Cat High

Section A

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

For Examiner's Use

1 Fig. 1.1 shows a simple pendulum that oscillates between the points A and D with a period of 0.72 s.

Point B is the equilibrium position of the pendulum.

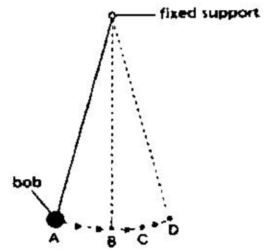


Fig. 1.1

(a) Explain what is meant by '*the period is 0.72 s*'.

.... [1]

(b) The bob is released from rest at point A. Determine the time required for it to reach point B.

time = ... [1]

(c) Explain why a student measuring the period should start timing when the pendulum bob is at point B, instead of point A or D.

....

....

....

.... [2]

(d) State and explain the effect on the period if the simple pendulum in Fig. 1.1 is replaced with a uniform iron rod of the same length.

....

.... [2]

For Examiner's Use

2 A climber of weight 720 N is rappelling down a cliff. At the instant shown in Fig. 2.1, he is stationary and in a state of equilibrium.

The rope makes an angle of θ with the vertical, and the cliff exerts a force F of 300 N on the feet of the climber. This force F is directed at 22° above the horizontal.

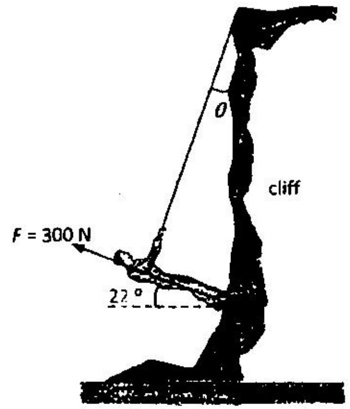


Fig. 2.1

(a) State the conditions for a body to be in equilibrium.

....

....

....

.... [2]

(b) In the space below, draw a scaled diagram to show the forces acting on the climber.

Determine the magnitude of the tension in the rope, and the angle θ it makes with the vertical.

tension = ...

θ = ...

[3]

(c) The force F can be said to be the resultant of two forces acting on the climber. One of them is the normal contact force by the cliff on him.

State the other force that acts on the climber, and state its direction.

....

.... [2]

3 Fig. 3.1 shows a glass tube dipped into mercury. A vacuum pump is connected to the top of the tube and switched on. The mercury rises up the tube and stops.

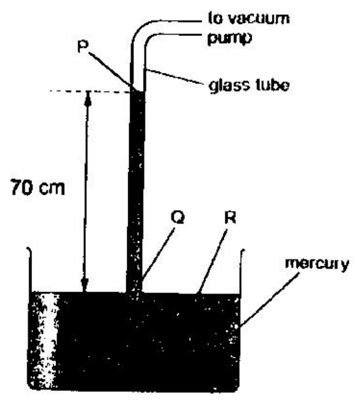


Fig. 3.1

(a) Three points on Fig. 3.1 are labelled P, Q and R.

State which of these point(s) is/are at atmospheric pressure.

.... [1]

(b) The density of mercury is 13 600 kg m^{-3} and the gravitational field strength is 10 N kg^{-1}.

Calculate the pressure due to the 70 cm long column of mercury.

pressure = ... [2]

(c) A student observes that the pressure calculated in **(b)** is lower than the atmospheric pressure. Suggest a reason for this.

.... [1]

(d) State and explain what happens if the mercury is replaced with water.

....

....

.... [2]

4 Fig. 4.1 below shows the structure of a simple periscope used at sporting events to see over the heads of the crowd.

For Examiner's Use

The critical angle of the material used in the prisms must be less than 45°.

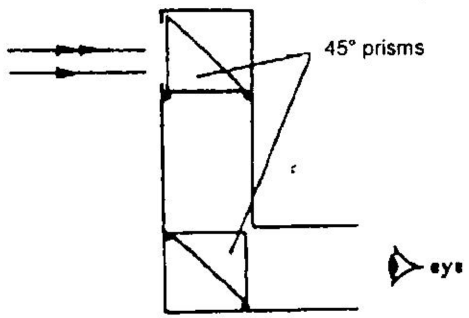


Fig. 4.1

(a) On Fig. 4.1, complete the paths of the two light rays through the periscope to the eye. [2]

(b) Given that dispersion of light can occur in a prism, explain why light of different colours will take the same paths through the prism.

....

....

.... [2]

(c) Is the image right way up or inverted? Explain your answer.

....

....

.... [2]

(d) Determine the smallest possible refractive index for the material of the prisms.

smallest refractive index = ... [2]

5 Two identical large shallow dishes are filled with water at 30 °C as shown in Fig. 5.1.

For Examiner's Use

Dish K is **covered** while dish L is not. A steady stream of air is blown over both dishes.

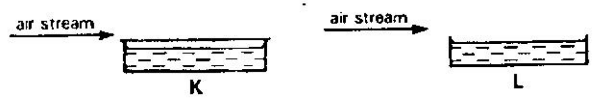


Fig. 5.1

(a) Using ideas about molecules, explain why

(i) the water in dish L cools down,

....

....

....

.... [2]

(ii) the volume of water in dish L decreases more rapidly than that in dish K.

....

....

....

.... [2]

(b) The water in dish L reaches 25 °C and is found to have a mass of 1.5 kg. Dish L is then placed in the freezer.

(i) The water cools from 25 °C to 0 °C in a time of 60 minutes. The specific heat capacity of water is $4.2\ J\ g^{-1}\ °C^{-1}$.

Calculate the thermal energy removed from the water as it cools from 25 °C to 0 °C.

energy removed = ... [2]

(ii) After the water has reached 0 °C, thermal energy is removed from the water at the same rate in **(b)(i)**.

The specific latent heat of fusion of water is $3.3 \times 10^5\ J\ kg^{-1}$.

Calculate the mass of water at 0 °C that becomes ice in 60 minutes.

mass = ... [2]

6 Fig. 6.1 shows the wavefronts of a water wave in deep water in a ripple tank. The frequency of the water wave in deep water is 5.0 Hz.

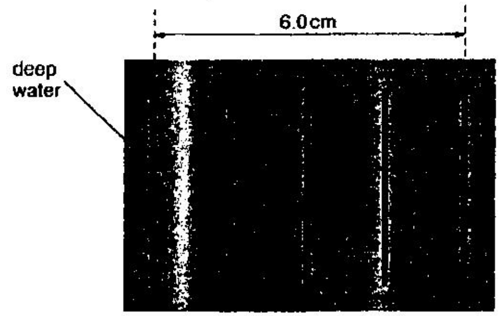


Fig. 6.1

(a) Explain what is meant by ***wavefronts***.

....

.... [1]

(b) Calculate the speed of the wave in deep water.

speed = ... [3]

(c) The water wave passes from deep water into shallow water.

State and explain how this affects the wavelength of the wave.

....

....

....

.... [2]

7 Fig. 7.1 shows two horizontal plates X and Y connected to a high potential difference source. An uncharged conducting sphere is introduced into the region between the plates as shown.

