of two converging lenses. One reason for using two lenses rather than just one is that it is easier to get higher magnification. For example, in order to have an overall magnification of 27, one lens can magnify by a factor of 3, and the second by a factor of 9.

It is generally easier to get a large magnification factor of 27 in this way than to use a single lens.

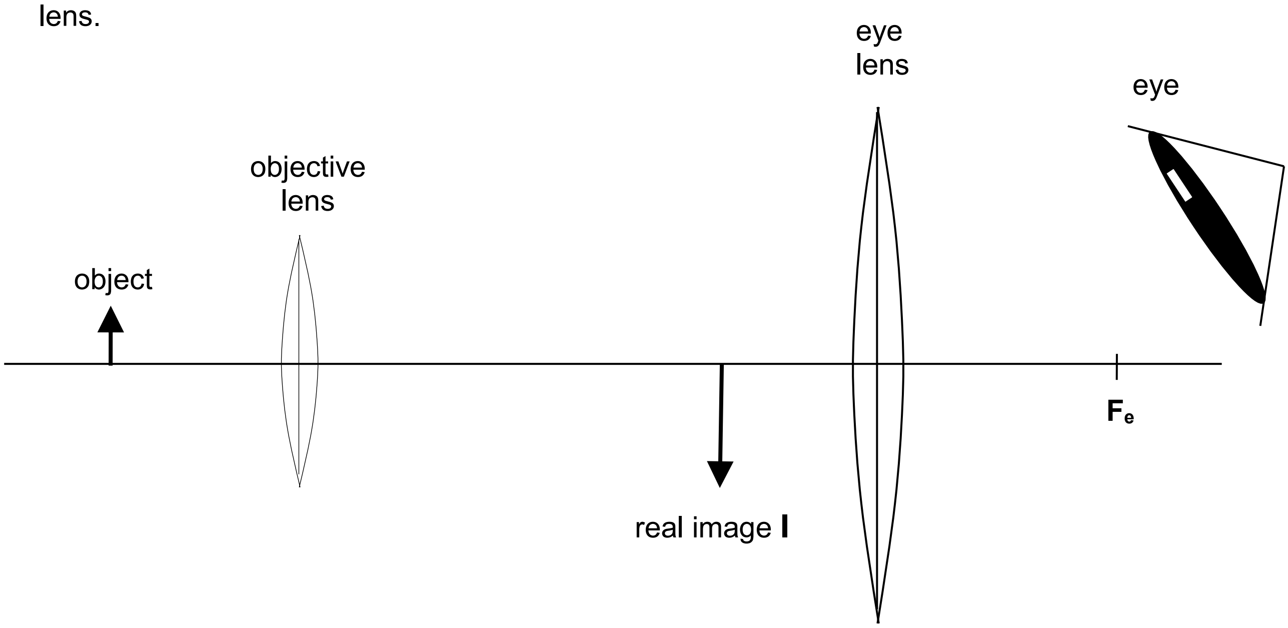

Fig. 11.4

A microscope arrangement is shown in Fig. 11.4. The objective lens creates a real image **I**. This image is the object for the eye lens (with its focal point at $\mathbf{F_e}$), and the image created by the eye lens is the one seen by the eye through the microscope.

(a) On Fig. 11.4, draw the two rays from the object to show how the image **I** is being formed by the objective lens. Locate and label the focal point $\mathbf{F_o}$ of the objective lens. [3]

(b) Draw two rays to locate the image as seen by the eye, when **I** is being magnified by the eye lens on Fig. 11.4. Label clearly this image **P**. [3]

(c) Hence, calculate as accurately as possible the magnification factor of the microscope used in Fig. 11.4. Hint: Magnification factor = Height of image/Height of object

magnification factor = …………………….. [1]

(d) State one other characteristic of the magnified image **P**.

……………………………………………………………………………………………….[1]

(e) The converging lens works based on the laws of refraction of light.

State the laws of refraction.

1. ……………………………………………………………………………………………

…………………………………………………………………………………………………

2. ……………………………………………………………………………………………

……………………………………………………………………………………………….[2]

- End of Paper -

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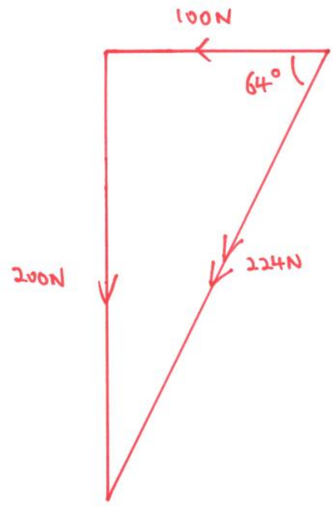
CHIJ SECONDARY (TOA PAYOH)
PRELIMINARY TWO EXAMINATION 2018
SECONDARY 4(EXPRESS)

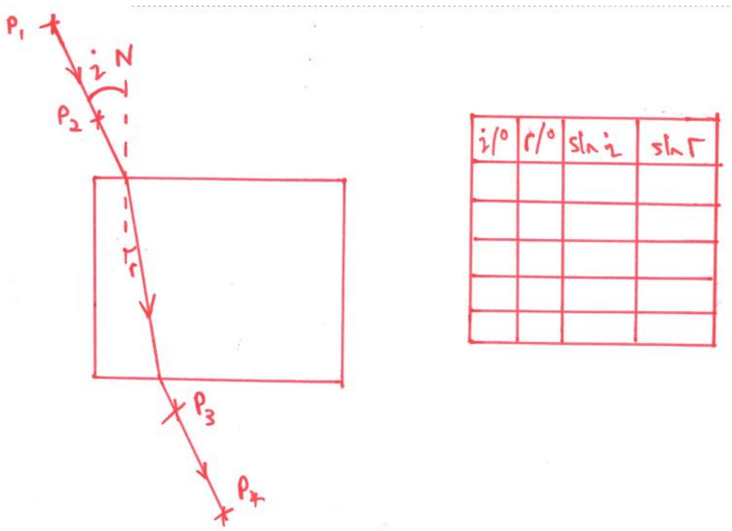
PHYSICS
6091/01
Paper 1

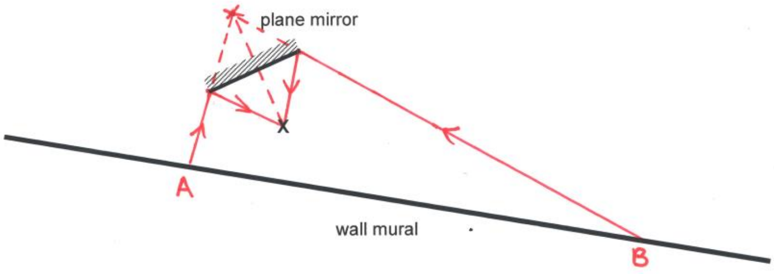
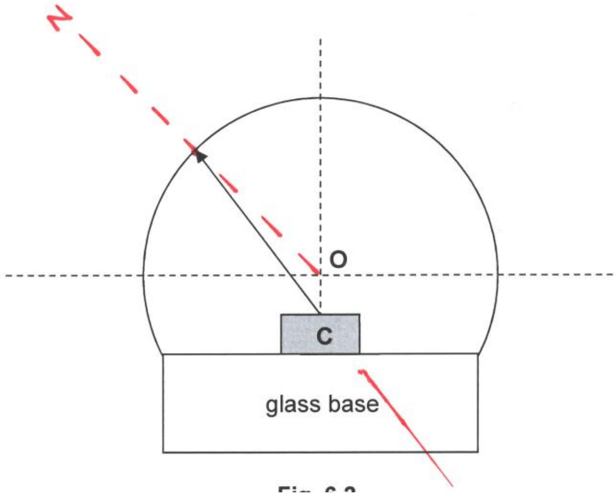
1	**D**	**11**	**B**	**21**	**B**	**31**	**B**
2	**B**	**12**	**C**	**22**	**D**	**32**	**B**
3	**C**	**13**	**B**	**23**	**D**	**33**	**C**
4	**B**	**14**	**B**	**24**	**D**	**34**	**C**
5	**B**	**15**	**C**	**25**	**A**	**35**	**D**
6	**C**	**16**	**A**	**26**	**B**	**36**	**D**
7	**D**	**17**	**C**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

Paper 2
5059/02

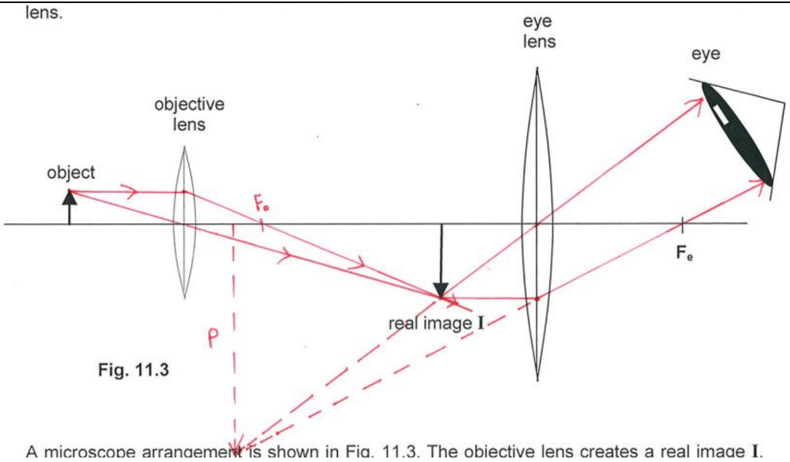
Qn	**Answers**	**Mark**	
1(a)(i)	Between 0 s and 2 s. Between 16 s to 24 s.	1 1	
1(a)(ii)	Between 0 s to 2 s, car is stationery. Between 16 s to 24 s, car is moving at a constant speed/velocity.	1 1	
1(b)(i)	At t = 2 s, resistive force = 0 N. Resultant force, F = ma = 2500 N 900 x a = 2500 a = 2.78 m/s^2	 1 1	
1(b)(ii)	Resultant force, F = ma = 900 x 2.0 = 1800 N Resultant force = Driving force – resistive force 1800 = 2500 – resistive force Resistive force = 2500 – 1800 = 700 N From Fig. 1.2, t = 6 s	1 1 1	
2			

	- Correct tension in rope drawn from vector triangle - Correct weight drawn - Appropriate scale - Correct value of tension - Correct X Magnitude of tension = 224 N Angle X = 63 °	1 1 1 1 1	
3(a)	When an object is balanced, the sum of clockwise moment about a pivot is equal to the sum of anti-clockwise moment about the same pivot.	1	
3(b)	Total moment = force x perpendicular distance = 6 x 100 x 1.2 = 720 Nm	1 1	
3(c)	When balanced, Sum of clockwise moment = sum of anti-clockwise moment 720 = Weight x 0.5 Weight = 1440 N	 1 1	
4(a)	$(\rho hg)_{water} = (\rho hg)_{alcohol}$ 1.0 x h x 10 = 0.8 x 60 x 10 h = 48 mm	1 1 1	
4(b)	The difference in water level will be lesser. If the density of alcohol decreases, the total pressure exerted by the alcohol will also decrease.	1 1	
5(a)	- Draw outline of glass block on a piece of paper. - Construct an angle of incidence, i = 30°, on one side of glass block. - Place two pins, P_1 and P_2 on the incident ray. - Look through the glass block from the other side, place two pins, P_3 and P_4, such that they are all in a straight line with images of P_1 and P_2. - Construct the emerging ray and the refracted ray. - Measure the angle of refraction. - Record values in a table. - Repeat for 4 further values of angle i. - Compute sin i and sin r. - Plot a graph of sin i against sin r. - Draw a best fit straight line. - Determine the gradient - Gradient represents refractive index of glass block. - Appropriate diagram	1 1 1 1 1 1 1	



