Name: _____( ) Class:_____

PRELIMINARY EXAMINATIONS 2016

Secondary Four Express

PHYSICS (WITH SPA) 5059/01

Paper 1 Multiple Choice Duration: 1 hour

Class: 406

Additional Materials: Optical Answer Sheet

READ THESE INSTRUCTIONS FIRST

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

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

Read the instructions on the Optical 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.

1 Study the four equations shown below.

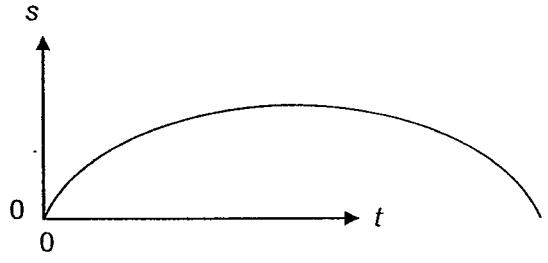
$$\text{force} = \text{mass} \times \text{acceleration} \qquad \text{power} = \frac{\text{work done}}{\text{time}}$$

$$\text{velocity} = \frac{\text{displacement}}{\text{time}} \qquad \text{density} = \frac{\text{mass}}{\text{volume}}$$

How many different vector quantities can be found in these equations?

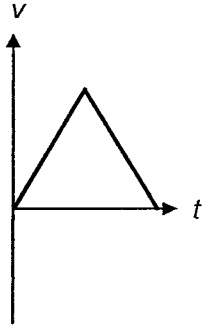
A 3
B 4
C 7
D 8

2 The diagram shows a graph of displacement *s* against time *t* of an object moving in a straight line.

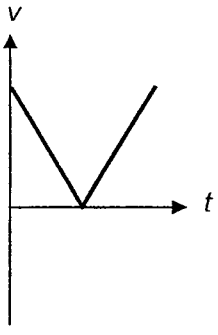


Which graph of velocity *v* against time *t* correctly represents the motion of the object?

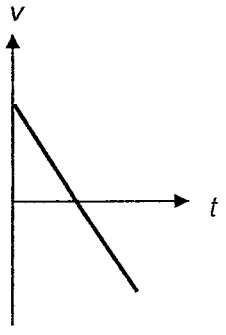
A



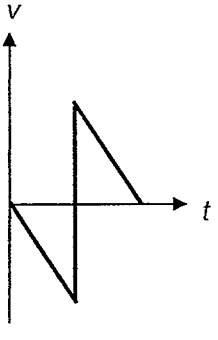
B



C



D



3 Two objects X and Y are identical in size and shape but X has 3 times the mass of Y. They are both released simultaneously from a point 100 m above the ground.

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

I The rate of change of velocity is the same for X and Y as soon as they are released.
II Both X and Y will reach the same terminal velocity.
III X will reach the floor before Y.

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

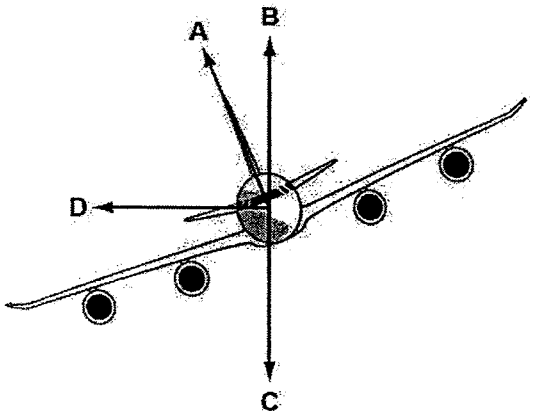
4 A skier of mass 80 kg accelerates down an inclined slope at 2 m / s^2 and encounters a constant frictional force of 20 N. The gravitational field strength *g* is 10 N / kg.

What is the weight of the skier and the resultant force on the skier?

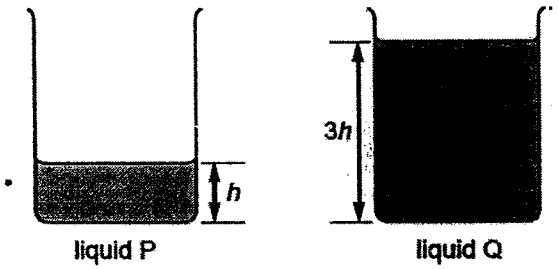
	weight / N	resultant force / N
A	800	140
B	800	160
C	800	1580
D	8000	160

5 The diagram shows an aeroplane turning in a horizontal circle at constant speed.

Which is the direction of the resultant force?



6 Two identical beakers contain two liquids of different densities. Liquid Q has density ρ. The ratio of mass of liquid P to the mass of liquid Q is 2:3.



What is the density of liquid P?

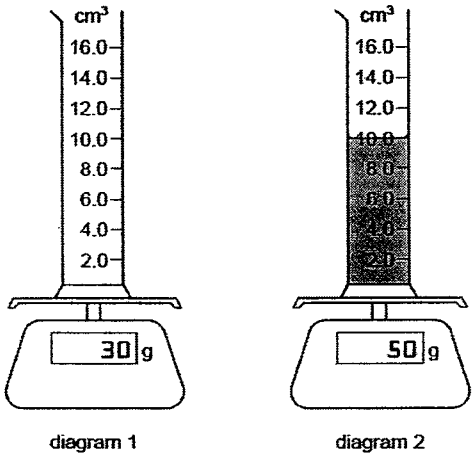
A $\frac{1}{2}\rho$

B $\frac{3}{2}\rho$

C 2ρ

D 3ρ

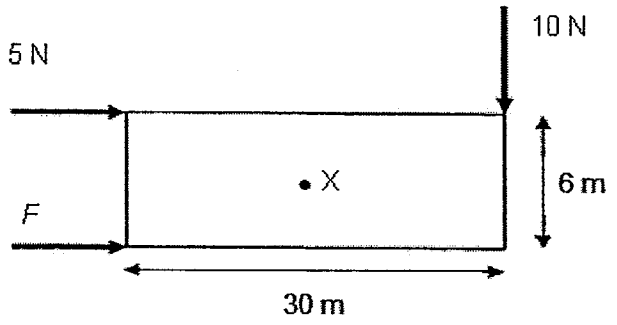
7 Diagram 1 shows an empty measuring cylinder on a mass balance.
Diagram 2 shows the same measuring cylinder containing a liquid on the same mass balance.



What is the density of the liquid?

A 0.2 g / cm^3
B 0.5 g / cm^3
C 2.0 g / cm^3
D 5.0 g / cm^3

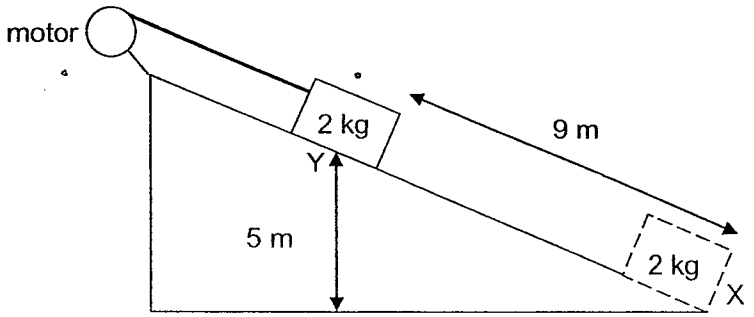
8 The diagram shows the plan view of an uniform rectangular board with three forces, 5 N, 10 N and *F*, acting at its edges. A pin passes through the centre of gravity of the board at X so that the board is able to rotate freely about X.



What is the value of *F* so that the board remains in equilibrium?

A 30 N
B 45 N
C 55 N
D 60 N

9 The diagram shows a motor used to lift up a mass of 2 kg up a ramp.



The frictional force between the mass and the ramp is 8 N.

Given that the gravitational field strength of Earth is 10 N / kg and the mass is moving at constant speed between X and Y, what is the power of the motor if the mass is lifted from point X to point Y in 4 s?

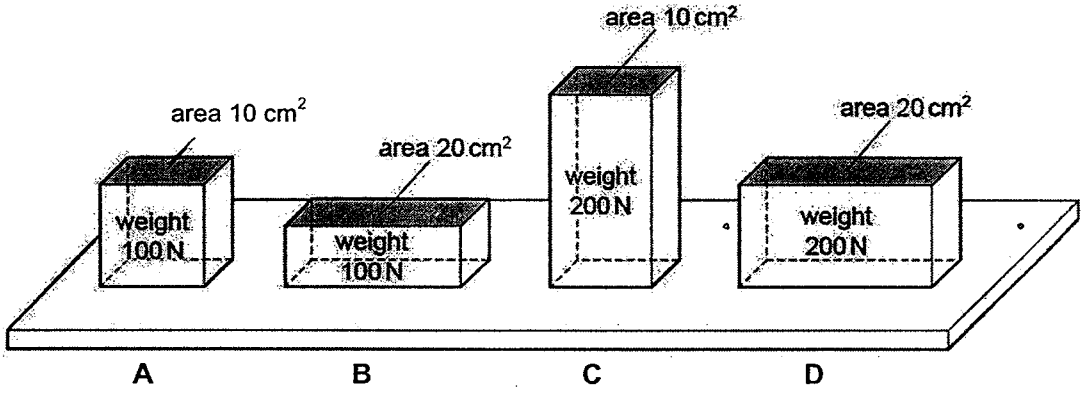
A 4.5 W
B 7 W
C 25 W
D 43 W

10 A cyclist accelerates up a slope.

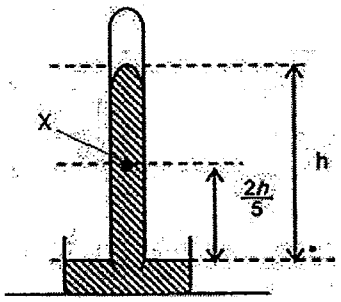
What are the changes in the kinetic and gravitational potential energy?

	kinetic energy	gravitational potential energy
A	decrease	increase
B	increase	decrease
C	increase	increase
D	no change	no change

11 Which block exerts the greatest pressure on the surface below it?



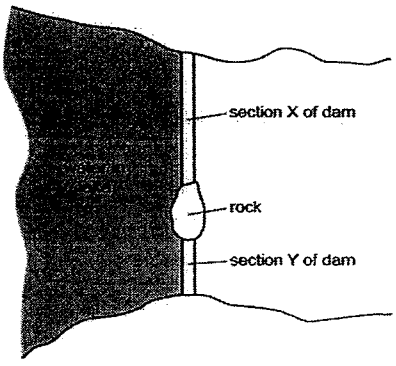
12 The height of a mercury barometer is h when the atmospheric pressure is 10^5 Pa.



