Preliminary Examination 2016

CANDIDATE NAME

CLASS | | | | INDEX NUMBER | | |

PHYSICS

5059/01

Paper 1 Multiple Choice

29 August 2016

Secondary 4 Express

1 hour

Setter: Mr Tay Choon Yam
Vetter: Mr Zhuang Haoyang

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

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

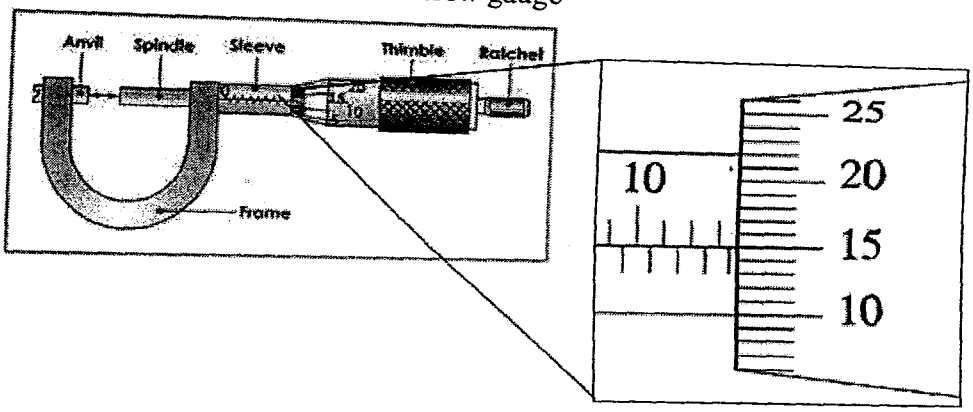
There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C**, **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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

For Examiner's Use	
Total	/40
Parent's Signature	

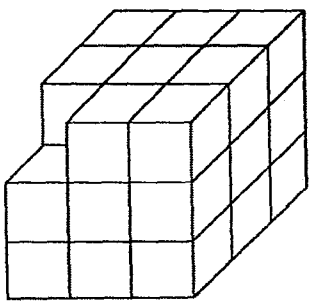
1. The diagram shows a micrometer screw gauge



What is the distance between the anvil and the spindle and how many revolutions does the thimble revolve?

	Distance between anvil and spindle	Number of revolutions of thimble
A	13.15 mm	26.30
B	13.15 mm	13.15
C	13.65 mm	27.30
D	13.65 mm	13.65

2. Twenty seven identical small cubes are arranged such that it forms a big cube. The cubes are of the same material and the density of each cube is ρ. If one small cube is removed from the arrangement as shown in the diagram below, what is the density of the big cube?

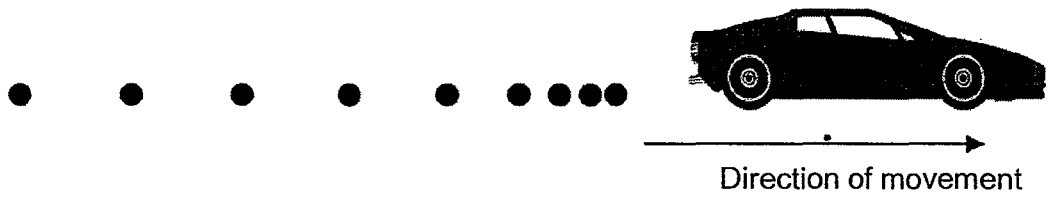


A ρ B 26/27 ρ C 27/26 ρ D 28/27 ρ

3. A bus was travelling at a speed of 20 m/s. When the bus was 50 m from a traffic light, the light turned red. The bus driver applied a constant braking force for 5 seconds. Which of the following correctly describes the motion of the bus?

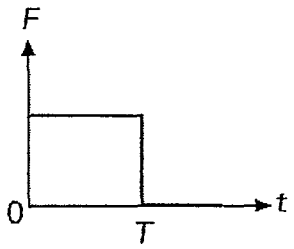
A The bus could not stop in time and overshot 2 m from the traffic light.
B The bus stopped right before the traffic light.
C The bus stopped at 2 m before the traffic light.
D The bus sped past the traffic light.

4. Oil drips at a constant rate from a moving car. The diagram shows the pattern of the drips on a road.



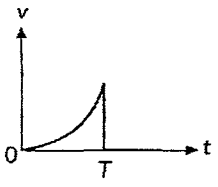
Which statement describes the motion of the car?
A It moved at a steady speed and then accelerated.
B It moved at a steady speed and then decelerated.
C It accelerated and then slowed down.
D It accelerated at a uniform rate.

5. The figure shows the variation with time of a net force which is acting on an object.

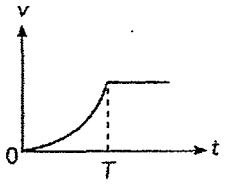


Which one of the following graphs correctly shows the variation of its velocity with time?

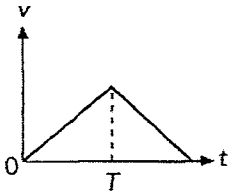
A



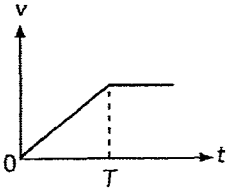
B



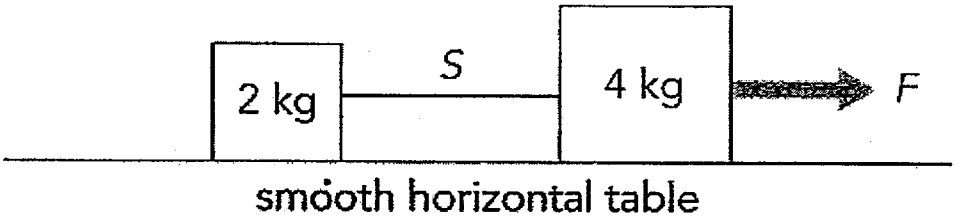
C



D



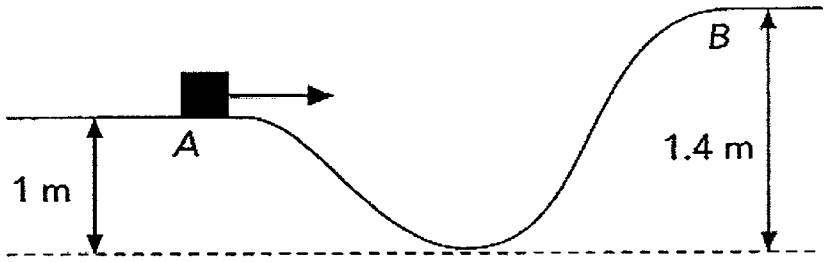
6. Two blocks are connected by a light string S as shown in the figure. Under the action of a constant force, F, they move with a uniform acceleration of 3m s^{-2}.



What will the acceleration of the 4 kg block be if the string S suddenly breaks?

A 3.0 m s^{-2} B 4.5 m s^{-2} C 6.0 m s^{-2} D 7.5 m s^{-2}

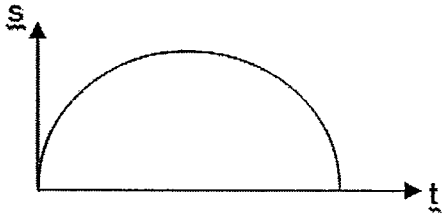
7. A small object of mass 2 kg moves along a track as shown in the figure. The speeds of the object at points A and B are 4 m s-1 and 1 m s-1 respectively. The length of the track AB is 2.5 m.



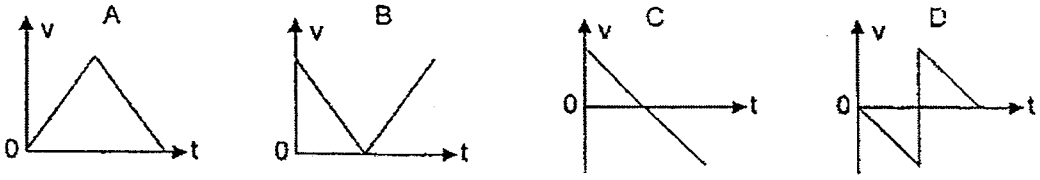
What is the average value of the frictional force acting on the object as it is moving from A to B?

A 2.8 N B 5.6 N C 11.2 N D 22.4 N

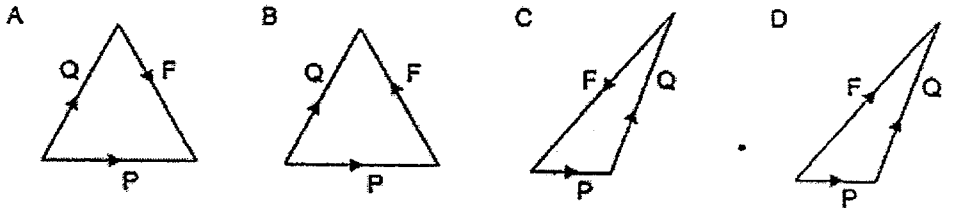
8. The diagram shows the graph of displacement s against time t for a body moving in a straight line.



Which of the following shows the graph of speed V against time t for this body?



9. A body is acted on by two forces, P and Q. A frictional force holds the body in equilibrium. Which vector triangle could represent the relationship between these forces?

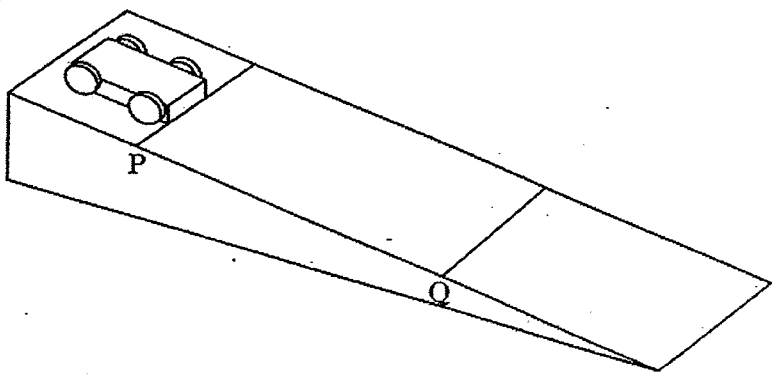


10. A lunar landing module is descending to Moon's surface at a steady velocity of 10 m/s. At the height of 120 m, a small object falls from its landing gear.

Taking the Moon's gravitational acceleration as 1.6 m s^{-2}, at what speed does the object strike the Moon?

A 22 m s^{-1} B 20 m s^{-1} C 17 m s^{-1} D 10 m s^{-1}

11. A trolley is released from position P on a slope as shown.



The length of the trolley is 0.2 metres.
To calculate the instantaneous speed of the trolley at Q, we also need to know

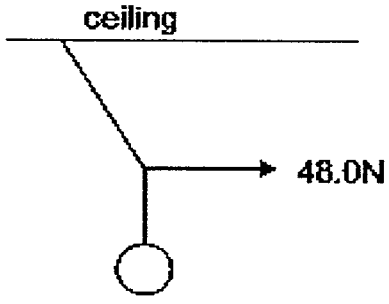
A the time taken by the trolley to move from position P to position Q.

B the speed of the trolley at position P.

C the time taken for the trolley to pass position P'

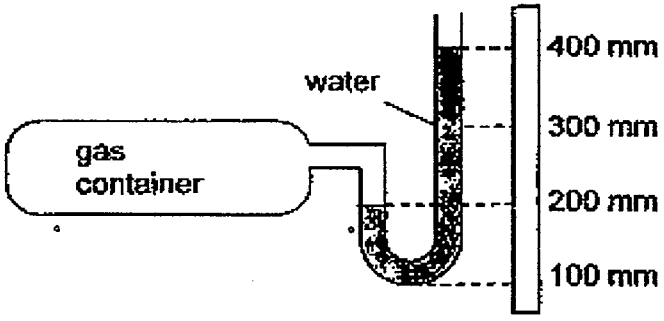
D the time taken for the trolley to pass position Q.

12. An object of mass 2 kg, hanging from a rope is pulled to one side by a horizontal force of 48.0 N. What is the tension in the rope attached to the ceiling?



A 28.0 N B 52.0 N C 58.0 N D 62.5 N

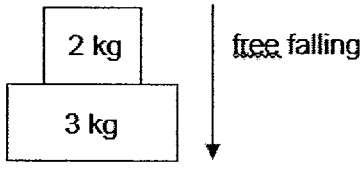
13. A manometer is connected to a gas container. The atmospheric pressure is 1.0×10^5 Pa and the density of water is 1000 kg/m^3 .



What is the pressure of the gas?

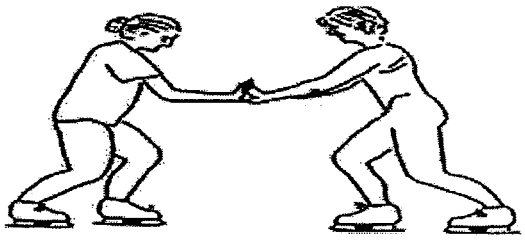
A 2000 Pa B 9800 Pa C 102000 Pa D 120000 Pa

14. Two metal blocks are stacked one on top of the other as shown in the diagram below. They are dropped in vacuum, falling together freely under earth's gravitational field. What is the net force acting on the 3 kg metal block during the fall?



A 10 N B 20 N C 30 N D 40 N

15. A girl and a boy at an ice skating rink push each other as shown below. The girl exerts a force of 20 N on the boy while the boy exerts a force of 25 N on the girl. What is the net horizontal force experienced by the girl?