6(a)	 - Two correct rays drawn.	2	
6(b)	 - Correct normal drawn - Correct angle of incident measured. - Angle i = 8 °	1 1	
6(c)	n = sin r / sin i 1.50 = sin r / sin 8 r = 12 ° - Correct angle of refraction drawn	1 1	
6(d)	n = 1 / sin c c = $\sin^{-1}$ [1/1.50] = 41.8° Since the <u>angle of incident is less than the critical angle</u>, total internal reflection will not take place.	1 1	
7(a)	A / B = P / Q A / B = 10 / 20 = 1 : 2	1	
7(b)	Point X and point Y are at the same potential. Hence, there is no difference in potential.	1	
7(c)	½ = [9.0×10^{-7} x $3I_B$ / $4A_B$] / [p x I_B / A_B] p = [9.0×10^{-7} x ¾] / ½ p = 1.35×10^{-6} Ωm	1 1 1	
7(d)	Ohm's Law states that the current flowing through a metallic conductor is directly proportional to the potential difference between the 2 ends, provided that temperature and other physical conditions remain constant.	1 1	
8	Voltmeter 1: As contact C moves from X to Y, voltmeter 1 reading will increase from 4V to 12 V. Voltmeter 2: As contact C moves from X to Y, voltmeter 2 reading will decrease from 8 V to 0 V. Ammeter: Ammeter reading will increase.	2 1 1	
	END OF SECTION A		
9(a)	Datalogging is suitable for this experiment because the time duration is very short	1	

	OR the height changes too quickly for measurement to be taken manually.		
9(b)(i)	Initial height = 2.2 – 0.4 = 1.8 m	1	
9(b)(ii)	Maximum height = 2.2 – 1.7 = 0.5 m	1	
9(b)(iii)	Speed = gradient at 0.5 s Speed = [2.1 – .07] / [0.6 – 0.3] = 4.67 m/s	1 1	
9(b)(iv)	0 m/s	1	
9(c)	Loss in energy = loss in G.P.E = $mg(h_1 – h_2)$ = 1.5 x 10 x (1.8-0.5) = 19.5 J	 1 1	
9(d)	Vα r^3 V = m x r^3, where m is a constant Vnew = m x $[2r]^3$ Vnew = m x $8r^3$ = 8 x V Since density is the same, New mass = 8 x 1.5 = 12 kg		
10(a)	Place empty kettle on a electronic balance. -Pour 2 kg of water into kettle. -Switch on the kettle. -<u>Start stop-watch once the water starts to boil</u>. -<u>Stop the stop-watch</u> once the reading on the electronic balance <u>decreases by 1 kg</u>. - Record time as t s. <u>Power x time = m x lv</u> <u>Power = 1 x 2.36 x 10^6 / t</u>	 1 1 1 1	
10(b)(i)	Electrical energy in Joules = Power x time = 1500 x 3 x 60 = 270 kJ	1 1	
10(b)(ii)	Electrical energy in kWh = 1.5kW x 3/60 h = 0.0750 kWh	1	
10(b)(ii)	0.075 kWh = 270 kJ 1 kWh = 1 x 270/0.075 = 3.6 MJ	 1	
10(c)	The more energetic molecules will leave the surface of water leaving behind the less energetic molecules. Hence, the average kinetic energy of the remaining molecules decreases.	1 1	
11	**EITHER**		
11(a)	Input transducers convert non-electrical energy to electrical energy while output transducers convert electrical energy to other non-electrical energy.	1	
11(b)(i)	From the graph, resistance = 2.5 kΩ	1	
11(b)(ii)	Temperature sensor is not an ohmic conductor because resistance is not constant as temperature increases.	1 1	
11(c)	I = V/R = 20.0/[2500 + 7500] I = 2 mA	2	
11(d)(i)	Output voltage, V = IR = 0.002x7500 = 15 V	1	
11(d)(ii)	$V_{output} = R/[R+R_T]$ x 20.0 V 6.0 = 7500/[7500+R_T] x 20.0 V R_T = 17.5 kΩ From graph, minimum temperature = 0 ˚C 10.0 = 7500/[7500+R_T] x 20.0 V R_T = 7.5 kΩ From the graph, maximum temperature = 15 ˚C	1 1 1	
11(d)(iii)	To switch on a heater whenever the temperature drops below	1	

	15 ˚C.		
	OR		
11(a)	 - 2 correct rays - F_o indicated correctly	 2 1	
11(b)	- 2 correct rays - Image P indicated correctly	2 1	
11(c)	Magnification = Image height / Object height = 4.9 / 0.7 = 7.0	 1	
11(d)	The image P is virtual or upright.	1	
11(e)(i)	1. At the point of incident, the normal, the incident ray and the refracted ray all lies on the same plane. 2. For 2 given media, the ratio sin i / sin r is a constant, where i is the angle of incidence and r is the angle of refraction.	1 1	
	END OF PAPER 2		

Section A	☐ s.f. ☐ formula	50

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

PHYSICS

6091/02

Paper 2 Theory

12 September 2018
1 hour 45 minutes

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

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question **13** has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their workings in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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

For examiner's use only:

Section A	/ 50
Section B	/ 30
Total Marks	**/ 80**

Paper	Type of Paper	Marks	Weighting
1	Multiple Choice	40	30 %
2	Theory	80	50 %
3	Practical	40	20 %

Section A

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

1 A person winds some thread tightly 4 times round the length of a metre rule and cuts the ends off level with the left-hand end of the rule, as shown in Fig. 1.1.

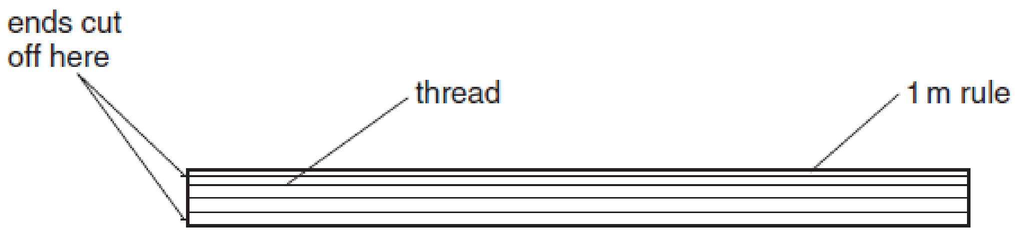


Fig. 1.1

(a) Determine the length of the thread, to the nearest metre.

.... m [1]

(b) State and explain whether the actual length of thread is **slightly greater** or **slightly less** than your answer to **(a)**.

....

....

.... [1]

2 Fig. 2.1 shows the arm of a crane when it is lifting a heavy box.

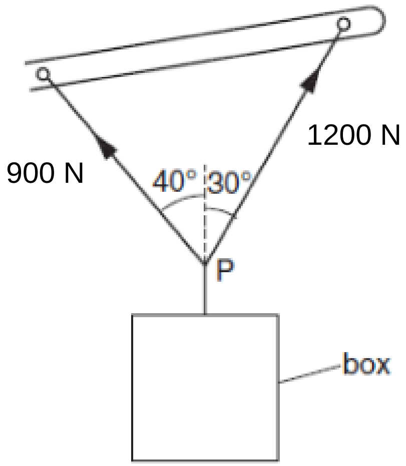


Fig. 2.1

By the use of a scale diagram of the forces acting at P, find the weight of the box. Show all workings clearly.

weight of box = ______________________________ [4]

3 Fig. 3.1 shows a hinged rail in a fence. The rail has to be lifted vertically in order to let people through.

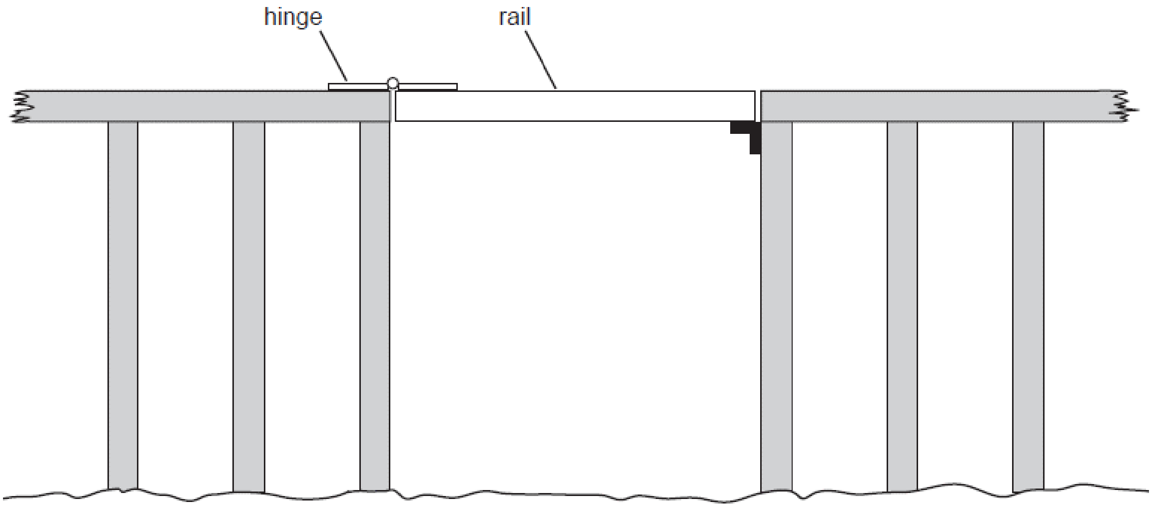


Fig. 3.1

(a) On Fig. 3.1, draw an arrow to show the position and direction of the smallest force that would be needed to begin to raise the rail. [2]

(b) Suggest one way the designer of the fence could have reduced the force needed to raise the rail.

....

.... [1]

4 Fig. 4.1 shows a can of compressed air that is being used to blow dust off a computer keyboard.

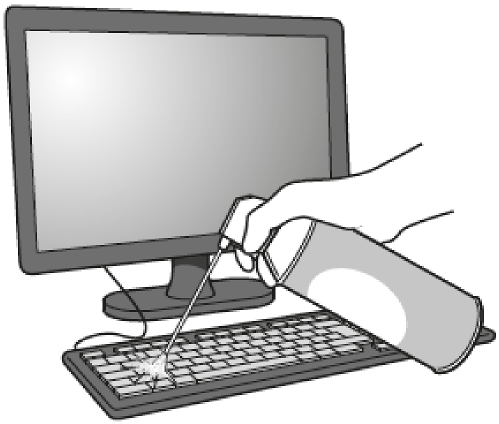


Fig. 4.1

The pressure of the air inside the can is greater than the pressure of the atmosphere.

(a) State what is meant by the term *pressure*.

....

.... [1]

(b) Using ideas about molecules and the definition of pressure, explain why the pressure of the air inside the can decreases as it is used.

....

....

....