Fig. 7.1

(a) State the sign of the charges on each plate when the switch S is closed.

Plate X ....

Plate Y .... [1]

(b) Indicate on Fig. 7.1 the charges induced on the conducting sphere. [1]

(c) The sphere falls towards plate Y.

Explain why the fall takes place and state what happens to the charges on the sphere as it makes contact with plate Y.

....

....

....

....

.... [2]

8 Fig. 8.1 shows the variation of the output voltage of an ideal transformer with time. The transformer has 100 turns on the primary coil and 200 turns on the secondary coil.

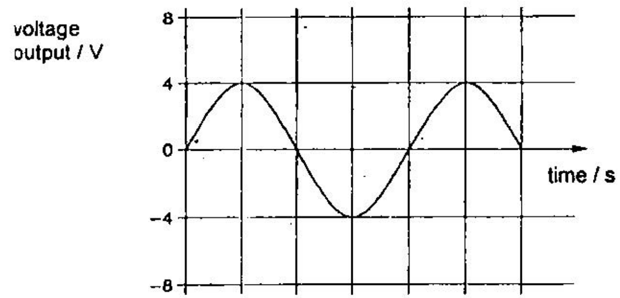


Fig. 8.1

(a) Explain what is meant by the transformer is *ideal*.

....

.... [1]

(b) Draw on Fig. 8.1 the new output voltage, if the number of turns on the secondary coil is increased to 300 while that of the primary coil remains unchanged. [2]

(c) The transformer is used to step up the voltage at the power station before the electrical power is supplied to homes and factories.

Explain why electrical power is transmitted at high voltage.

....

....

....

.... [2]

End of Section A

Section 2B	☐ s.f. ☐ formula	30

Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination 3
Secondary 4

PHYSICS — **5059/02**

Paper 2 Theory

13 September 2016
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 **Question 11**.

9 A bungee jumper falls from a bridge above a river, as shown in Fig. 9.1.

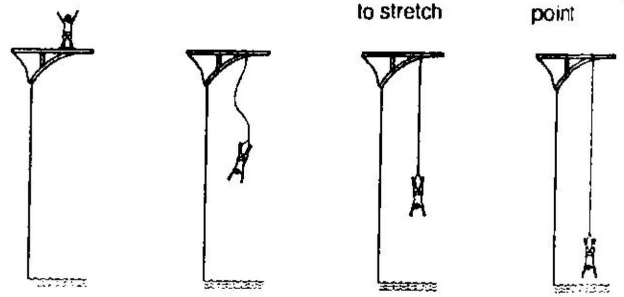


Fig. 9.1 (not drawn to scale)

The man starts from position A. The elastic cord starts to stretch at position C and he stops for the first time at position D. He continues to rise and fall after that.

Fig. 9.2 shows how the velocity of the man varies with time t.

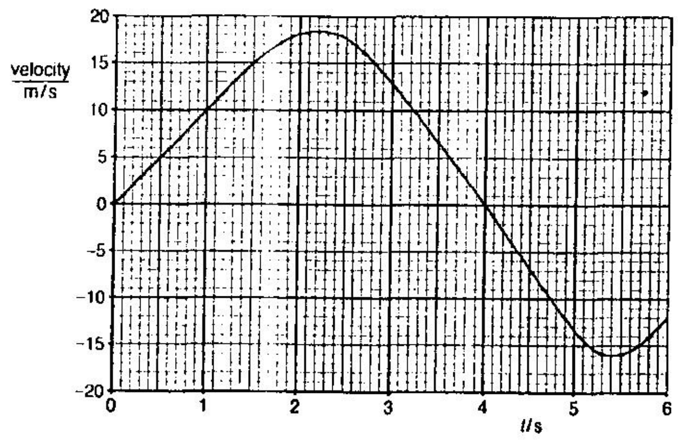


Fig. 9.2

(a) **(i)** State what is meant by ***velocity***.

....

.... [1]

(ii) State the difference between a positive velocity and a negative velocity.

.... [1]

(b) **(i)** State the **first** time interval for which the acceleration is uniform.

.... [1]

(ii) Using values from Fig. 9.2, determine the acceleration of the man for the time interval mentioned in **(b)(i)**.

acceleration = ... [2]

For Examiner's Use

(iii) Comment on your value of acceleration.

....

.... [1]

(c) (i) State the value of t when the man is at position D.

.... [1]

(ii) State and explain, in terms of the forces acting, the direction which the man is accelerating at position D.

....

....

....

.... [3]

10 (a) State the *Principle of Conservation of Energy*.

....

....

.... [2]

(b) A worker needs to move a box of mass 40 kg from the ground to the back of a truck as shown in Fig. 10.1.

The box moves 5.0 m along the ramp, which is inclined at an angle of 20 ° to the horizontal. The ramp is assumed to be frictionless.

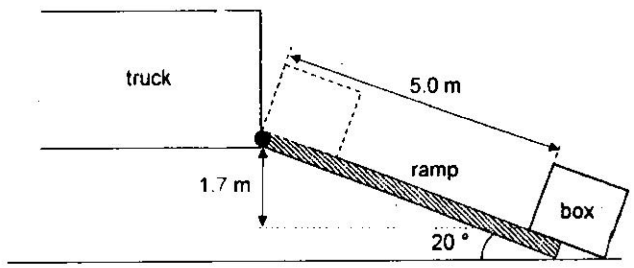


Fig. 10.1

(i) The worker gives a ***momentary*** push to the box to move it up the ramp.

Calculate the initial speed that the worker must impart to the box for it to reach the back of the truck. Take the gravitational field strength to be 10 N kg^{-1}.

speed = ... [3]

(ii) State the advantage of pushing the box up the ramp with a constant force, instead of lifting it up directly onto the truck.

....

.... [1]

(iii) Another worker proposes using a longer ramp inclined at a smaller angle of 15 ° to the horizontal. He claims that less work need to be done to get the box into the truck.

Comment on his claim.

....

....

....

.... [2]

(c) The truck in **(b)** accelerates uniformly, from a velocity of 2.0 m s^{-1} to 5.0 m s^{-1} in 3.0 s.

If the total mass of the truck and its contents is 2500 kg, calculate the additional work done by the engine in this time.

work done = ... [2]

11 EITHER

Fig. 11.1 shows an electromagnetic relay connected to a cell and a switch.

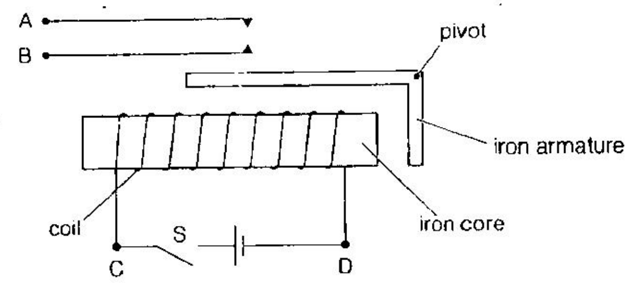


Fig. 11.1

(a) On Fig. 11.1, mark the north and south poles of the iron core when the switch S is closed. [1]

(b) Explain how the relay is used to close the contacts between A and B.