Given that the space above the mercury column is vacuum, what is the pressure of a point X inside the mercury?

A 40 kPa
B 60 kPa
C 140 kPa
D 160 kPa

13 The diagram shows a plan view of a dam across a lake divided into two sections by a rock. Section X is longer than section Y but the two sections are otherwise identical. The depth of water in the lake is the same at every point.

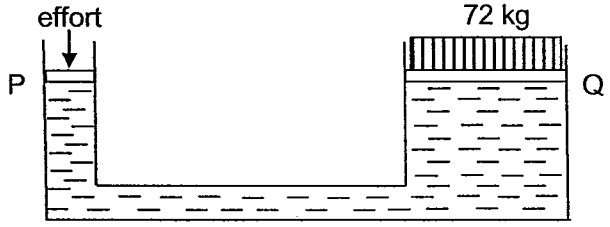


The water creates a total force on each section of the dam and an average pressure on each section of the dam.

Given that F_x and F_y; P_x and P_y are the forces and pressures acting on sections X and Y of the dam respectively, which option correctly describes the relative magnitude of pressure and force acting on X and Y?

	comparison between P_x and P_y	comparison between F_x and F_y
A	P_x is equal to P_y	F_x is equal to F_y
B	P_x is equal to P_y	F_x is greater than F_y
C	P_x is greater than P_y	F_x is equal to F_y
D	P_x is greater than P_y	F_x is greater than F_y

14 The diagram shows a hydraulic press made of two circular platform at P and Q. The diameter of piston P is 2.0 cm and that of piston Q is 6.0 cm. A block of mass 72 kg is placed on piston Q.



The efficiency of the hydraulic press is 80 %.

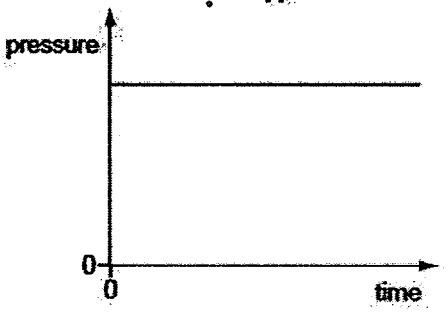
What is the effort required to raise the block of mass?

A 10 N
B 64 N
C 80 N
D 100 N

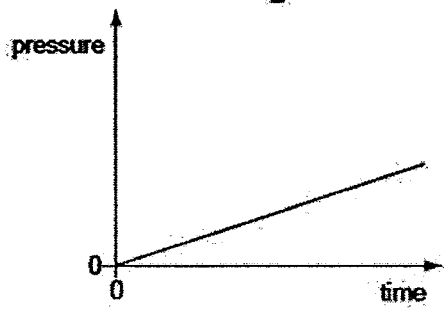
15 The pressure of a fixed mass of gas in a cylinder is measured. The volume of the gas in the cylinder is then slowly decreased. The temperature of the gas does not change.

Which graph best shows the change of pressure of the gas during this process?

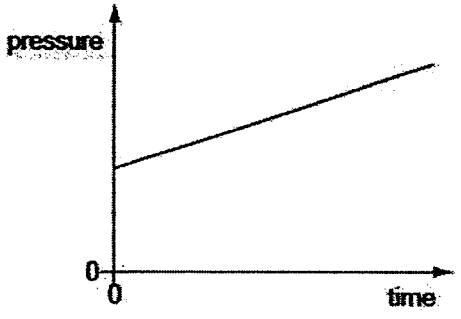
A



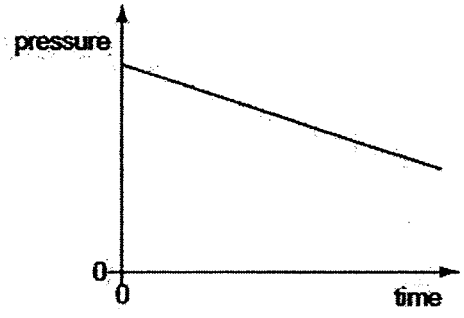
B



C



D



16 An inflated car tyre contains air at a constant volume. When the car is travelling on the road, the air inside the tyre gets heated and its air pressure increases.

Which option correctly describes the properties of the air molecules inside the tyre?

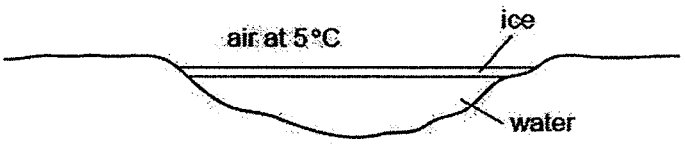
	number of air molecules in the tyre	force between air molecules and tyre wall	number of collisions per second between air molecules and tyre wall
A	increased	increased	decreased
B	increased	unchanged	decreased
C	unchanged	increased	increased
D	unchanged	unchanged	decreased

17 A student wraps a block of ice in a layer of wet newspaper and observes that the ice takes a longer to melt to become water.

What is the cause of this?

A Evaporation has occurred with the less energetic water molecules escaping from the newspaper which results in a decrease in the average speed of the remaining water molecules.
B Evaporation has occurred with the less energetic water molecules escaping from the newspaper which results in an increase in the average speed of the remaining water molecules.
C Evaporation has occurred with the more energetic water molecules escaping from the newspaper which results in a decrease in the average speed of the remaining water molecules.
D Evaporation has occurred with the more energetic water molecules escaping from the newspaper which results in an increase in the average speed of the remaining water molecules.

18 The diagram shows a frozen pond with the surface of the ice slowly melting as heat is gained from the warmer air above it.

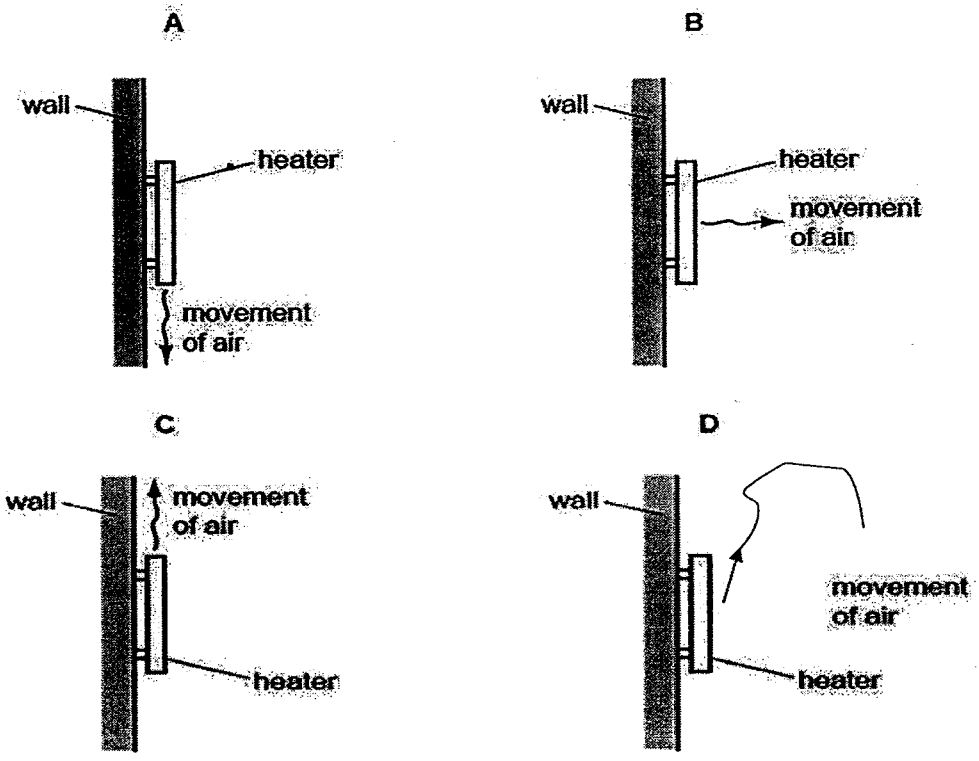


By which processes is heat transferred from the air to the ice?

A conduction and convection only
B conduction and radiation only
C convection and radiation only
D conduction, convection and radiation

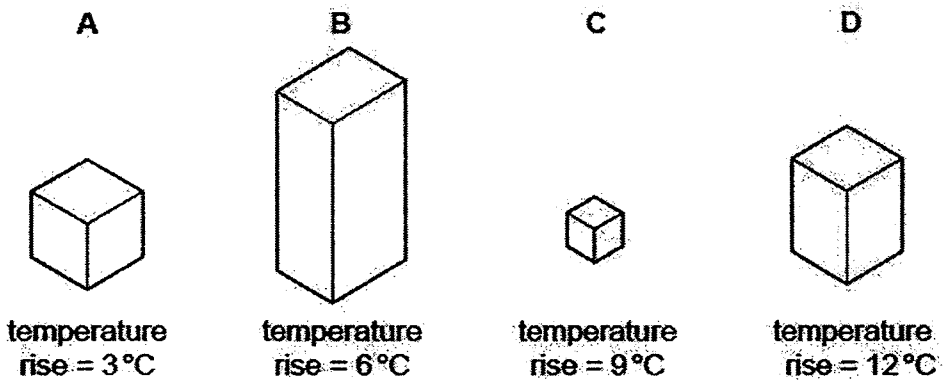
19 A convector heater is fixed to a wall.

Which diagram shows the movement of warm air due to convection current?



20 Four blocks of equal masses are made from different materials. Each block is heated so that they have the same increase in internal energy.

Which block has the smallest specific heat capacity?

