COMMONWEALTH SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2018

PHYSICS (6091/1)

Name: _____ ( ) Class: _____

SECONDARY FOUR EXPRESS
PAPER 1

17 September 2018
1 hour
1200 h – 1300 h

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the question paper and any separate answer sheets used.

There are **forty** questions in 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 OTAS.

Read very carefully the instructions on the OTAS.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

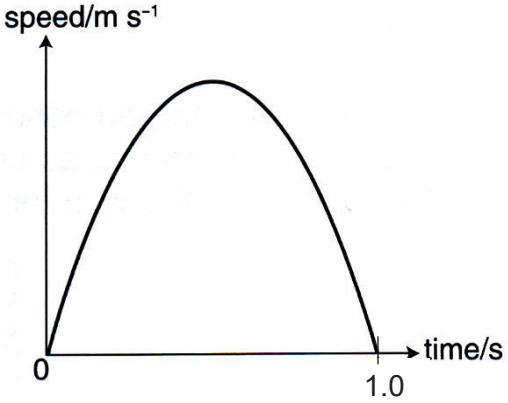
Any rough working should be done in this booklet.

Take the gravitational field strength on Earth, g to be 10 Nkg^{-1}.

This paper consists of **19** printed pages including the cover page.

[Turn over

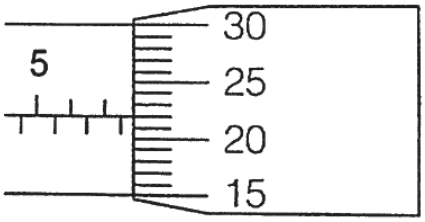
1 The graph shows the speed-time graph of a pendulum bob oscillating from a point.



What is the period of the oscillation of the pendulum bob?

A 5 s **B** 1.0 s **C** 1.5 s **D** 2.0 s

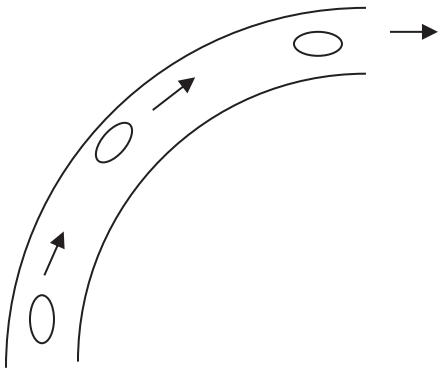
2 The following diagram shows the thickness of 10 metal coins using a micrometer.



What is the thickness of one metal coin?

A 0.72 mm **B** 0.77 mm **C** 5.72 mm **D** 7.72 mm

3 A car travels at *constant speed* round a bend.



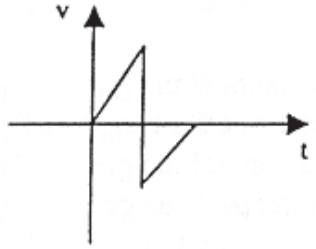
Which of the following statements about the motion of the car is **not** correct?

A The car is accelerating.
B The velocity of the car is uniform.
C The displacement of the car increases.
D The distance covered per unit time by the car is constant.

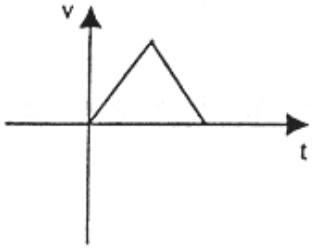
4 A stone is thrown vertically upwards and falls back to its starting point and stops.

Taking velocity in the upward direction as positive, which of the following velocity-time (v-t) graphs is correct?

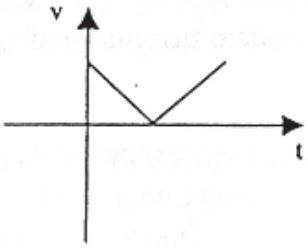
A



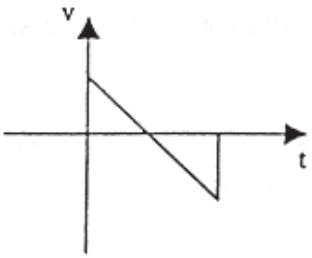
B



C



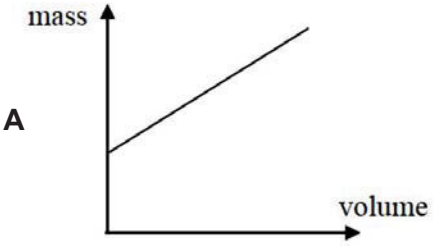
D



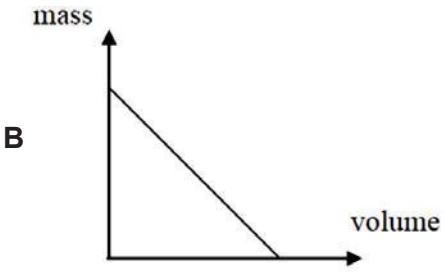
5 Some students want to calculate the density of pure copper. They measured the mass and volume of different samples of pure copper.

Which of the following mass-volume graphs shows their results?

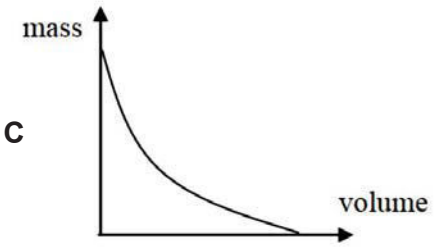
A



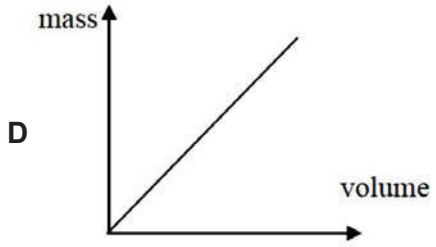
B



C



D



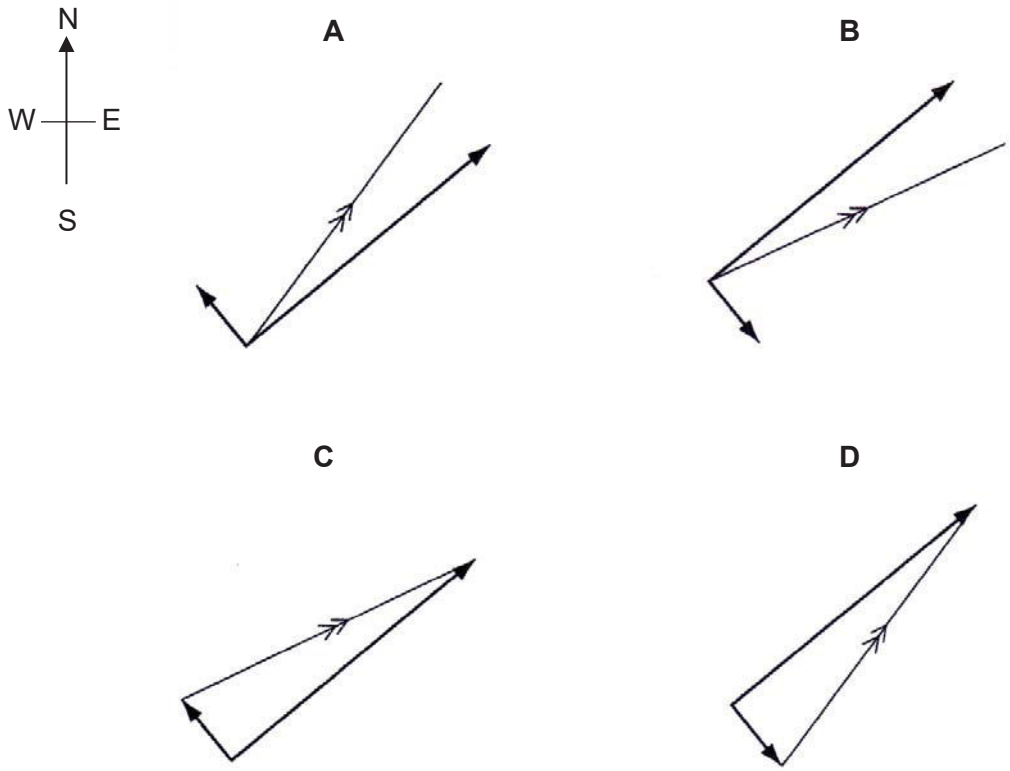
6 A rocket has a mass of 100 kg. The force produced by the engine of the rocket is 3000 N in the direction against the force of gravity.