A 5 N B 20 N C 25 N D 45 N

16. An object is pulled up a rough slope at a constant speed. Which of the following statement is **true**?

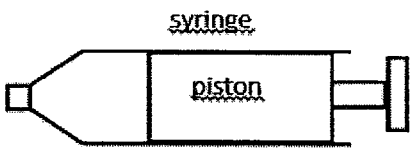
A Work done by the pulling force is equal to the gain in gravitational potential energy minus the work done against friction and kinetic energy.

B Work done by the pulling force is equal to the gain in gravitational potential energy plus the work done against friction and kinetic energy.

C Work done by the pulling force is equal to the gain in gravitational potential energy minus the work done against friction.

D Work done by the pulling force is equal to the gain in gravitational potential energy plus the work done against friction.

17. A fixed mass of gas is heated in a frictionless syringe under constant pressure.



Which of the following statements is **false**?

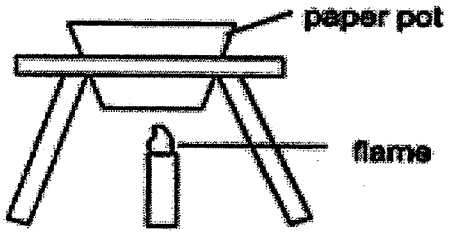
A The average distance between the gas molecules increases.

B The average force of the molecules on the wall of the piston increases.

C The average speed of the gas molecules increases.

D The frequency of collisions of the gas molecules on the wall of the syringe increases.

18. Some Japanese restaurants use paper pots for their customers to boil the food. What are the reasons for the paper pot not catching fire when in contact with the flame?



(1) Water has a boiling point lower than the burning temperature of the paper.
(2) The paper is thin and therefore heat is conducted quickly to the water in the paper pot.
(3) The paper is thick enough to withstand the high temperature of the flame.

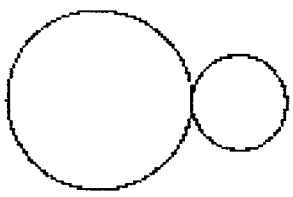
A (1) and (2) only.
B (1) and (3) only.
C (2) and (3) only.
D all of the above.

19. Which of the following is **true** when ice changes to water at its melting point?

(1) Thermal energy is absorbed to break the forces of attraction between the particles.
(2) Thermal energy is absorbed to increase the temperature.
(3) Kinetic energy is increased.
(4) Internal energy is increased.

A all of the above
B (1), (2) and (3)
C (1), (3) and (4)
D (1) and (4)

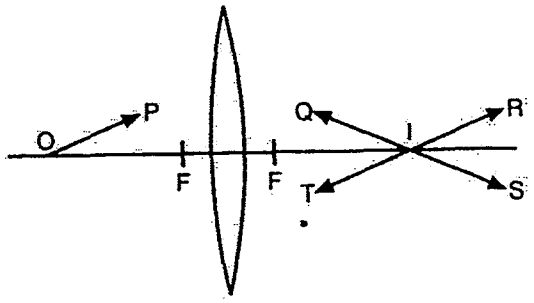
20. Two metal spheres of different radii are in thermal contact in a vacuum as shown.



The spheres are at the same temperature.
Which statement must be correct?

A Each sphere has the same internal energy.
B Both spheres radiate energy at the same rate.
C There is no net transfer of thermal energy between the spheres.
D The larger sphere has a greater average internal energy per atom than the smaller sphere.

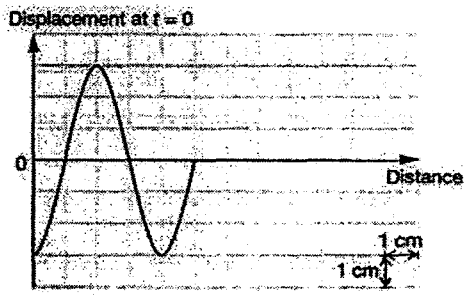
21. A point object O moves from the principal axis of a converging lens in a direction OP as shown in the diagram.



I is the image of **O.** It will move in the direction _____.

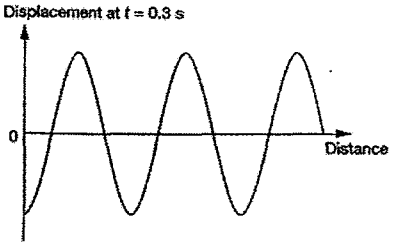
A IQ **B** IR **C** IS **D** IT

22. The displacement-distance graph of the particles along a travelling transverse wave at t = 0 is shown below. The frequency of the wave is 5 Hz.

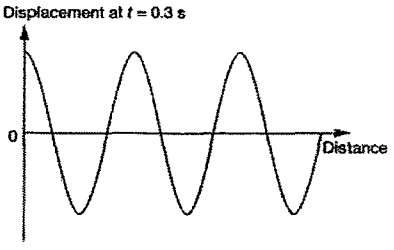


Which of the following shows the waveform at t = 0.3 s?

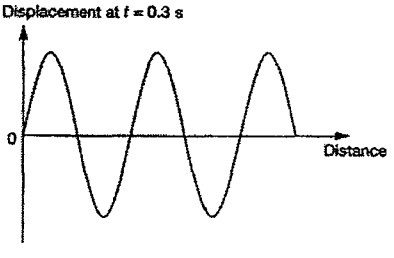
A



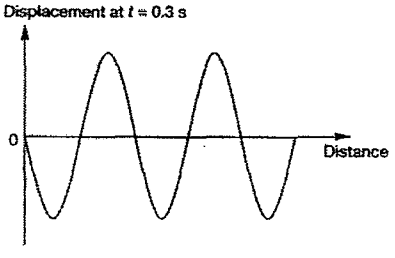
B



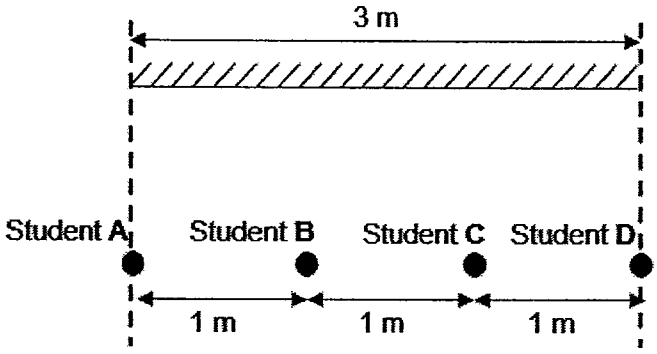
C



D



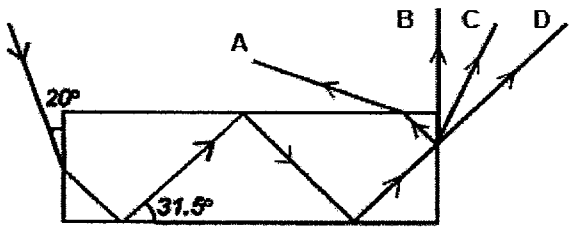
23. Four students stand in a row 1 m apart parallel to a plane mirror that is 3 m long as shown below.



How many students can see the images of the other three students?

A 1 B 2 C 3 D 4

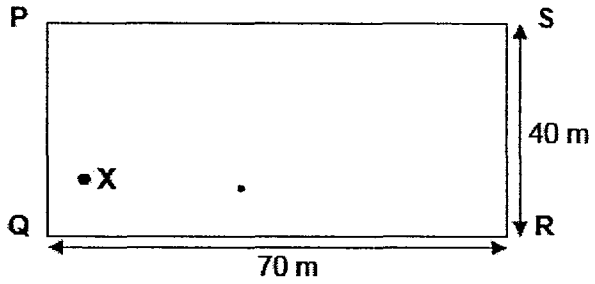
24. A ray of light is directed towards a rectangular glass block as shown below. In the diagram, the ray of light undergoes refraction and total internal reflection. Which of the following rays **A**, **B**, **C** or **D** shows the correct path?



25. When an object is placed 20 cm from a thin converging lens, a real image equal in size to the object is formed. The object is then moved 5 cm towards the lens. Which of the following describes the new image formed?

	Image distance	**Image size**
A	more than 20 cm	diminished
B	more than 20 cm	magnified
C	less than 20 cm	diminished
D	less than 20 cm	magnified

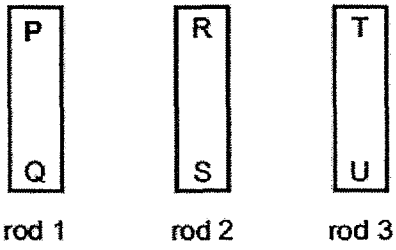
26. The diagram below shows an enclosed concert hall whose walls are assumed to be perfect reflectors of sound waves.



A sound detector is placed at the position **X**. The detector picks up the first two echoes at 20 ms and 60 ms respectively. How far is the detector placed away from walls **PQ** and **PS** respectively? (Assume the speed of sound in air to be 330 m s^{-1})

	distance from PQ	**distance from PS**
A	3.3 m	9.9 m
B	3.3 m	30.1 m
C	6.6 m	19.8 m
D	6.6 m	20.2 m

27. Felicia conducts an experiment to find out whether there is/are magnet(s) among the metal rods by placing ends of rods close to other ends of the other rods.



	end R	**end S**	**end T**	**end U**
end P	No observation	No observation	Attraction	Attraction

Which of the following statements best conclude her experiment?

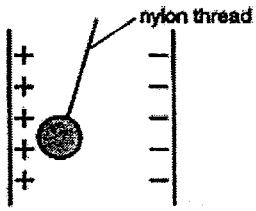
A None of the rods are magnets.

B The results obtained are inconclusive.

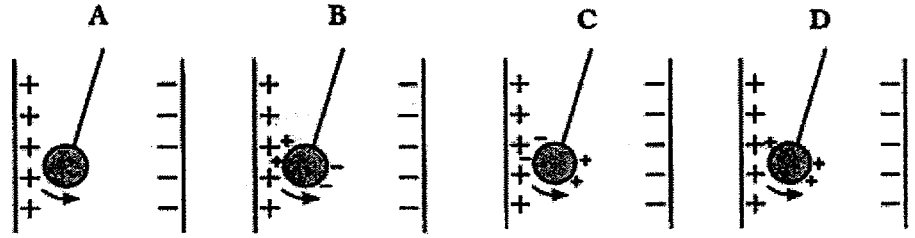
C Rods 1 and 3 are magnets.

D Rod 3 is a magnet.

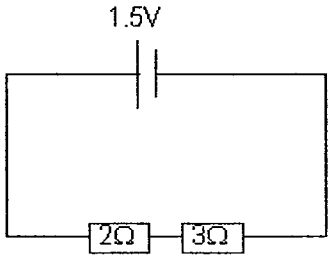
28. A light uncharged conducting ball is moved towards the positive plate.



Which diagram correctly shows the charges on the ball just after it has touched the positive plate?



29. A 1.5V battery is connected to a 3Ω and 2Ω resistor in series. What is the work done to drive a 1C charge through the 3Ω resistor?



A 0.60 J B 0.90 J C 1.50 J D 3.0 J

30. A student uses a voltmeter to measure the electromotive force (e.m.f.) of a battery. He then measures the potential difference (p.d.) across the resistor connected to the battery. The p.d is a lesser value than the e.m.f. What could be the reason?

A The voltmeter is faulty.

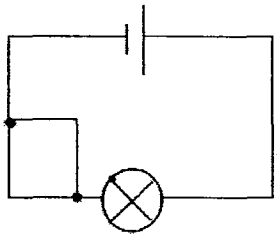
B There was zero error in the voltmeter.

C The resistance of the voltmeter is not high enough.

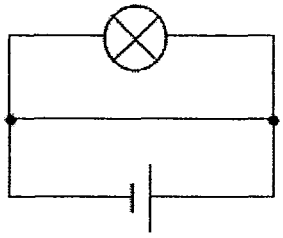
D The resistance of the connecting wires is not negligible.

31. In which circuit will the bulb glow brightest? [The cells and bulbs are identical.]

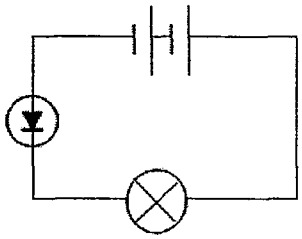
A.



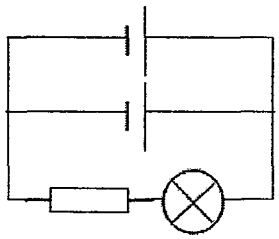
B.



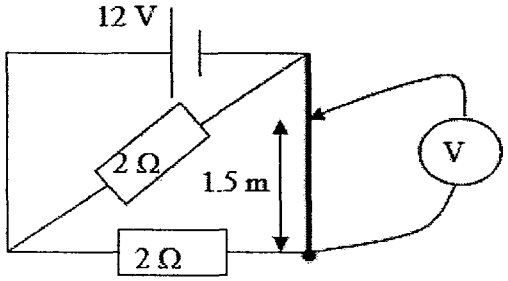
C.



D.



32. A 10 ohm resistance wire AB of 2.0 m long is connected in the circuit shown below.



What is the reading on the voltmeter?

A 6.00 V B 6.50 V C 7.50 V D 9.0 V

33. In which of the following situations will a fuse likely melt?

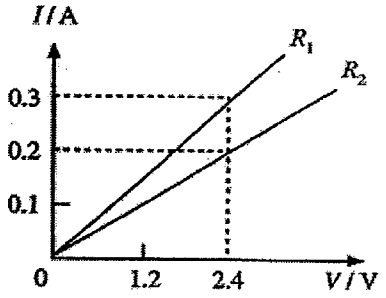
I The earth wire is broken.

II There is a short circuit in the electrical circuit.

III The fuse is fixed along the neutral wire instead of live wire.