....

....

....

.... [2]

(c) Explain why the core is made of iron and not steel.

....

....

.... [2]

(d) Fig. 11.2 shows the relay with its switch S and cell removed and connected to a circuit with a 12 V battery. The resistance of the thermistor, X decreases with temperature.

The coil has to close the contacts A and B for the bell to ring. The bell is not ringing at the instant shown.

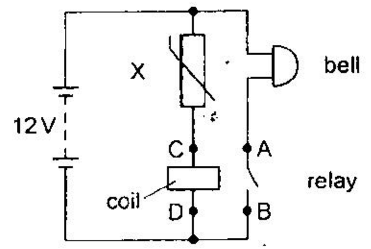


Fig. 11.2

(i) Explain why the bell rings when the temperature of the thermistor, X rises.

....

....

....

.... [2]

(ii) When the resistance of X is 2000 Ω, the current flowing in the coil is 1.5 mA. This causes the contacts between A and B to close. The resistance of the bell is 200 Ω. Calculate

1. the potential difference across X,

potential difference = ... [2]

2. the current in the battery.

current = ... [1]

11 OR

The vibrations of a guitar string are picked up by a small coil of wire wound round a cylindrical magnet as shown in Fig. 11.3.

The string is made from steel. When it vibrates, an electrical signal is generated between the terminals of the coil.

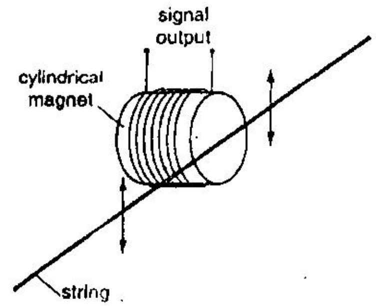


Fig. 11.3

(a) (i) State *Faraday's Law of Electromagnetic Induction.*

....

....

.... [2]

(ii) Use Faraday's Law to explain why an electrical signal is generated.

....

....

....

.... [2]

(iii) Explain why no signal will be picked up if the guitar string is made from nylon.

....

....

.... [2]

For Examiner's Use

(b) Fig. 11.4 shows the display on the C.R.O. screen when a signal from the guitar is fed into it. The time base on the screen is set to 2.0 ms/cm.

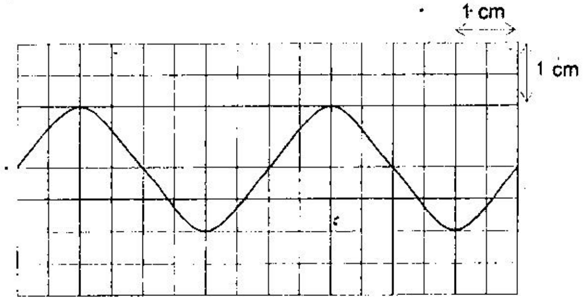


Fig. 11.4

(i) Calculate the frequency of the sound produced.

frequency = ... [2]

(ii) Draw on Fig. 11.4 the signal displayed on the C.R.O. screen when the frequency of the sound is doubled and its loudness is halved.

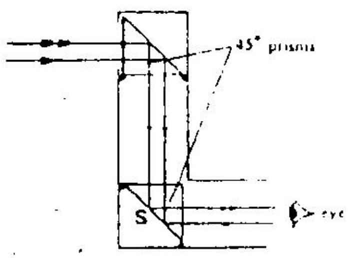
[2]

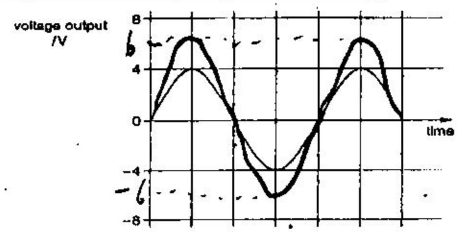
End of Section B

ANSWERS

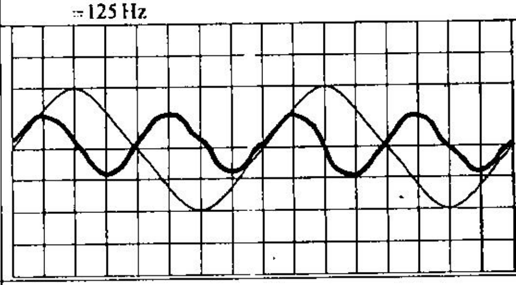
Catholic High 2016 – Physics Sec 4 Preliminary Examination 3

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

1	(a)		The time for one complete oscillation is 0.72 s.	1
	(b)		$\text{time} = \frac{0.72}{4} = 0.18\text{ s}$	1
	(c)		The pendulum is momentarily at rest at points A and D. So the student will not know when exactly to start his stopwatch. The pendulum bob moves with a non-zero speed at point B so the moment to start timing is more clearly defined.	2
	(d)		The period will be shorter. The mass distribution of the pendulum is changed with a uniform rod and its centre of gravity shifts nearer to the fixed support.	2
2	(a)		Resultant force on the body is zero. Resultant moment about any point on the body is zero.	2
	(b)		 Scale 1.0 cm : 100 N Tension = 670 N Θ = 24°	3
	(c)		Friction between the climber's feet and the cliff. It is acting in the direction up the cliff.	2
3	(a)		Q and R	1
	(b)		$P = h\rho g$ $= 0.70 \times 10 \times 13600$ $= 95200\text{ Pa}$	2
	(c)		The vacuum pump cannot create a perfect vacuum in the glass tube.	1
	(d)		The water column will be longer as water has a lower density so a longer column is required to exert the same pressure as mercury.	2
4	(a)			2

	(b)		There is no refraction as the light enters and leaves each prism. At the surfaces where total internal reflection occurs, the angle of incidence equals angle of reflection for all colours of light. So there is no dispersion of light.	2
	(c)		Right way up. The first prism inverts and the second prism reinverts the image.	2
	(d)		c must be lesser than 45°. $n > \frac{1}{\sin 45°}$ $n > 1.41$	2
5	(a)	(i)	The more energetic water molecules are able to escape from the water surface into the atmosphere. This causes the average kinetic energy of the remaining water molecules to decrease, leading to a decrease in temperature.	2
		(ii)	In dish K, some of the escaped water molecules return back to the water due to collision with air particles. For dish L, the escaped water molecules are quickly swept away by the air stream.	2
	(b)	(i)	$Q = mc\Delta\theta$ $= 1.5 \times 4200 \times (25 - 0)$ $= 15800\text{ J}$	2
		(ii)	$Pt = ml_f$ $m = \frac{157500}{60 \times 60} \times \frac{60 \times 60}{330000}$ $= 0.477\text{ kg}$	2
6	(a)		Imaginary lines joining adjacent points on the wave with the same phase.	1
	(b)		$\lambda = \frac{0.060}{4} = 0.015\text{ m}$ $v = f\lambda$ $= 5.0 \times 0.015$ $= 0.075\text{ m s}^{-1}$	3
	(c)		The wavelength decreases. The wave speed slows down in shallow water and since the frequency of the wave remains unchanged, the wavelength of the waves must have decreased (as $v = f\lambda$).	2
7	(a)		Plate X: Negative, Plate Y: Positive	1
	(b)			1
	(c)		The sum of the weight of the sphere and the downward electrostatic force on the negatively charged region of the sphere is greater than the upward force on the positively charged region of the sphere. The negative charges will flow from the sphere to Y on contact.	2
8	(a)		No power loss between the primary and secondary coils of the transformer.	1
	(b)			2