What is the acceleration of the rocket?

A 10 ms^{-2}
B 20 ms^{-2}
C 30 ms^{-2}
D 40 ms^{-2}

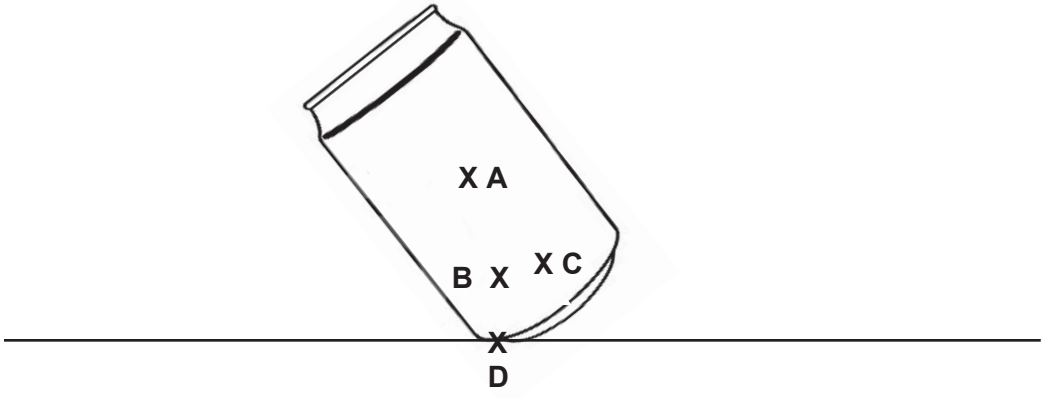
7 An aircraft heads north-east at 400 km/h. The wind is blowing towards the north-west at 100 km/h.

Which vector diagram represents the correct way to obtain the resultant velocity of the aircraft?



8 The diagram below shows a can of soft drink balanced on its edge.

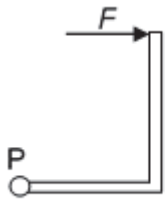
Where is the likely position of the centre of gravity?



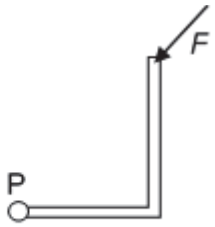
9 A force ***F*** acts on an L-shaped object pivoted at point **P** at different positions.

Which of the following diagrams shows the position where force ***F*** is applied that would result in the lowest magnitude of moment about pivot **P**?

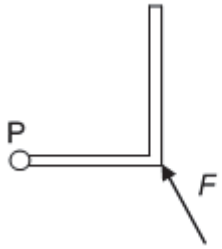
A



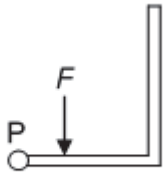
B



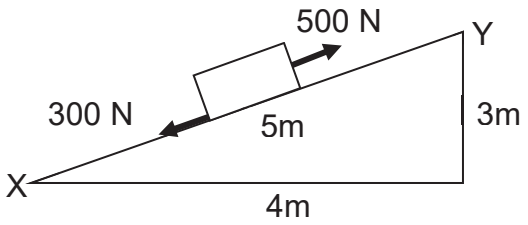
C



D



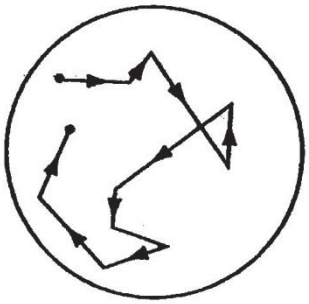
10 A force of 500 N is applied to a box to move it up the ramp as shown. The friction acting on the box is 300 N.



How much work is done against friction?

A 300 J
B 1 200 J
C 1 500 J
D 3 000 J

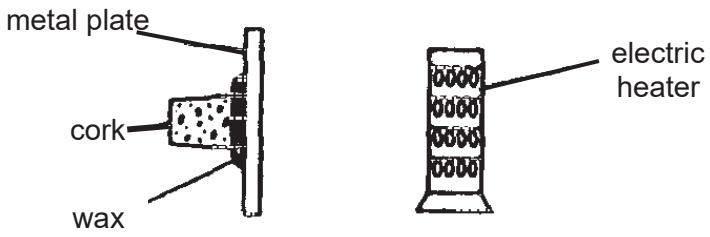
11 Smoke particles in a transparent box are observed using a microscope. A small point of light is seen to move around as shown.



What does this experiment demonstrate about air molecules?

A They are in continuous random motion.
B They can be seen through a microscope.
C They move more quickly when they are heated.
D They move because of collisions with smoke particles.

12 A small cork is fixed with wax to a metal plate. An electric heater is placed close to the plate.

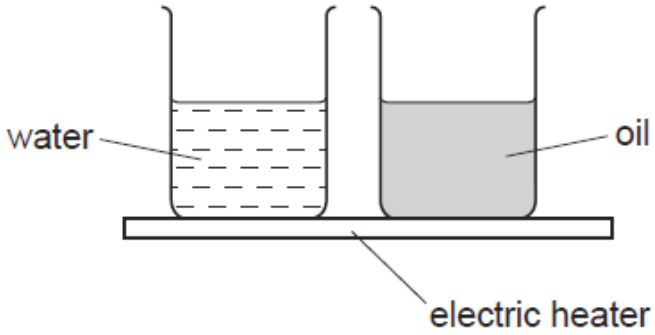


After some time, the wax melts and the cork drops off.

How does heat reach the wax?

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

13 The diagram shows an electric heater being used to heat a beaker of water and a beaker of oil for several minutes. Both beakers are identical in size.



The temperature of the water and the temperature of the oil increase constantly. The rise in temperature of the oil is much greater than that of the water.

Which of the following explains the observation?

A The oil has a higher boiling point than water.
B The oil has a higher heat capacity than water.
C The oil has a lower boiling point than water.
D The oil has a lower heat capacity than water.

14 A piece of wire has an electrical resistance of 2.0 Ω in melting ice and 2.5 Ω in boiling water.

What is the resistance at 20 °C assuming that resistance changes uniformly with temperature?

A 2.1 Ω
B 2.2 Ω
C 2.3 Ω
D 2.4 Ω

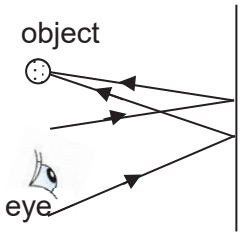
15 The following steps are used to construct and calibrate a thermometer in the Celsius scale. Arrange them in the correct order.

1 Measure the value of the thermometric property at steam point.
2 Choose an appropriate thermometric property.
3 Measure the value of the thermometric property at ice point.
4 Divide the temperature range between the two fixed points into 100 equal parts.

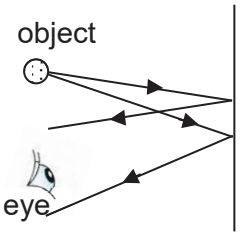
A 3, 2, 1, 4
B 2, 3, 1, 4
C 2, 4, 3, 1
D 4, 2, 3, 1

16 Which of the following ray diagrams is correct?

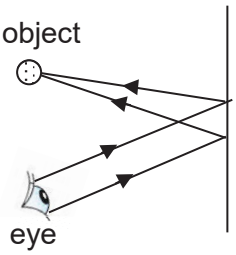
A



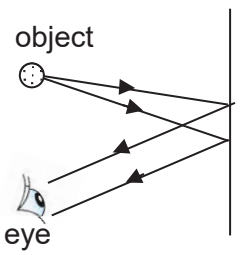
B



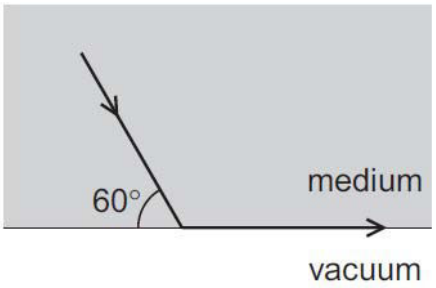
C



D



17 The diagram shows light travelling through a medium. The light reaches the boundary with a vacuum as shown. The light emerges travelling along the surface.