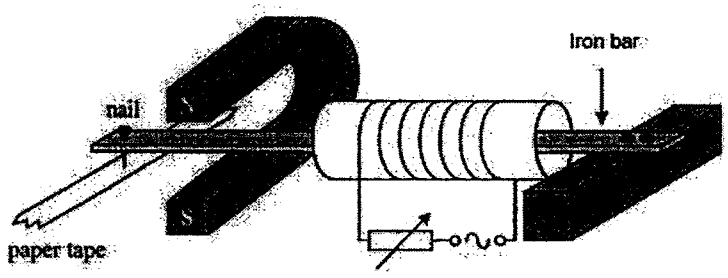
A I only B II only C I and II only D I and III only

34. The figure shows the I-V characteristic of resistors R_1 and R_2. The two resistors are connected in series with a power supply. The power dissipation of R_1 is 4W. What is the power dissipation of R_2?



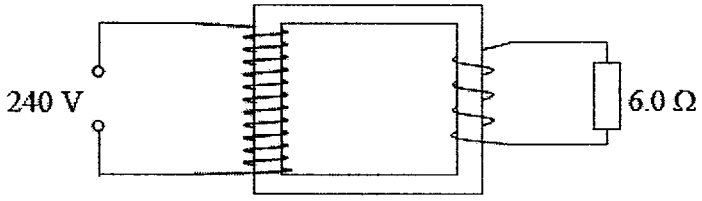
A 2W B 4W C 6 W D 10 W

35 The following diagram shows the set up of a simple ticker-tape timer. When a paper tape is pulled at a velocity of 12.5 cm/s, the separation between any two dots is 2.5 mm. What is the frequency of the a.c. source?



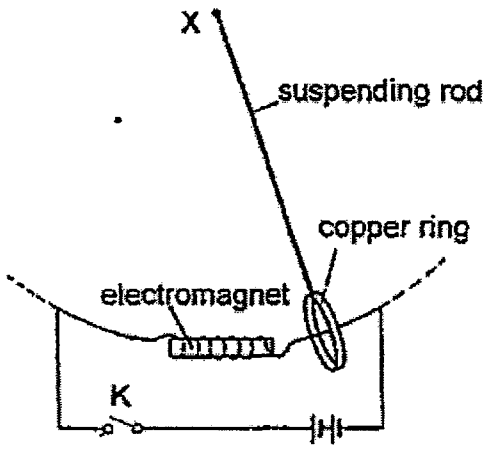
A 10 Hz B 12.5 Hz C 25 Hz D 50 Hz

36. The diagram shows part of an ideal iron-cored transformer which has a turns ratio of 1:20. The primary coil is connected to a 240 V d.c supply. What is the current in the secondary coil?



A 0.00 A B 0.14 A C 2.00 A D 40.00 A

37. A copper ring is suspended by a long, light rod pivoted at X so that it may swing as a pendulum, as shown below. An electromagnet is mounted so that the ring passes over it as it swings



The ring is set into oscillation with switch K open. What happens to the motion after switch K has been closed?

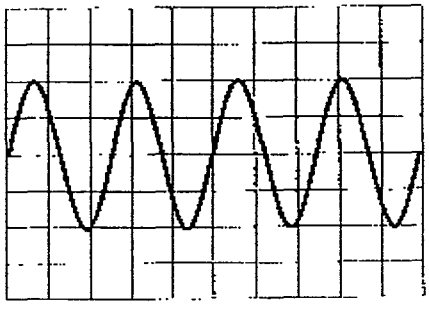
A The amplitude will increase because the ring is accelerated towards the magnet.

B The ring will be brought to rest with the rod inclined to the vertical.

C The periodic time will decrease.

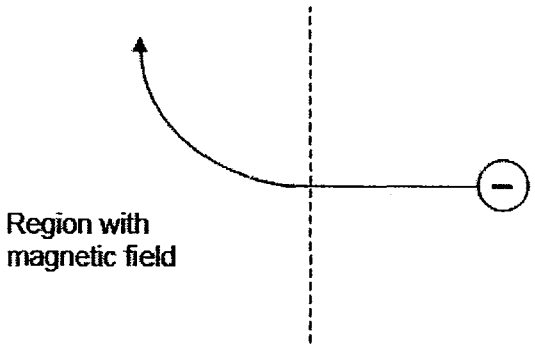
D The oscillation will be damped.

38. The diagram below shows the trace obtained on the screen of a cathode-ray oscilloscope when a given signal is applied to the input terminals. The time-base is set at 2.0 ms/div, and the voltage sensitivity is set at 2.0 V/div. What is the peak voltage and frequency of the signal?



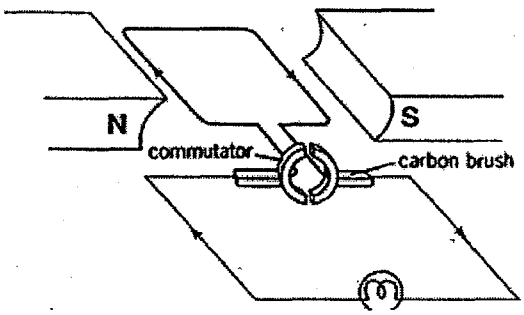
A. 4.0 V, 100 Hz B. 4.0 V, 200 Hz C. 8.0 V, 500 Hz D. 8.0 V, 200 Hz

39. The diagram shows a beam of electrons entering a magnetic field. What will be the direction of the field?

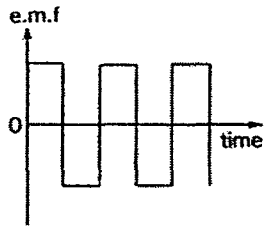


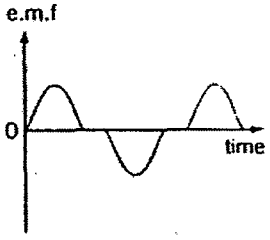
A Towards the bottom of the page
B Towards the top of the page
C Out of the page
D Into the page

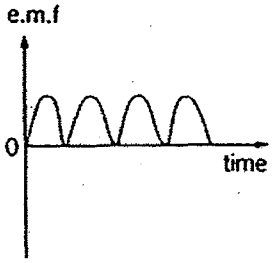
40. The diagram below shows a simple generator using a commutator.

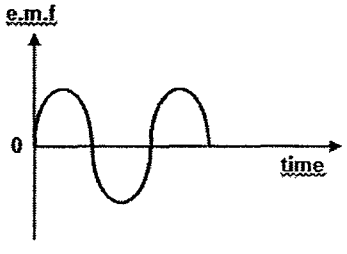


Which one of the following graph represents the electromotive force induced in circuit?

A


B


C


D


End of Paper

Preliminary Examination 2016

CANDIDATE NAME

CLASS | | | | INDEX NUMBER | | |

PHYSICS

5059/02

Paper 2 Theory

23 August 2016

Secondary 4 Express

1 hour 45 minutes

Setter: Mr Tay Choon Yam
Vetter: Mr Zhuang Haoyang

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

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 12 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.

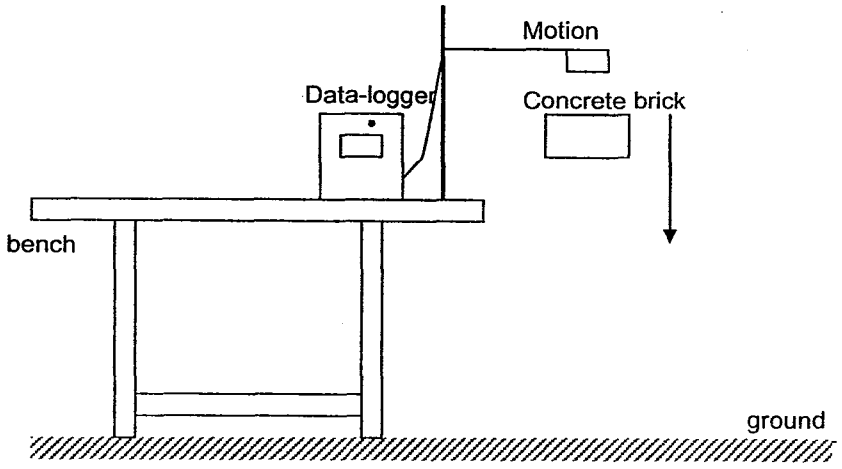
For Examiner's Use	
Section A	/50
Section B	/30
Total	/80
Parent's Signature	

Section A

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

For Examiner's Use

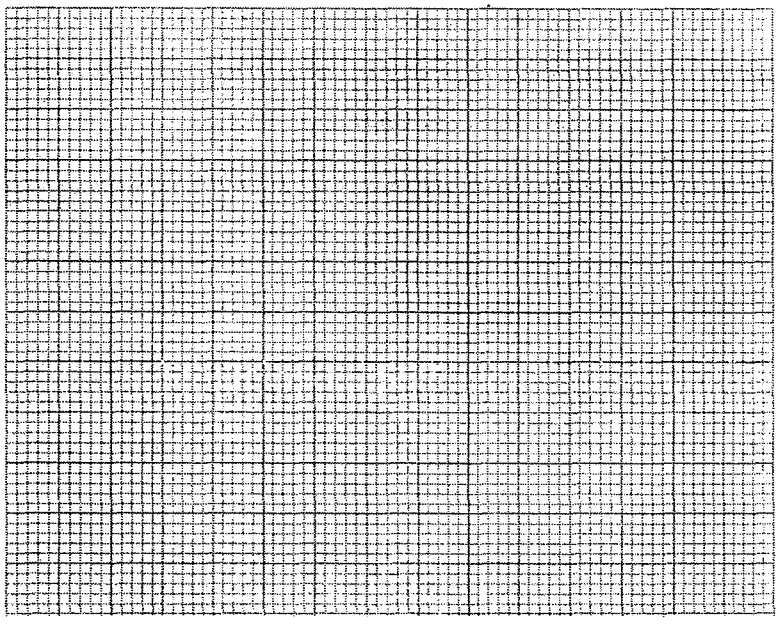
1. Mr Zhuang used a data-logging system to record the speed of a falling brick.



The concrete brick of mass 2 kg was released from rest under a motion sensor. The data logger obtained the following data.

speed/ ms^{-1}	0.00	0.00	0.00	0.45	0.85	1.50	1.70	2.10	2.55	2.95
time/s	7.80	7.85	7.90	7.95	8.00	8.05	8.10	8.15	8.20	8.25

(a) Using the data from the table above, plot a speed-time graph in the grid given.[3]



For Examiner's Use

(b) From your graph, estimate the distance travelled by the brick. [2]

Distance = ...

(c) Determine the loss in potential energy of the brick during the journey in (b). [1]

loss in potential energy = ...

(d) From your **graph**, find the maximum kinetic energy of the brick. [2]

Max. kinetic energy = ...

(e) Explain why there is a difference in the values obtained in (c) and (d).[1]

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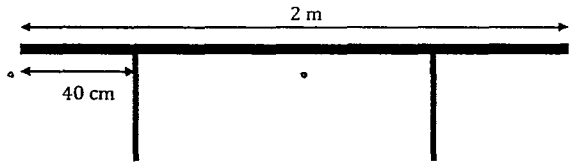
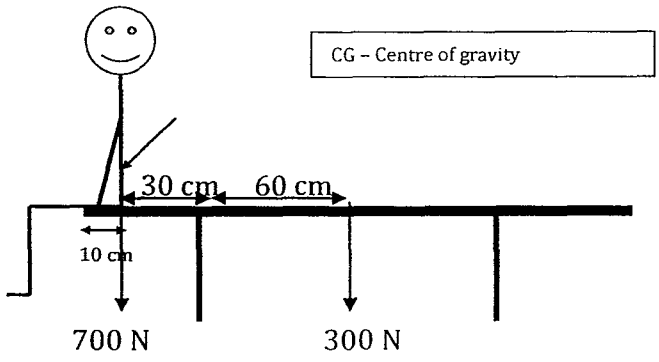
2. A uniform teacher's desk has a mass of 30 kg. The desk is 2 m long with legs mounted 40 cm away from the edges as seen in the diagram below

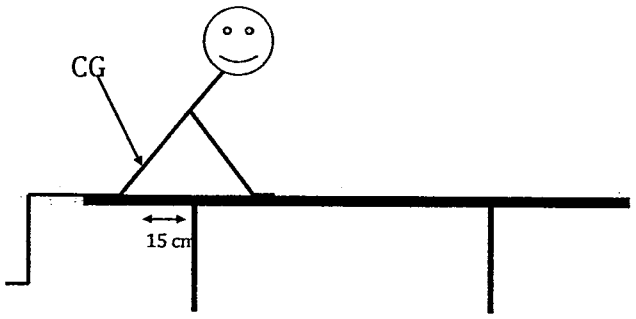


(a) Addy Tan who weighs 700 N sits on the desk, 10 cm from the edge as seen from the diagram below.



Show with mathematical proof why the desk would be tipped over by Addy. [2]

(b) Addy now adjusted himself as can be seen below.