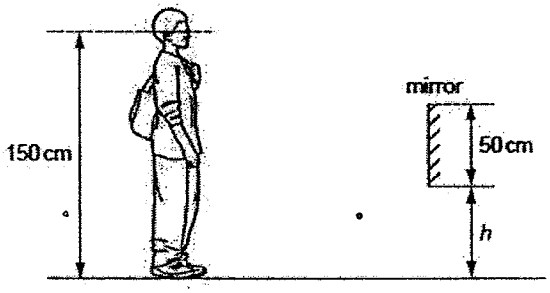


21 A substance has a melting point of –17 °C and a boiling point of 117 °C.

In which state does the substance exist at –30 °C and at 100 °C?

	at –30 °C	at 100 °C
A	solid	liquid
B	solid	gas
C	liquid	liquid
D	liquid	gas

22 A shoe shop places a mirror on the wall so that customers can look at their new shoes. The length of the mirror is 50 cm. The distance between the customer's eyes and the ground is 150 cm. The bottom of the mirror is at height *h* above the ground.

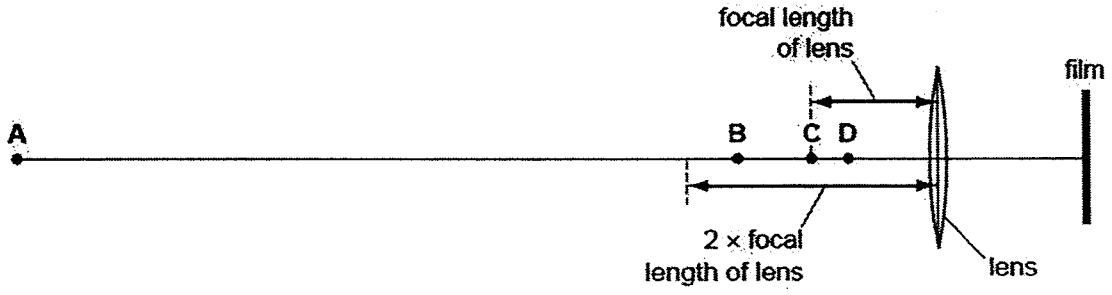


What is the smallest value of *h* that allows the customer to see an image of his new shoes in the mirror?

A 25
B 50
C 75
D 100

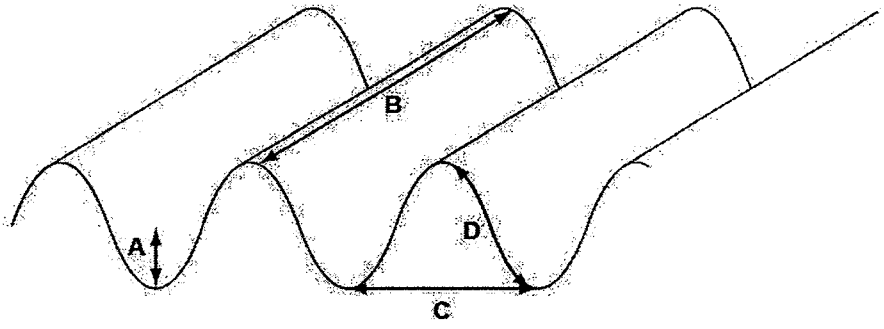
23 The converging lens in a camera is used to make an image on a film.

At which labelled point could a large object be placed so that it forms a smaller image?

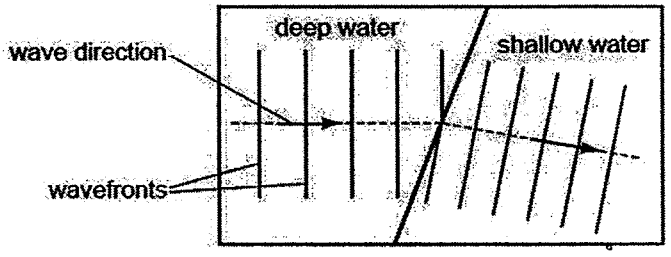


24 The diagram shows a water wave in a ripple tank.

Which line represents a wavefront?



25 Water waves can be used to demonstrate refraction by passing them in a trough of water of different depths.



Which statement describes why the water wave changes direction as it passes into the shallow water?

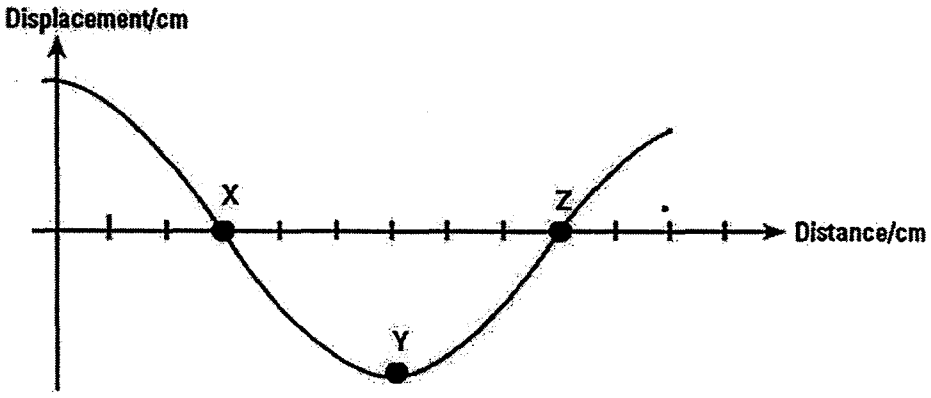
A The frequency of the wave decreases.
B The frequency of the wave increases.
C The speed of the wave decreases.
D The speed of the wave increases.

26 Infra-red waves, microwaves, radio waves and sound waves are used for communication.

Which waves travel at the same speed in a vacuum?

A infra-red waves, microwaves and radio waves
B infra-red waves, microwaves and sound waves
C infra-red waves, radio waves and sound waves
D microwaves, radio waves and sound waves

27 The diagram shows the displacement-distance graph of a sound wave. The sound wave is travelling to the right. Three of the particles X, Y and Z in the sound wave are marked below.

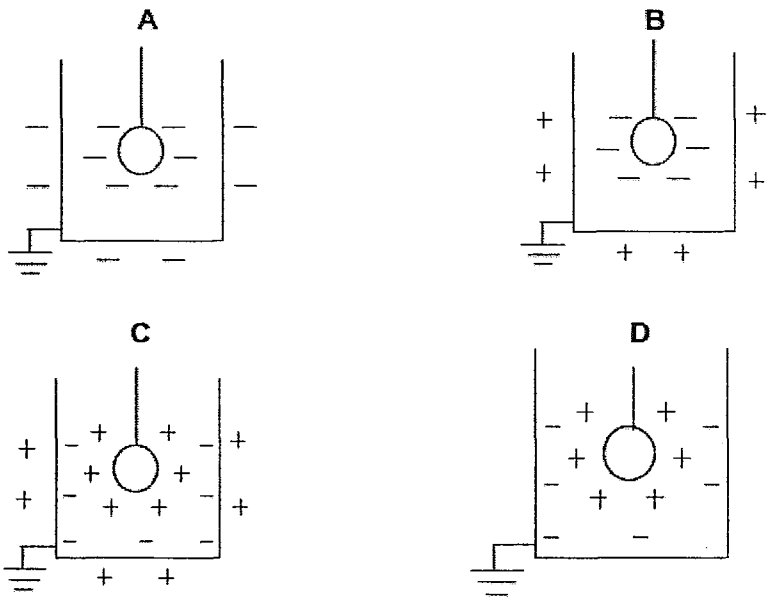


Which particle(s) in the graph is/ are at the centre(s) of rarefaction?

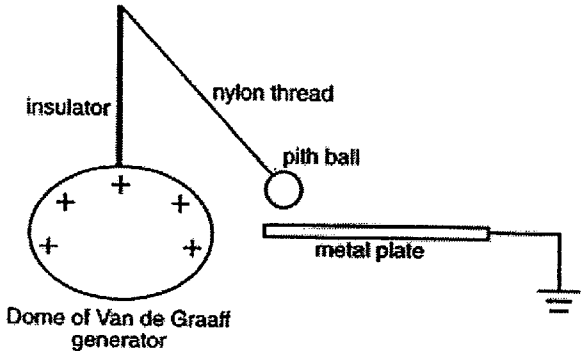
A particle X
B particle Y
C particle Z
D particles X and Z

28 A charged sphere is suspended by an insulating thread inside a metal can. The outside of the can is earthed.

Which diagram shows the resulting charges on the sphere and on the can?



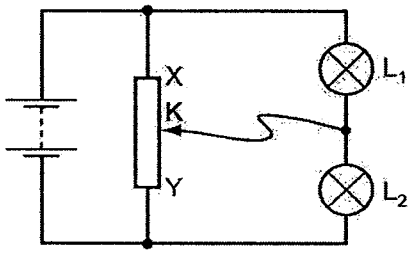
29 A suspended uncharged pith ball first makes contact with a positively-charged dome of a Van de Graaf generator. The pith ball is repelled and moves close to a metal plate without touching the metal plate.



Which statement correctly describes the movement of charges in the metal plate?

A Electrons move to the ground and the metal plate becomes negatively-charged.
B Electrons move to the ground and the metal plate becomes positively-charged.
C Electrons move towards the metal plate and the metal plate becomes negatively-charged.
D Electrons move towards the metal plate and the metal plate becomes positively-charged.

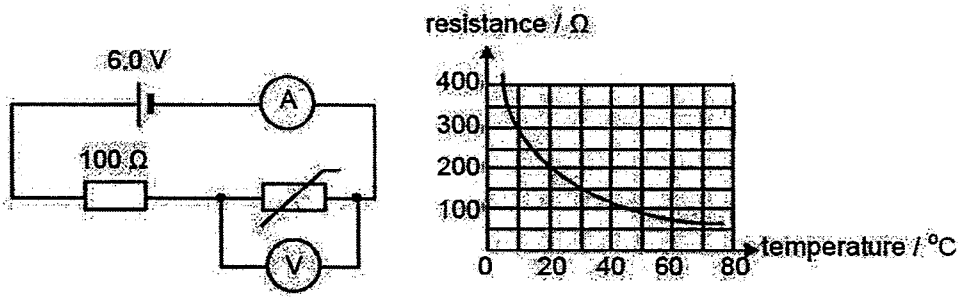
30 The diagram shows a potential divider circuit with two identical lamps L_1 and L_2.