	(c)		Transmitting at high voltage causes the current in the cables to be small (as $P = VI$). This reduces the power loss due to heating in the cables ($P_{Loss} = I^2R$).	2
9	(a)	(i)	Rate of change of displacement.	1
		(ii)	They are in opposite directions.	1
	(b)	(i)	0 to 1.5 s	1
		(ii)	$a = \frac{v-u}{t}$ $= \frac{15-0}{1.5}$ $= 10\ \text{m s}^{-2}$	2
		(iii)	Equal to acceleration of free fall as the man's velocity is low so air resistance is negligible.	1
	(c)	(i)	4.0 s	1
		(ii)	The tension in the cord causes an upward force to act on him and this force increases as he is moving downwards. At D, this upward force is greater than his weight which is acting downwards, thus his acceleration is upwards.	3
10	(a)		Energy can neither be created nor destroyed. It can be transformed or transferred but the total amount in any (isolated) system must remain constant.	2
	(b)	(i)	By Principle of Conservation of Energy $\frac{1}{2}mv^2 = mgh$ $v = \sqrt{2gh}$ $= \sqrt{2 \times 10 \times 1.7}$ $= 5.8\ \text{m s}^{-1}$	3
		(ii)	Less force is required to push the box up the ramp.	1
		(iii)	Not true as the smaller force required to push the box up the ramp has to be applied over a larger distance (longer ramp). The work done should be the same by the principle of conservation of energy.	2
	(c)		$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$ $= \frac{1}{2}(2500)(5.0^2 - 2.0^2)$ $= 26300\ \text{J}$	2
11	Either			
	(a)		N S	1
	(b)		The iron core attracts the iron armature towards its S-pole when the switch is closed. This causes the armature to turn clockwise about its pivot and push the contacts A and B together.	2
	(c)		Iron retains its magnetism so the iron armature will still be attracted to the core even when the switch is opened. Thus the contacts A and B will not be apart.	2
	(d)	(i)	As the temperature of X (thermistor) rises, its resistance decreases, which causes the current through the coil to increase. This strongly magnetises the coil and closes the contacts A and B.	2
		(ii)	$V = IR$ $= 0.0015 \times 2000$ $= 3.0\ \text{V}$	2

		(iii)	I = sum of currents through the two branches $= 0.0015 + \frac{V}{R_{bell}}$ $= 0.0015 + \frac{12}{200} = 0.062\ \text{A}$	1
11	OR			
	(a)	(i)	The magnitude of the induced emf in a circuit is directly proportional to the rate of change of magnetic flux linkage in the circuit.	2
		(ii)	The cylindrical magnet magnetises the steel string. When the steel string vibrates, its magnetic field cuts the coil of wire, producing a continuously changing magnetic flux linkage in the coil. By Faraday's law, an emf which causes the signal is induced.	2
		(iii)	Nylon is not a magnetic material so it cannot be magnetised. There is no changing magnetic field to cause a change in magnetic flux linkage in the coil.	2
	(b)	(i)	Period $= 4 \times 0.002$ $= 0.0080\ \text{ms}$ $f = \frac{1}{T}$ $= \frac{1}{0.0080}$ $= 125\ \text{Hz}$	2
		(ii)		2

Section A

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

1 Fig. 1.1 shows a ship-to-ship cable used to transfer people and goods from one ship to another.

(a) A 500 N object is suspended at the mid-point of the cable ABC. By using a suitable scale drawing, find the tension present in the cable AB and BC.

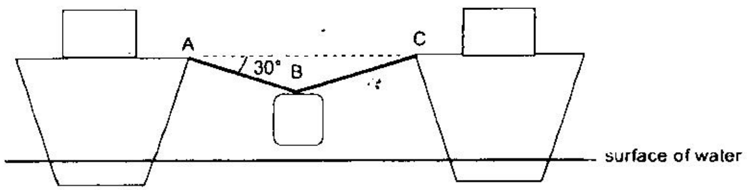


Fig. 1.1 (not drawn to scale)

tension in AB= ....

tension in BC = ... [4]

(b) When both ships are moving apart, the cable may break and cause severe injury. Suggest why an almost horizontal cable is more likely to break as compared to the cable in **(a)**.

....

.... [1]

(c) Fig. 1.2 shows all the forces acting on one of the ship. The tension, T, of the cable is 100 kN. **The centre of gravity is at point C. The weight of the ship, W, is 500 kN. The** buoyant force, F_B, by the water acts at point D.

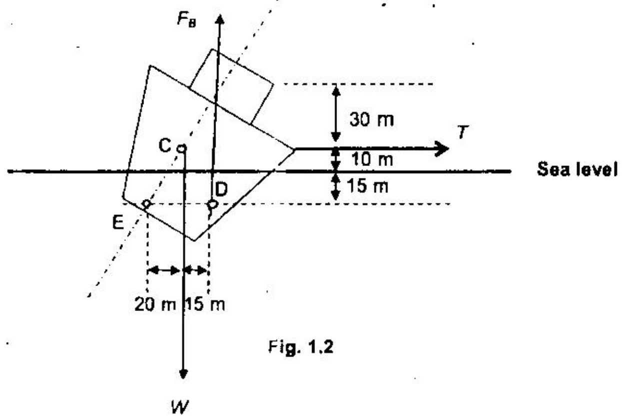


Fig. 1.2

(i) Calculate the sum of the clockwise moments due to the tension of the cable and the weight of the ship about point E. Leave your answer in kNm.

moment = ... [2]

(ii) Calculate the minimum buoyant force, F_B required to prevent the ship from toppling.

force = ... [2]

2 When large buildings are being erected, particularly on soft ground, piles are driven into the ground to provide a firm foundation. Fig. 2.1 shows a pile hammer in operation. The pile hammer has a mass of 5000 kg.