At this new position, Addy is now more "stable". Explain why. [2]

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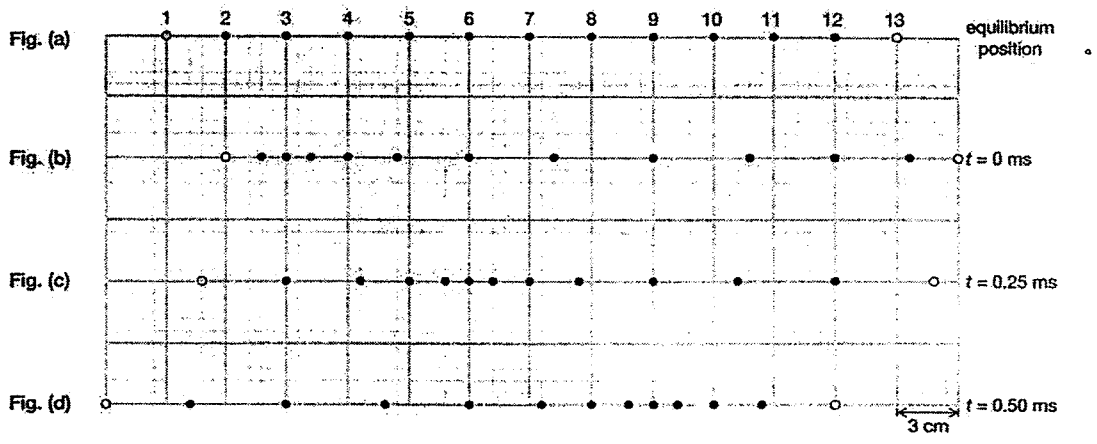
3.



A sound wave travels from left to right in air. Fig. (a) shows the equilibrium positions of a series of particles in air. The positions of the particles at different instants within a period are shown in Fig. (b), (c) and (d).

(a) Which particles in Fig. (c) correspond to the centre of a compression and the centre of a rarefaction respectively? [2]

Centre of compression = ...

Centre of rarefaction = ...

(b) Find the wavelength, frequency and speed of the wave. [3]

For Examiner's Use

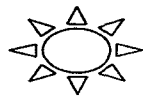
Wavelength = ...

Frequency = ...

Speed = ...

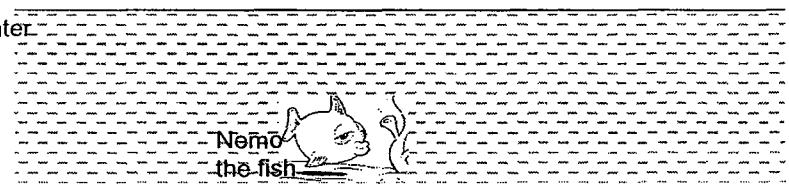
4 Kingfishers usually hunt from a perch a few metres above the water, swooping down at up to 100 km/h to snatch their prey, before returning to the perch. The whole process is an extraordinary feat of calculation, not only must the bird work out the depth of the fish before it dives, but it also compensates for the effect of refraction in the water. In addition, these birds have special features in their eyes to cut out *reflection* and see their prey better.

[Extract from Focus magazine, Issue 219]



air

Fresh water



(a) Explain what is meant by the refractive index of water? [1]

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(b) Why must the bird "work out the depth of the fish" before it dives? [1]

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(c) On the diagram draw a ray to show how light from the fish travels to the kingfisher. [2]

For Examiner's Use

(d) Sometimes the kingfisher might not even see the fish especially when the fish is at a particular position. This is a phenomenon common to light when it travels from water to air. Explain what this phenomenon is and how it can occur. [2]

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5. Fig. 5.1 represents a simple camera which makes use of a converging lens of focal length *f*.

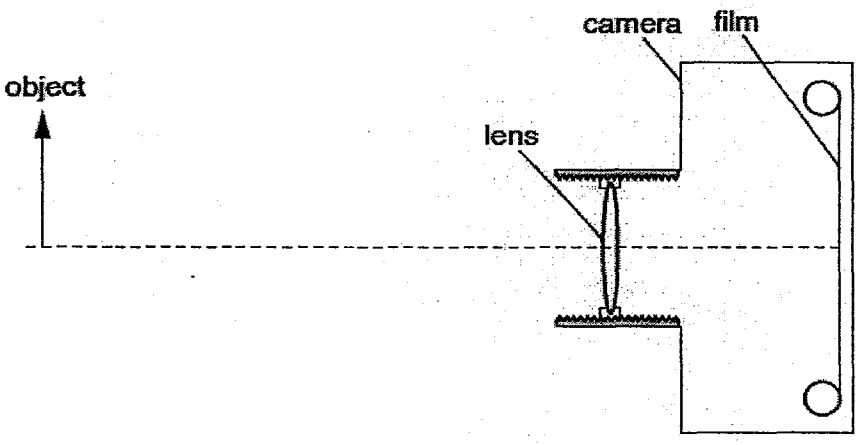

Fig. 5.1 (to scale)

(a) Define what is meant by *focal length*. [1]

.....

.....

(b) Draw two rays from the top of the object to show how the sharpe image is formed on the film. [3]
Mark and label the image on the film.

(c) Fig. 5.1 is drawn to scale. Determine the linear magnification of the object shown in Fig. 5.1. [1]

Linear magnification = ...

(d) Explain why, when taking photographs of other objects, it may be necessary to move the lens towards the film. [1]

For Examiner's Use

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6. Ice with a mass of 22 g at a temperature of -12 °C is taken from a freezer and placed in a polystyrene cup containing water at 22 °C.
Given that the specific heat capacity of ice = 2100 $Jkg^{-1}K^{-1}$
and the latent heat of fusion of ice = 3.3×10^5 Jkg^{-1} .

(a) calculate the quantity of heat needed
(i) to raise the temperature of ice from -12 ° C to 0° C [1]

quantity of heat .....

(ii) to change the ice to water without a change in temperature. [1]

quantity of heat = ...

(b) The temperature of the water in the cup falls after the ice has been added.
Specific heat capacity of water = 4200 J/(kg °C)

(i) Calculate the mass of water in the cup if the lowest temperature reached by the water is 8 °C. [2]

mass of water = ...

(ii) State an assumption you have made in **(b)(i)**. [1]

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7. In the circuit shown in Fig. 7.1, the battery, of negligible internal resistance, has an e.m.f of 12 V.

For Examiner's Use

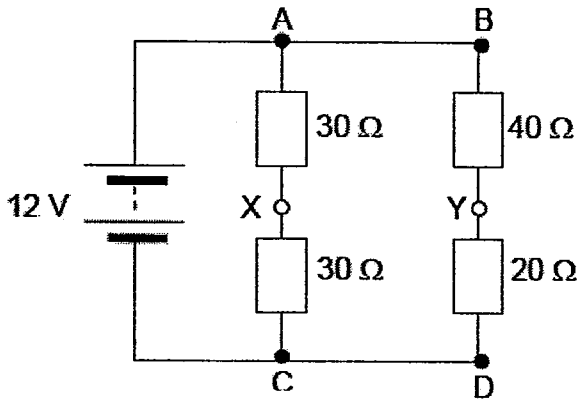


Fig. 7.1

(a) What is the effective resistance in the circuit? [1]

effective resistance = ...

(b) What is the current supplied by the battery? [1]

current = ...

(c) Is the current in **(b)** divided equally between the two arms (**AC** and **BD**) of the resistor network? Why? [2]

.....

.....

(d) What is the potential difference between **X** and **C**? [1]

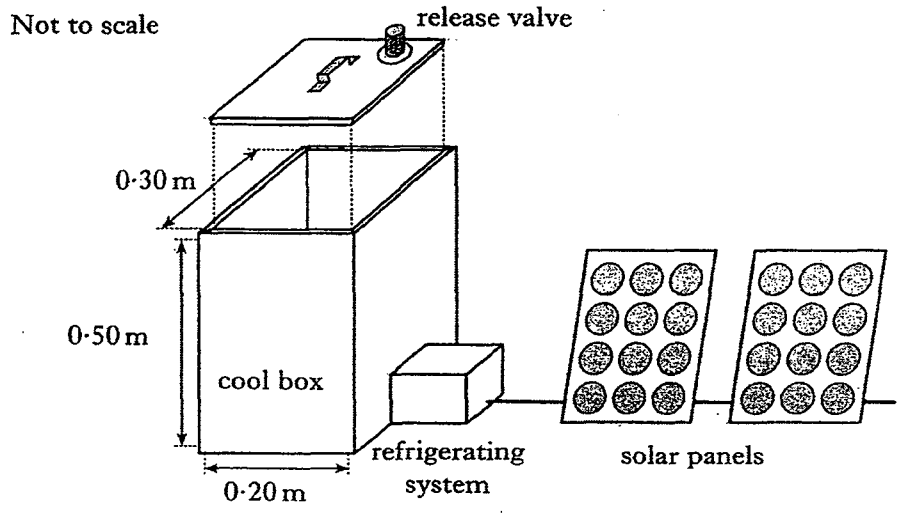
potential difference = ...

(e) If a high resistance voltmeter is connected between **X** and **Y**, what would be the reading on the voltmeter? [1]

Reading = ...

8. A refrigerated cool box is being prepared to carry medical supplies in a hot country. The **internal** dimensions of the box are 0.30 m x 0.20 m x 0.50 m.

For Examiner's Use



The lid is placed on the cool box with the release valve closed. An airtight seal is formed. When the lid is closed the air inside the cool box is at a temperature of 33^0C and a pressure of 1.01×10^5 Pa. The refrigerating system then reduces the temperature of the air inside the cool box until it reaches its working temperature. At this temperature the air inside is at a pressure of 9.05×10^4 Pa.

(a) Calculate the temperature of the air inside the cool box when it is at its working temperature. [2]

Temperature = ...

(b) Describe, using the kinetic model, how the decrease in temperature affects the air pressure inside the cool box. [2]

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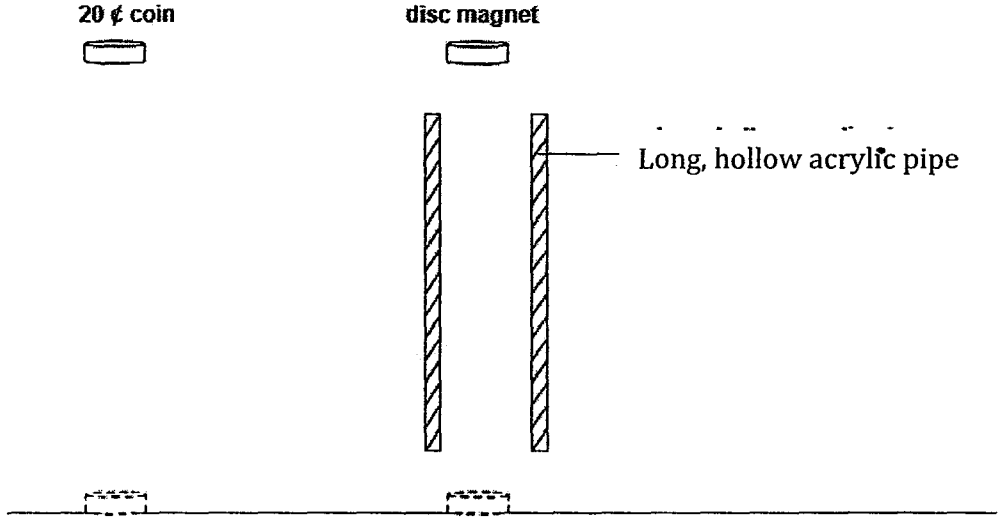
9. A teacher carried out an experiment to investigate the acceleration of free fall of a disc magnet in a hollow pipe made of different materials.

For Examiner's Use

In a control experiment, a 20 cents coin and a disc magnet is dropped from rest in air and into a long hollow acrylic pipe (about 3 m long, standing vertically and made from a form of plastic) from the same height above the ground.



Both reach the ground at the same time. The time taken for both magnet and coin to reach the bottom was measured using a sensitive electronic timer

(a) State the value of the acceleration for both objects. [1]

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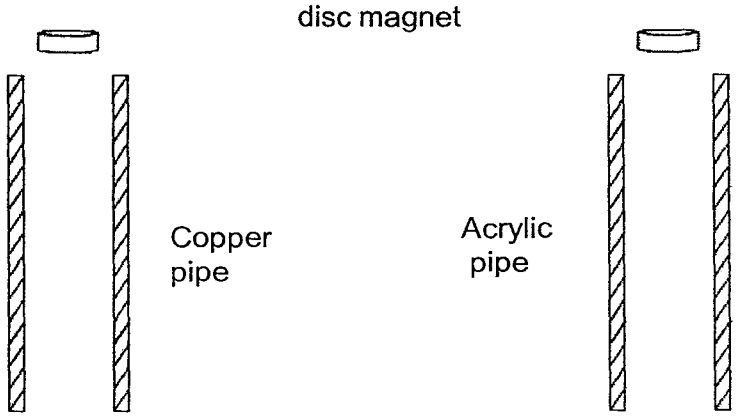
Two hollow pipes of similar length as in part (a) but made of different materials were used to carry out further investigation. The disc magnet is allowed to fall freely from rest in each case from the same height.

It is assumed that the magnet fall through the hollow pipe without contacting the pipes.



(b) It was found that the disc magnet reached the bottom fastest in the acrylic pipe and slowest in the copper pipe.

For Examiner's Use

Explain why the magnet takes a longer time to reach the bottom of the copper pipe compared to the acrylic pipe. [2]

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(c) In another experiment, the disc magnet was dropped into another hollow pipe made of aluminium at the same height. The time taken for the disc magnet to reach the bottom is different as compared to the disc magnet falling through the copper pipe.

Is the time of fall shorter or longer as compared to the copper pipe? Explain your reasoning. [2]

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Section B

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

For Examiner's Use

10 (a) Read the article below extracted from the Straits Times, August 15 2009 and answer the corresponding questions.

Hot spring heat source could 'power 50,000 homes'

A HOT spring tucked away in Sembawang might just hold the key to Singapore's untapped geothermal power potential, and at least one geologist is going full steam ahead on the idea.

Dr Grahame Oliver believes the energy that heats the unassuming spring could be tapped – based on his geologic predictions and evidence from Singapore quarries – to power 50, 000 homes here.