What will happen to the brightness of the lamps when contact K is moved towards X?

	lamp L_1	lamp L_2
A	brighter	brighter
B	brighter	dimmer
C	dimmer	brighter
D	dimmer	dimmer

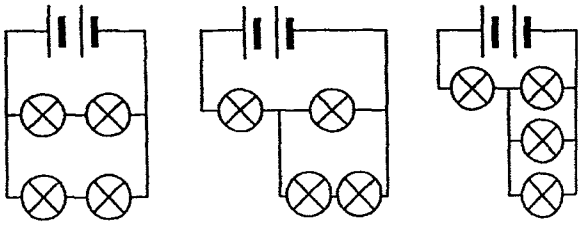
31 The diagram shows the resistance–temperature graph of a thermistor in a circuit.



What are the current and voltage when the temperature of the thermistor is 30 °C?

	current / A	voltage / V
A	0.024	2.4
B	0.024	3.6
C	0.040	2.4
D	0.040	3.6

32 In circuits X, Y and Z shown, all the lamps are identical and they use identical dry cells.



circuit X circuit Y circuit Z

What is the descending order of power in each circuit?

A X, Y and Z
B X, Z and Y
C Y, Z and X
D Z, Y and X

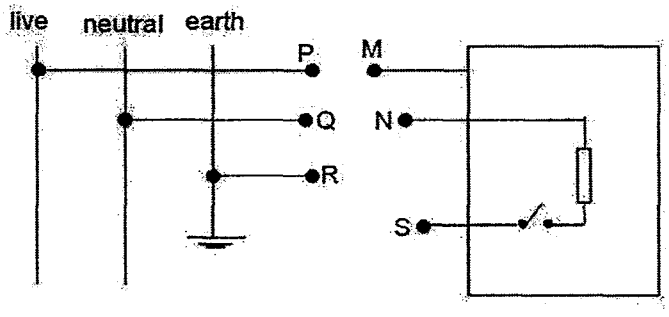
33 An electrical cable contains three wires: live, neutral and earth. The cable is correctly wired to a plug which contains a 3 A fuse. The cable insulation becomes damaged and the bare metal wires are exposed. Five possible events may occur.

- A person touches the earth wire.
- A person touches the neutral wire.
- A person touches the live wire.
- The live wire touches the neutral wire.
- The live wire touches the earth wire.

How many of these events will cause the fuse in the plug to blow?

A 2
B 3
C 4
D 5

34 The diagram shows an electrical appliance with a metal casing connected to the mains supply.



Which row shows the correct connection of the wires from P, Q and R respectively?

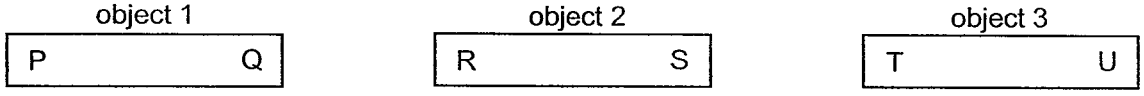
	P	Q	R
A	S	M	N
B	S	N	M
C	N	M	S
D	N	S	M

35 The diagram shows the direction of two compass needles when placed near two bar magnets.

What are the likely poles at A and B?

	pole at A	pole at B
A	north	north
B	north	south
C	south	north
D	south	south

36 Jean wanted to test the magnetic properties of the following three objects.



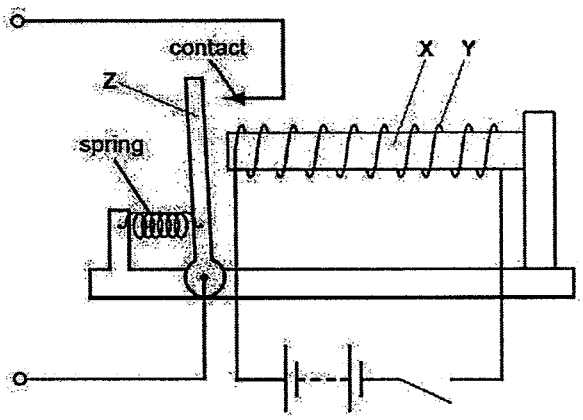
She made the following observations:

- P repels U.
- P attracts T.
- Both R and S are attracted by P.

Which conclusion is true?

A Objects 1 and 2 are magnets while object 3 is a magnetic material.
B Objects 1 and 3 are magnets while object 2 is a magnetic material.
C Objects 2 and 3 are magnets while object 1 is a magnetic material.
D Objects 1, 2 and 3 are magnets.

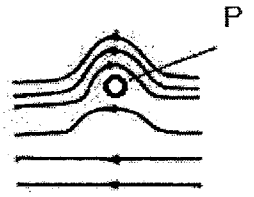
37 A student sets up the apparatus shown in order to make a relay.



Which metal should be used to make X, Y and Z?

	X	Y	Z
A	copper	steel	iron
B	iron	copper	steel
C	steel	iron	copper
D	iron	copper	iron

38 The diagram shows a wire carrying a direct current inserted at point P which is perpendicular to the magnetic field lines. The current flows into the page.

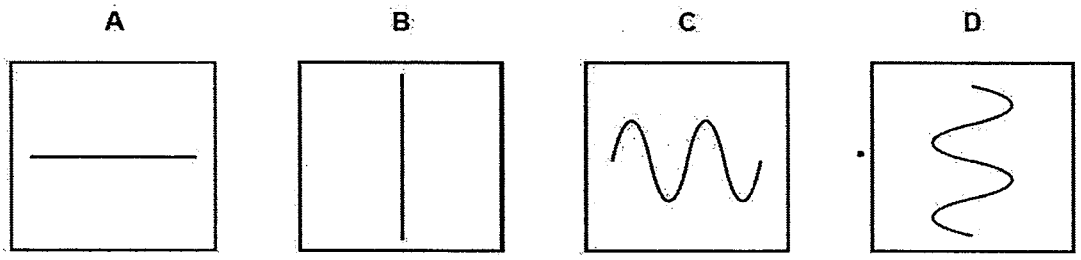


What is the direction of resultant force acting on the wire?

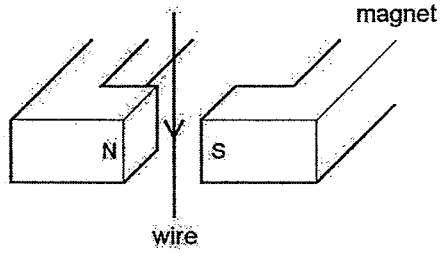
A downward
B into the page
C out of the page
D upward

39 The diagrams show patterns which can be seen on the screen of a cathode-ray oscilloscope.

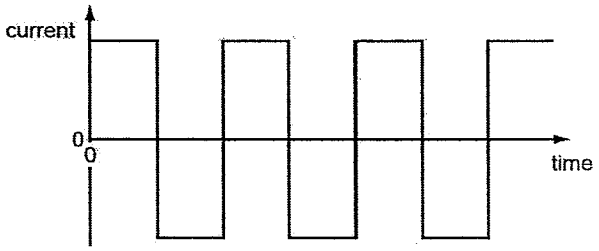
Which pattern would appear if an alternating current is applied to the Y-plates, with the time-base switched off?



40 The diagram shows a current flowing in a wire placed between the poles of a magnet.



The same current in the wire repeatedly changes its direction as shown in the graph.



What is the effect on the wire?

A The force on the wire is constant in size and alternates between one direction and the opposite direction.
B The force on the wire is constant in size and direction.
C The force on the wire keeps changing in size and alternates between one direction and the opposite direction.
D The force on the wire keeps changing in size but acts in the same direction.

Name: _____( ) Class:_____

PRELIMINARY EXAMINATIONS 2016

Secondary Four Express

PHYSICS (WITH SPA) 5059/02

Paper 2 Duration: 1 hour 45 minutes

Class: 406

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions.

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

Candidates are reminded that **all** quantitative answers should include appropriate units.
Thus 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	
Paper 1	/ 40
Paper 2	
Section A	/ 50
Section B	/ 30
TOTAL	/ 120

Section A

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

1 Fig. 1.1 shows three cylinders X, Y and Z are supported by three ropes that passes through ring R.

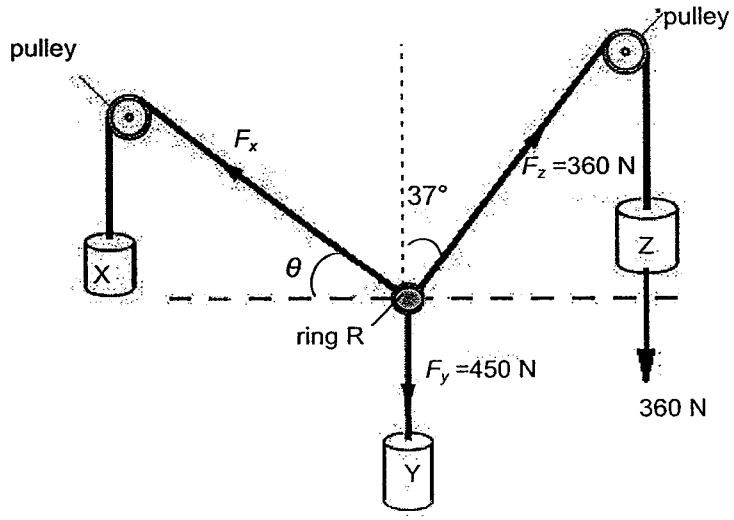


Fig. 1.1

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

Draw a vector diagram to find F_x and angle θ.

F_x = ...

angle θ = ...[4]

1 (b) (i) Given that the gravitational field strength is 10 N / kg, calculate the mass of cylinder Z.

mass = ...[1]

(ii) Cylinder Z is made of two smaller cylinders P and Q with identical cross-sectional area. The volume of cylinder Z is 4.8×10^{-3} m^3.

Complete Table 1.1 to show the density reading of cylinder Q.