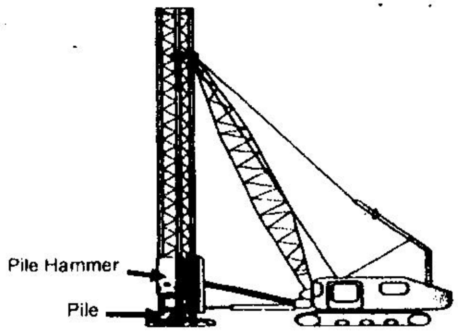


Fig. 2.1

(a) Calculate the loss of gravitational potential energy when the hammer falls 4.0 m to hit the pile.

loss of gravitational potential energy = ... [2]

(b) Assuming negligible air-resistance, calculate the speed of the hammer when it hits the pile.

speed = ... [2]

(c) Calculate the efficiency of the piling process given that 50 000 J of energy is converted sound and thermal energy.

efficiency = ... [2]

3 Fig. 3.1 shows a magnet picking up an iron coin.

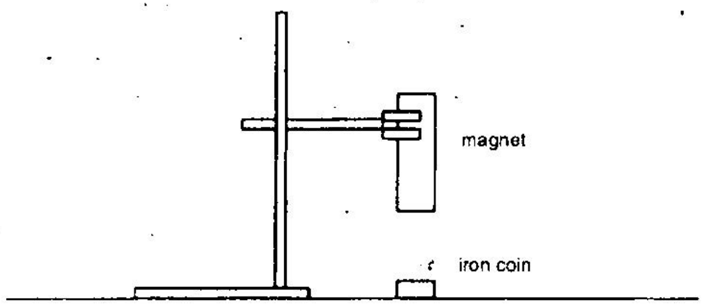


Fig. 3.1

The coin has a mass of 0.02 kg.
The initial attractive force on the iron coin by the magnet was 0.3 N.

(a) Explain why there is an attractive force on the iron coin by the magnet.

....

....

.... [2]

(b) Calculate

(i) the initial resultant force acting on the coin,

resultant force = ... [2]

(ii) the initial acceleration of the coin.

acceleration = ... [2]

4 Fig. 4.1 shows a long vertical glass tube with one end immersed in mercury and the other connected to a vacuum pump. The tube fits tightly into a bell jar. With tap B open, and air pumped out via A, the mercury rises to a maximum height of 76.0 cm above the dish.

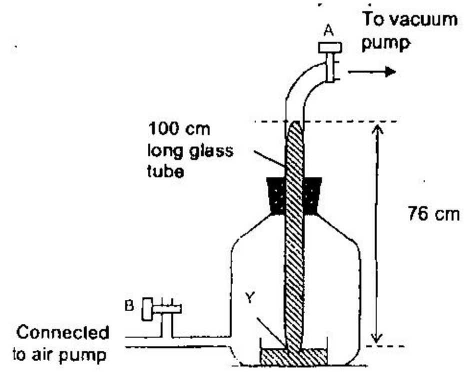


Fig. 4.1

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

....

....

.... [2]

(b) Given that the density of mercury is 13 600 kg/m^3, calculate the pressure at Y. Leave your answer in Pa.

pressure = ...Pa [2]

(c) Suggest how you can make the mercury column rise to a greater height.

....

.... [1]

5 The piston for the bicycle pump in Fig. 5.1 is pushed in slowly until the piston comes to its positions shown in Fig 5.2. The air in the pump remains at a constant temperature throughout.

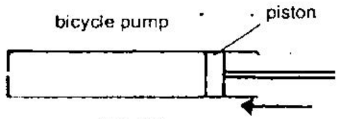


Fig. 5.1

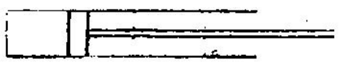


Fig. 5.2

(a) Describe the motion of the air molecules in the pump in Fig. 5.1.

....

.... [1]

(b) Using ideas about molecules, explain why the pressure in Fig. 5.2 is greater than in Fig. 5.1.

....

....

....

.... [3]

(c) If the piston was pushed in quickly instead, the temperature of the air in the pump would have increased. Using ideas about molecules, explain how this would affect the pressure in the pump as compared to your answer in **(b)**.

....

....

....

.... [3]

6 Fig. 6.1 shows the screen of a cathode ray oscilloscope. The time-base is set at 0.4ms/mm and the length of the time-base sweep MN is 100mm.

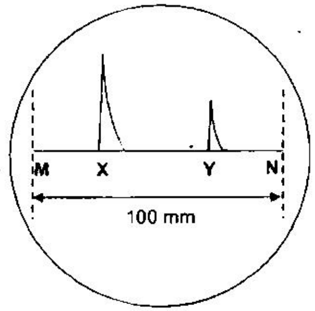


Fig. 6.1 (scaled diagram)

(a) Calculate the time represented by MN.

time = ... [1]

(b) A radar signal, sent from the radar station to a distant aircraft, is displayed on the CRO at X and the signal received back from the aircraft is displayed at Y. The speed of radio waves is 3.0×10^8 m/s. Calculate the distance of the aircraft from the radar station.

distance = ... [3]

(c) State why the signal displayed at Y is weaker than that at X.

....

.... [1]

7 Fig. 7.1 shows a thin converging lens used to improve the efficiency of a solar cell.

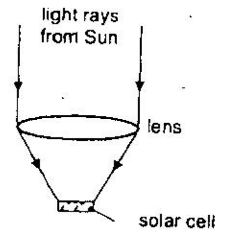


Fig. 7.1

Fig. 7.1 is drawn to scale.

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

....

.... [1]

(ii) On Fig. 7.1, draw construction lines to determine the focal length of the lens.

focal length = ... [2]

(b) Explain how the lens affects the amount of electrical power generated by the solar cell.

....

....

....

.... [2]

(c) The lens is replaced with a replacement lens that has a longer focal length compared to the original lens.

State and explain whether the replacement lens has to be placed closer or further away from the solar cell in order for the efficiency of the solar cell to remain the same.

....

....

....

.... [1]

8 Fig. 8.1 shows a magnet being dropped vertically down through a solenoid. Fig. 8.2 shows how the induced current in the solenoid changes with time.

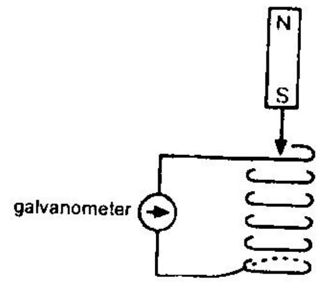


Fig. 8.1

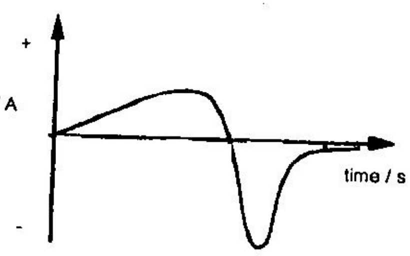


Fig. 8.2

(a) Explain why the second (negative) pulse of induced current is shorter in duration.

....

....

.... [1]

(b) Explain why the second pulse of current has a greater magnitude that the first (positive) pulse of induced current.

....

....

....

.... [2]

(c) In the space below, sketch the graph, if the North end of the magnet was dropped first into the coil instead of the South end. [1]

(d) State two ways in which the magnitude of the induced current generated can be increased.

....

....

.... [2]

Section B

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

9 In recycling plants, electromagnets are used to separate empty drink cans from the rest of the other materials. Fig. 9.1 shows an example of an electromagnet used to lift some cans.