His theory suggests that a shaft could be drilled about 2 km into the earth at the right spot near Sembawang or another hot spring, such as the one at Pulau Tekong, a military training area.

At that depth, the water would be about 150 °C and emerge as steam, which could drive a turbine to produce electricity. The water would be channeled back into the earth.

Or cooler water – at about 70 °C – could be pumped up to flash-boil another liquid with a boiling point lower than that of water, producing steam for the turbine.

The process of building the geothermal plant would require a capital of $27 million but a 50 MW plant the size of three football fields could pay for itself in about 5 years, power an HDB town and save about half a million barrels of oil a year.

(i) State one advantage of using geothermal energy as compared with other sources of energy. [1]

.....

(ii) It is stated in the article that the plant could generate 50 MW every hour. If it cost $3 per MW h, calculate the cost of producing power for a typical town for 5 years. (Note: Assume 1 month to be 30 days.) [2]

Cost = ...

(iii) If the temperature is not high enough for water to form into steam, explain how geothermal enegy can still be tapped to generate electricity. [2]

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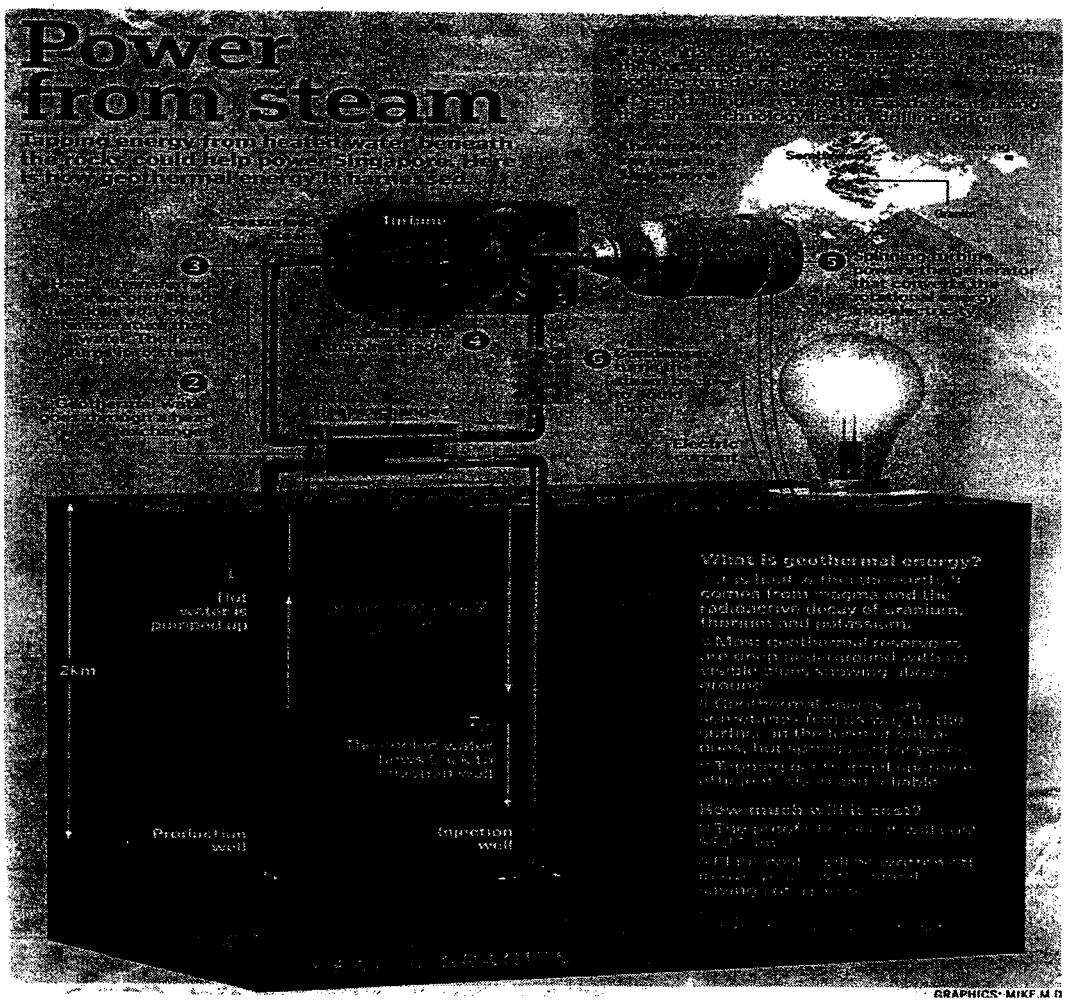
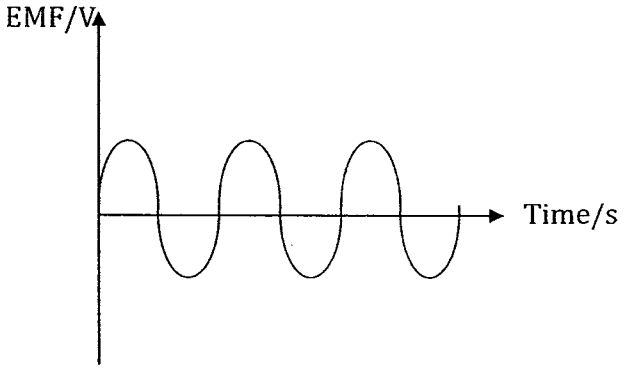
(b) The diagram below shows as example of how geothermal energy can be harnessed.

For Examiner's Use



(i) The waveform of the induced EMF by the generator is illustrated below.



On the diagram above, sketch the changes to the waveform if the turbine rotates twice as fast. [1]

(ii) With an aid of a labelled diagram, explain briefly the working operation of a generator that can be found typically in a geothermal plant. [4]

For Examiner's Use

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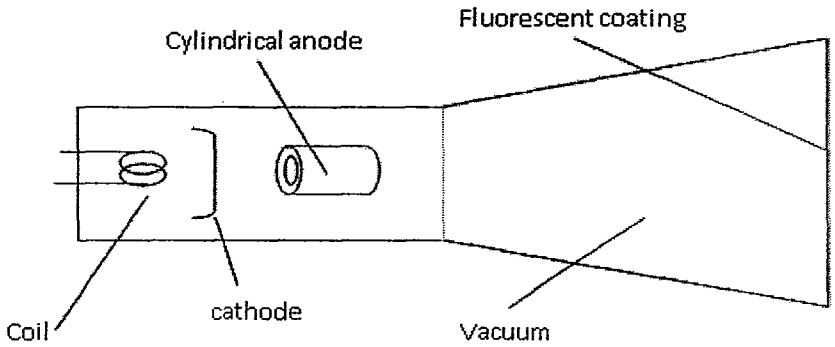
11 (a) The figure below represents a tube capable of producing a beam of electrons flowing from the cathode to the flourescent coating.



(i) State the purpose of the coil, cylindrical anode and vacuum [3]

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In 12 s, the number of electrons, each carrying a charge of 1.6×10^{-19} C, that strike the coating is 2.4×10^{14}. The potential difference causing the electrons in the beam to accelerate is 3.0×10^{3} V.

For Examiner's Use

(ii) Calculate the current in the tube. [2]

Current = ...

(iii) Calculate the power conveyed by the electron beam. [2]

Power = ...

(b) Two vertical metal plates are connected to a high voltage power supply, as shown in the diagrams below. An electric field exists in the space between the plates.

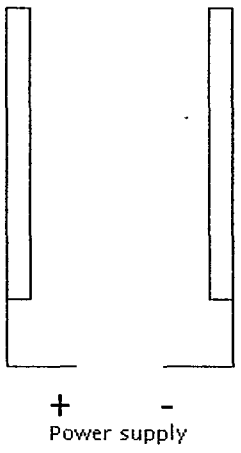


Figure 1

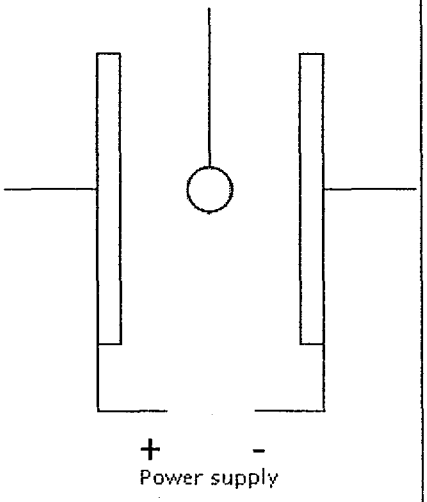


Figure 2

(i) On Figure 1, draw lines of force to show the electric field between the two plates. [1]

An uncharged metal ball is hung by an insulated thread between the two plates as shown on Figure 2.

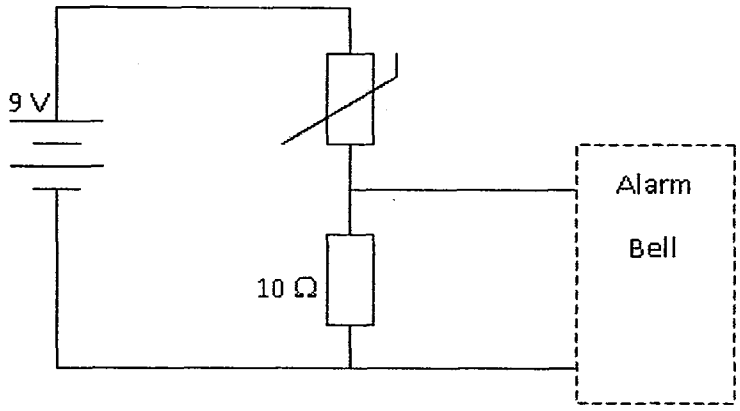
(ii) Draw the distribution of charge that will be found on the metal ball. [1]

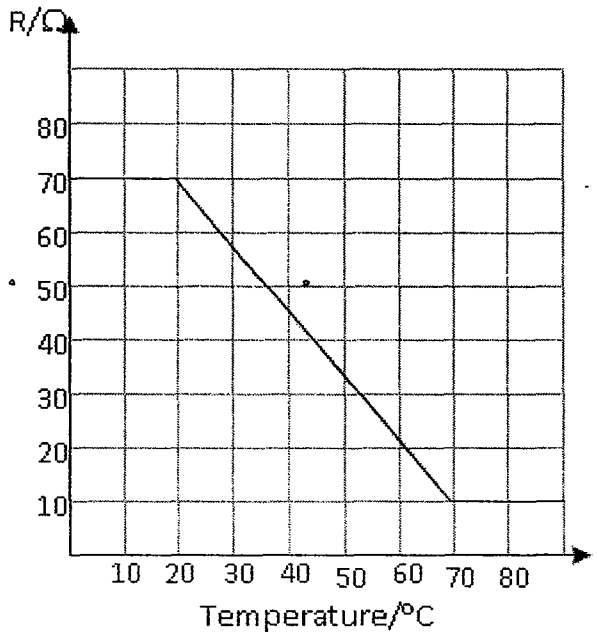
(iii) Draw lines of force to show the new electric field between the plates. [1]

12 **EITHER**

For Examiner's Use

The schematic diagrams below shows of a fire alarm system and the thermistor's characteristic graph.





The potential divider circuit works in conjunction with the thermistor. The alarm bell should ring when the surrounding temperature of the thermistor reach a certain value. The graph above depicts the resistance of the thermistor at various temperatures.

(a) The alarm will be activated. The potential difference across the 10 Ω resistor reaches 3 V. Determine the trigger temperature of the thermistor to activate the alarm. [3]

Temperature = ...

For Examiner's Use

(b) Expain how the circuit can be modified such that the trigger temperature at which the alarm will be activated can be varied. [2]

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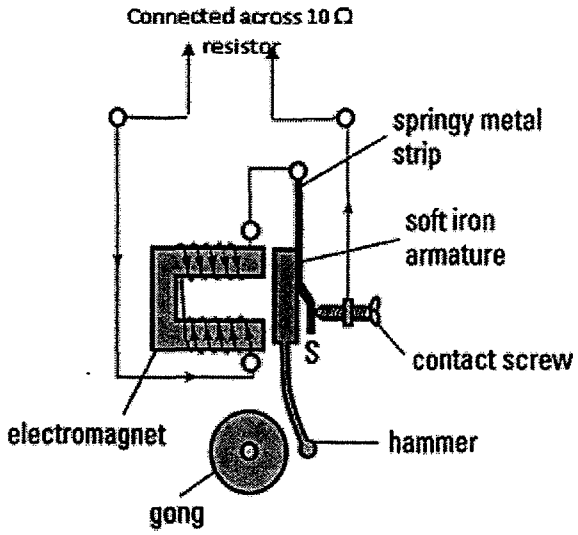
.....

(c) The figure below is an example of an alarm bell that can be connected across the 10 Ω resistor.



(i) Explain why soft iron is used as an electromagnet. [1]

.....

.....

(ii) Indicate on the figure above, the polarity of the electromagnet as the current flows through the coil. [1]

(iii) Explain the effect of increasing the voltage across the 10Ω resistor.[1]

.....

.....

(iv) Explain how the alarm bell can be adjusted such that the voltage to activate it can be decreased. [2]

.....