Table 1.1

	P	Q
density / kg m^{-3}	8000	
volume / m^3	3.6×10^{-3}	1.2×10^{-3}

[2]

[Total: 7]

2 Fig. 2.1 shows a velocity-time graph of a ball bouncing vertically on a hard surface. The ball was dropped at $t = 0$ s.

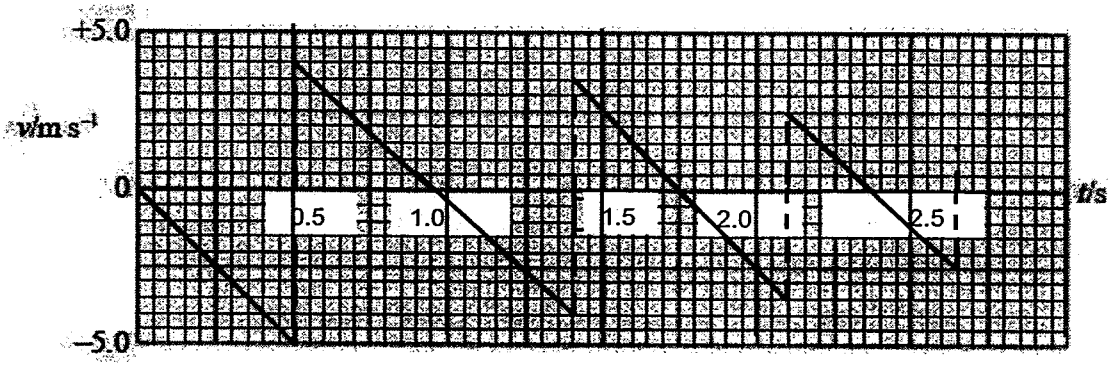


Fig. 2.1

(a) Determine the time the ball is in contact with the ground for the third time.

time = ...[1]

(b) Calculate the acceleration due to free fall.

acceleration = ...[2]

(c) Calculate the height from which the ball was dropped.

height = ...[2]

[Total: 5]

3 This is an extract from an article about the launch of the space shuttle.

"At lift-off, the shuttle assembly including orbiter, booster rockets and fuel load, has a mass of 2.0×10^6 kg. The rocket engines initially provide a thrust of 3.0×10^7 N. During the climb into orbit out of Earth, the crew members can experience forces up to three times their own weight."

(a) Using Newton's third law of motion, explain how the space shuttle can lift itself above the surface of Earth.

.....

.....

.....

.....[2]

(b) Calculate the initial acceleration of the shuttle as it is about to take off from the ground.

acceleration = ...[2]

(c) In the early stages of the flight within the atmosphere of Earth, the acceleration of the shuttle increases rapidly from the initial acceleration, even though the engine thrust remains roughly constant.

Suggest a reason for this.

.....

.....

.....

.....[2]

[Total: 6]

4 Fig. 4.1 shows a system supporting a load.

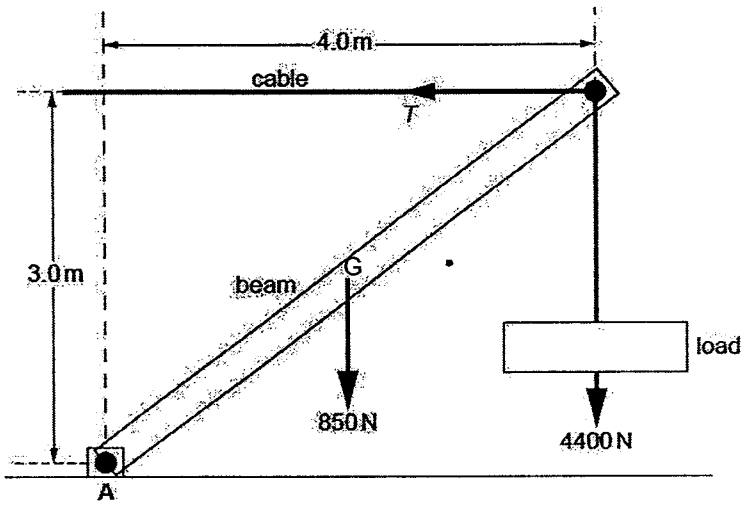


Fig. 4.1

The load of weight 4400 N is hanging from a uniform beam. The beam is supported by a horizontal cable which is experiencing tension *T*. The beam of weight 850 N is hinged at A. Its centre of gravity is located at G. The beam is in equilibrium under the action of these forces.

(a) Explain what is meant by *centre of gravity*.

.....

.....[1]

(b) Calculate the tension *T*.

tension *T* = ...[2]

4 **(c)** Hence, or otherwise, deduce the horizontal force and vertical force acting at hinge A.

horizontal force = ...

vertical force = ...[2]

[Total: 5]

5 A ball of mass 65 g is thrown vertically upwards from ground level with a speed of 16 m s^{-1}. Air resistance is negligible.

Given that the gravitational field strength is 10 N / kg, calculate

(a) the initial kinetic energy of the ball,

initial kinetic energy = ...[2]

(b) the maximum height reached by the ball.

maximum height = ...[2]

5 (c) State and explain the effect of air resistance on the maximum height reached by the ball.

.....

.....

.....

.....[2]

[Total: 6]

6 A 1 m long barometer tube was filled with mercury to the brim of the tube. The open end was held carefully by the thumb and then inverted in a trough of mercury. The thumb was then removed. Fig. 6.1 shows the barometer at the instant when the thumb was just removed.

(a) (i) Fig. 6.2 shows the height h reached by the mercury in the tube. The atmospheric pressure is 102 000 Pa and mercury has a density of 13 600 kg / m^3.

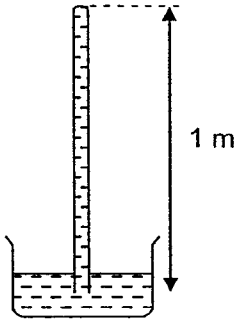


Fig. 6.1

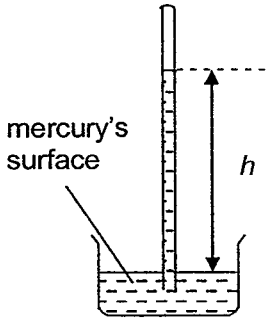


Fig. 6.2

Calculate the height h.

h = ...[2]

6 (a) (ii) Suggest a simple way to check that there is no air trapped in the space above the mercury column in the barometer tube.

.....

.....[1]

(b) Another mercury barometer shown in Fig. 6.3 has a mercury column of 760 mm above the surface of mercury in the trough. The barometer is located near the bottom of a mountain.

On Fig. 6.3, state and indicate the new mercury level in the barometer when it is brought to a mountain top which has an altitude of 4000 m. The density of air is constant at 1.23 kg / m^3 and atmospheric pressure on the sea level is 102 000 Pa. Show all calculations clearly.

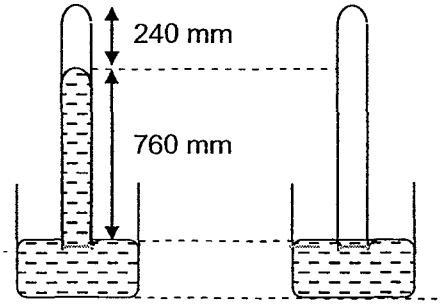


Fig. 6.3

[3]

[Total: 6]

7 A test-tube containing 120 g of solid wax is heated. It is then placed in a cool room. Fig. 7.1 shows how the temperature T of the wax changes with time in the cool room.

Fig. 7.1

(a) Determine the melting point of the wax.

melting point = ...[1]

(b) During solidification, the wax releases thermal energy at 30 J / s.

Calculate the specific latent heat of fusion of the wax.

specific latent heat of fusion = ...[2]

7 **(c)** The mass of the wax used is now reduced to 60 g.

On Fig. 7.1, sketch a graph to show how the temperature of the wax changes with time. [1]

(d) Use kinetic model of matter to explain why the temperature of the wax remains constant when it is cooled.

.....

.....

.....

.....[2]

[Total: 6]

8 Fig. 8.1 shows a beam of blue light shining into a glass prism placed on a sheet of paper.

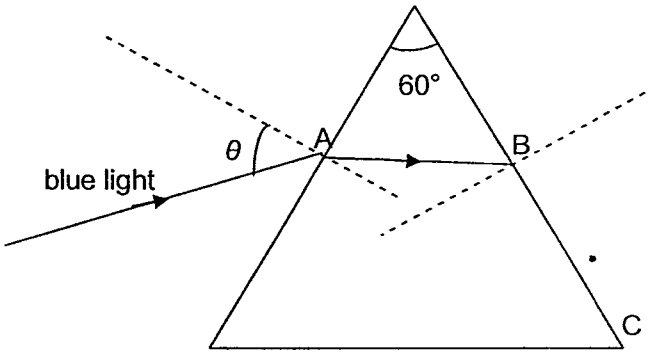


Fig. 8.1

The blue light enters the prism at an angle θ of 45°. It passes through the path AB in the prism.

(a) The angle of refraction in the glass is 28°.

Calculate the refractive index of the glass.

refractive index = ...[2]

(b) The angle of incidence θ is gradually decreased so that the blue light is totally reflected at surface BC.

(i) State one condition for the above phenomenon to occur.

.....

.....[1]

(ii) Calculate the maximum value of θ.

maximum value of θ = ...[2]

[Total: 5]

9 Fig. 9.1 shows two vertically mounted unmagnetised metal rods, A and B, which have similar solenoids around them wound from a single length of wire. One of the rods is made of soft iron and the other of steel.

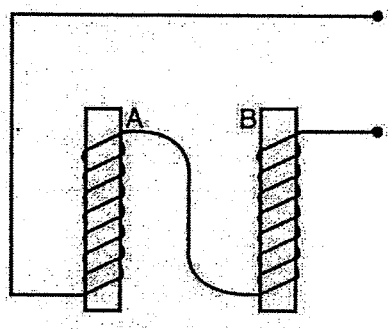


Fig. 9.1

(a) On Fig. 9.1, draw the circuit which would enable a range of currents to flow through the solenoids. Include an instrument which would enable you to measure the current. [2]

(b) State a simple test you would carry out to estimate the strength of the magnetised rods, A and B, as the current is increased. Explain how this test could be used to identify the soft iron and steel rods.