.... [3]

5 Fig. 5.1 shows a water manometer used to measure the pressure inside a gas pipe.

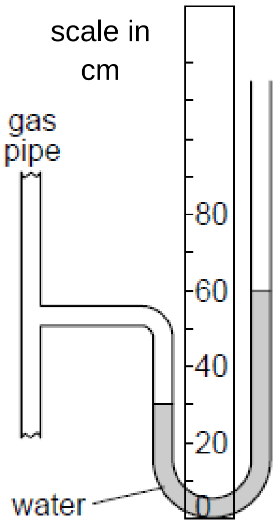


Fig. 5.1

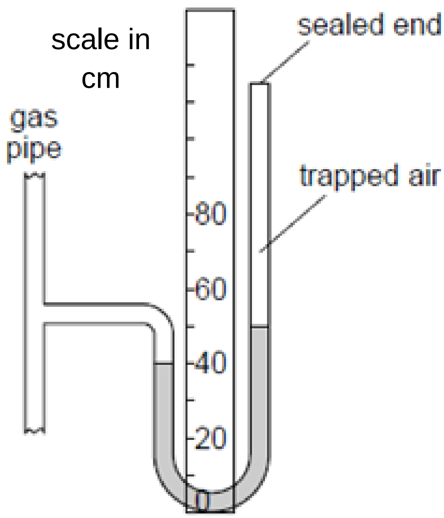


Fig. 5.2

(a) In Fig. 5.1,

(i) state and explain whether the pressure inside the gas pipe is larger than or smaller than atmospheric pressure.

....

....

.... [2]

(ii) the atmospheric pressure is 100 kPa and the density of water is 1000 kg/m^3. The gravitational field strength is 10 N/kg.

Calculate the pressure inside the gas pipe.

pressure = ... [2]

(b) In Fig. 5.2, the manometer shown has its top end sealed.

Explain why the water levels are different in Figs. 5.1 and 5.2, even though the pressure in the gas pipe is the same.

....

.... [1]

6 Fig. 6.1 shows a mercury-in-glass thermometer made using a glass capillary tube.

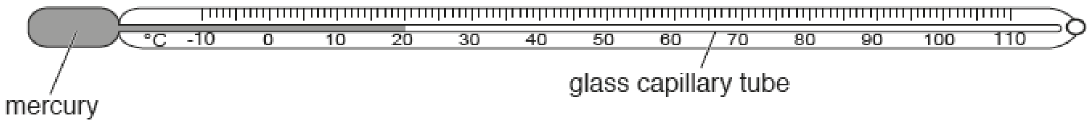


Fig. 6.1

(a) Describe how to check that the 100 °C mark is in the correct position on the thermometer.

....

....

.... [2]

(b) Some thermometers contain ethanol instead of mercury.

A second glass capillary tube is identical to the tube in Fig. 6.1, except that it has no markings on the glass. This tube is used to make an ethanol-in-glass thermometer. The volume of the ethanol in this thermometer is equal to the volume of mercury in the thermometer in Fig. 6.1.

The thermal expansion of ethanol is more than that of mercury.

State, and explain, how the maximum possible temperature measured by the ethanol-in-glass thermometer differs from that of the thermometer in Fig. 6.1.

....

....

.... [2]

7 A plastic ice tray has 16 sections filled with water. When placed in the ice box, the water freezes to form ice cubes. Each section contains a mass of 20 g of water that is initially completely liquid at a temperature of 0 °C. The specific latent heat of fusion of ice is 330 J/g.

(a) Calculate the amount of energy that must be taken from the tray of water to enable all the water in the tray to become ice at 0 °C.

energy = ... [2]

(b) State why the heat capacity of the plastic tray does not affect the answer to **(a)**.

....

.... [1]

(c) The ice box takes energy from the water at a rate of 30 W. Estimate the time taken for all the water in the tray to become ice.

time = ... [1]

8 Some medical processes involve the use of ultrasound.

(a) State what is meant by *ultrasound*.

....

.... [1]

(b) Explain briefly how ultrasound is used in pre-natal scanning.

....

....

.... [2]

9 A 600 Ω resistor and a thermistor are connected in series with an ammeter and a 20 V d.c. power supply. A voltmeter is in parallel with the resistor.

Fig. 9.1 is the circuit diagram.

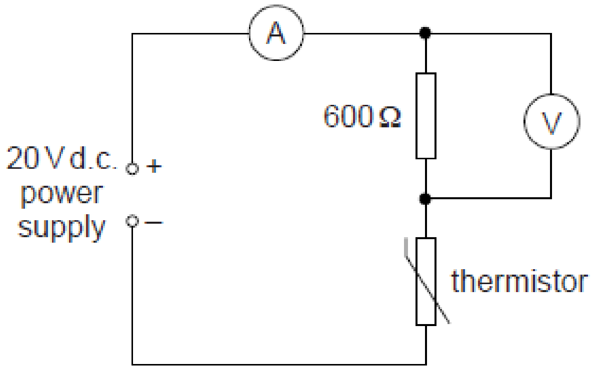


Fig. 9.1

The ammeter reads 0.025 A.

(a) Calculate

(i) the reading on the voltmeter,

reading = ... [2]

(ii) the resistance of the thermistor.

resistance = ... [2]

(b) The temperature of the thermistor increases.

State what, if anything, happens to

(i) the resistance of the thermistor,

.... [1]

(ii) the ammeter reading and to the voltmeter reading.

ammeter reading: ....

voltmeter reading: .... [1]

10 Fig. 10.1 shows a mains extension lead. The six sockets allow several electrical appliances to be connected to the mains supply through one cable.

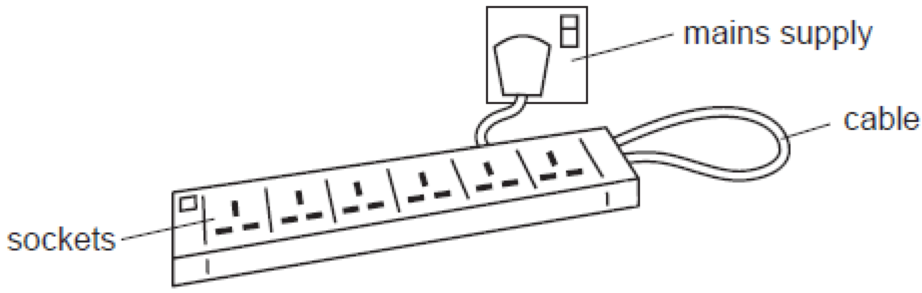


Fig. 10.1

(a) The cable connects the sockets to the mains supply.

The cable contains three wires: live, neutral and earth. State what is meant by

(i) *live,*

....

.... [1]

(ii) *earth.*

....

.... [1]

(b) Six powerful lamps are plugged into the sockets and switched on, one by one.

(i) State and explain what happens in the cable as the lamps are switched on, one by one.

....

....

....

.... [2]

(ii) Explain why it can be dangerous when a fuse of the wrong value is used in the plug.

....

....

....

.... [2]

11 A length of flexible, slack wire is fixed at A and B so that part of it is held vertically in the field of a horseshoe magnet, as shown in Fig. 11.1.

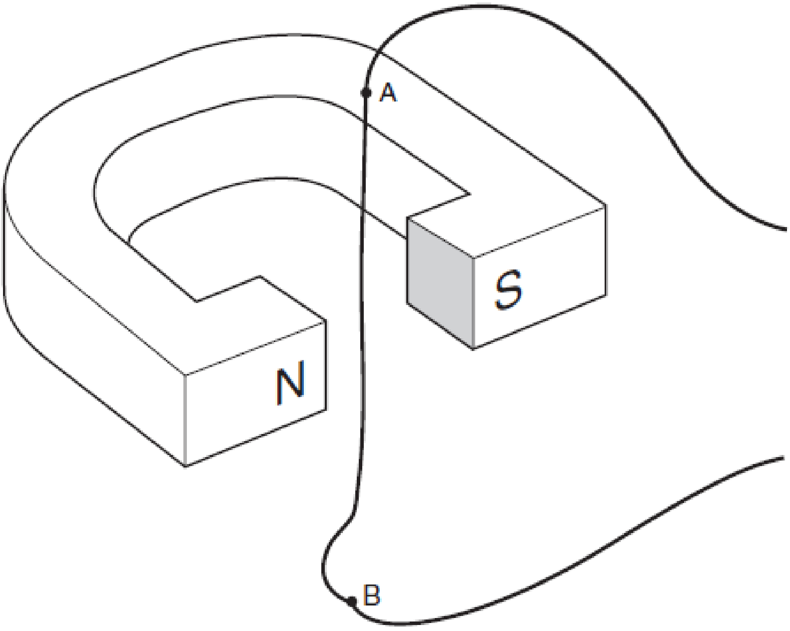


Fig. 11.1

Figs. 11.2 and 11.3 each show the same section through the apparatus. The wire between A and B is not shown.

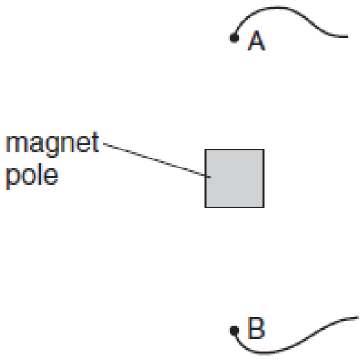


Fig. 11.2

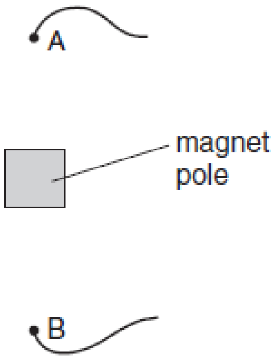


Fig. 11.3

(a) **(i)** On Fig. 11.2, draw what the wire might look like when a large current flows from A to B . [1]

(ii) Using ideas about magnetic fields, explain why the wire looks like this.

....

....

.... [2]

(b) On Fig. 11.3, draw what the wire might look like if the current in **(a)** is larger **and** reversed in direction. [1]

12 A transformer has an output of 24 V when supplying a current of 2.0 A. The current in the primary coil is 0.40 A and the transformer is 100% efficient.

(a) Calculate

(i) the power output of the transformer,

power = ... [1]

(ii) the voltage applied across the primary coil.

voltage = ... [1]

(b) **(i)** State one reason why the transformer may not be 100% efficient.

....

.... [1]

(ii) Explain briefly how the transformer changes an input voltage into a different output voltage.

....

....

....

.... [2]

Section B	☐ s.f. ☐ formula	30

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

PHYSICS **6091/02**

Paper 2 Theory

12 September 2018
1 hour 45 minutes

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

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Q13**.

13 Wind is a cheap and renewable energy source. Wind turbines provide electrical energy by making use of wind to turn its turbine blades, which in turn spins a coil placed between two permanent magnets.

Wind turbines come in various sizes and have various power ratings. Fig. 13.1 shows one of the smallest wind turbines for domestic use while Fig. 13.2 shows the generator connected to the turbine blades.