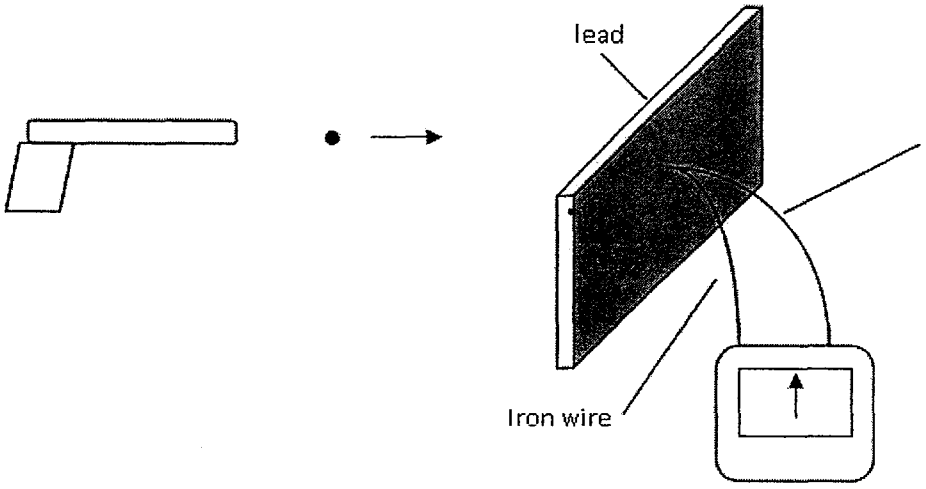
.....

.....

OR

For Examiner's Use

The figure below shows the arrangement used to measure the temperature rise of a piece of lead struck by air-gun pellets.



The thermometer consists of a thermocouple whose junction is embedded in the lead. When the temperature of the junction is raised, a deflection is observed on the galvanometer. Then, the lead pellets are fired into the lead target. The results and data are given below.

Mass of lead target = 39.5 g
Mass of pellet = 0.5 kg
Deflection on galvanometer = 5 divisions
Specific heat capacity of lead = 130 J kg^{-1} °C^{-1}
Galvanometer sensitivity = 10 divisions °C^{-1}

(a) Explain what is meant by specific heat capacity of lead is 130 J kg^{-1} °C^{-1}. [1]

.....

.....

(b) What is the temperature rise recorded? [1]

Temperature rise = ...

(c) Assuming that the pellet and lead targets were all at the same temperature before impact, calculate the internal energy change resulting from the impact. [2]

energy change = ...

(d) What is the speed of the pellet just before impact? State one assumption you have made in arriving at the answer. [2]

For Examiner's Use

speed = ...

assumption : .....

.....

(e) The pellet is then brought to rest as it penetrates the target in 0.05 s. Find

(i) the depth of penetration. [2]

depth = ...

(ii) the average resistive force of the target. [2]

average resistive force = ...

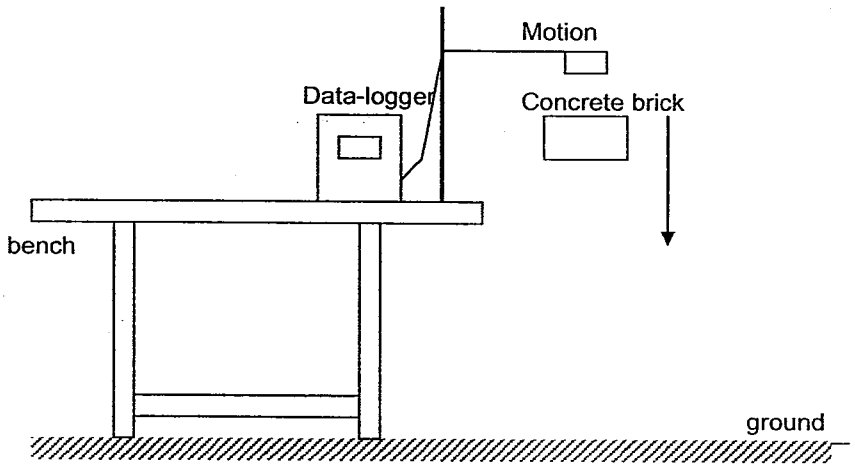
End Of Paper

Section A

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

For Examiner's Use

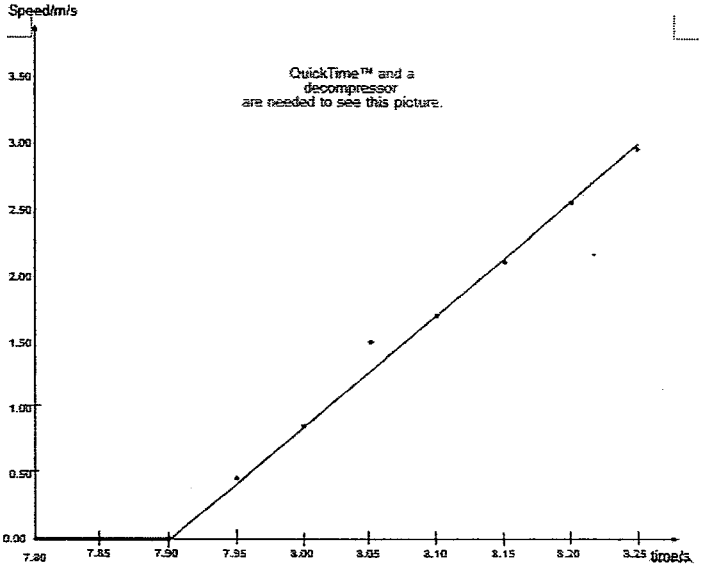
1. Mr Zhuang used a data-logging system to record the speed of a falling brick.



The concrete brick of mass 2 kg was released from rest under a motion sensor. The data logger obtained the following data.

speed/ ms^{-1}	0.00	0.00	0.00	0.45	0.85	1.50	1.70	2.10	2.55	2.95
time/s	7.80	7.85	7.90	7.95	8.00	8.05	8.10	8.15	8.20	8.25

(a) Using the data from the table above, plot a speed-time graph in the grid given. [3]



For Examiner's Use

(b) From your graph, estimate the distance travelled by the brick. [2]

Distance travelled by the brick is 0.516 m

(c) Determine the loss in potential energy of the brick during the journey in (b). [1]

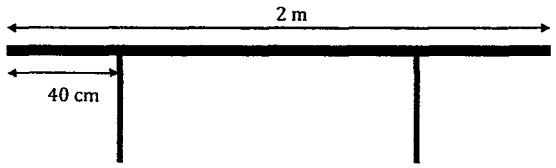
P.E. = mgh = $2 \times 10 \times 0.516 = 10.32$
The loss of potential energy is 10.3 J

(d) From your **graph**, find the maximum kinetic energy of the brick. [2]

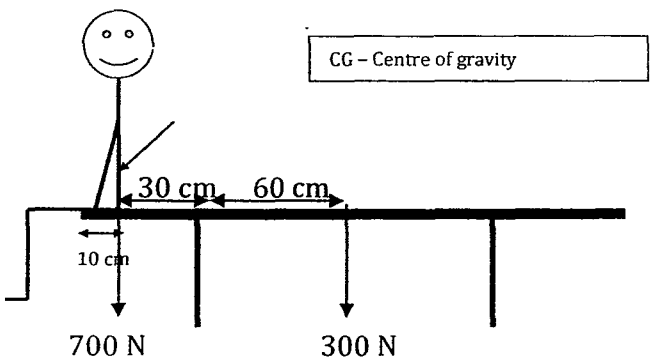
Max velocity = 2.95 m/s
K.E. = $\frac{1}{2}mv^2 = \frac{1}{2} \times 2 \times 2.96^2 = 8.70$
The maximum kinetic energy of the brick is 8.70 J

(e) Explain why there is a difference in the values obtained in (c) and (d).[1]
There is energy loss due to air resistance resulted in falling object. Cannot accept just friction

2. A uniform teacher's desk has a mass of 30 kg. The desk is 2 m long with legs mounted 40 cm away from the edges as seen in the diagram below



(a) Addy Tan who weighs 700 N sits on the desk, 10 cm from the edge as seen from the diagram below.

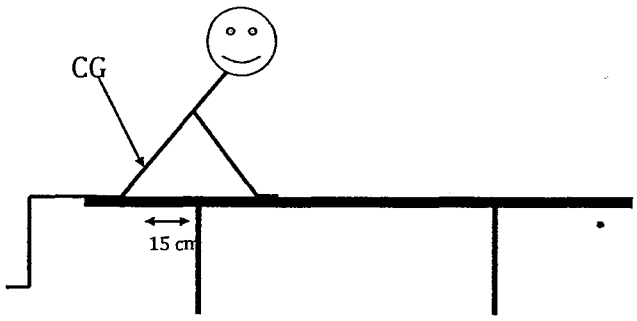


Show with mathematical proof why the desk would be tipped over by Addy. [2]

Taking moments about left leg,
Clockwise moment = $0.6 \times 300 = 180$ Nm
Anticlockwise moment = $700 \times 0.3 = 210$ Nm
Hence clockwise moment < anticlockwise moment,
table tips over in anticlockwise direction about left leg.

For Examiner's Use

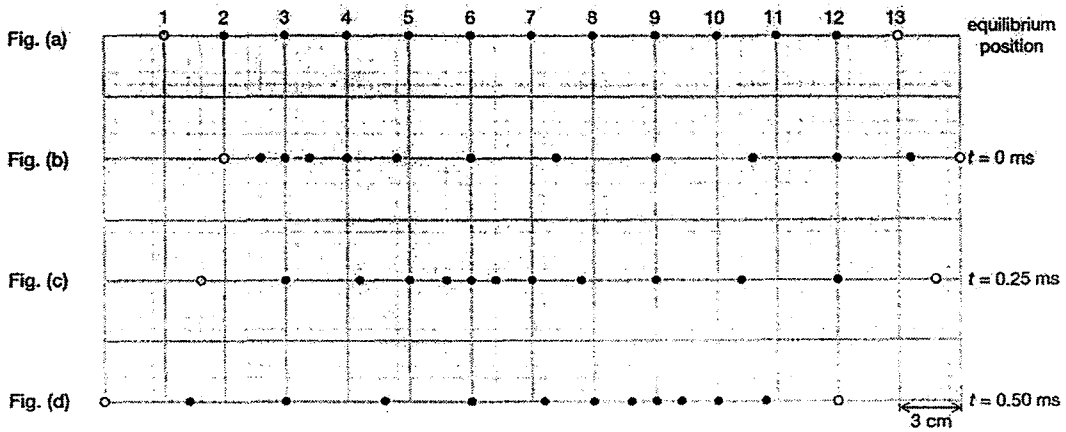
(b) Addy now adjusted himself as can be seen below.



At this new position, Addy is now more "stable". Explain why. [2]

The centre of gravity has shifted such that anticlockwise moment about the left leg due to the Addy's weight is now less(distance between CG and pivot is less) than the clockwise moment. Hence table will not tip.

3.



A sound wave travels from left to right in air. Fig. (a) shows the equilibrium positions of a series of particles in air. The positions of the particles at different instants within a period are shown in Fig. (b), (c) and (d).

(a) Which particles in Fig. (c) correspond to the centre of a compression and the centre of a rarefaction respectively? [2]

Particle 6 is at the centre of a compression and particle 12 is at the centre of a rarefaction.

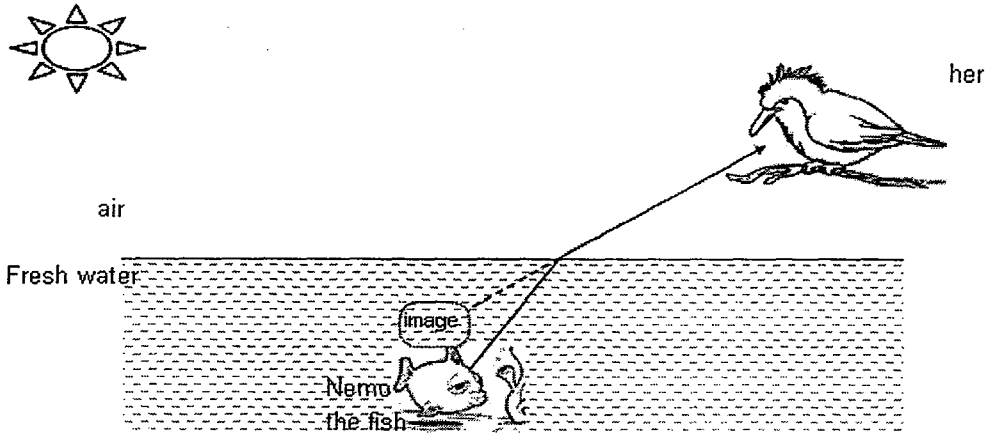
(b) Find the wavelength, frequency and speed of the wave. [2]

period T = 0.5 x 2 = 1 ms **frequency f = 1/T = 1000 Hz**
wavelength λ = 3 x 6 x 2 = 36 cm
speed v = λ/T = 0.36 / 1 x 10^{-3} = 360 m/s

4. Kingfishers usually hunt from a perch a few metres above the water, swooping down at up to 100 km/h to snatch their prey, before returning to the perch. The whole process is an extraordinary feat of calculation, not only must the bird work out the depth of the fish before it dives, but it also compensates for the effect of refraction in the water. In addition, these birds have special features in their eyes to cut out *reflection* and see their prey better.

[Extract from Focus magazine, Issue 219]

For Examiner's Use



(a) Explain what is meant by the refractive index of water? [1]

It is the ratio of speed of light in (vaccum)air and the speed of light in water

(b) Why must the bird "work out the depth of the fish" before it dives? [1]

The bird would not be seen at the real depth of the fish. Fish would look nearer than it is.

(c) On the diagram draw a ray to show how light from the fish travels to the kingfisher. [2]

(d) Sometimes the kingfisher might not even see the fish especially when the fish is at a particular position. This is a phenomenon common to light when it travels from water to air. Explain what this phenomenon is and how it can occur. [2]

Total internal reflection has occurred.[1]
Light must travel from the water to air (denser to less dense medium). The angle of incidence must be greater than the critical angle.[1]

5. Fig. 5.1 represents a simple camera which makes use of a converging lens of focal

length *f*.