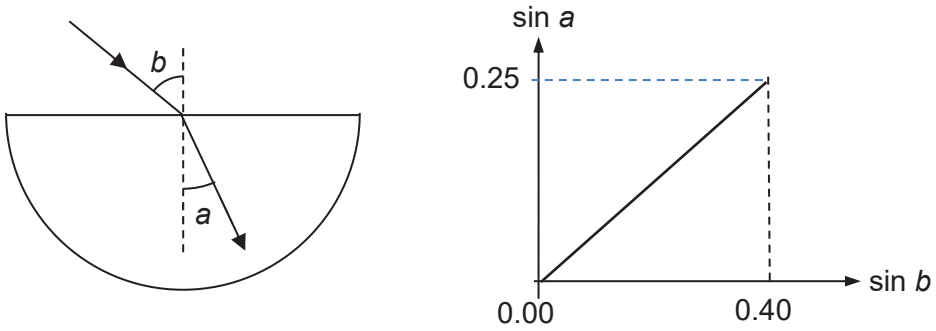


What is the refractive index of the medium?

A $\frac{\sin 30°}{\sin 90°}$ **B** $\frac{\sin 60°}{\sin 90°}$

C $\frac{\sin 90°}{\sin 30°}$ **D** $\frac{\sin 90°}{\sin 60°}$

18 A light beam is incident into a semi-circular glass block and refracted out as shown. A graph of sin *a* against sin *b* is plotted as shown.



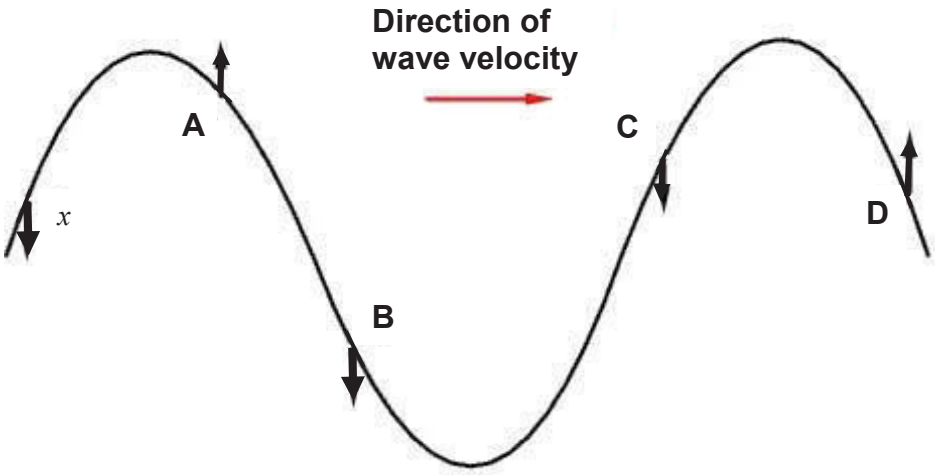
What is the critical angle of the glass?

A 37° **B** 39°

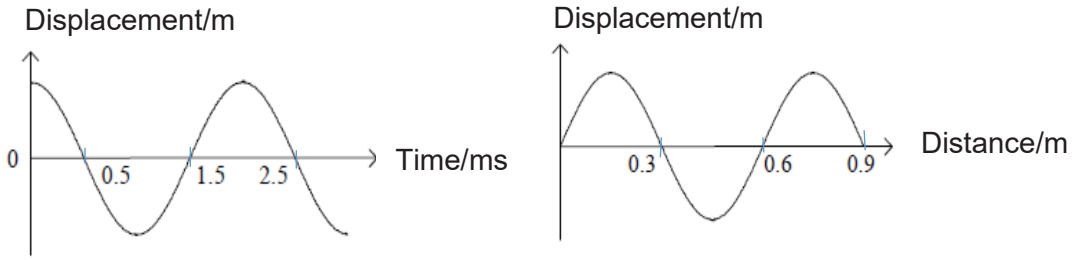
C 51° **D** 53°

19 The diagram shows a section of a wave motion. The particle at position x moves in the direction of the arrow shown.

Which of the following particles at the labelled positions, **A**, **B**, **C** and **D** is incorrect?



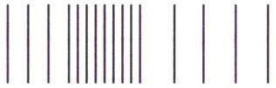
20 The two graphs shown below refer to the same wave.



What is the speed of the wave?

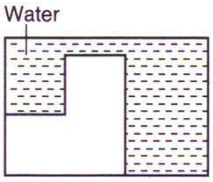
A 0.3 ms^{-1}
B 1.2 ms^{-1}
C 150 ms^{-1}
D 300 ms^{-1}

21 The diagram shows wavefronts moving from left to right as seen from above a ripple tank.

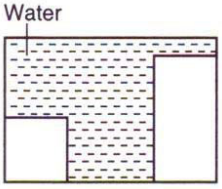


Which of the following shows the correct depth of the water in the tank as seen from the cross-section of the tank?

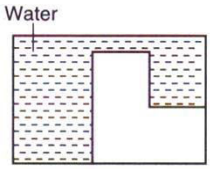
A



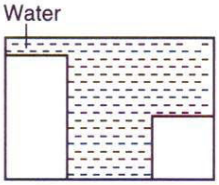
B



C



D



22 Below are three statements about electromagnetic radiation.

- Microwaves may cause the ionisation of cells.
- Radio waves are use in cancer radiotherapy.
- Ultraviolet radiation is used in remote controls for television sets.

How many of the statements are correct?

A 0
B 1
C 2
D 3

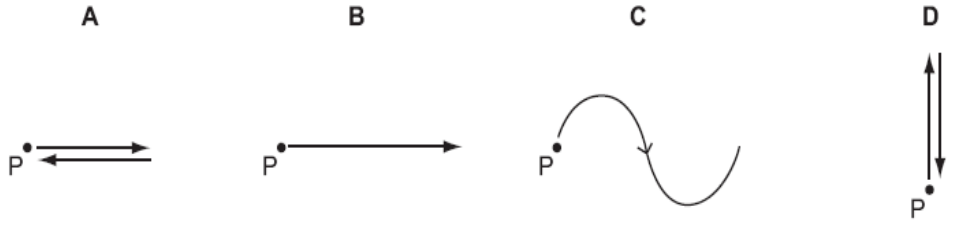
23 Radio waves, visible light and X-rays are all part of the electromagnetic spectrum.

What is the correct order of increasing wavelength?

	shortest ⟶		longest
A	radio waves	visible light	X-rays
B	radio waves	X-rays	visible light
C	X-rays	radio waves	visible light
D	X-rays	visible light	radio waves

24 The diagram shows a loudspeaker that is producing a continuous sound wave of frequency 200 Hz in air.

Which diagram best shows how the sound causes a molecule at P to move during $\frac{1}{200}$ s?

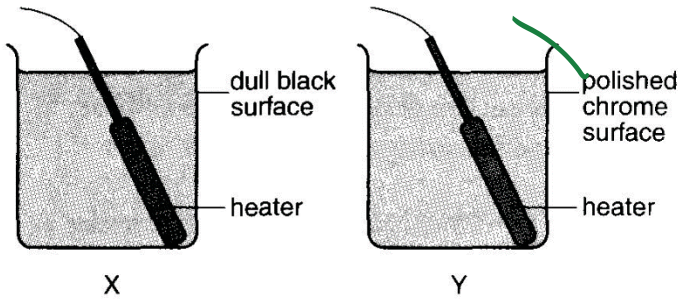


25 The speed of a sound wave is reduced by half when it passes from medium A to medium B.

Which statement below describes the change in the sound wave correctly?

A The frequency is reduced by half.
B The wavelength is reduced by half.
C The frequency becomes twice its initial value.
D The wavelength becomes twice its initial value.