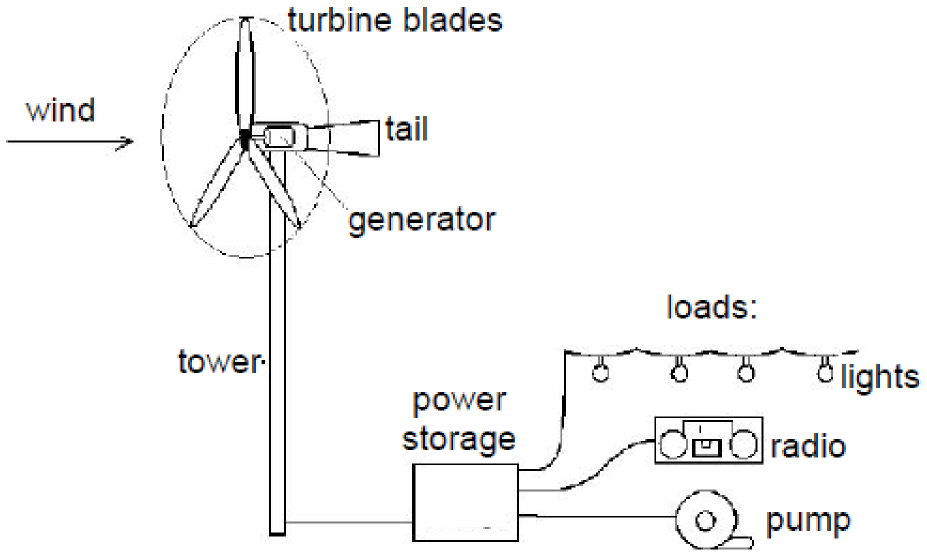


Fig. 13.1

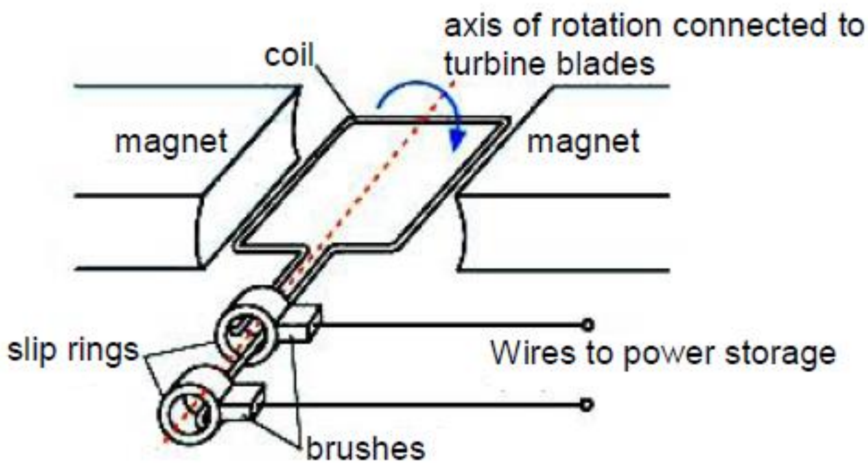


Fig. 13.2

Fig. 13.3 shows the specification of the wind turbine.

blade diameter	2.7 m
cut-in wind speed	2.5 m/s
cut-out wind speed	15 m/s
rated wind speed	9.0 m/s
maximum output power	650 W
output voltage	48 V (a.c.)
average annual energy output	1997 kWh

Fig. 13.3

Fig. 13.4 shows the electrical power generated by the wind turbine at different wind speeds.

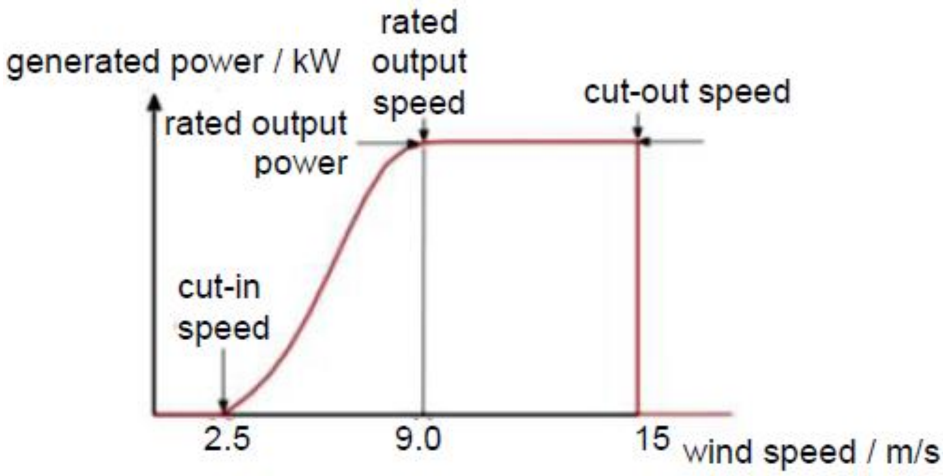


Fig. 13.4

(a) In Fig. 13.2, explain

(i) the purpose of the slip rings and brushes arrangement.

....

....

.... [1]

(ii) why work needs to be done to produce the induced e.m.f.

....

.... [1]

(b) **(i)** State the wind speed at which the turbine blades first start to turn.

Suggest why the turbine blades would only start turning at this speed.

[2]

(ii) At a wind speed of 15 m/s, brakes are immediately employed to bring the turbine to a standstill.

Suggest why this is necessary.

[1]

(c) The coil of the generator rotates 1.5 times in each second when the wind speed is 15 m/s.

On Fig. 13.5 below, sketch a labelled graph of e.m.f. against time, for a time interval of one second from the instant the generator starts turning from the position shown in Fig. 13.2.

[2]

Fig. 13.5

(d) A suggestion was made for a small home to be run solely on this wind turbine.

Assuming that on an average day, the electrical needs of the home are:

electrical needs	power consumption	no. of hours used
lights	600 W	6
radio	20 W	12
water pump	750 W	3

(i) Calculate the energy needed for a day.

energy = ... [2]

(ii) Hence, explain if this suggestion is suitable.

....

.... [1]

14 **(a)** Fig. 14.1 shows a ray of light passing through the edge of a converging lens.

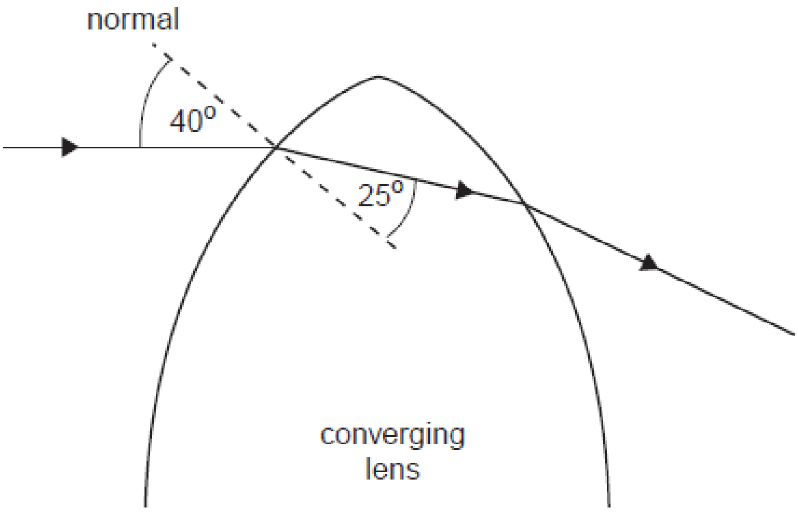


Fig. 14.1

(i) State and explain what happens to the direction of the ray of light as it enters the lens.

....

....

.... [2]

(ii) Calculate the refractive index of the glass used in the lens.

refractive index = ... [2]

(b) An object is placed 2 cm from the lens and a virtual image is formed 5 cm from the lens.

(i) State what is meant by the *focal length* of a lens.

....

.... [1]

(ii) Draw a ray diagram to scale to show the formation of the image. [3]

Hence determine the focal length of the lens.

focal length = ... [1]

(iii) State **two** other properties of the image.

....

....

.... [1]

15 EITHER

Fig. 15.1 shows a large container ship travelling at constant speed in a straight line.

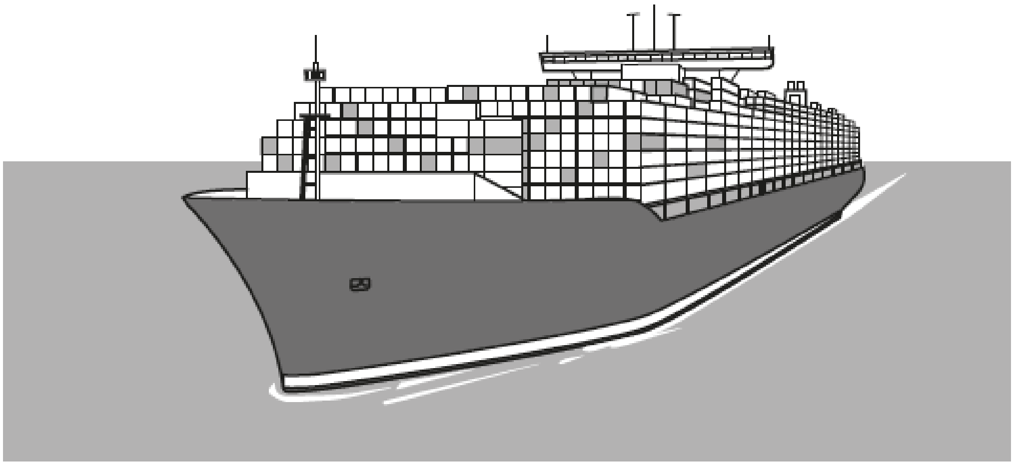


Fig. 15.1

The resistive force acting on the ship is 2.8×10^6 N.

(a) The speed of the ship is 9.7 m/s.

(i) Calculate the work done against the resistive force on the ship in 10 s.

work done = ... [2]

(ii) The engines are powered by oil.

State the energy transfer that is taking place when the ship is travelling at constant speed.

....

.... [1]

(b) The mass of the ship is 2.2×10^8 kg. The engines are switched off and the resistive force causes the ship to decelerate.

(i) Calculate the initial deceleration of the ship.

deceleration = ... [2]

(ii) As the speed of the ship decreases, its deceleration changes.

1. Suggest and explain how the deceleration changes.

....

....

.... [2]

2. On Fig. 15.2, sketch a possible speed-time graph for the ship as it decelerates to rest.

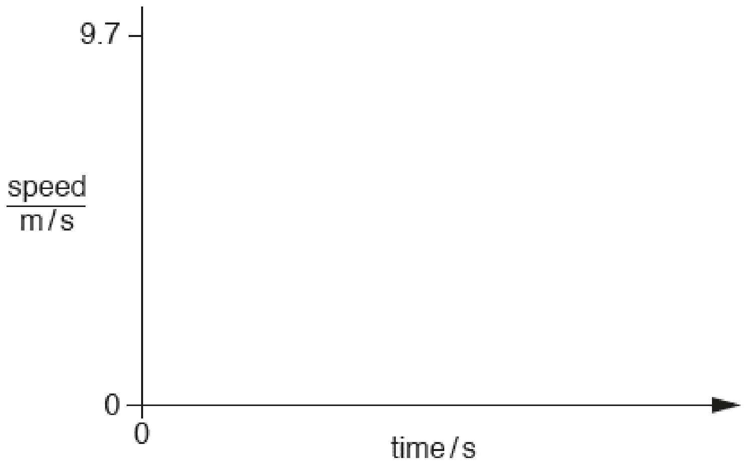


Fig. 15.2

[2]

(c) When the ship is travelling at a different speed, energy is being supplied to the engines at a rate of 33 MJ/s. The efficiency of the engines is 0.36 (36%).

Calculate the rate at which energy is wasted in the engines.

rate at which energy is wasted = ... [1]

15 OR

Thin wire, covered in plastic insulation, is used to make a solenoid (long coil). The solenoid is connected to a sensitive ammeter. Fig. 15.3 shows the N-pole of a steel magnet placed next to the solenoid.