.....

.....

.....

.....[2]

[Total: 4]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 12**.

10 Fig. 10.1 shows a circuit consisting of a 3.0 V dry cell, a rheostat and a fixed resistor connected in series. The resistance R of the rheostat is varied.

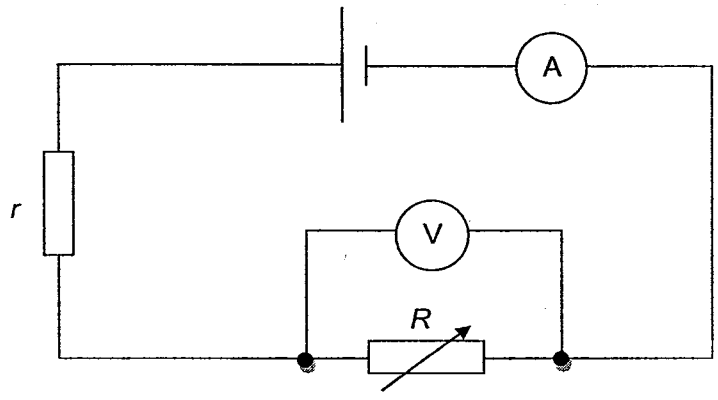


Fig. 10.1

Fig. 10.2 shows how the power P dissipated in the rheostat changes the potential difference V across it.

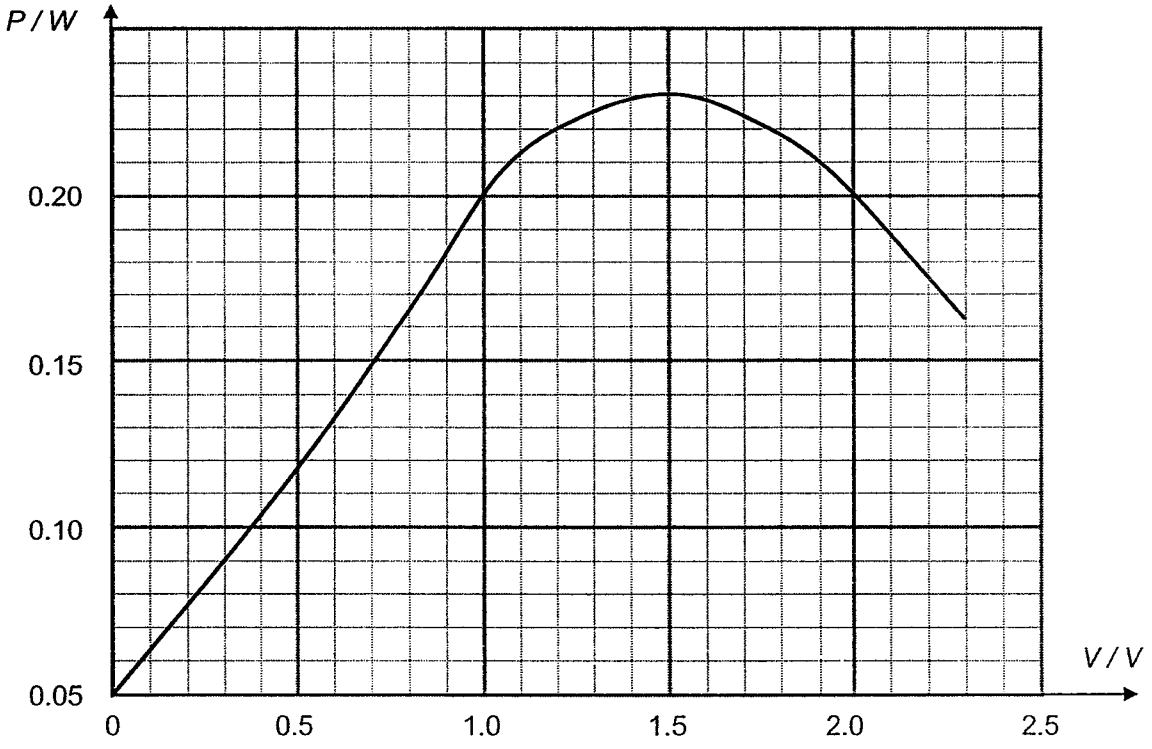


Fig. 10.2

10 **(a)** **(i)** From Fig. 10.2, determine the maximum power P dissipated by the rheostat.

maximum power P = ...[1]

(ii) Hence, calculate the resistance R of the rheostat at maximum power dissipation.

resistance R = ...[3]

(iii) Calculate the resistance r of the fixed resistor at maximum power dissipation of the rheostat.

resistance r = ...[2]

(b) On Fig. 10.2, there are two values of potential difference V for which the power dissipation is 0.20 W.

State, with a reason, which value of V will result in less power being dissipated by the fixed resistor.

.....

.....

.....

.....[2]

10 (c) The fixed resistor is replaced by another resistor Q which is made of the same material. Q has twice the cross-sectional area and its length is thrice as long as the fixed resistor.

Explain how the change will affect the current flowing through the circuit.

.....

.....

.....

.....[2]

[Total: 10]

11 (a) Describe the transmission of sound energy through its interaction with air molecules.

.....

.....

.....

.....[2]

(b) Fig. 11.1 shows a loudspeaker system which when placed over the central pole of the permanent magnet converts electrical signals into sound by passing alternating current into a metal coil. The metal coil is joined to two speaker cones at its sides which is able to slide forward and backward as shown in Fig. 11.1. The current size varies according to the electrical signals. Fig. 11.2 shows the front view of the magnet and its polarities.

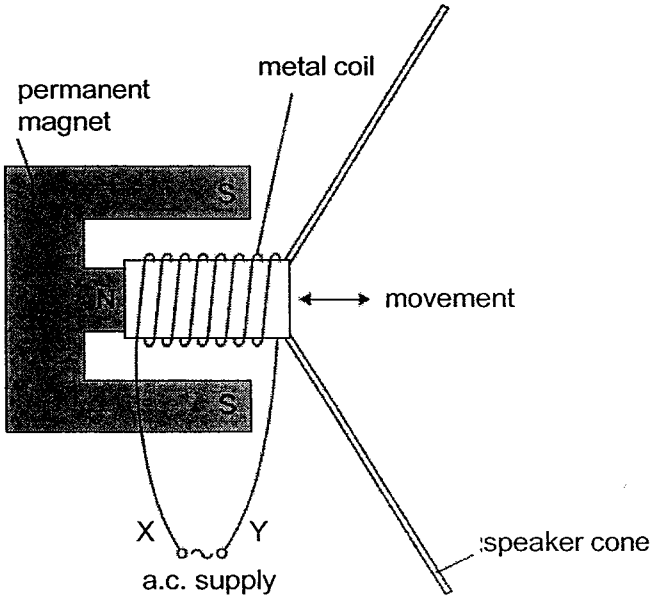


Fig. 11.1

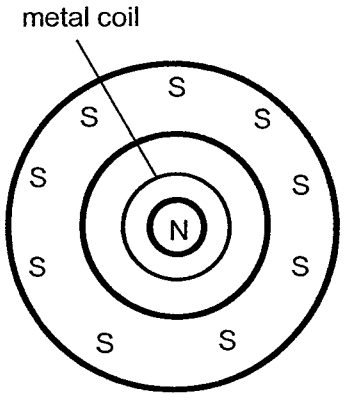


Fig. 11.2

(i) The current flows from X to Y momentarily. On Fig. 11.2, indicate the direction of current flowing in the coil. [1]

(ii) State and explain how you deduce the direction in which the metal coil moves when the current flows from X to Y.

.....

.....

.....

.....[2]

11 (b) (iii) Explain why sounds are heard when alternating current of varying magnitude flows through the coil.

.....

.....

.....

.....

.....

.....[3]

(c) Suggest two ways to increase the loudness and pitch of the sound heard.

.....

.....

.....

.....[2]

[Total: 10]

12 Either

Fig. 12.1 shows a bar magnet dropped from rest through the centre of a coil of wire which is connected to a resistor and datalogger.

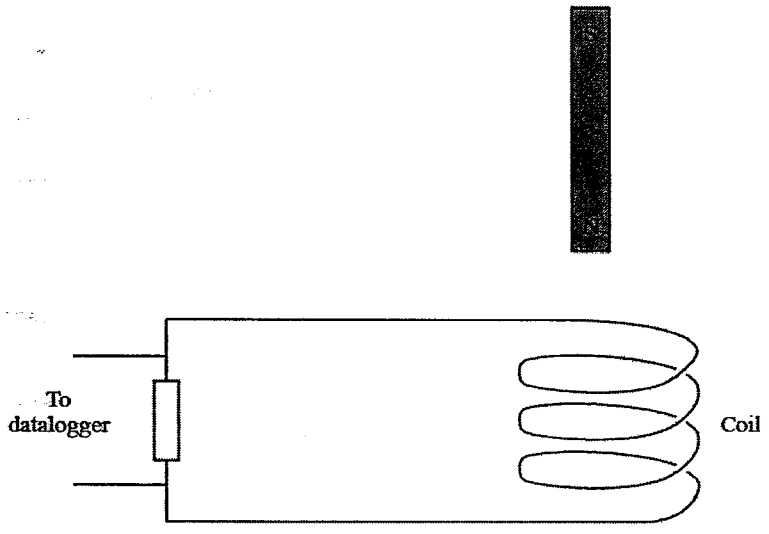


Fig. 12.1

(a) Explain what happens to the magnet as it falls towards the coil.

.....

.....

.....

.....[2]

12 **(b)** Fig. 12.2 shows the variation of the induced current in the resistor with time as the magnet falls.