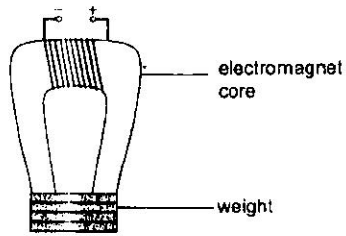


Fig. 9.1

Fig. 9.2 shows the data for four cores made from different materials.

Material	Density / gcm^{-3}	Relative Permeability	Resistivity / Ωm
H	7.87	5000	1×10^{-7}
I	7.85	1000	2.2×10^{-7}
J	8.90	600	6.84×10^{-8}
K	2.71	1	2.62×10^{-8}

Fig. 9.2

The relative permeability of a material is the ease at which the material can be magnetised. The strength of the magnet increases with the ease at which a material can be magnetised.

(a) Identify the best material to be used as an electromagnet core for lifting the most number of cans. Explain why.

....

....

.... [1]

(b) If material K is used for the manufacture of the drink cans, explain whether there is an increase or decrease in the number of drink cans that the electromagnet is able to lift compared to the other materials.

....

....

.... [1]

(c) The cans are attracted to the electromagnet through the process of induced magnetism. Describe what is induced magnetism.

....

....

.... [1]

(d) From Fig. 9.2, state and explain the relationship between hard magnetic materials and their electrical resistance.

....

.... [2]

(e) Fig. 9.3 shows how the weight lifted by the electromagnet using material **H** core is dependent on the current in the coil.

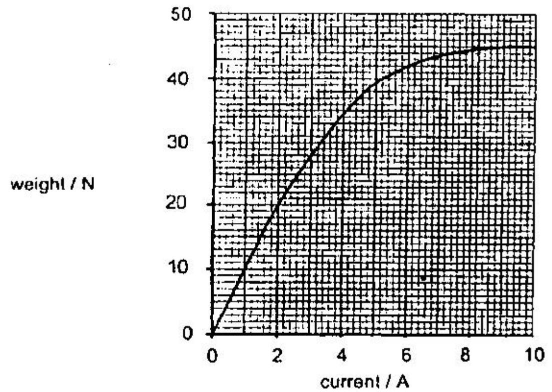


Fig. 9.3

(i) Suggest two methods to modify the electromagnet to lift a heavier load.

....

....

.... [2]

(ii) On Fig. 9.3, sketch the relationship between weight and current if material J is used for the core. [1]

(iii) The current is set so that the electromagnet can only lift the weight of 10 cans. One can weighs 2.5 N.

Using Fig. 9.3, explain if the electromagnet is able to lift 20 cans at the same time if the current is doubled.

....

....

....

.... [2]

10 The brightness of the lamp inside a train is built in such a way that it becomes brighter as the external environment gets darker. The train enters a tunnel at t = 0 s.
Fig. 10.1 shows how the brightness of the lamp inside the train changes as it enters and moves through the tunnel at constant speed.

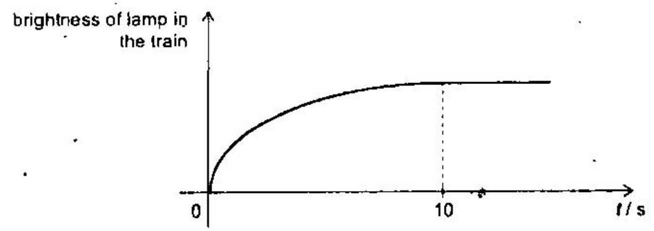


Fig. 10.1

(a) Suggest 2 possible reasons for the shape of the graph in Fig. 10.1 after t = 10 s.

1: ....

2: .... [2]

(b) If the train were to move at twice the original speed, sketch on Fig. 10.1., how the brightness of the lamp inside the train will change as it moves through the same tunnel. [2]

(c) Fig. 10.2 shows the equipment that is connected in a circuit with the lamp in the train.

Equipment	Quantity
12 V dry cell	1
fixed resistor	1
light-dependent resistor (LDR)	1
lamp	1

Fig. 10.2

(i) In the space below, draw a circuit using the equipment from Fig. 10.2, which can be used for the lighting in the train [2]

(ii) Explain how the circuit in **c(i)** increases the brightness of the lamp in the train as it enters the tunnel.

....

....

....

....

....

.... [2]

(d) **(i)** The lamp in the train is connected to a 12 V dry cell, which dissipates energy at a rate of 270 mW.

Calculate the current flowing through the lamp.

current = ... [1]

(ii) The lamp uses an input transducer to control the brightness of the lamp in the train.

Define the term input transducer.

....

.... [1]

11 **EITHER**

A vacuum flask is a container that keeps a substance hot or cold by means of a double wall enclosing a vacuum. Fig. 11.1 shows a cross-sectional view of a vacuum flask.

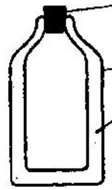


Fig 11.1

(a) Explain why it is not essential to close the top of the vacuum flask to keep water cold for a period of time.

....

.... [1]

(b) Explain how a silvered surface is able to keep water in the flask cold.

....

.... [1]

(c) Explain the ways in which a vacuum flask keeps hot liquid warm for a long time.

....

....

.... [2]

(d) When a flask was filled with hot water, it felt warm.

Identify and explain the fault(s) present in the flask.

....

....

.... [3]

(e) An immersion heater producing 300 W of power is placed in a vacuum flask containing ice at -5 °C.

Calculate the time taken to melt 0.2 kg of ice completely, assuming that all the energy dissipated by the heater is absorbed by the ice.

Specific latent heat of ice = 330 000 J/kg
Specific heat capacity of ice = 2000 J/kg°C

time taken for ice to melt = ... [4]

11 OR

Fig 11.2 shows a part of the main electrical circuit in a house.

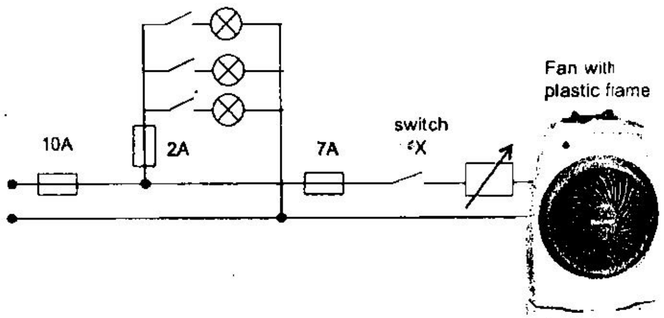


Fig. 11.2

Three lamps, each rated 60 W, 960 Ω are connected to the live wire through a 2 A fuse. An electrical fan rated at 1200 W, 240 V is connected to the live wire through a 7 A fuse. There is a 10 A fuse protecting the whole circuit. The mains supply is 240 V.

(a) State the function of the neutral wire in a circuit.

....

.... [1]

(b) Explain if it is dangerous to connect only the live and neutral wire to the fan.

....

....

.... [1]

(c) Describe how the speed of the rotation of the fan blades can be increased.

....

....

....