26 In the diagram, two copper cans X and Y with outer surface of different texture are filled with same amount of water at room temperature and heated by heaters of the same power



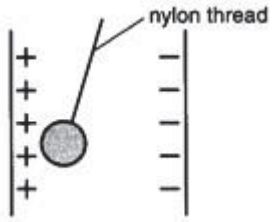
Which of the following statements is correct?

A Water in X boils faster because dull surface is a good absorber of radiation.
B Water in Y boils faster because polished chrome surface is a poor absorber of radiation.
C Water in Y boils faster because polished chrome surface is a poor emitter of radiation.
D Water in both cans take the same length of time to boil because the texture of outer surface will not affect the rate of energy absorbed by the water.

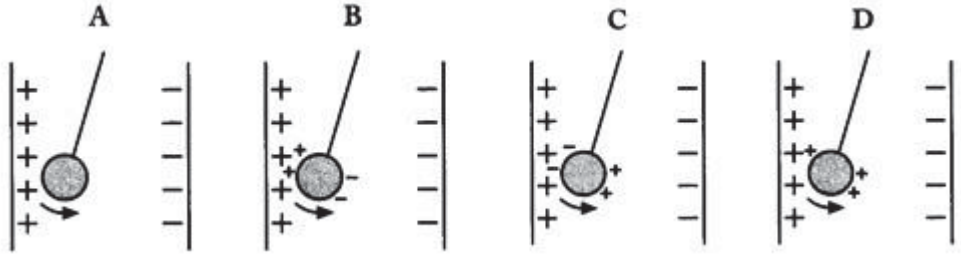
27 Which of the following statements is true?

A All metals are magnetic materials.
B All electrical conductors are magnetic materials.
C All materials that can be electrically charged are magnetic materials.
D All materials that can affect the direction of a compass needle are magnetic materials.

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?

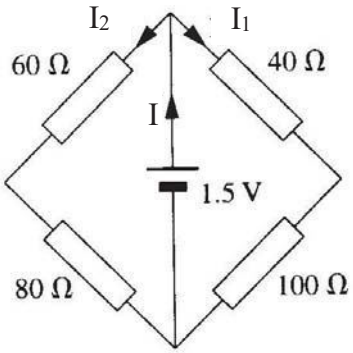


29 The electromotive force of a cell is 2.0 V.

Which of the following statements about the cell is correct?

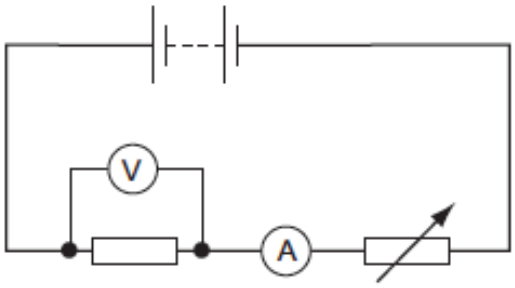
A The cell can supply 2.0 C of charge per second.
B The cell can supply 2.0 W of electrical power per second.
C The cell can supply 2.0 J of energy per coulomb of charge.
D The cell can supply 2.0 J of energy per coulomb of charge per second.

30 What is the current I?



A 5.4 mA
B 11 mA
C 21 mA
D 43 mA

31 The diagram shows a battery, a fixed resistor, an ammeter and a variable resistor connected in series. A voltmeter is connected across the fixed resistor.



The resistance of the variable resistor is reduced.

Which of the following correctly describes the changes in the readings of the ammeter and the voltmeter?

	ammeter	**voltmeter**
A	increases	increases
B	increases	decreases
C	decreases	increases
D	decreases	decreases

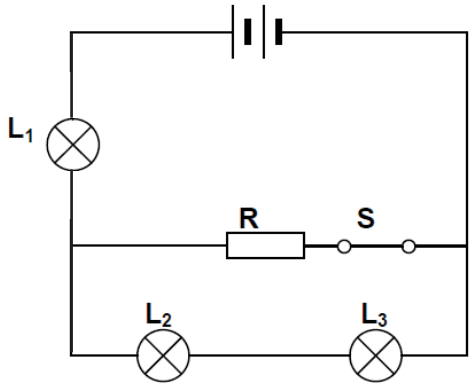
32 The steps taken to charge a conductor are shown below.

1 Place the conductor to be charged on an insulating stand.
2 Remove the charged rod.
3 Place a positively-charged rod near the surface of the conductor.
4 Connect the conductor to the ground.
5 Remove the ground wire.

Which of the following shows the correct sequence of events?

A 1, 3, 4, 2, 5
B 1, 3, 4, 5, 2
C 1, 3, 2, 4, 5
D 3, 1, 2, 5, 4

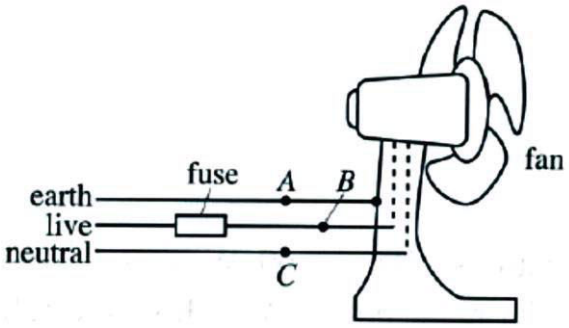
33 Three identical light bulbs, L_1, L_2 and L_3, and a resistor **R** are connected as shown in the diagram.



How will the brightness of lamps L_1, L_2 and L_3 change when the switch **S** is opened?

	brightness of L_1	brightness of L_2	brightness of L_3
A	dimmer	dimmer	dimmer
B	dimmer	brighter	brighter
C	brighter	brighter	brighter
D	brighter	same	same

34 The diagram below shows the simple circuit of an electric fan. Which of the following actions will blow the fuse?

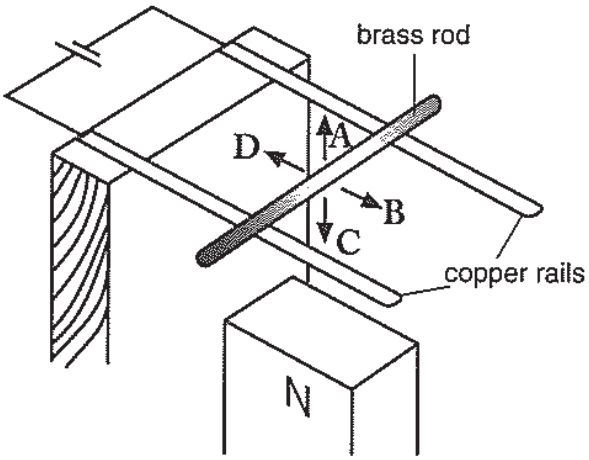


I Point ***A*** touches point ***C***.
II Point ***B*** touches point ***C***.
III Point ***A*** touches point ***B***.

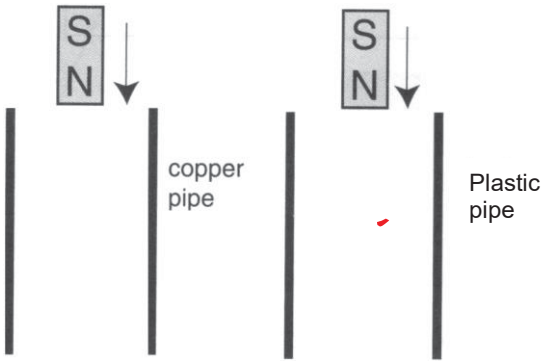
A **I** only
B **I** and **II** only
C **II** and **III** only
D **I**, **II** and **III**

35 The diagram shows a brass rod supported on two copper rails which are connected to a battery. The N-pole of a magnet is placed beneath the rails.

In which direction does the brass rod experience a force?