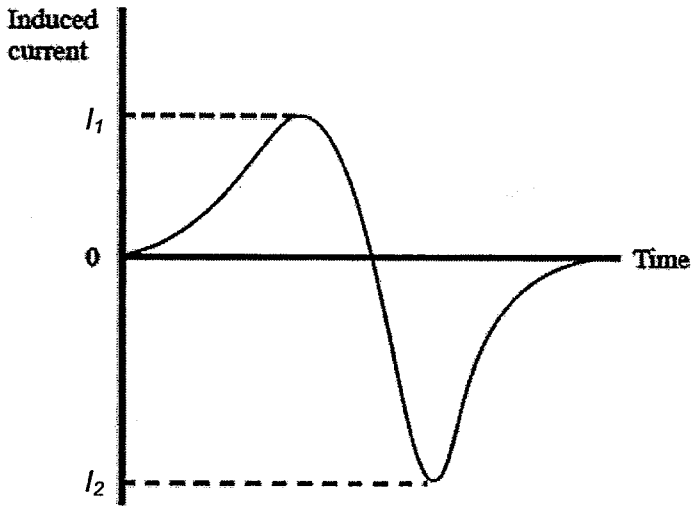


Fig. 12.2

(i) Explain why the magnitude of I_2 is greater than I_1.

.....

.....

.....

.....[2]

(ii) Use the information from Fig. 12.2 to explain how the direction of the current changes in the coil as the magnet falls.

.....

.....

.....

.....[2]

(iii) Describe how the current is affected if a diode is installed in the circuit.

.....

.....[1]

12 **(c)** Fig. 12.3 shows how two metal balls mounted on an insulating stand are charged positively.

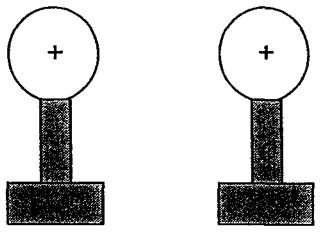


Fig. 12.3

(i) Explain what happens as the metal balls are pushed closer together.

.....

.....[1]

(ii) Sparks jump across the metal balls when they are very close to each other. The energy to cause the spark is 0.0080 J while the potential difference across the metal balls is 5000 V.

Calculate the charge passing between the metal balls.

charge = ...[2]

[Total: 10]

12 Or

Fig. 12.4 shows a simplified diagram of the transmission of electrical power from a power station to homes using transmission cables. The total length of the cables is 50 km.

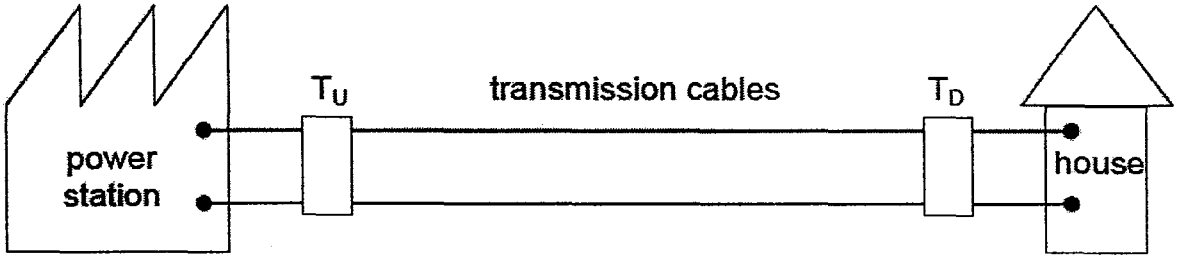


Fig. 12.4

A step-up transformer, T_U, increases the voltage of the power station to 120 kV along the transmission cables and a step-down transformer, T_D, decreases the voltage to 220 V. The typical resistance of the transmission cables is 0.50 Ω / km.

(a) (i) Explain why it is necessary to step-up the voltage along the transmission cables.

.....

.....[1]

(ii) If the power output of the power station on a particular day is 20 MW, calculate the current flowing in the transmission cables.

current = ...[2]

(iii) Hence, calculate the power loss in the transmission cables during transmission.

power loss = ... [2]

12 **(b)** Fig. 12.5 shows an electric cooker hob. The simplified circuit diagram shows how the four heating elements connect to the mains electricity supply. The heating elements are identical.

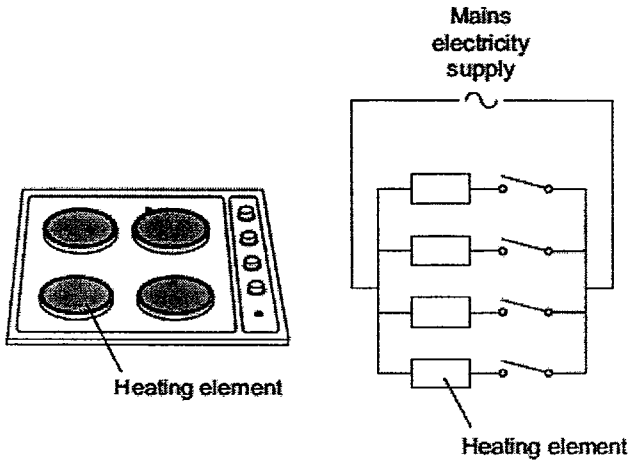


Fig. 12.5

When all four heating elements are switched on at full power the hob draws a total current of 26 A from the 230 V mains electricity supply.

(i) Calculate the resistance of one heating element when the hob is switched on at full power.

resistance = ...[2]

(ii) Given that the cost of electricity is $0.30 per kWh, calculate the total cost in using the electric cooker hob for 5 days if the hob is switched on at full power for 4 hours each day.

total cost = ...[2]

12 (b) (iii) Suggest why it is not advisable to connect the four heating elements in series to the main supply.

.....

.....[1]

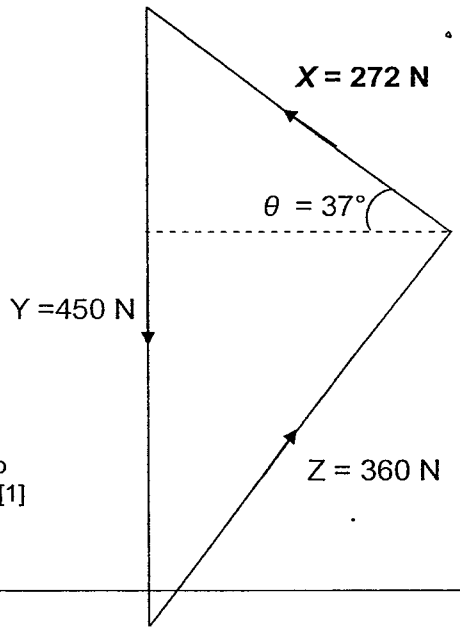
[Total: 10]

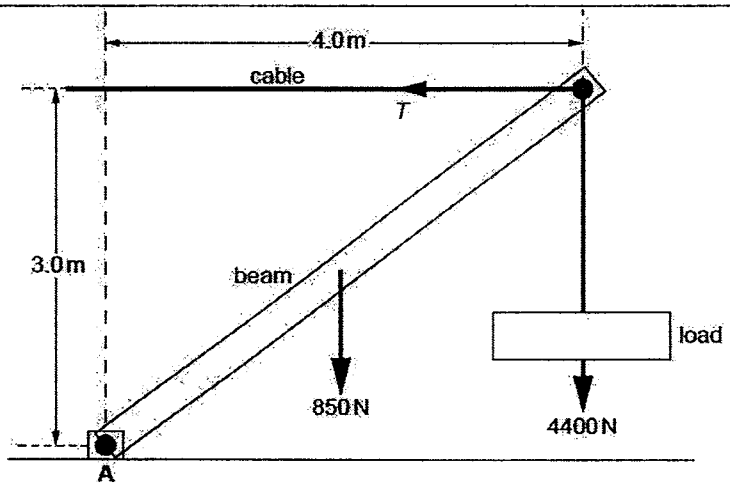
Prelims Examination 2016
Secondary 4 Express
Pure Physics
Marking Scheme

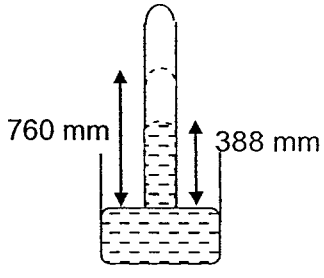
Section A (40 marks)

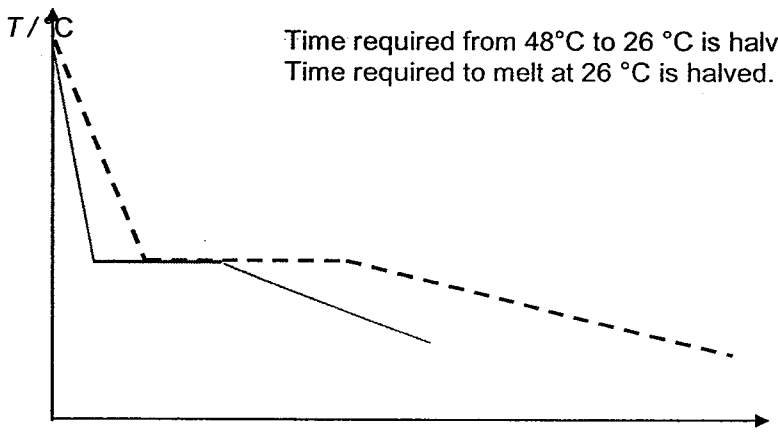
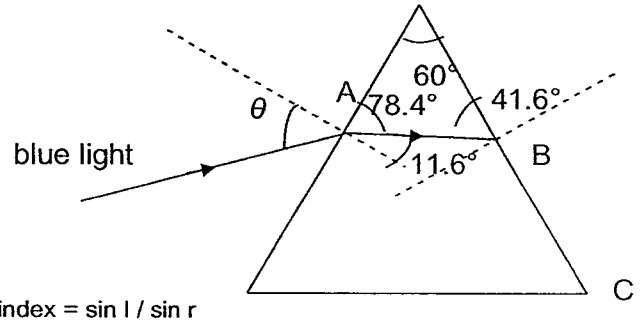
1	2	3	4	5	6	7	8	9	10
B	C	B	B	D	C	C	C	D	C
11	12	13	14	15	16	17	18	19	20
C	B	B	D	C	C	C	B	D	D
21	22	23	24	25	26	27	28	29	30
A	A	A	B	C	A	C	D	C	C
31	32	33	34	35	36	37	38	39	40
B	B	A	B	A	B	D	D	B	A

Section B (50 marks)