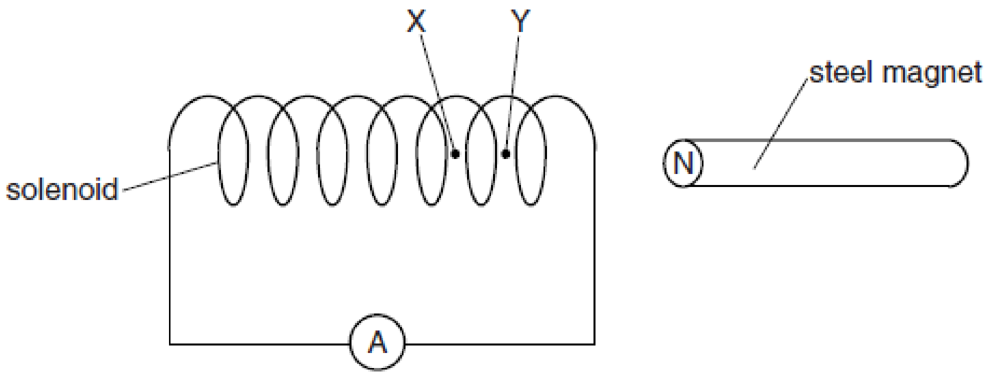


Fig. 15.3

Point X and point Y are on the axis of the solenoid.

(a) **(i)** Explain why plastic is an electrical insulator.

....

.... [1]

(ii) Explain why the magnet is **not** made from

1. aluminium,

....

.... [1]

2. iron.

....

.... [1]

(b) In one experiment, the magnet in Fig. 15.3 is moved to the left and passes into the solenoid.

The N-pole of the magnet travels from Y to X at a constant speed. As it moves, the ammeter shows a small current.

(i) Explain why there is a current in the solenoid when the magnet is moving.

....

....

.... [2]

(ii) The N-pole travels from Y to X in 0.14 s. As it moves, the current shown on the ammeter is 0.045 mA.

Calculate the charge that passes through the solenoid as the N-pole moves from Y to X.

charge = ... [2]

(c) In a second experiment, the speed of the N-pole is greater than its speed in the first experiment. It now takes only 0.070 s to travel from Y to X. A current in the same direction is shown on the ammeter.

The same quantity of charge passes through the coil in both the first and second experiments.

Explain why this is the case.

....

....

.... [1]

(d) State two ways in which the equipment shown in Fig. 15.3 can be used to produce a current in the solenoid that is in the opposite direction.

1. ....

2. ....

[2]

Section A	☐ s.f. ☐ formula	50

Name:		Index Number:		Class:	

ANSWERS

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

PHYSICS **6091/02**

Paper 2 Theory

12 September 2018
1 hour 45 minutes

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

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For examiner's use only:

Section A	/ 50
Section B	/ 30
Total Marks	**/ 80**

Paper	Type of Paper	Marks	Weighting
1	Multiple Choice	40	30 %
2	Theory	80	50 %
3	Practical	40	20 %

This document consists of 24 printed pages.

Section A

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

1 A person winds some thread tightly 4 times round the length of a metre rule and cuts the ends off level with the left-hand end of the rule, as shown in Fig. 1.1.

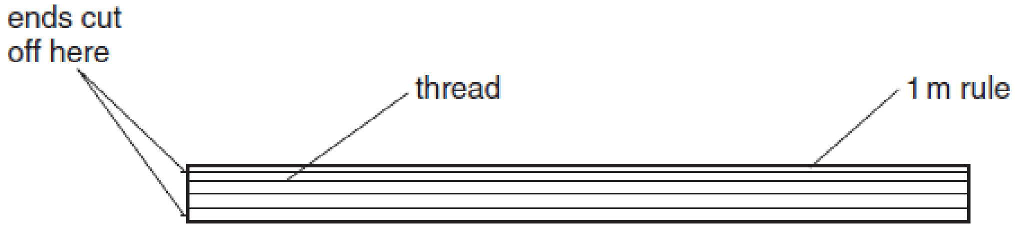


Fig. 1.1

(a) Determine the length of the thread, to the nearest metre.

8 m [1]

(b) State and explain whether the actual length of thread is **slightly greater** or **slightly less** than your answer to **(a)**.

EITHER: *Slightly greater*
Reason: Due to thickness of rule/ Thread overlap at ends *[1]*

OR: *Slightly less.*
Reason: Thread stretched when on rule/ Rule is worn out at ends

[1]

2 Fig. 2.1 shows the arm of a crane when it is lifting a heavy box.

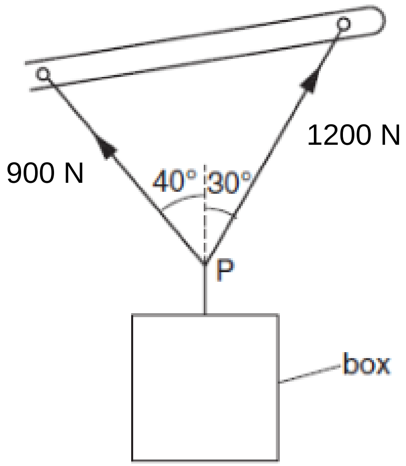
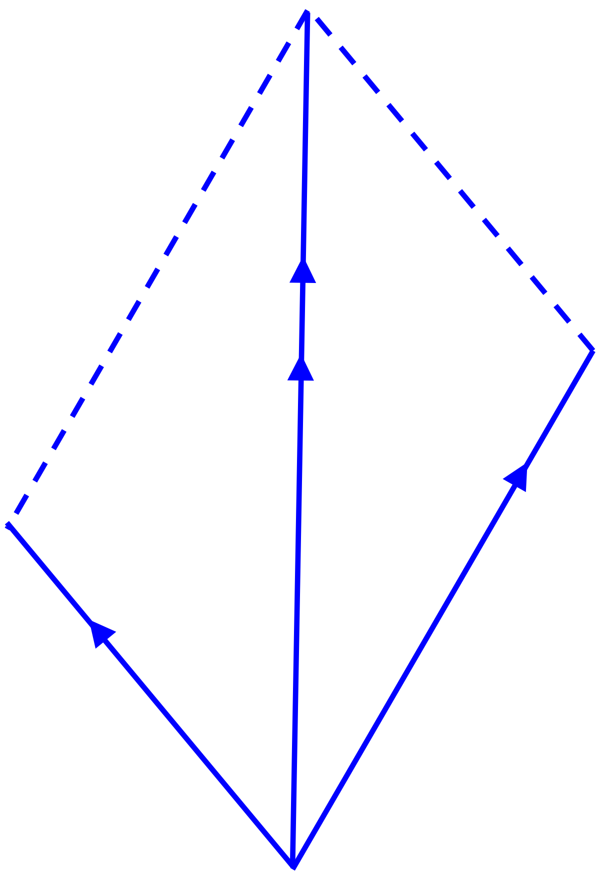


Fig. 2.1

By the use of a scale diagram of the forces acting at P, find the weight of the box. Show all workings clearly.



Scale 1 cm: 200 N

Resultant force
= 8.6 × 200 N
= 1720 N (3 s.f.)

Weight is opposite direction to the resultant force *[1]*
Weight = ***1720 N***

- *Actual: 1729 N. Accept ± 5%: i.e. 1642 N to 1878 N* *[1]*
- *Correct method: parallelogram or tip-to-tail* *[1]*
- *Correct vector diagram (arrows for forces, double arrows for resultant force, dotted lines if parallelogram)* *[1]*

weight of box = ______________________________ [4]

3 Fig. 3.1 shows a hinged rail in a fence. The rail has to be lifted vertically in order to let people through.

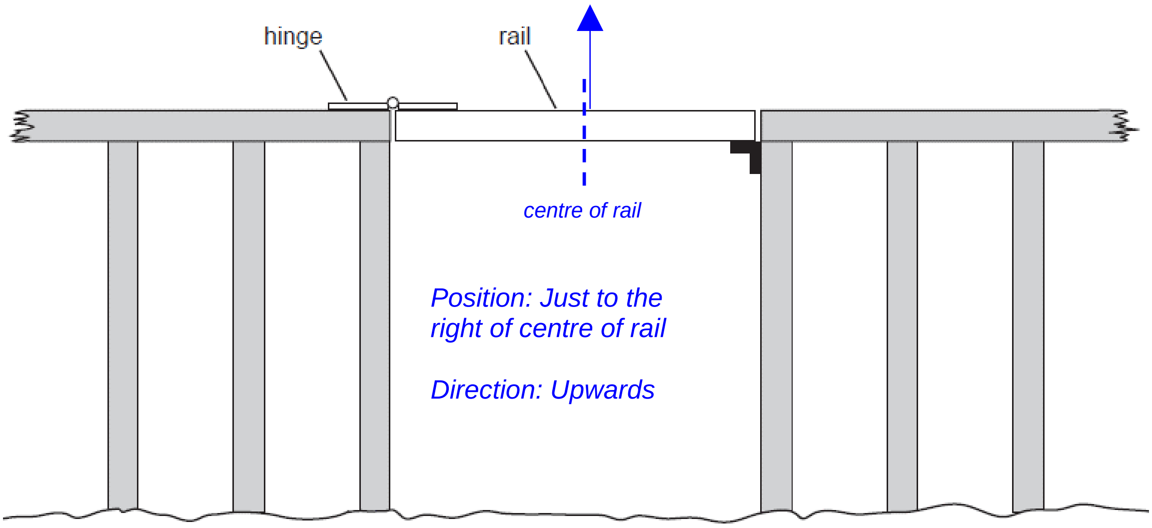


Fig. 3.1

(a) On Fig. 3.1, draw an arrow to show the position and direction of the smallest force that would be needed to begin to raise the rail. [2]

(b) Suggest one way the designer of the fence could have reduced the force needed to raise the rail.

- *Reduce weight/mass of rail OR thinner rail*
- *Open sideways* *[1]*

etc.

[1]

4 Fig. 4.1 shows a can of compressed air that is being used to blow dust off a computer keyboard.

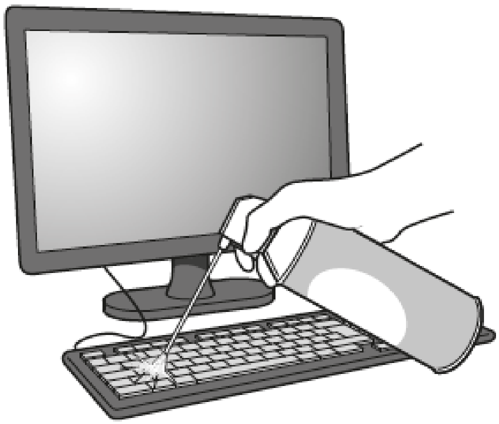


Fig. 4.1

The pressure of the air inside the can is greater than the pressure of the atmosphere.

(a) State what is meant by the term *pressure*.

Force acting per unit area. *[1]*

[1]

(b) Using ideas about molecules and the definition of pressure, explain why the pressure of the air inside the can decreases as it is used.

Using ideas about molecules:

- *Less molecules per unit volume/ Less molecules in same volume* *[1]*
- *Frequency of collisions with walls decreases* *[1]*

Using definition of pressure:
Less force acting on the same area of the walls *[1]*

[3]

5 Fig. 5.1 shows a water manometer used to measure the pressure inside a gas pipe.

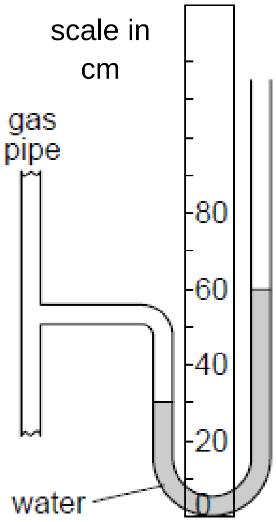


Fig. 5.1

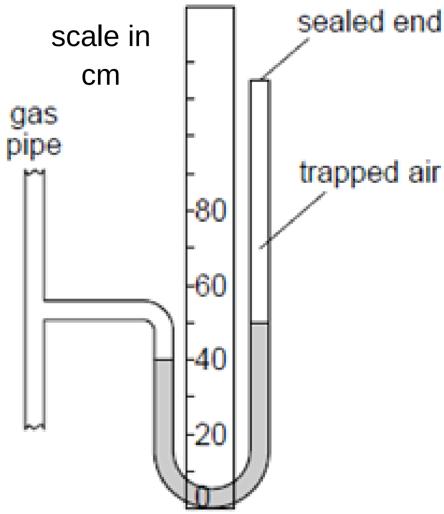


Fig. 5.2

(a) In Fig. 5.1,

(i) state and explain whether the pressure inside the gas pipe is larger than or smaller than atmospheric pressure.