3 Two magnets are dropped vertically from the same height.

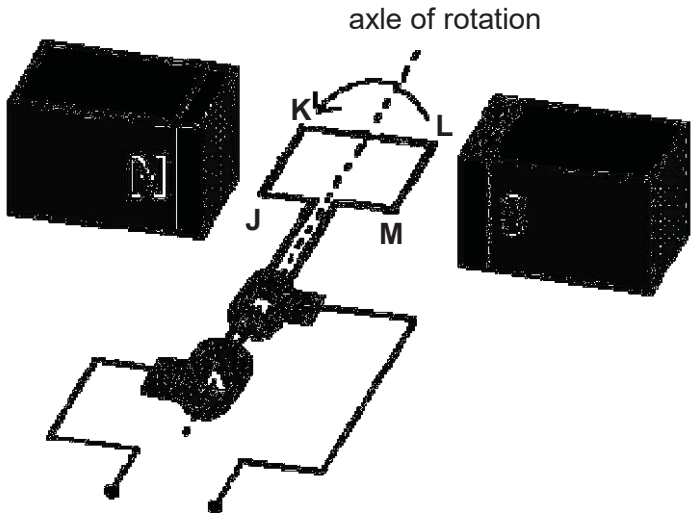


The magnet that dropped through the copper pipe took a longer time to drop through the pipe compared to the other one that dropped through the plastic pipe.

Which of the following is the correct explanation?

A Current is induced in the copper pipe.
B Copper pipe is a non-magnetic material.
C Magnetism is induced in the copper pipe.
D Plastic is a better conductor of electricity.

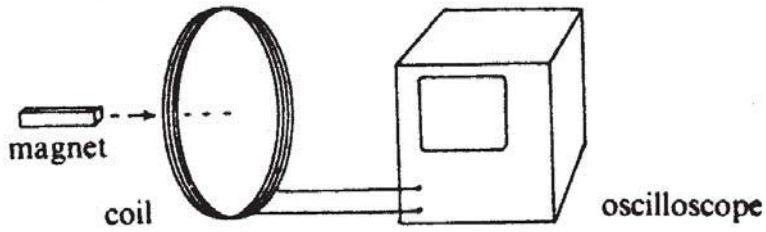
37 The diagram below shows a generator turning in the anti-clockwise direction.



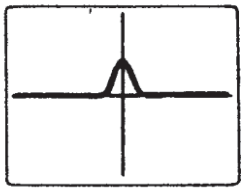
Which row is correct?

	direction of current flow through the coil at the position shown	position of coil when current through the coil is maximum
A	J → K → L → M	horizontal
B	J → K → L → M	vertical
C	M → L → K → J	horizontal
D	M → L → K → J	vertical

38 A bar magnet is moved slowly into a coil of wire which is connected to an oscilloscope.



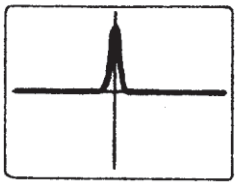
The trace on the oscilloscope is shown below:



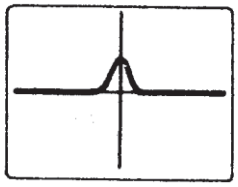
The magnet is then moved back from the coil at a greater speed.

Which trace shows this?

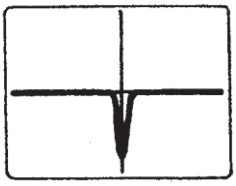
A



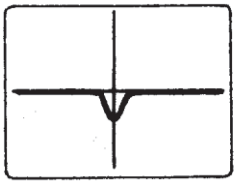
B



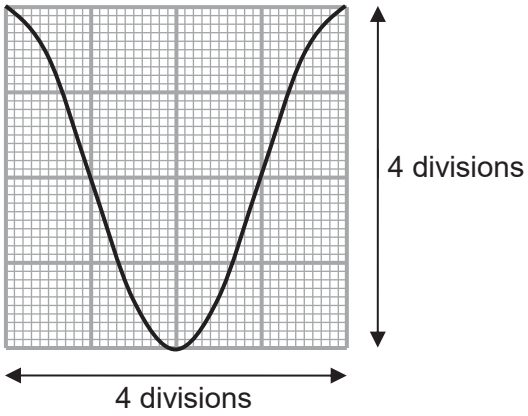
C



D



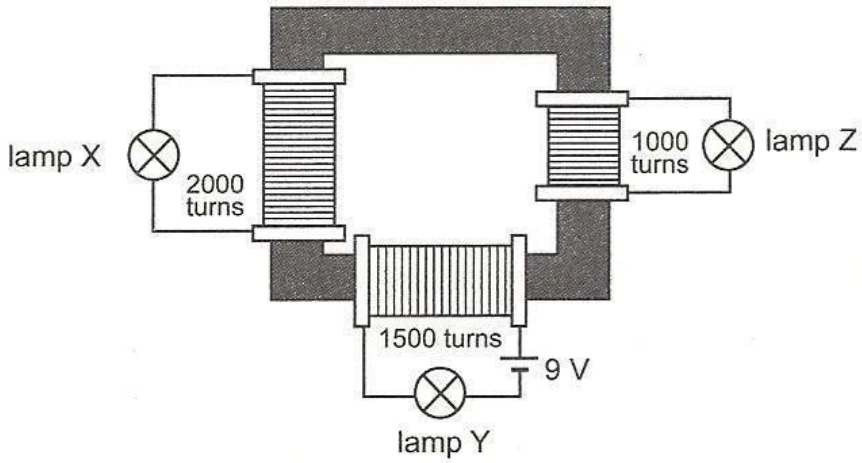
39 The diagram illustrates the trace obtained on the screen of an oscilloscope when a given signal is applied to the input terminals.



The time-base is set to 2.0 ms/div and the voltage sensitivity is 2.0 V/div.
Which of the following correctly represents the peak voltage and frequency of the signal?

	Peak voltage	Frequency
A	4.0 V	83.3 Hz
B	4.0 V	125 Hz
C	8.0 V	83.3 Hz
D	8.0 V	125 Hz

40 Three identical filament lamps, X, Y and Z, are connected to a transformer with multiple coils. The resistance of each lamp is 4.5 Ω and each requires a current of 2.0 A to light up normally.



What can be observed about the brightness of the three lamps?

	Lamp X	Lamp Y	Lamp Z
A	Dimmer than normal	Normal brightness	Brighter than normal
B	Brighter than normal	Normal brightness	Dimmer than normal
C	Not lit	Normal brightness	Not lit
D	Not lit	Not lit	Not lit

COMMONWEALTH SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2018

PHYSICS (6091/2)

Name: _____ ( ) Class: _____

SECONDARY FOUR EXPRESS
PAPER 2

14 September 2018
1 h and 45 minutes
0800 h – 0945 h

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the question paper and any separate answer sheets used.
Write in dark blue or black pen.

Section A (50 marks)
Answer all questions.
Write your answers in the spaces provided on the question paper.

Section B (30 marks)
Answer all three questions.
Question 12 has a choice of parts to answer.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
Candidates are reminded that all quantitative answers should include appropriate units.
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.

Take the gravitational field strength g on Earth to be 10 Nkg^{-1}.

At the end of the examination, ensure that you have submitted all your work.

For Examiner's Use	
Paper 2	80

Parent's/Guardian's Signature

This paper consists of **20** printed pages including the cover page.

[Turn over

1 A sky-diver jumps from a high-altitude helicopter as shown in **Fig. 1.1**.

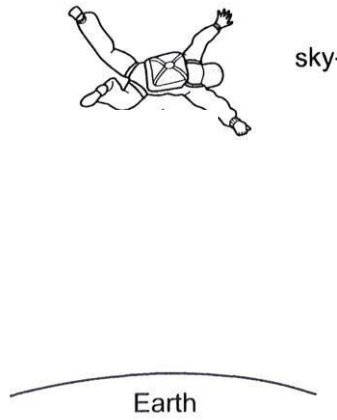


Fig. 1.1

(a) Explain why the acceleration of the sky-diver

(i) is 10.0 ms^{-2} at the start of the jump, [1]

……

……

(ii) decreases with time. [2]

……

……

……

(b) At one point during the dive, the acceleration of the sky-diver was 7.5 ms^{-2}. The sky-diver and his equipment have a total mass of 90 kg.

Determine the total resistive force acting on the sky-diver at that point. [2]

total resistive force = …….

2 **(a)** Define *gravitational field strength*. [1]

……

……

(b) A stone is released from rest at an unknown height on the Earth. It reaches the ground after 2.0 s. Assume that air resistance is negligible.