Question	Correct Response	Marks
1(a)	θ = 37° [1] (accepts 36° to 38°) X = 272 N [1] (accepts X ranges from 250 to 290 N) All arrows points in the correct directions [1] Scale marks only given to students who give a scale **1:50** only, provided the forces Y and Z are represented correctly and accurately. Else, no mark even if the scale is correct.[1]  	[4]
1(b)(i)	Mass of cylinder Z = mg m(10) = 360 m = 36 kg.	[1]
1(b)(ii)	Mass of Z = mass of P + mass of Q $36 = (8000X3.6 \times 10^{-2}) + (RX1.2 \times 10^{-2})$ R = 6000 kg / m^3	[1] [1]
		[7]

Question	Correct Response	Marks
2(a)	t = 2.1 s	[1]
2(b)	Acceleration = $\frac{5}{0.5}$ m / s^2 = 10.0 m / s^2	[1] [1]
2(c)	Height dropped = Area of triangle = ½ x 5 x 0.5 m = 1.25 m	[1] [1]
		[5]
3(a)	The force exerted by the space shuttle pushed the ground, and by Newton's third law an equal and opposite force exerted by the ground on the space shuttle.	[1] [1]
3(b)	F = ma 3.0 × 10^7 N = 2.0 × 10^6 kg x a a = 15.0 m / s^2	[1] [1]
3(c)	As shuttle moves, fuel is consumed and this decreases the mass, and acceleration is inversely proportional to the mass. **Or** As shuttle moves higher, less air resistance as air is less dense at higher altitude, this increases the resultant force.	[1] [1] [1] [1] Max 2
		[6]
4(a)	Centre of gravity refers to a point on an object where its weight appear to act through regardless of the object's orientation.	[1]
4(b)	 Take moments about A, (850 N X 2 m) + (4400 N X 4 m) = (T x 3 m) T = 6430 N (3 sf)	[1] [1]

Question	Correct Response	Marks
4(c)	In equilibrium, therefore Horizontal force at A = 6430 N Vertical force at A = 4400 + 850 N = 5250 N	 [1] [1]
		[5]
5(a)	Initial ke = ½ mv^2 = ½ x 0.065 kg x $(16)^2$ = 8.32 J	 [1] [1]
5(b)	gravitational potential energy = kinetic energy 0.065 x 10 x h = 8.32 h = 12.8 m	 [1] [1]
5(c)	With air resistance part of the initial kinetic energy of the ball is converted to thermal energy and its gravitational potential energy is reduced. The ball's maximum height is reduced.	[1/2] [1/2] [1]
		[6]
6(a)(i)	P = ρgh h = P / ρg = 102 000 / (13600 x 10) m = 0.750 m	 [1] [1]
6(a)(ii)	Tilt the mercury tube slightly and if the perpendicular height of tube above the basin is still *h*, then the space above mercury should be vacuum.	[1]
6(b)	Pressure exerted by 4000 m of air column = ρgh = 1.23 x 10 x 4000 Pa = 49.2 kPa Pressure at top of mountain (4000 m above sea level) = Pressure at sea level – 49.2 kPa = 102 – 49.2 kPa = 52.8 kPa Height of mercury = 52.8 kPa / (13600 x 10) = 388 mm above mercury's surface.  	 [1] [1]
		[6]

Question	Correct Response	Marks
7(a)	Melting point = 26 °C	[1]
7(b)	$P \times t = mL_f$ $L_f = (30 \times 18 \times 60)/0.12$ J / kg = 270 kJ / kg	[1] [1]
7(c)		[1]
7(d)	As wax is cooled, thermal energy is released to **form the intermolecular bonds among the wax molecules.** The **average kinetic energy and average speed** of the wax molecules remains **unchanged** and thus its temperature remains constant.	[1] [1]
		[6]
8(a)	 Refractive index = sin I / sin r = sin 45° / sin 28° = 1.51	[1] [1]
8(b)(i)	For total internal reflection to occur, the angle of incidence at B needs to be greater than the critical angle of glass. (Also accept 2nd condition)	[1]
8(b)(ii)	sin c = 1 / n $c = \sin^{-1}(1/n)$ = 41.5° sin θ / sin 18.5° = 1.51 θ = 28.7°	[1] [1]
		[5]

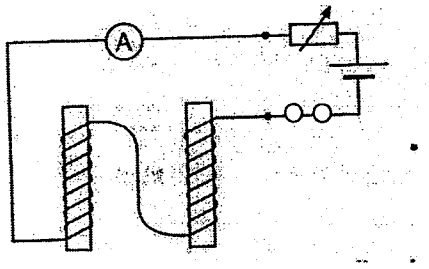
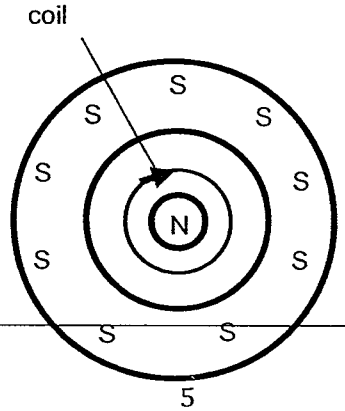
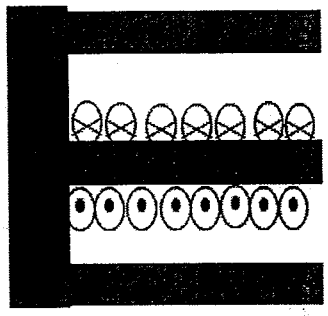
Question	Correct Response	Marks
9(a)		[0.5] ammeter [0.5]rheostat [0.5] switch [0.5] cells
9(b)	Place the rods over a pile of paper clips. The electromagnet that attracts the most clips is soft iron and the other that attracts less Is steel.	[1] [1]
		[4]
Section B		
10(a)(i)	From Fig. 10.2, maximum power = 0.23 W.	[1]
10(a)(ii)	From Fig. 10.2, V = 1.5 V when power = 0.23 W. Power = (voltage)^2 x resistance R R = power / (voltage)^2 = 0.23 W / (1.5 V)^2 = 9.78 Ω (3 sf)	[1] [1] [1]
10(a)(iii)	Voltage across R = 1.5 V Voltage across r = 3 – 1.5 V = 1.5 V Current through r = Current through R = 1.5 V / 9.78 Ω = 0.153 A Resistance r = 1.5 V / 0.153 A = 9.78 Ω	[1] [1]
10(b)	1.0 V Power dissipated in r is proportional to V^2/r. Thus, power dissipated is smaller for lower V as r is a constant.	[1] [1]
10(c)	Since resistance is proportional to length and inversely proportional to area, resistance of Q is 3/2 times the resistance of r. The increase in resistance will cause a reduction in current flowing through the circuit.	[1] [1]
		[10]
11(a)	When sound energy is transmitted to air molecules, the air molecules will **vibrate to and fro about respective equilibrium positions.** The air molecules **pass on the sound energy** to **the neighbouring air molecules** while the air molecules are not displaced.	[1] [1]
11(b)(i)		[1]

Fig. 11.2

Question	Correct Response	Marks
11(b)(ii)	 F F When the current flows from X to Y and through the metal coil which is placed in a magnetic field, a force (towards the right) is experienced by the conductor (metal coil) by using Fleming LHR.	[1] [1]
11(b)(iii)	As alternating current flows from X to Y, the **size and direction of force** acting on the cone keeps changing. Thus air molecules are pushed to **move different distances in alternate directions,** sound energy of **different amplitude and frequency** are then passed on from one air molecule to the next and sounds are heard.	[1/2] [1/2] [1/2] [1/2] [1]
11(c)	To increase the loudness, -Use alternating current with higher value - more turns of coils around the solenoid - use stronger magnets To increase the pitch, -increase the frequency -Use smaller speakers with smaller cones move faster	[1] [1]
		[10]
Either		
12(a)	As magnet falls and gets close enough for its magnetic field to cut through the coil, by Lenz's law, an equal and opposite magnetic field is induced in the coil to oppose the motion of the magnet. As the magnet falls through the coil, by Lenz's law, the magnet induced a magnetic field which attracts the falling magnet (opposing the motion of the magnet).	[1] [1]
12(b)(i)	The magnet falls at a greater speed as its length of fall is greater. The rate of change of magnetic flux induced in the coil is larger means the current induced is larger as well.	[1] [1]
12(b)(ii)	As the N pole of magnet approaches the coil, current flows in anticlockwise direction in the coil to produce a north-pointing (upward) magnetic field. As the N pole of magnet is leaving the coil, current flows in clockwise direction in the coil to produce a north-pointing (downward) magnetic field to attract the S pole of the falling magnet.	[1] [1]
12(b)(iii)	If the magnet is dropped from higher height and a diode is used, the magnitude of current I_1 is larger and there is no current I_2. Or The current flows in one direction.	[1]
12(c)(i)	The repulsive force becomes stronger if the spheres are pushed closer.	[1]

Question	Correct Response	Marks
12(c)(ii)	Work done = Charge / potential difference Charge = work done x potential difference = 0.008/ 5000 = 1.60×10^{-6} C	 [1] [1]
OR		[10]
12(a)(i)	By stepping up the voltage, heat dissipated in the cables will reduce and efficiency of transmission is improved.	[1]
12(a)(ii)	Current = power / voltage = 20×10^6 / 120×10^3 A = 167 A	 [1] [1]
12(a)(iii)	Resistance of cable (50 km) = 50 x 0.5 Ω = 25 Ω Power lost = I^2R = $(167)^2$x25 W = 697 kW	 [1] [1]
12(b)(i)	R = voltage / current = (230 V / 26)/4 A = 35.4 Ω	 [1] [1]
12(b)(ii)	Power dissipated in four resistors = current x voltage = 26 A x 230 V = 5.98 kW (3 sf) Total cost = total electricity usage x 5 days x 4 hrs x \$0.30 / kWh = 5.98 kW x 20 h x \$0.30 / kWh = \$35.88 (3 sf)	 [1] [1]
12(b)(iii)	Much lesser current will be drawn out and the four heating elements will not be able to work to its maximum power. / More time is used to cook the food.	[1]
		[10]