Larger than atmospheric pressure. *[1]*

The higher gas pressure exerts a larger force on the water on the left limb of the monomer and hence pushes the water level to a lower level. *[1]*

[2]

(ii) the atmospheric pressure is 100 kPa and the density of water is 1000 kg/m^3. The gravitational field strength is 10 N/kg.

Calculate the pressure inside the gas pipe.

$P = \rho g \Delta h + P_{atm}$

$= (1000)(10)(30 \div 100) + 100\,000$ *[1]*

$= 3000 + 100\,000$

$= \underline{103\,000 \text{ W}}$ (3 s.f.) *[1]*

pressure = ... [2]

(b) In Fig. 5.2, the manometer shown has its top end sealed.

Explain why the water levels are different in Figs. 5.1 and 5.2, even though the pressure in the gas pipe is the same.

The trapped air exerts a pressure larger than atmospheric pressure *[1]*

[1]

6 Fig. 6.1 shows a mercury-in-glass thermometer made using a glass capillary tube.

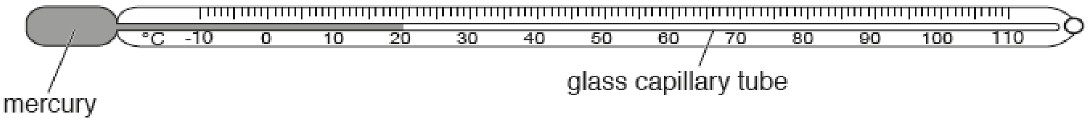


Fig. 6.1

(a) Describe how to check that the 100 °C mark is in the correct position on the thermometer.

Place a thermometer into steam above pure boiling water, at a pressure of one atmosphere. *[1]*

When the reading of the mercury level stabilizes, the level should be at the 100 °C mark *[1]*

[2]

(b) Some thermometers contain ethanol instead of mercury.

A second glass capillary tube is identical to the tube in Fig. 6.1, except that it has no markings on the glass. This tube is used to make an ethanol-in-glass thermometer. The volume of the ethanol in this thermometer is equal to the volume of mercury in the thermometer in Fig. 6.1.

The thermal expansion of ethanol is more than that of mercury.

State, and explain, how the maximum possible temperature measured by the ethanol-in-glass thermometer differs from that of the thermometer in Fig. 6.1.

Maximum possible temperature which can be measured by the ethanol-in-glass thermometer is smaller. *[1]*

The ethanol (thread) reaches the end of the tube at a lower temperature. *[1]*

[2]

7 A plastic ice tray has 16 sections filled with water. When placed in the ice box, the water freezes to form ice cubes. Each section contains a mass of 20 g of water that is initially completely liquid at a temperature of 0 °C. The specific latent heat of fusion of ice is 330 J/g.

(a) Calculate the amount of energy that must be taken from the tray of water to enable all the water in the tray to become ice at 0 °C.

$Q = ml_f$
$= (16 \times 20)(330)$ *[1]*
$= 105\ 600$
= <u>106 000 W</u> (3 s.f.) *[1]*

energy = ... [2]

(b) State why the heat capacity of the plastic tray does not affect the answer to **(a)**.

There is <u>no change in the temperature</u> of the plastic tray/ the plastic tray <u>does not change state</u>. *[1]*

.... [1]

(c) The ice box takes energy from the water at a rate of 30 W. Estimate the time taken for all the water in the tray to become ice.

$P = \Delta Q \div t$
$30 = 105\ 600 \div t$
$t = 105\ 600 \div 30$
= <u>3520 s</u> (3 s.f.) *[1]*

time = ... [1]

8 Some medical processes involve the use of ultrasound.

(a) State what is meant by *ultrasound*.

Sound having frequencies above the audible frequency of human beings. *[1]*

[1]

(b) Explain briefly how ultrasound is used in pre-natal scanning.

The ultrasound is transmitted into the body. *[1]*

An echo / reflection is produced from the baby / fetus. *[1]*

[2]

9 A 600 Ω resistor and a thermistor are connected in series with an ammeter and a 20 V d.c. power supply. A voltmeter is in parallel with the resistor.

Fig. 9.1 is the circuit diagram.

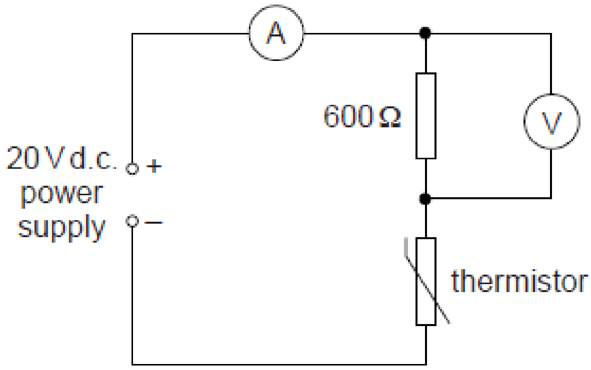


Fig. 9.1

The ammeter reads 0.025 A.

(a) Calculate

(i) the reading on the voltmeter,

V across resistor = IR
= (0.025)(600) *[1]*
= 15.0 V (3 s.f.) *[1]*

reading = ... [2]

(ii) the resistance of the thermistor.

V across thermistor = 20 - 15.0 = 5 V *[1]*

R of thermistor = V ÷ I = 5 ÷ 0.025 = 200 Ω (3 s.f.) *[1]*

Or: Total R of circuit = V ÷ I = 20 ÷ 0.025 = 800 Ω
R of thermistor = 800 - 600 = 200 Ω (0 d.p.)

resistance = ... [2]

(b) The temperature of the thermistor increases.

State what, if anything, happens to

(i) the resistance of the thermistor,

Decreases.
(Or: Increases.) [1]

(ii) the ammeter reading and to the voltmeter reading.

ammeter reading: *Increases.* *(Or: Decreases.)*

voltmeter reading: *Increases.* *(Or: Decreases.)*

[1]

10 Fig. 10.1 shows a mains extension lead. The six sockets allow several electrical appliances to be connected to the mains supply through one cable.

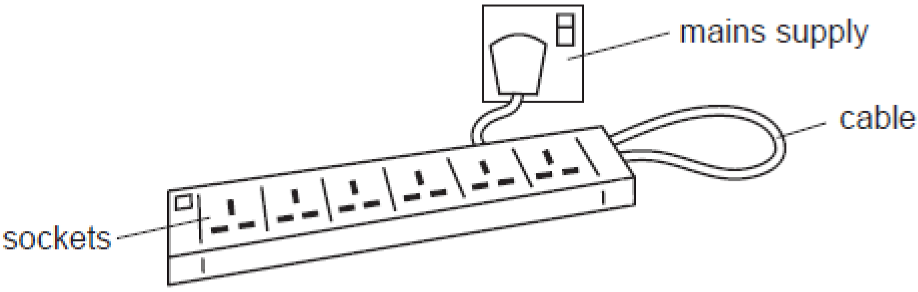


Fig. 10.1

(a) The cable connects the sockets to the mains supply.

The cable contains three wires: live, neutral and earth. State what is meant by

(i) *live,*

Live wire is the wire at high potential. *[1]*

[1]

(ii) *earth.*

Earth wire is a low-resistance wire that is connected to the ground. *[1]*

[1]

(b) Six powerful lamps are plugged into the sockets and switched on, one by one.

(i) State and explain what happens in the cable as the lamps are switched on, one by one.

The current in the cable increases. *[1]*
Reason: The lamps are connected in parallel and resistance decreases. *[1]*

Or:
The cable heats up.
Reason: The current in the cable increases. [2]

(ii) Explain why it can be dangerous when a fuse of the wrong value is used in the plug.

If a larger than normal fuse rating is used, a very large current can pass through the cable. *[1]*
This may melt the wire and cause an electrical fire. *[1]*
Or:
If a larger than normal fuse rating is used, a large current is allowed to pass through and the appliance may still work. However, the fault in the appliance/ circuit is still not corrected.
[Note: 'Fuse will blow/ melt' is not accepted.] [2]

11 A length of flexible, slack wire is fixed at A and B so that part of it is held vertically in the field of a horseshoe magnet, as shown in Fig. 11.1.

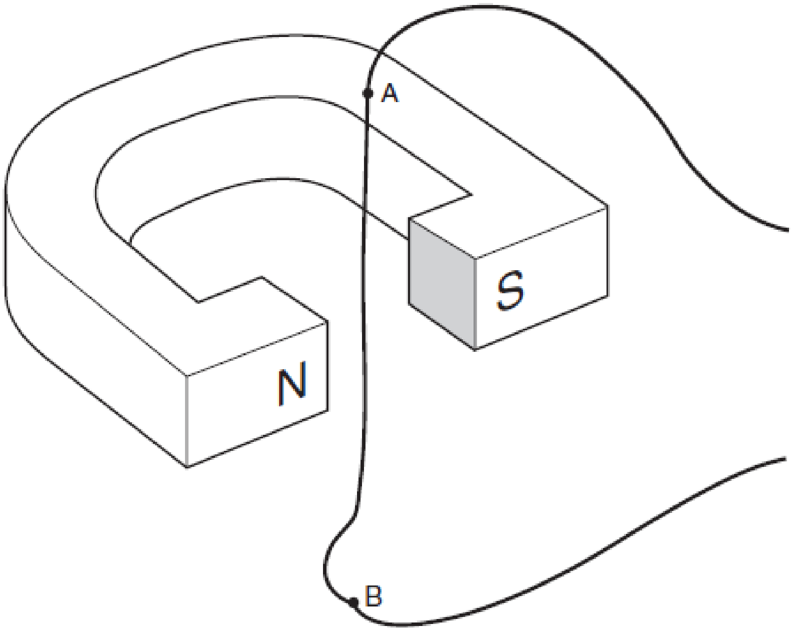


Fig. 11.1

Figs. 11.2 and 11.3 each show the same section through the apparatus. The wire between A and B is not shown.

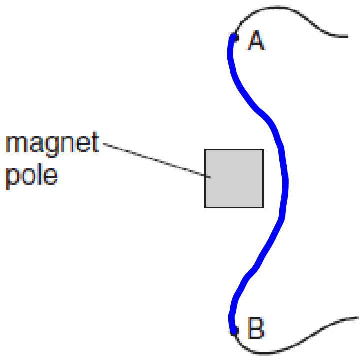


Fig. 11.2

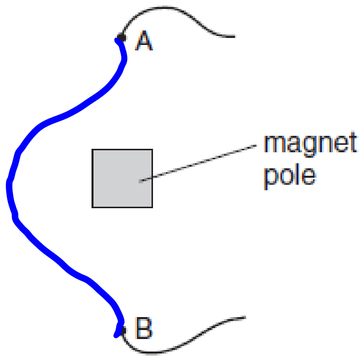


Fig. 11.3

(a) **(i)** On Fig. 11.2, draw what the wire might look like when a large current flows from A to B . [1]

(ii) Using ideas about magnetic fields, explain why the wire looks like this.