(i) Calculate the velocity of the stone at 2.0 s. [2]

Velocity = ……

(ii) In the space below, sketch the velocity-time graph of the stone. Indicate time = 2.0 s and its corresponding velocity on the axes. [2]

(iii) Determine the height from where the stone is dropped. [2]

Height = ……

3 Fossil fuels will eventually run out. This has led to scientists looking for alternative sources of energy. Tidal stream systems use the kinetic energy of seawater to generate electrical energy during the incoming and outgoing tides.

Fig. 3.1 below shows a twin-turbine system in which flowing seawater turns the turbine blades.

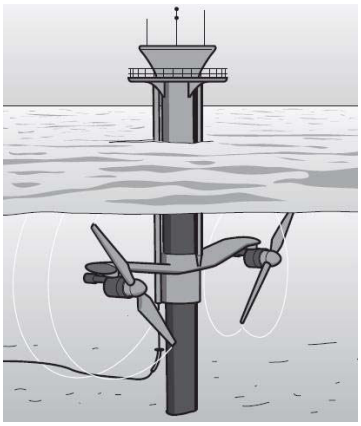


Fig. 3.1

When operating, 9.7×10^5 kg of seawater travelling at a speed of 3.0 ms^{-1} passes through each turbine every second. Each turbine generates 1.2×10^6 W of electrical energy.

(a) Define *power.* [1]

……

(b) The input power to each turbine is the kinetic energy of the seawater that flows through each turbine in one second.

Calculate the input power of each turbine. [2]

Input power = ……

(c) Calculate the percentage efficiency of each turbine. [2]

Percentage efficiency =…….

(d) Suggest one advantage of tidal stream systems over conventional wind farms. [1]

……

……

4 **Fig. 4.1** shows a very large plane mirror, inclined at 45° to the horizontal, beneath a pattern on the high ceiling of a hall.

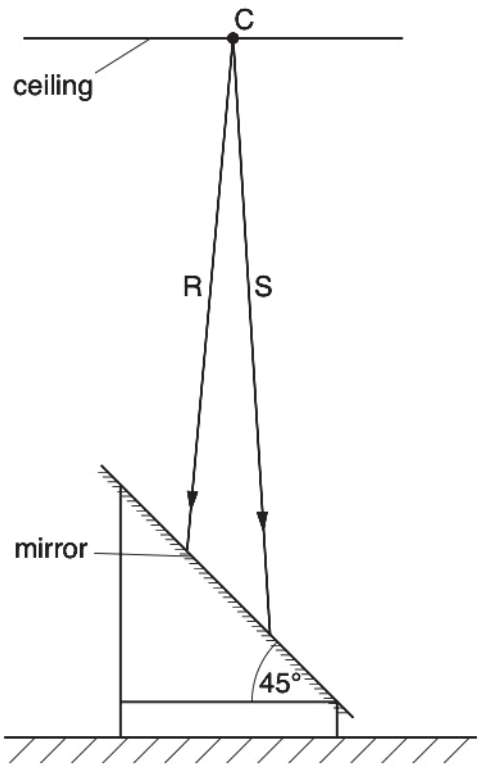


Fig. 4.1

The mirror is set on a stand immediately below the centre **C** of the pattern. **R** and **S** are two rays of light from **C** that strike the mirror.

The diagram is drawn to scale.

(a) On **Fig. 4.1**, mark with a cross (x) the position of **I**, the image of **C**. Label your cross **I**. [1]

(b) Complete the light rays to show how Rays **R** and **S** travel after they strike the mirror. [2]

5 **Fig. 5.1** shows rays from a distant object reaching a converging lens with a focal length of 6.0 cm.

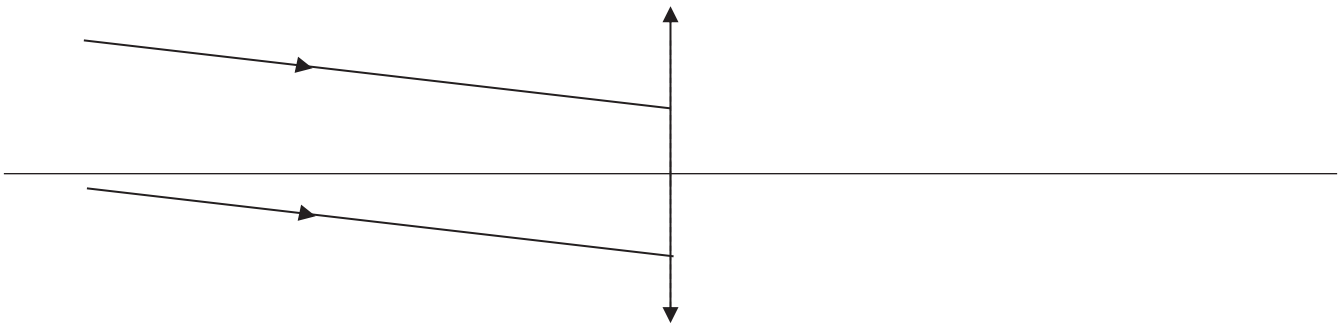


Fig. 5.1

(a) State what is meant by the phrase "*the focal length of a converging lens is 6.0 cm*". [1]

……..……...

……..……...

……..……...

(b) Complete the ray diagram in **Fig. 5.1** to scale to show how the converging lens forms an image. [3]

(c) Describe the effect, if any, on the image when half of the lens is being cut away. [1]

……..……...

……..……...

6 **Fig. 6.1** shows two flat metal plates positioned horizontally, one above the other. The positive terminal of a high-voltage supply unit is connected to the bottom plate and the negative terminal is connected to the top plate.

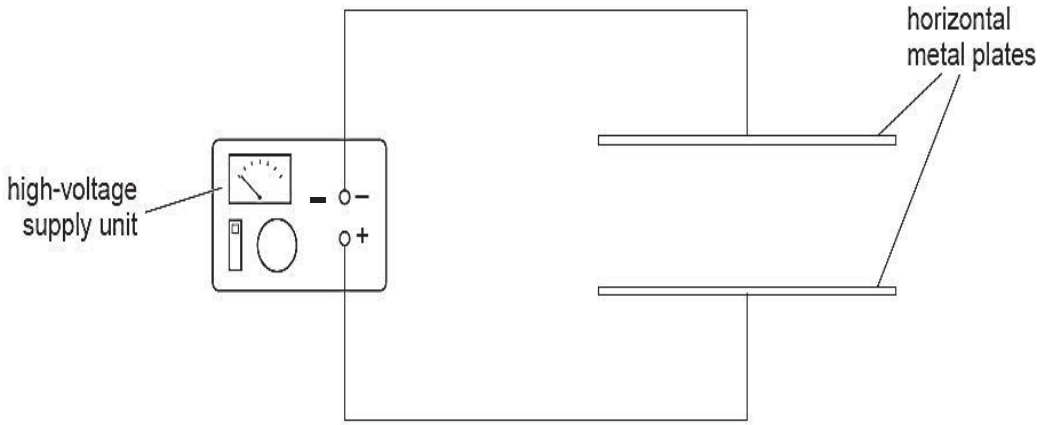


Fig. 6.1

The high-voltage supply is switched on.

(a) On **Fig. 6.1,** draw the shape and the direction of the electric field produced by the horizontal plates. [3]

(b) A small oil droplet is placed between the two metal plates. The oil droplet remains stationary in mid-air.

(i) State the charge of the oil droplet. [1]

……

(ii) Explain, using your understanding of Newton's laws of motion, how the oil droplet can remain stationary in mid-air. [3]

……

……..

……..

……..

……..

7 A lamp is operated from a 12 V d.c supply. The brightness of the lamp is to be varied continuously over a wide range. This is made possible by using a variable resistor **AB** of maximum resistance 6.0 Ω with sliding contact **X**. Two circuits for achieving the desired results are suggested and shown in **Fig 7.1** and **Fig. 7.2**.