.... [2]

(d) Determine the current in each of the fuses when all the appliances are switched on.

current in 2 A fuse = ...

current in 7 A fuse = ...

current in 10 A fuse = ... [3]

(e) With all the appliances being switched on, the live wire touches the neutral wire at switch X.

(i) Describe and explain the effect on the lamps, fan and fuses when this fault happens.

....

....

....

....

.... [2]

(ii) Suggest another device that can replace the fuse in the circuit. State the advantage of using the device instead of the fuse.

....

....

.... [1]

End of Paper

Anglo Chinese School (Barker Road)
2016 Sec 4 5059 Prelim

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

Qn.		Answers	Marks	Markers' Comments
1	(a)	Scale: 1 cm : 50N (490N – 510N) or 1cm: 100N (480N to 520N) Correct shape Correct direction of arrows Tension = 500 N Comments: Scale must be mentioned and not inferred from the vector diagram.	B1 B1 B1 B1	Students made common mistakes in the identification of the direction of the tensional forces. Most students make the mistake of pointing the tensional forces towards the weight. Most students have trouble in identifying that the two tensional forces will act to have a resultant upwards force. Students could properly identify a proper scale.
	(b)	As the angle between the ropes increase, tension in the rope increases, causing it to break.	A1	Generally well done although a few students made the mistake of using moments to answer the question.
	(c) (i)	Total clockwise moments =T(25) + W(20) = 100(25)+500(20) = 2500 + 10000 = 12,500 kNm	M1 A1	Many students had trouble identifying the correct perpendicular distances to calculate the moments cause by each force.
	(ii)	Take moments about E, T(25) + W(20) = $F_B(35)$ 12500 = $F_B(35)$ F_B = 357 kN	M1 A1	Most students got this question correct due to ecf. Students were able to identify the correct perpendicular distance.
2	(a)	GPE = mgh = 5000 x 10 x 4 = 200, 000 J	M1 A1	
	(b)	Loss in GPE = Gain in KE 200,000 = 0.5 x 5000 x v^2 v = 8.94m/s	M1 A1	Most students were able to equate the GPE to KE.
	(c)	Efficiency = (Output / Input) x 100% = (150 000 / 200 000) x 100 = 75%	M1 A1	Most students were able to use the correct values to calculate the efficiency. Some students showed lack of understanding and used 200 000 / 250 000 to calculate
3	(a)	Iron is a magnetic material. The coin becomes a induced magnet which cause an attraction between the coin and the magnet. Comments: Accept magnetic object (given BOD), magnetic conductor is not accepted. An explanation involving magnetic poles being induced and therefore attracting each other because unlike poles attract.	M1 A1	Most students were able to correctly use the term magnetic material. Some students use magnetic object and were given BOD marks. Students were unable to adequately explain the second point on the induction of magnetic properties/polarity on the coin.
	(b) (i)	F = 0.3 – (0.02 x 10) = 0.1 N	M1 A1	Some students were unable to identify that the attractive force and weight acted in opposite direction.
	(ii)	F = ma = 0.1 / 0.02 = 5m/s^2	M1 A1	Most were able to get this question correct due to ecf
4	(a)	Atmospheric pressure of 76 cmHg, acts on the surface of mercury reservoir. The pressure at Y will only be due to the mercury acting above it, so the mercury will rise to a height of 76cm Hg.	M1 A1	Most were able to get answer that atmospheric pressure acted on the surface of the mercury but only a small percentage of students were able to identify that the pressure at Y was due to the height of mercury above it.
	(b)	Pressure = density x g x h = 13 600 x 10 x (76/100) = 1.03×10^5 Pa	M1 A1	
	(c)	Pump more air into the bell jar through tap B. Or any logical answer Comment: Accept 1) increase temperature in the jar 2) bring to lower elevation	A1	Most students were able to give sound and logical answers.

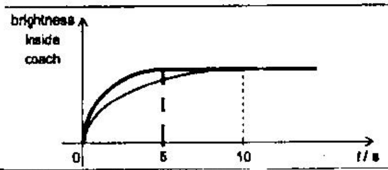
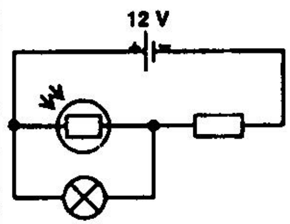
5	(a)	Air molecules are in **continuous random motion** and moving at **high speeds**. Comment: Kinetic energy may be accepted in exchange for speed.	A1	Some of students were unable to give both portions of the answers in the description of the motion.
	(b)	Because the pump is pushed in, the **number of molecule per unit volume is greater.** The **frequency of collision** of the molecules with walls of the pump **increases**, therefore causing a force to be exerted on the piston to be higher. Since pressure is **force per unit area**, pressure is higher Comment: Accept 'space' in exchange for 'volume'	M1 M1 A1	Most of the students had trouble obtaining full credit for this question. They failed to give the following 1) Correct description of no. of molecules per unit volume 2) Identifying the increase in frequency as the cause of the increase in force on the walls 3) Stating that the increase in force per unit area as pressure
	(c)	**Kinetic energy of the molecules increase** due to increase in temperature. Pressure would increase even more than in (b). As molecules will collide **more frequently** and with **greater force** on the walls of the pump. Comment: Accept the use of the word 'speed' instead of 'kinetic energy'	M1 B1 A1	Most students were unable to state that the increase in KE of the molecules results in a increase in frequency of collision and the force of collision.
6	(a)	Time = 100 x 0.4ms = 40 ms or 4 x 10^{-2}s or 0.04s	A1	Some students incorrectly used 100/0.4 to calculate the answer.
	(b)	Time taken = [(2.2/5) x 100] x 0.4 =17.6 ms 2d = speed x time d = [(3x10^8) x (17.6 X 10^-3)]/2 d = 2 640 000 m Comment: Accept range of measurement between 5.1cm to 5cm Range for time taken = 17.2 ms or 17.6ms Range for d = 2 580 000m or 2 640 000m	M1 M1 A1	Most students were unable to calculate the time taken from X to Y. Most students incorrectly used speed x time to calculate the distance when they should have divided that value by 2 to calculate due to the echo.
	(C)	Energy is absorbed by the surrounding air. Thus less energy is received by the radar.	A1	Generally well done although a handful of students were unable to adequately describe energy loss.

7	(a)i	It is the point at which all light rays that travel parallel to the principal axis converge on	1	Most students were unable to correctly define this.
	(a)ii	Correct drawing to extend the light rays to converge at a point 2cm (accept 1.9 to 2.1)	[B1] [B1]	Most students were able to draw the path of the light ray however some students made the error in measuring the focal length from the top part or bottom part of the lens instead of the center.
	(b)	The lens converges the light rays, Allowing more **solar energy** to reach the solar cell **per unit time** which will allow the solar cell to increase the amount of electrical power generated. Comment: Accept as long as the idea of convergence is shown	[M1] [A1]	Most students were able to identify the convergence as a lens for the reason for an increase in solar energy hitting the surface of the solar cell but were unable to relate the quantity energy and power.
	(c)	The lens will have to be positioned further away from the cell. With a larger focal length, light rays will need to travel a longer distance to converge on the same area Comment: Accept as long as the idea of the point of convergence is at a point that that is a longer distance away from the lens is shown	[M1]	*Question Voided* Most students were unable to adequately explain that the longer focal length results in the light rays converging at a distance that is greater.