The magnetic field due to the current interacts with the magnetic field of the magnet. *[1]*

A resultant unbalanced magnetic field is produced such that the left side is stronger. *[1]*

[2]

(b) On Fig. 11.3, draw what the wire might look like if the current in **(a)** is larger **and** reversed in direction. [1]

12 A transformer has an output of 24 V when supplying a current of 2.0 A. The current in the primary coil is 0.40 A and the transformer is 100% efficient.

(a) Calculate

(i) the power output of the transformer,

P = IV
= (24)(2.0)
= 48.0 W (3 s.f.) *[1]*

power = ... [1]

(ii) the voltage applied across the primary coil.

Primary power = Secondary power
48.0 = (0.40)V
V = 120 V (3 s.f.) *[1]*

voltage = ... [1]

(b) **(i)** State one reason why the transformer may not be 100% efficient.

- *Heat loss due to resistance of the coils*
- *Leakage of magnetic field lines between the primary and secondary coils* *[1]*
- *Heat loss due to eddy currents induced in the iron core* [1]

(ii) Explain briefly how the transformer changes an input voltage into a different output voltage.

The larger the number of turns the secondary coil has, the larger the change in magnetic field linked to the secondary coil. *[1]*

The e.m.f. induced in the secondary coil will thus be larger. *[1]*

....

.... [2]

Section B	☐ s.f. ☐ formula	30

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

PHYSICS **6091/02**

Paper 2 Theory

12 September 2018
1 hour 45 minutes

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

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Q13**.

13 Wind is a cheap and renewable energy source. Wind turbines provide electrical energy by making use of wind to turn its turbine blades, which in turn spins a coil placed between two permanent magnets.

Wind turbines come in various sizes and have various power ratings. Fig. 13.1 shows one of the smallest wind turbines for domestic use while Fig. 13.2 shows the generator connected to the turbine blades.

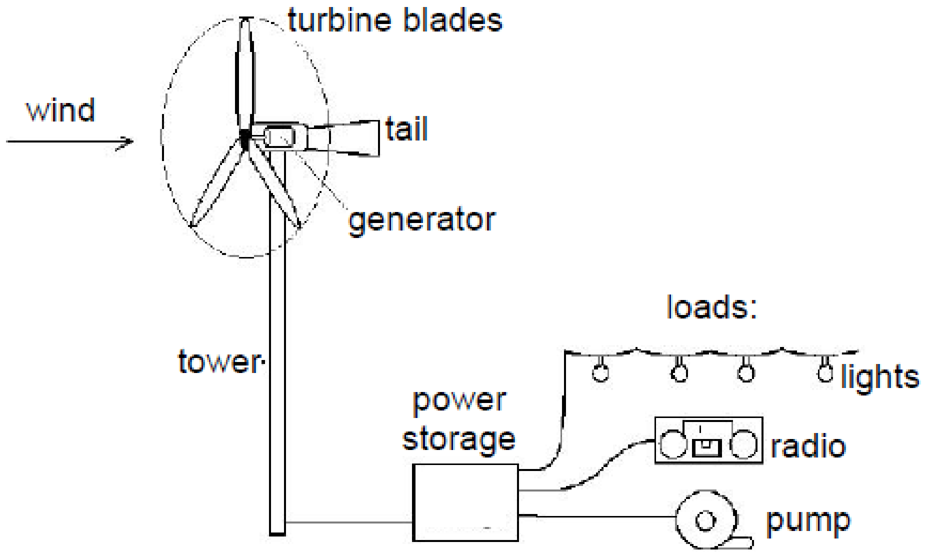


Fig. 13.1

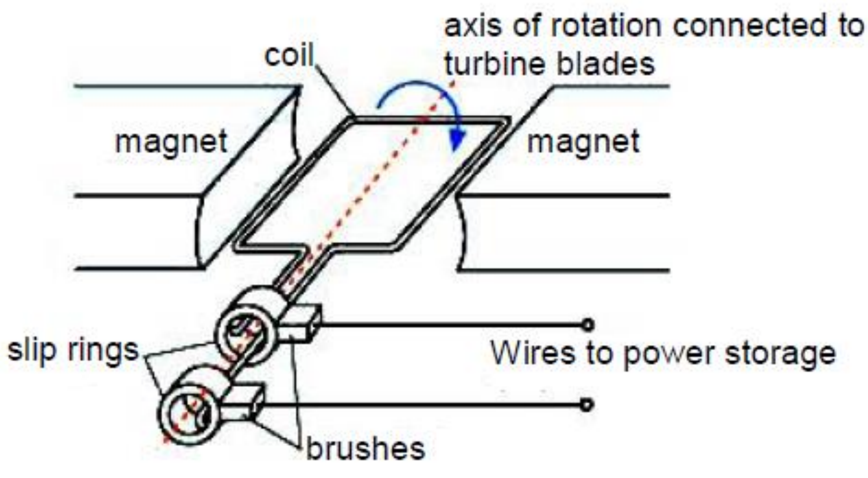


Fig. 13.2

Fig. 13.3 shows the specification of the wind turbine.

blade diameter	2.7 m
cut-in wind speed	2.5 m/s
cut-out wind speed	15 m/s
rated wind speed	9.0 m/s
maximum output power	650 W
output voltage	48 V (a.c.)
average annual energy output	1997 kWh

Fig. 13.3

Fig. 13.4 shows the electrical power generated by the wind turbine at different wind speeds.

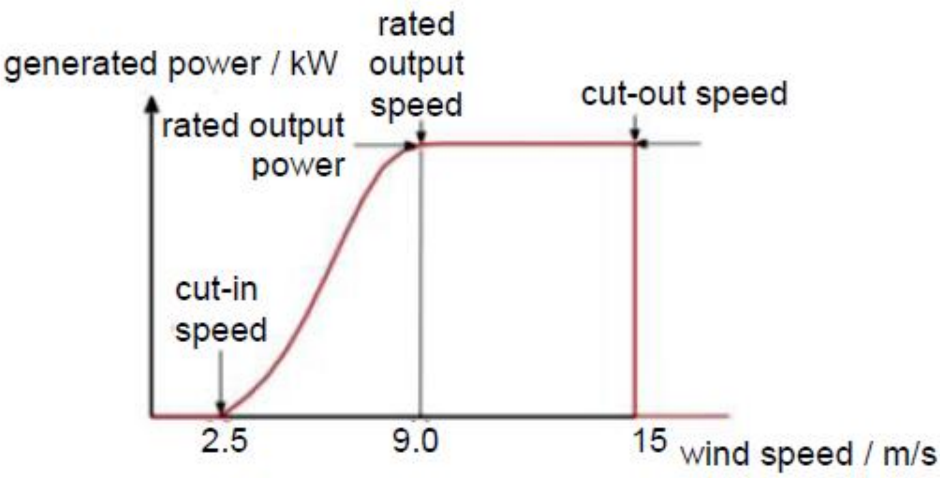


Fig. 13.4

(a) In Fig. 13.2, explain

(i) the purpose of the slip rings and brushes arrangement.

Slip rings: To prevent the coil from entangling. *[1]*

Carbon brushes: To reduce friction with the slip rings as the coil rotates. *[1]*

[1]

(ii) why work needs to be done to produce the induced e.m.f.

According to Lenz's Law, *[1]*

work has to be done against the force that is produced due to the interaction of the magnetic fields of the induced current and magnets [1]

(b) **(i)** State the wind speed at which the turbine blades first start to turn.

Suggest why the turbine blades would only start turning at this speed.

2.5 m/s. *[1]*

At this speed, there will be enough force to overcome the friction between the moving parts of the turbine. *[1]*

[2]

(ii) At a wind speed of 15 m/s, brakes are immediately employed to bring the turbine to a standstill.

Suggest why this is necessary.

To prevent overheating of the electrical cables in the turbine (when too high a current is produced). *[1]*

[1]

(c) The coil of the generator rotates 1.5 times in each second when the wind speed is 15 m/s.

On Fig. 13.5 below, sketch a labelled graph of e.m.f. against time, for a time interval of one second from the instant the generator starts turning from the position shown in Fig. 13.2.

[2]

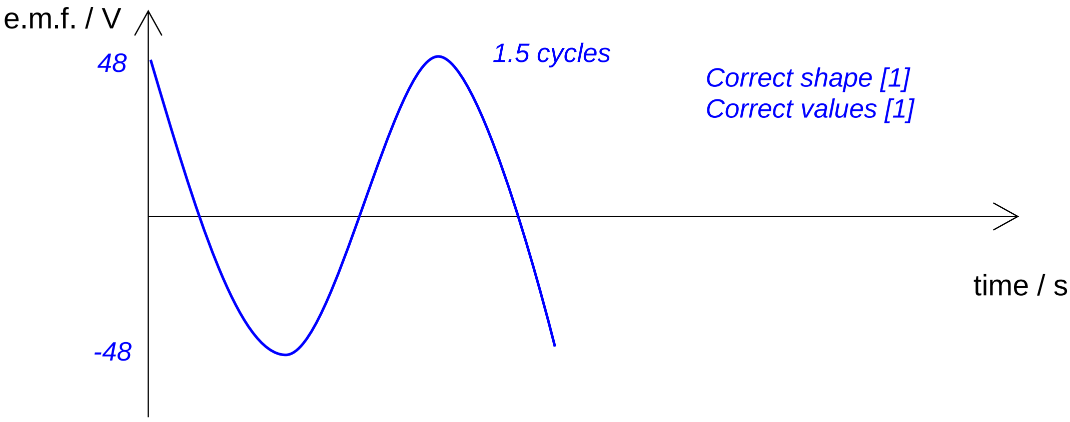


Fig. 13.5

(d) A suggestion was made for a small home to be run solely on this wind turbine.

Assuming that on an average day, the electrical needs of the home are:

electrical needs	power consumption	no. of hours used
lights	600 W	6
radio	20 W	12
water pump	750 W	3

(i) Calculate the energy needed for a day.

Total energy needed = (No. of kWh)(No. of hours)
= (0.600)(6) + (0.020)(12) + (0.750)(3) *[1]*
= 6.09 kWh (3 s.f.) *[1]*

energy = ... [2]

(ii) Hence, explain if this suggestion is suitable.

Energy supplied by wind turbine in a day = 1997 ÷ 365 = 5.47 kWh

The suggestion is not suitable, as the energy supplied by wind turbine is less than the energy required in 1 day. [1]

14 **(a)** Fig. 14.1 shows a ray of light passing through the edge of a converging lens.

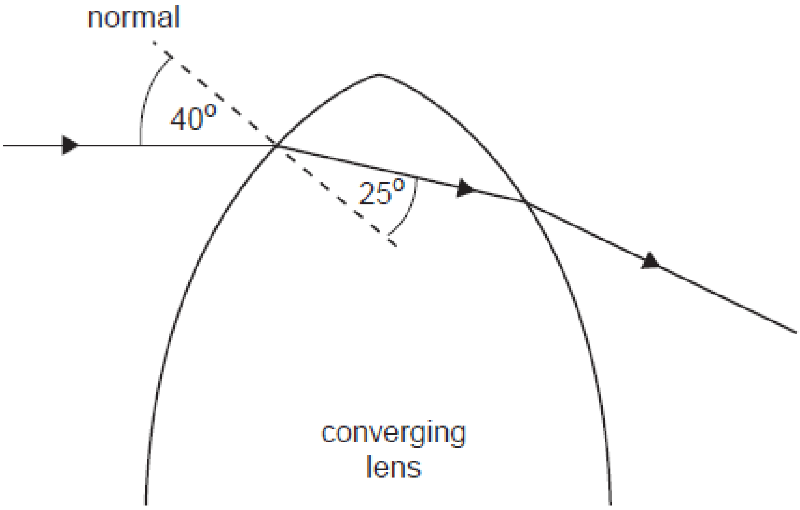


Fig. 14.1

(i) State and explain what happens to the direction of the ray of light as it enters the lens.