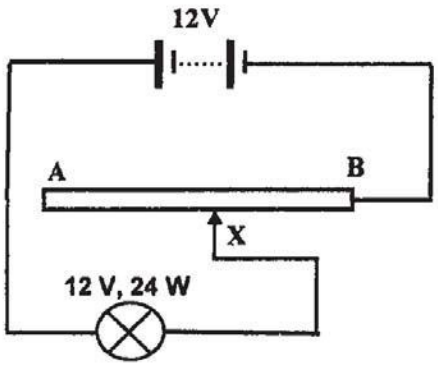


Fig. 7.1

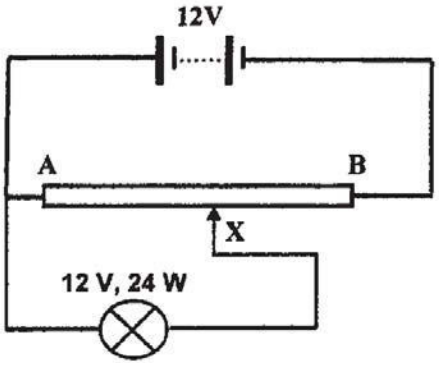


Fig. 7.2

(a) Calculate the resistance of the lamp. [2]

Resistance = …….

(b) Calculate the maximum and minimum current flowing through the lamp in

(i) circuit in **Fig. 7.1**, [2]

Maximum current = ……...

Minimum current = ……....

(ii) circuit in **Fig. 7.2**. [2]

Maximum current = ……...

Minimum current = ……....

8 **Fig. 8.1** shows the side view of water waves formed in a ripple tank.

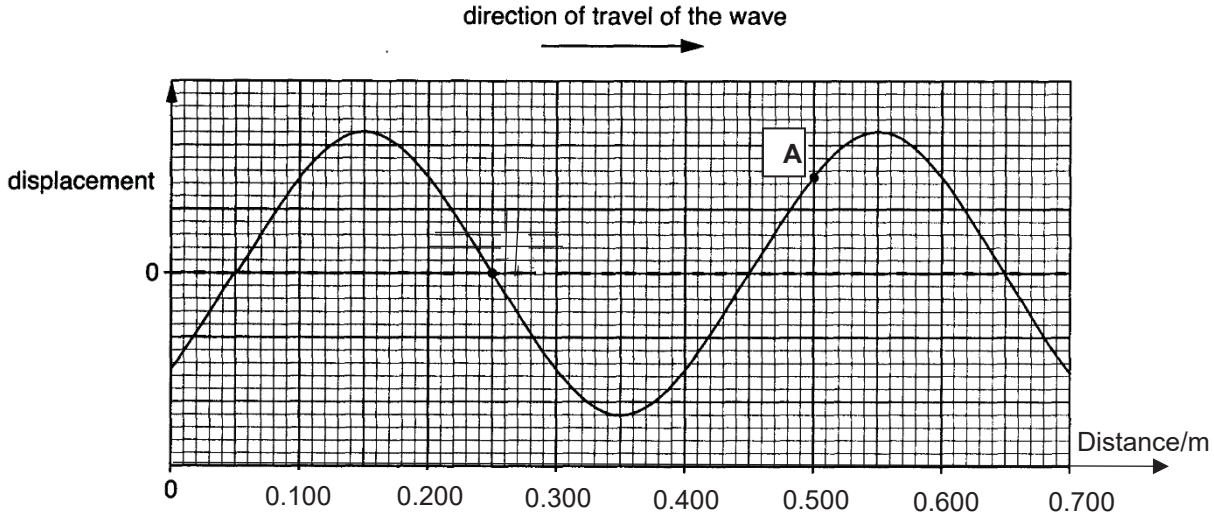


Fig. 8.1

(a) Determine the wavelength of the wave. [1]

Wavelength = …….

(b) Given that the period of the wave is 0.33 s, determine the speed of the wave. [2]

Speed of the wave = …….

(c) A small piece of styrofoam is floating at **A** on the wave at 0.500 m horizontally from the origin (0,0). State and explain what would be the horizontal distance of the styrofoam from the origin after 2.0 s. [3]

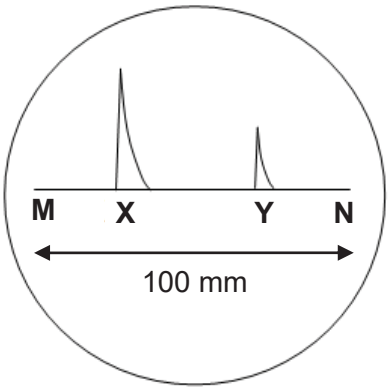
……

……

……

……

9 The diagram below shows the screen of a cathode ray oscilloscope (CRO). The time-base is set at 0.20 ms/mm and the length of the time-base sweep **MN** is 100 mm.



(a) Calculate the time duration represented by **MN**. [1]

Time = …….

(b) A radar signal, sent from a radar station to a distant aircraft, is displayed on the CRO at **X** and the signal received back from the aircraft is displayed at **Y**. The distance **XY** is 60 mm.

Given that the speed of the radio wave is 3.0×10^8 ms^{-1}, calculate the distance of the aircraft from the radar station. [2]

Distance = …….

(c) The signal displayed at **Y** is weaker than that at **X**. State a reason why this is so. [2]

……..

……..

……..

Section B

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

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

10 Four transformers, **A**, **B**, **C** and **D** are being investigated. For each transformer, the input voltage is changed and the output voltage measured each time. The results for each transformer are shown by the graphs in **Fig. 10.1.**

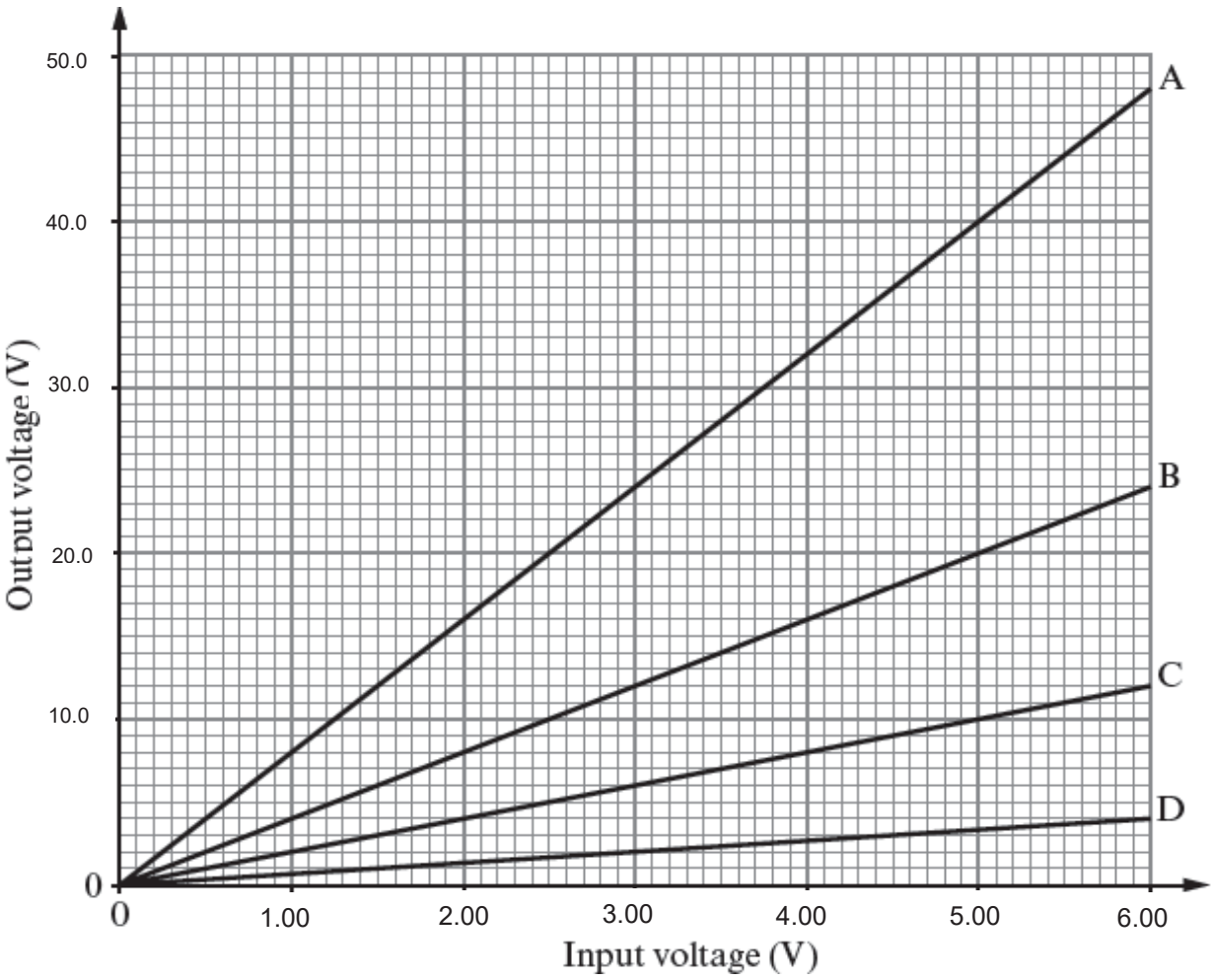


Fig. 10.1

One of the transformers is then used to light up a 12 V lamp from a 3 V power supply as shown in **Fig. 10.2**.