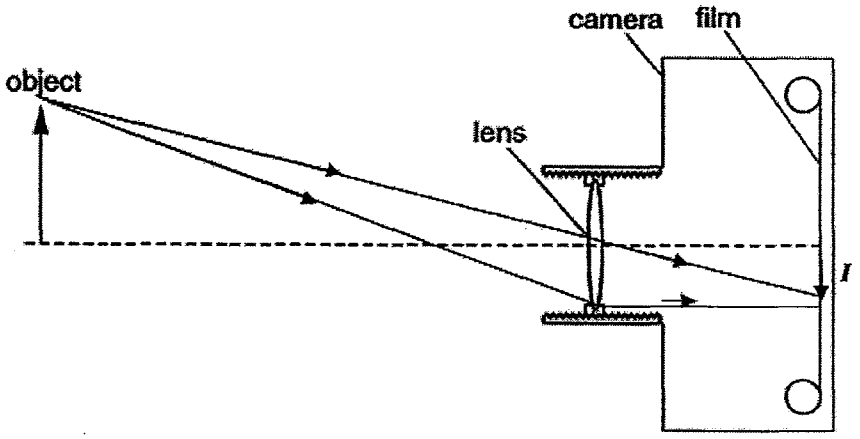


Fig. 5.1 (to scale)

(a) Define what is meant by *focal length*. [1]

It is the distance between the optical centre and focal point of a converging lens.

(b) Draw two rays from the top of the object to show how the image is formed on the film. [2]
Mark and label the image on the film.

(c) Fig. 5.1 is drawn to scale. Determine the linear magnification of the object shown in Fig. 5.1. [1]

Linear magnification = 0.40 (± 0.05) (can accept 1 sf)

(d) Explain why, when taking photographs of other objects, it may be necessary to move the lens towards the film. [1]

For other objects which are further away (or increased object distance), the lens has to move towards the film in order for the light rays to converge onto the film and produce a sharp image.

6. Ice with a mass of 22 g at a temperature of -12 °C is taken from a freezer and placed in a polystyrene cup containing water at 22 °C.
Given that the specific heat capacity of ice = 2100 Jkg-1K-1
and the latent heat of fusion of ice = 3.3×10^5 Jkg-1,

(a) calculate the quantity of heat needed
(i) to raise the temperature of ice from -12 ° C to 0° C [1]

$Q = mc\Delta\theta = 22 \times 2.1 \times 12 = 554$ J

(ii) to change the ice to water without a change in temperature. [1]

$Q = mL = 22 \times 330 = 7260$ J

(b) The temperature of the water in the cup falls after the ice has been added.
Specific heat capacity of water = 4200 J/(kg ° C)

(i) Calculate the mass of water in the cup if the lowest temperature reached by the water is 8 °C. [2]

$Q = mc\Delta\theta = m \times 4.2 \times (22 - 8) = 7814 + (22 \times 4.2 \times 8)$
$m \times 58.8 = 7814 + 739.2$
$m = 8553.2 / 58.8 = 145.5$ g

(ii) State an assumption you have made in **(b)(i)**. [1]

No heat lost from the water / No melted ice water

7. In the circuit shown in Fig. 7.1, the battery, of negligible internal resistance, has an e.m.f of 12 V.

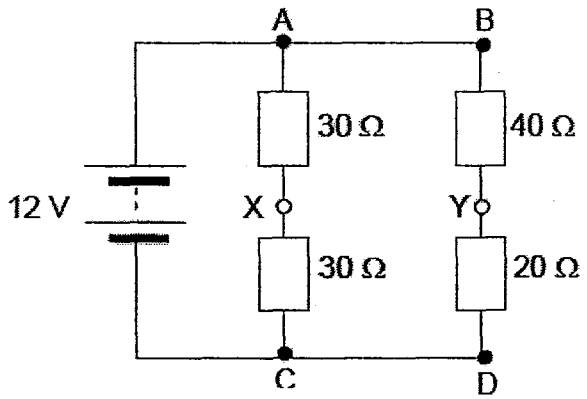


Fig. 7.1

(a) What is the effective resistance in the circuit? [1]

Ans. 30 Ω

(b) What is the current supplied by the battery? [1]

$I = \frac{12}{30} = 0.4$ A

(c) Is the current in **(b)** divided equally between the two arms (**AC** and **BD**) of the resistor network? Why? [2]

For Examiner's Use

yes effective R across both arms same

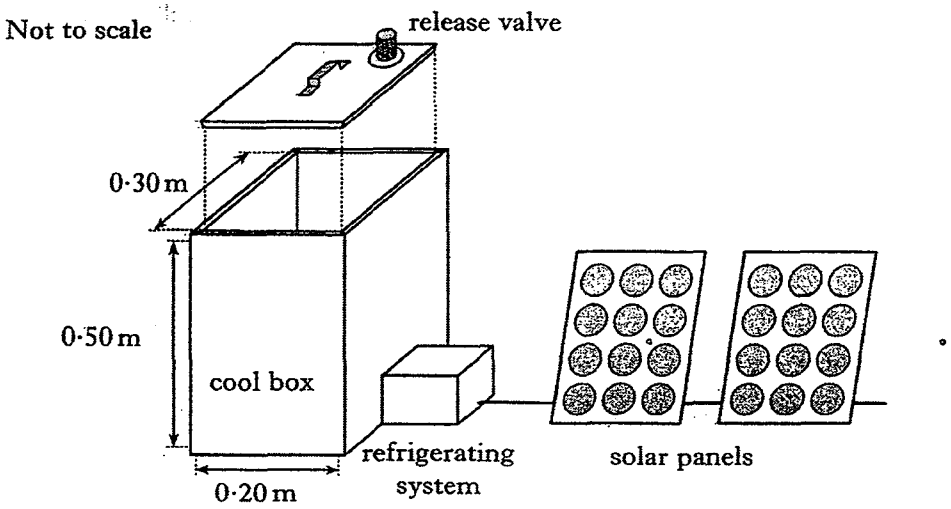
(d) What is the potential difference between **X** and **C**? [1]

6V

(e) If a high resistance voltmeter is connected between **X** and **Y**, what would be the reading on the voltmeter? [1]

2 V

8. A refrigerated cool box is being prepared to carry medical supplies in a hot country. The **internal** dimensions of the box are 0.30 m x 0.20 m x 0.50 m.



The lid is placed on the cool box with the release valve closed. An airtight seal is formed. When the lid is closed the air inside the cool box is at a temperature of 33^0C and a pressure of 1.01×10^5 Pa. The refrigerating system then reduces the temperature of the air inside the cool box until it reaches its working temperature. At this temperature the air inside is at a pressure of 9.05×10^4 Pa.

(a) Calculate the temperature of the air inside the cool box when it is at its working temperature. [2]

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \rightarrow \frac{1.01x10^5}{306} = \frac{9.05x10^4}{T_2} \rightarrow \mathbf{T_2 = 274\ K\ (1°C)}$$

(b) Describe, using the kinetic model, how the decrease in temperature affects the air pressure inside the cool box. [2]

E_k of particles in air decreases. Collisions with walls less often. Pressure decreases.

9.

For Examiner's Use

(a) State the value of the acceleration for both objects. [1]

10 m s^{-2}

(b) It was found that the disc magnet reached the bottom fastest in the acrylic pipe and slowest in the copper pipe.

Explain why the magnet takes a longer time to reach the bottom of the copper pipe compared to the acrylic pipe. [2]

There is a changing magnetic field in the copper pipe as the disc magnet falls [1] inside the pipe.
This induces an emf in the pipe and the induced current produces a magnetic pole to repel the falling disc magnet in accordance to Lenz's Law. [1] This repulsion force reduces the net downward force, resulting in a reduced acceleration (and thus a longer time) [1] Max [2]
(Note: for acrylic pipe, there is no induced emf as acrylic is a non-conductor)

(c) In another experiment, the disc magnet was dropped into another hollow pipe made of aluminium at the same height. The time taken for the disc magnet to reach the bottom is different as compared to the disc magnet falling through the copper pipe.

Is the time of fall shorter or longer as compared to the copper pipe? Explain your reasoning. [2]

Time of fall is shorter in the aluminium pipe as compared to the copper pipe [1]
The electrical resistance is copper is much lower than aluminium, hence a higher induced current (and thus a greater repulsion force) is produced in the copper pipe.This cause the acceleration of the disc magnet in the copper pipe to be smaller [1]

Section B

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

For Examiner's Use

10. (a) Read the article below extracted from the Straits Times, August 15 2009 and answer the corresponding questions.

Hot spring heat source could 'power 50,000 homes'

A HOT spring tucked away in Sembawang might just hold the key to Singapore's untapped geothermal power potential, and at least one geologist is going full steam ahead on the idea.

Dr Grahame Oliver believes the energy that heats the unassuming spring could be tapped – based on his geologic predictions and evidence from Singapore quarries – to power 50, 000 homes here.

His theory suggests that a shaft could be drilled about 2 km into the earth at the right spot near Sembawang or another hot spring, such as the one at Pulau Tekong, a military training area.

At that depth, the water would be about 150 °C and emerge as steam, which could drive a turbine to produce electricity. The water would be channeled back into the earth.

Or cooler water – at about 70 °C – could be pumped up to flash-boil another liquid with a boiling point lower than that of water, producing steam for the turbine.

The process of building the geothermal plant would require a capital of $27 million but a 50 MW plant the size of three football fields could pay for itself in about 5 years, power an HDB town and save about half a million barrels of oil a year.

(i) State one advantage of using geothermal energy as compared with other sources of energy. [1]

Less pollution. Save cost in the long run

(ii) It is stated in the article that the plant could generate 50 MW every hour. If it cost $3 per MW h, calculate the cost of producing power for a typical town for 5 years. (Note: Assume 1 month to be 30 days.) [2]

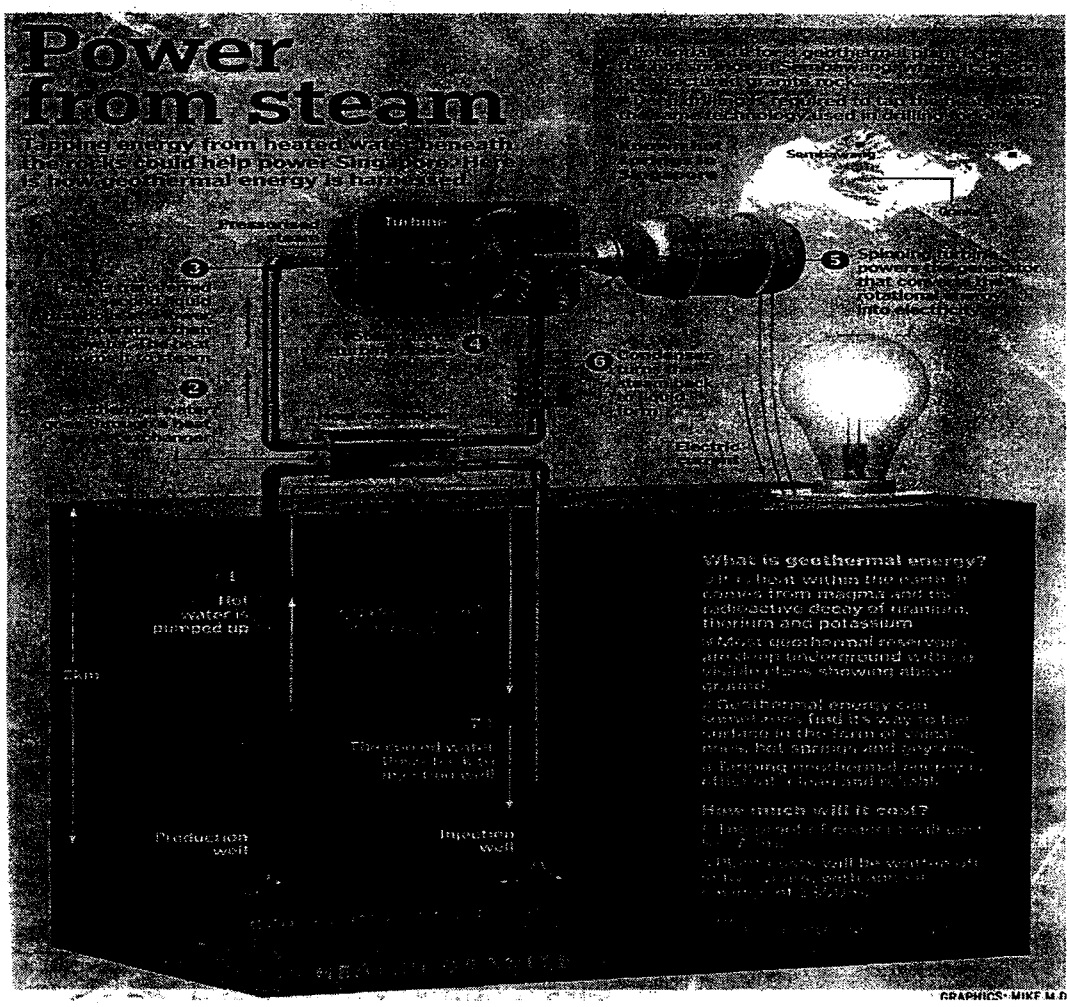
(24 × 30 × 12 × 5) × 50 × 3 = $6 480 000

(iii) If the temperature is not high enough for water to form into steam, explain how geothermal enegy can still be tapped to generate electricity. [2]

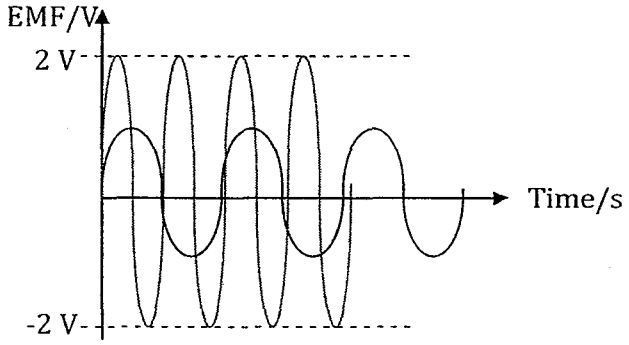
Flash boil. Warm water (70 °C) use to heat other liquid with low boiling boil. Steam then produced by liquid when it boils to turn generator.