As it enters the lens, it bends towards the normal. *[1]*

This is due to the speed of light decreasing as it enters an optically denser medium *[1]*

[2]

(ii) Calculate the refractive index of the glass used in the lens.

n = (sin i) ÷ (sin r)

= (sin 40°) ÷ (sin 25°) *[1]*

= 1.52 (3 s.f.) *[1]*

refractive index = ... [2]

(b) An object is placed 2 cm from the lens and a virtual image is formed 5 cm from the lens.

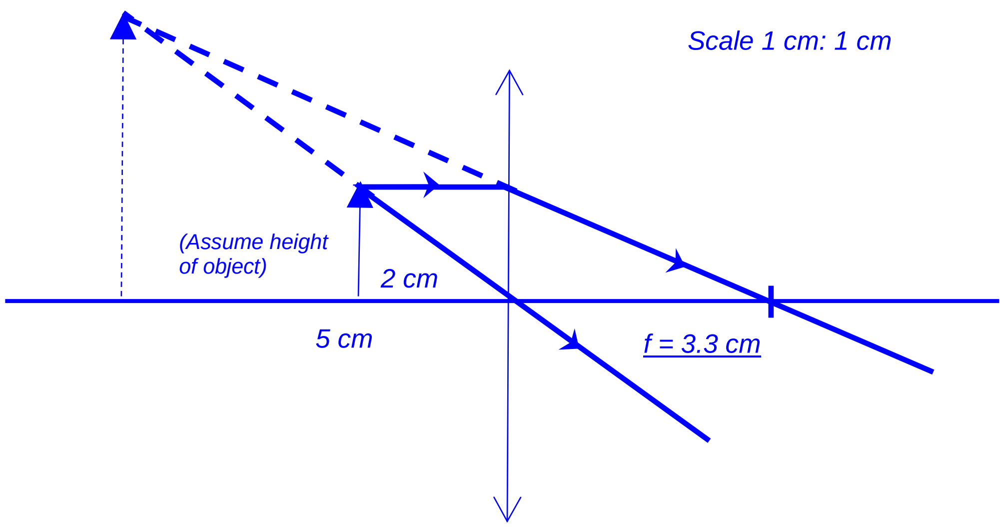
(i) State what is meant by the *focal length* of a lens.

Distance between the principal focus/ focal point and the centre of lens. [1]

[1]

(ii) Draw a ray diagram to scale to show the formation of the image. [3]

Hence determine the focal length of the lens.



- *Correct image (dotted lines) [1]*
- *Correct ray diagram [1]*
- *Correct scale [1]*

- *Focal length correctly determined: accept 3.2 to 3.4 cm [1]*

focal length = ... [1]

(iii) State **two** other properties of the image.
- *Enlarged/ magnified (Not accepted: 'larger')*
- *Upright*
- *Same side as object from lens*

(Any 2)

[1]

15 EITHER

Fig. 15.1 shows a large container ship travelling at constant speed in a straight line.

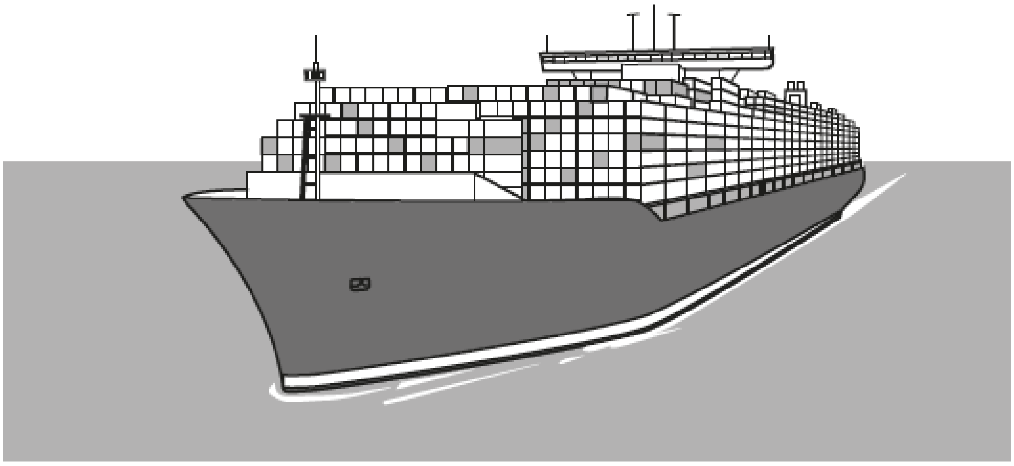


Fig. 15.1

The resistive force acting on the ship is 2.8×10^6 N.

(a) The speed of the ship is 9.7 m/s.

(i) Calculate the work done against the resistive force on the ship in 10 s.

Work done = Fs

= $(2.8 \times 10^6 \text{ N})(9.7 \times 10)$ *[1]*

= $\underline{2.72 \times 10^7 \text{ J}}$ (3 s.f.) *[1]*

work done = ... [2]

(ii) The engines are powered by oil.

State the energy transfer that is taking place when the ship is travelling at constant speed.

chemical potential energy (of ship) → thermal energy (of ship and water)

.... [1]

(b) The mass of the ship is 2.2×10^8 kg. The engines are switched off and the resistive force causes the ship to decelerate.

(i) Calculate the initial deceleration of the ship.

$F_R = ma$

Deceleration = $F_R \div m$
= $(2.8 \times 10^6) \div (2.2 \times 10^8)$ *[1]*
= 0.0127 m/s² (3 s.f.) *[1]*

deceleration = ... [2]

(ii) As the speed of the ship decreases, its deceleration changes.

1. Suggest and explain how the deceleration changes.

The deceleration decreases. *[1]*

The resistive force decreases as the speed decreases. *[1]*

.... [2]

2. On Fig. 15.2, sketch a possible speed-time graph for the ship as it decelerates to rest.

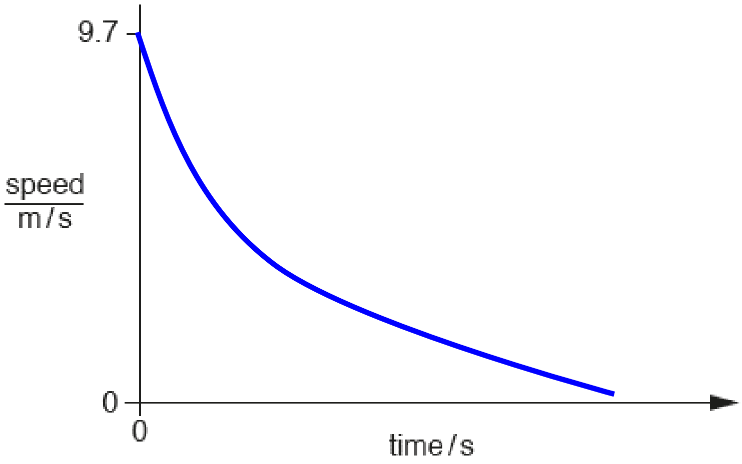


Fig. 15.2

[2]

(c) When the ship is travelling at a different speed, energy is being supplied to the engines at a rate of 33 MJ/s. The efficiency of the engines is 0.36 (36%).

Calculate the rate at which energy is wasted in the engines.

Efficiency = Useful power output ÷Total power input
0.36 = Useful power output ÷ 33
Useful power output= $0.36 \times 33 = 11.88 = 11.9$

Wasted power = 33 - 11.88 = 21.12 = 21 MJ/s (2 d.p.)

rate at which energy is wasted = ... [1]

15 OR

Thin wire, covered in plastic insulation, is used to make a solenoid (long coil). The solenoid is connected to a sensitive ammeter. Fig. 15.3 shows the N-pole of a steel magnet placed next to the solenoid.

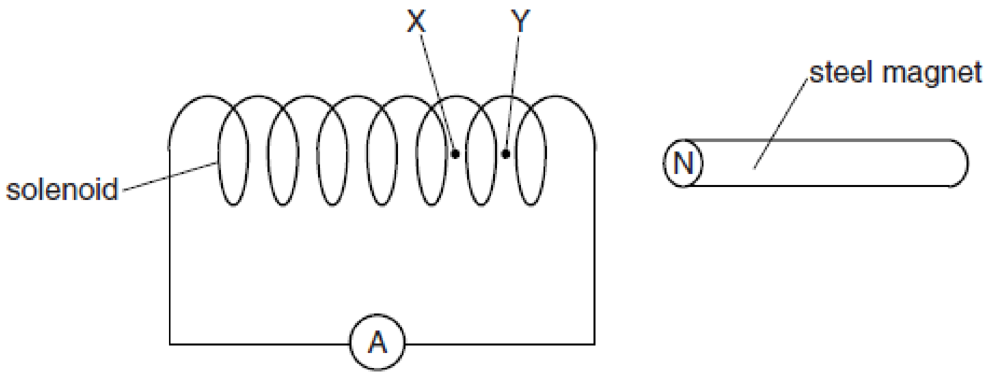


Fig. 15.3

Point X and point Y are on the axis of the solenoid.

(a) **(i)** Explain why plastic is an electrical insulator.

Plastic does not contain free electrons. *[1]*

[1]

(ii) Explain why the magnet is **not** made from

1. aluminium,

Aluminium is not a magnetic material, and e.m.f. cannot be induced.

[1]

2. iron.

Iron is used to make temporary magnets, and the magnetism will be lost easily.

[1]

(b) In one experiment, the magnet in Fig. 15.3 is moved to the left and passes into the solenoid.

The N-pole of the magnet travels from Y to X at a constant speed. As it moves, the ammeter shows a small current.

(i) Explain why there is a current in the solenoid when the magnet is moving.

The solenoid experiences a change in magnetic field/ magnetic flux linkages. *[1]*

An e.m.f. is induced, and hence a current as the circuit is closed. *[1]*

[2]

(ii) The N-pole travels from Y to X in 0.14 s. As it moves, the current shown on the ammeter is 0.045 mA.

Calculate the charge that passes through the solenoid as the N-pole moves from Y to X.

$I = Q \div t$

$Q = It$

$= (0.045 \times 10^{-3})(0.14)$ *[1]*

$= 6.30 \times 10^{-6}$ C or 0.0030 mC (3 s.f.) *[1]*

charge = ... [2]

(c) In a second experiment, the speed of the N-pole is greater than its speed in the first experiment. It now takes only 0.070 s to travel from Y to X. A current in the same direction is shown on the ammeter.

The same quantity of charge passes through the coil in both the first and second experiments.

Explain why this is the case.

Though the time was halved, the current was doubled.

[Note: since Q = It & greater speed resulted in larger induced current]

[1]

(d) State two ways in which the equipment shown in Fig. 15.3 can be used to produce a current in the solenoid that is in the opposite direction.

1.
- *Insert S-pole (at same end)*
- *Insert (N-pole) at other end or from other direction*

2.
- *Withdraw N-pole (from same end implied)*
- *Withdraw S-pole from other end or pass through completely*

[2]