8	a	The magnet is travelling faster and therefore takes a shorter time to leave the solenoid Comment: Accept – accelerating, speed increasing. Do not accept – Faster velocity/speed	A1	Most students were able to answer the question although a small amount of students used faster velocity instead of greater or larger velocity.
	b	The magnitude of the induced emf and the current is proportional to the rate of change of magnetic flux linkage with coil. Since the magnet is moving faster through the coil as it exits, there is a higher rate of change of magnetic flux linkage with coil. Comment: Accept (BOD) if 'with coil' is not present	[M1] [A1]	Most students could identify the 'rate of change of magnetic flux linkage with coil' as the reason for the greater current. However, most students used the term 'rate of change of magnetic flux'. Most students did not explain why the increase in rate of change of magnetic flux linkage with coil would result in a greater magnitude of current.
	c	The first pulse of the induced current will be negative and the second pulse will be positive	[A1]	

	d	Use a stronger magnet Increase the amount of coils in the solenoid. Comment: Do not accept the use of a soft iron core. Accept - throw the magnet in at a higher speed.	A1 A1	Some students incorrectly used soft iron core. Context of problem makes this method to increase the current impossible.

9	(a)		Material H Its high relative permeability allows the material to be magnetized easily	[A1]	Some students incorrectly identified K as the best material due to the lower density. The permeability is 5000 times greater in H compared to K, while the density is 3 times greater. The effect of the increase in permeability outweighs the increase in density
	(b)		Number of drink cans are reduced. Material K is difficult to magnetize compared to material H, I, J	[A1]	
	(c)		Induced magnetism is the process in which an object made of a magnetic material becomes a magnet when it is near or in contact with a magnet. Comment: Accept if 'magnetic material' is replaced with 'magnetic object'	A1	Most students had trouble defining induced magnetism adequately.
	(d)		Hard magnetic material corresponds to low resistivity. Since resistance is proportional to resistivity, hard magnetic materials corresponds to low resistance.	[A1] A1	Very few students were able to use the data to correctly identify the relationship between hard magnetic materials and resistivity. An even smaller amount of students were able to relate the quantities resistivity and resistance
	(e)	i	Increase current in the coil. Increase the number of turns in the coil	[A1] [A1]	
		ii	A curve below curve for material H	[A1]	
		iii	The current required to lift ten can of 25 N is 2.6 A. When the current is doubled to 5.2 A it can only lift up to 40 N. The electromagnet is unable to lift 20 cans which weigh 50N	 [M1] [A1]	

10	(a)		1: There is no change in the surrounding light intensity 2: The lamps are already operating at its maximum power / brightness Comment: Accept if the idea of light intensity is not changing is shown.	[A1] [A1]	Most students were able to identify that no change in external light condition as a reason but were unable to identify that the lamp has reached the maximum brightness as a reason.
	(b)		Steeper Value of brightness reach the same max level  	[A1] [A1]	
	(c)	i	Correct circuit symbols used Correct connection with LDR in parallel with lamp  	[A1] [A1]	Most students incorrectly drew LDR. A large number of student were unable to draw a correct circuit.
		ii	As the train enters the tunnel, the intensity of the surrounding light decreases, the resistance of the LDR increases. The higher the resistance, the higher the voltage across lamp, therefore increasing the brightness of the lamp.	[M1] [A1]	Most students incorrectly identified the relationship between the brightness of external condition and resistance of LDR. Most students were unable to identify the effect of increasing the resistance of the LDR.
	(d)	i	$I = P / V$ $= (270 \times 10^{-3}) / 12$ $= 0.0225$ A	 [A1]	Some students were unable to change milliwatt to watt.
		ii	Input transducer is an electronic device that converts non-electrical energy to electrical energy.	[A1]	Definition was poorly done

11 E	(a)	Cold air sinks as it is denser, hence heat loss via convection cannot effectively occur.	A1	Very few students are able to answer correctly. Most students were not able to identify effective convection cannot occur.
	(b)	Silver surfaces are good reflectors/poor absorbers of thermal energy and reduce heat gain from the surrounding via radiation	[A1]	Very few students are able to answer correctly. Most students were unable to adequately state that silver are poor absorbers of thermal energy and instead only state that silver reflects thermal energy.
	(c)	Surfaces of the walls are silver surfaces reduces heat loss by radiation. OR Vacuum layer reduces heat loss by conduction or convection OR Stopper prevents heat loss via convection and evaporation	M1 [A1]	Most students could only identify one proper way in which thermal energy is kept in the flask.
	(d)	The inner lining would have been damaged Therefore, air replaces the vacuum, hence heat can be lost through conduction. OR The surface maybe black due to accumulation of dirt or wear and tear. Therefore since black are better radiators of thermal energy, the bottle feels warm to the touch.	A1 A1	Most students did not understand the question. They were unable to identify possible faults and what form of transfer of thermal energy was involved to make the flask feel warm.
	(e)	$Q = mc(\Delta\theta)$ $= (0.2)(2000)(5)$ $= 2000$ J $Q = ml$ $= (0.2)(330\ 000)$ $= 66\ 000$J $t = E / P$ $= (66\ 000 + 2000) / 300$ $= 227$ s	B1 B1 [M1] [A1]	Most students are able to answer correctly.

11 O	(a)	The neutral wire allows current to return from the appliance to the power supply. Comment: Accept 'to complete the circuit'	[B1]	Most students are able to answer correctly
	(b)	No. The fan has a plastic casing and is doubly insulated. As such, the casing can never be live even when there is a fault Comment: Accept if the idea of current not being able to flow through is shown	[1]	Most students could not adequately explain that the plastic frame protects the user since current cannot flow through an insulator.
	(c)	When **resistance of the rheostat is reduced**, the current running through the fan will increase and increase the speed of rotation of the fan	[1] [1]	Most students could not link the information given in 11.2 to solve the question. Some incorrectly identified the rheostat as a thermistor and hence gave weird answers.
	(d)	P = I^2 x R 60 = I^2 x 960 I = 0.25 A I(in 2A fuse) = 0.25A x 3 = 0.75A P=IV 1200 = I x 240 I = 5A Current (10A) = 5 + (0.25x3) = 5.75 A	[1] [1] [1]	Most students had trouble using the correct formula to identify the current running through each of the fuses.
	e i	Short circuit will occur and the lamps and fans will not light up. A large current flows in the circuit and the 7A and 10A fuse will blow	M1 [A1]	Most students could identify that a short circuit will occur but were unable to identify that the 2A fuse will not blow.
	ii	Circuit breaker. It can be reset conveniently after the fault is corrected.	[A1]	