(b) The diagram below shows as example of how geothermal energy can be harnessed.

For Examiner's Use



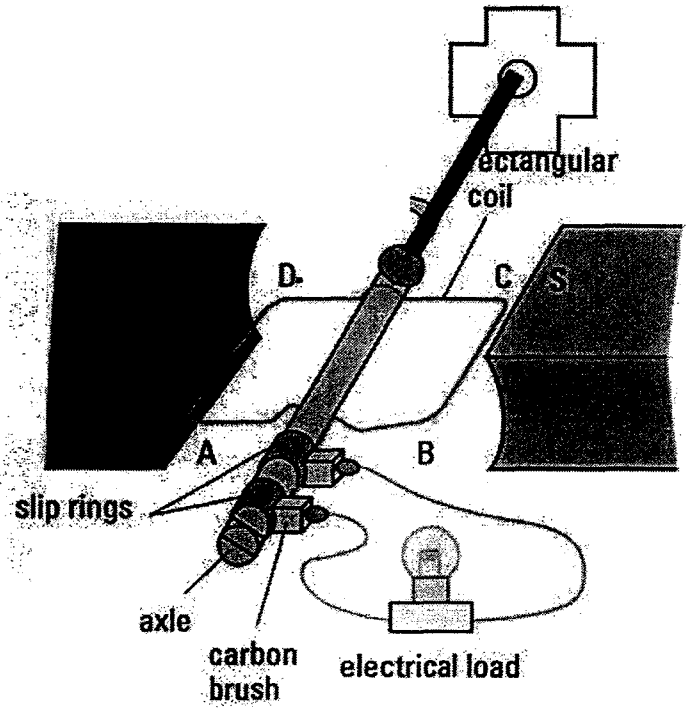
(i) The waveform of the induced EMF by the generator is illustrated below.



On the diagram above, sketch the changes to the waveform if the turbine rotates twice as fast. [1]

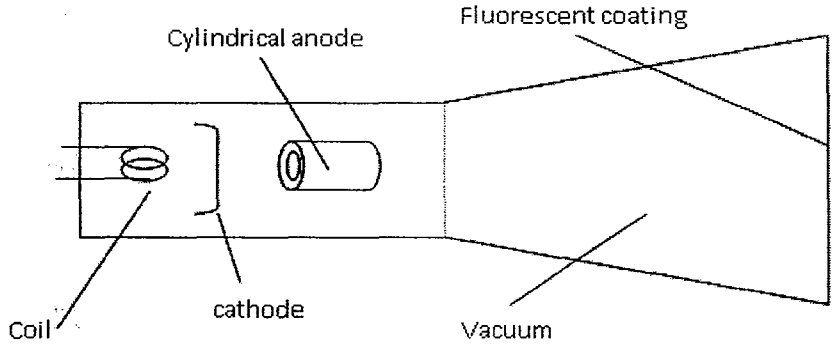
(ii) With an aid of a labelled diagram, explain briefly the working operation of a generator that can be found typically in a geothermal plant. [4]

For Examiner's Use



As turbine turns, coil will turn within magnetic field. This interaction between the turning effect of the coil and the magnetic field will induce current in the coil. Current flows through slip rings and carbon brushes into load (lamp). Current in load circuit change direcftion every half revoultion (coil) due to positions of slip rings. Hence Alternating current/EMF is induced.

11. (a) The figure below represents a tube capable of producing a beam of electrons flowing from the cathode to the flourescent coating.



(i) State the purpose of the coil, cylindrical anode and vacuum [3]

Coil – to heat cathode to generate electrons
Cylindrical anode – To accelerate electron beam
Vacuum – to allow electron to move unimpeded

In 12 s, the number of electrons, each carrying a charge of 1.6×10^{-19} C, that strike the coating is 2.4×10^{14}. The potential difference causing the electrons in the beam to accelerate is 3.0×10^{3} V.

For Examiner's Use

(ii) Calculate the current in the tube. [2]

Current in tube = $Q \div t = 1.6 \times 10^{-19} \div 12$
$= 3.2 \times 10^{-6}$ A

(iii) Calculate the power conveyed by the electron beam. [2]
Power conveyed by electron beam = IV
$= 3.2 \times 10^{-6} \times 3.0 \times 10^{3} = 9.6 \times 10^{-3}$ W

(b) Two vertical metal plates are connected to a high voltage power supply, as shown in the diagrams below. An electric field exists in the space between The plates.

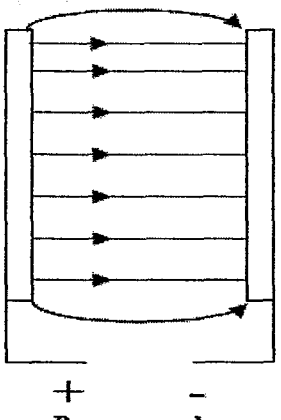


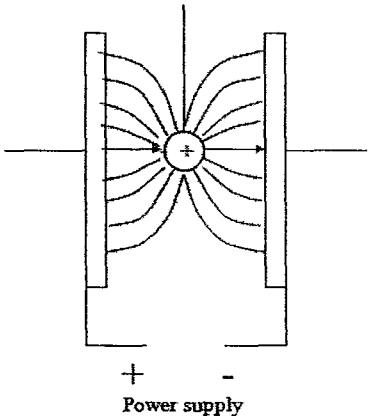
Figure 1

(i) On Figure 1, draw lines of force to show the electric field between the two plates. [1]

An uncharged metal ball is hung by an insulated thread between the two plates as shown on Figure 2.

(ii) Draw the distribution of charge that will be found on the metal ball. [1]

(iii) Draw line force to show the new electric field between the plates. [1]

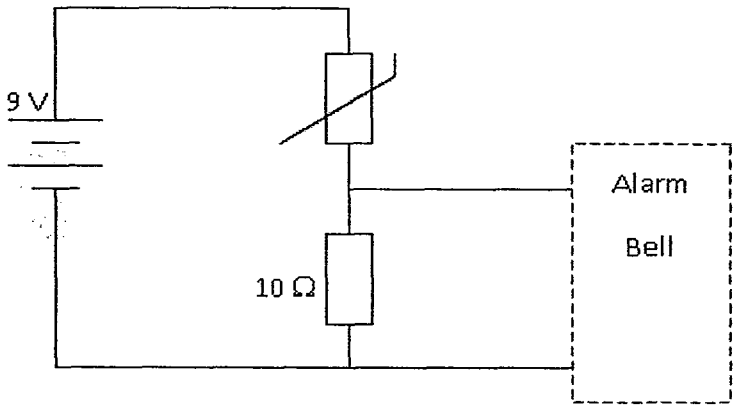


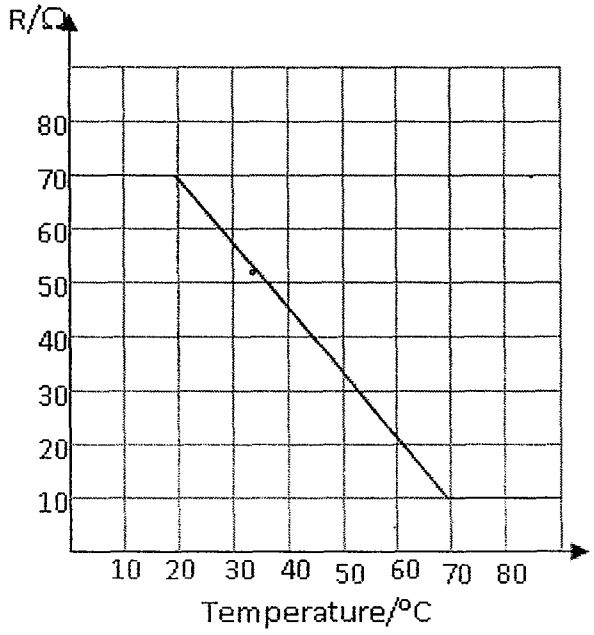
Fiure 2

12 **EITHER**

For Examiner's Use

The schematic diagrams below shows of a fire alarm system and the thermistor's characteristic graph.





The potential divider circuit works in conjunction with the thermistor. The alarm bell should ring when the surrounding temperature of the thermistor reach a certain value. The graph above depicts the resistance of the thermistor at various temperatures.

(a) The alarm will be activated. The potential difference across the 10 Ω resistor reaches 3 V. Determine the trigger temperature of the thermistor to activate the alarm. [3]

Vr – P.D across resistor Rt – resistance of thermistor
Vr = 10/(10+Rt) × 9 **[1]**
3 = 10/(10+Rt) × 9
Rt = 20 Ω **[1]**
20 Ω => 60 °C (from graph) **[1]**

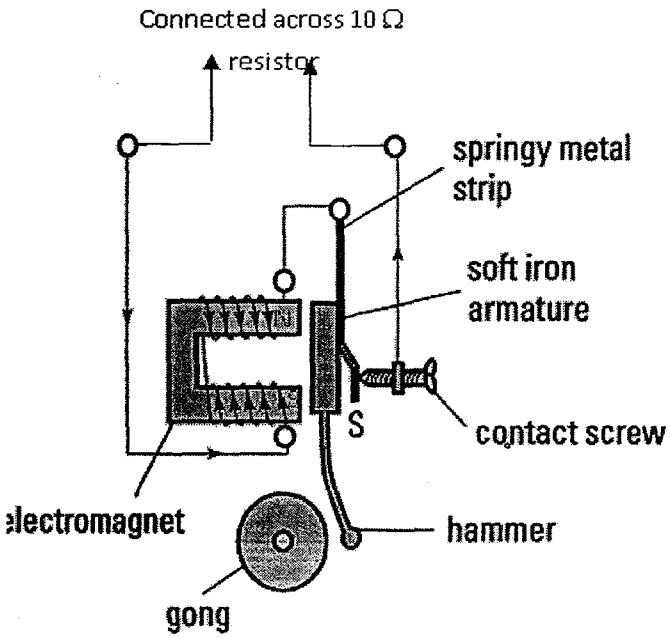
For Examiner's Use

(b) Expain how the circuit can be modified such that the trigger temperature at which the alarm will be activated can be varied. [2]

Replace 10 Ω resistor with a variable resistor. As value of variable resistor increases, trigger temperature decreases.

E.g. If Variable resistor increases to 20 Ω.
3 = 20/(20 + Rt) x 9 hence Rt = 40 Ω and trigger temperature = 45 °C

(c) The figure below is an example of an alarm bell that can be connected across the 10 Ω resistor.



(i) Explain why soft iron is used as an electromagnet. [1]

Loses and gain magnetism very easily.

(ii) Indicate on the figure above, the polarity of the electromagnet as the current flows through the coil. [1]

(iii) Explain the effect of increasing the voltage across the 10 Ω resistor. [1]

More current in coil. Hammer will be attracted to electromagnet more quickly or easily.

(iv) Explain how the alarm bell can be adjusted such that the voltage to activate it can be decreased. [2]
Adjusting the contact screw. By tightening the screw, hammer will be pushed closer to the electromagnet. Hence it take less current to attract hammer and strike the gong.

OR

For Examiner's Use

(a) Explain what is meant by specific heat capacity of lead is 130 J kg-1 C-1. [1]

The amount of energy (in joules) that is needed to raise the temperature of 1 kg of lead by 1 °C is 130 J.

(b) What is the temperature rise recorded? [1]

Temperature recorded = 5 ÷ 10 = 0.5 °C

(c) Assuming that the pellet and lead targets were all at the same temperature before impact, calculate the internal energy change resulting from the impact. [2]

$Q = mc\Delta\theta$
Internal energy change = 39.5/1000 × 130 × 0.5 = 2.57 J

(d) What is the speed of the pellet just before impact? State one assumption you have made in arriving at the answer. [2]

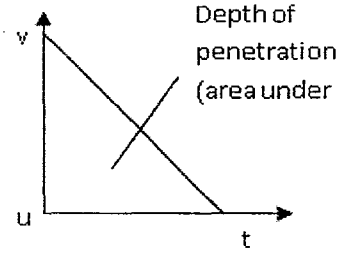
$KE = \frac{1}{2} mv^2$
Speed of pellet before impact,
$v = \sqrt{(2KE/m)}$
$= \sqrt{[(2\times2.57)/(0.5)]} = 3.20\ ms^{-1}$

Assumption: All the kinetic energy of the pellet is converted to the thermal energy absorbed by the lead.

(e) The pellet is then brought to rest as it penetrates the target in 0.05 s. Find

(i) the depth of penetration. [2]

$\frac{1}{2} \times 3.20 \times 0.05 = 0.08$ m



(ii) the average resistive force of the target. [2]

work = $\frac{1}{2} mv^2$
Fd = ½ mv2
F = 2.57 ÷ 0.08 = 32 N

End Of Paper

For Examiner's Use

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