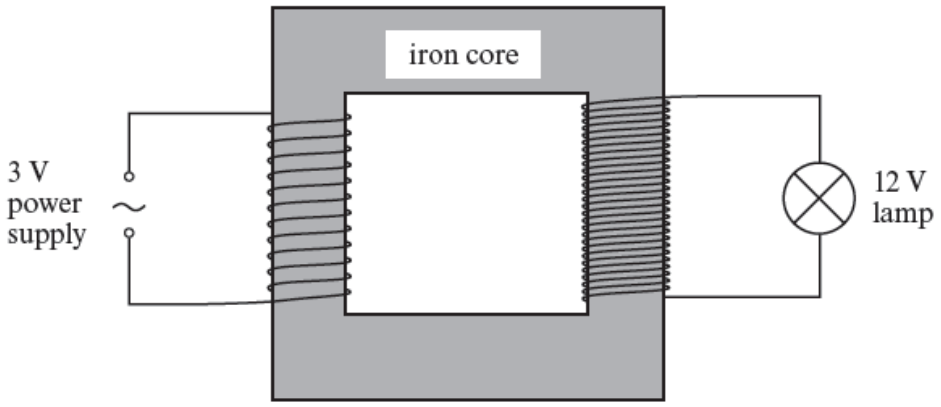


Fig. 10.2

(a) Explain how a current in the primary coil produces an output voltage in the secondary coil. [2]

……

……

……

(b) Describe the purpose of the iron core. [1]

……

……

(c) Use the data on the graphs in **Fig. 10.1** to answer the following questions.

(i) State and explain which transformer, **A**, **B**, **C** or **D**, would be used to light the 12 V lamp to normal brightness, from a 3 V supply as shown in **Fig. 10.2**. [1]

……

……

(ii) Transformer **C** contains 50 turns on its primary coil. Calculate the number of turns on its secondary coil. [2]

Number of turns = ……

(iii) Transformer **A** has a current of 0.500 A in the primary coil. Calculate the current in the secondary coil. [2]

Current = ……..

(iv) State and explain which transformer, **A**, **B**, **C** or **D**, is **not** suitable to be used for the transmission and distribution of energy from power stations to transmission cables. [2]

……

……

……

11 **(a)** **Fig. 11.1** shows a manometer which contains mercury being used to measure the pressure from a gas supply. One end of the tube is connected to the gas supply and the other end is open.

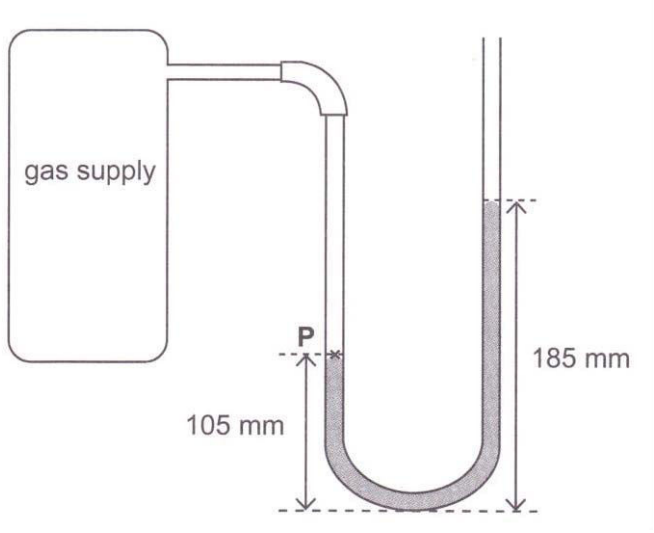


Fig. 11.1

(i) Explain how the gas molecules in the manometer create a pressure. [2]

……...

……...

……...

(ii) Mark and label on the right limb of the manometer in **Fig. 11.1**, a point **Q** in the tube which is at the same pressure as point **P**. [1]

(iii) Given that the density of mercury is 13600 kgm^{-3} and that the atmospheric pressure is 760 mmHg, calculate the pressure of the gas supply in Pa. [3]

Pressure = ……..

(iv) State how the liquid levels in the tube will change if a manometer tube of a larger bore (inner cross-sectional area) is used. The total amount of mercury is constant. [2]

……...

……...

……...

(b) **Fig. 11.2** shows a long vertical glass tube with one end immersed in mercury and the other connected to a vacuum pump at **A**. The glass tube fits tightly into a bell jar. With an opening at **B** and all air in the glass tube pumped out through **A**, the mercury rises to a maximum height of 760 mm above the level of mercury in the dish.

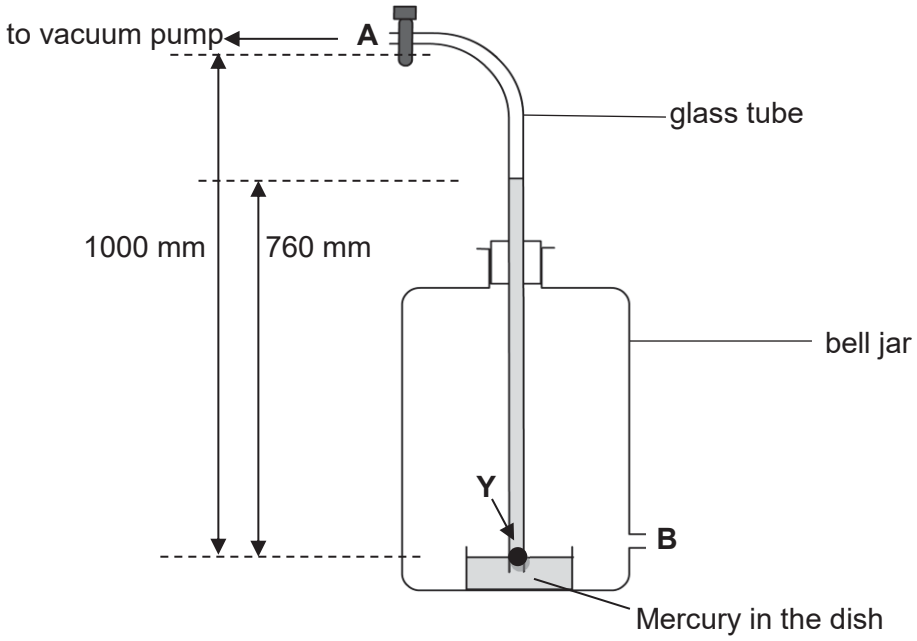


Fig. 11.2

A bicycle pump is now attached to opening **B** and air is being pumped into the bell jar.

State and explain how the mercury column in the glass tube would behave as air is pumped into the bell jar by the bicycle pump. [2]

……...

…...……...

…...……...

12 EITHER

(a) A veterinarian wants to do a minor surgery on a dog. She sterilizes her instruments, comprising of a scalpel and a hemostat, by immersing them in 2.0 kg of boiling water for 30 minutes. She then quickly transfers the instruments to a well-insulated tray containing 200 g of sterilized water at room temperature (28°C) which fully covers the instruments. After a few minutes, the instruments and water reach the same temperature, y °C.

The mass of the scalpel is 50 g and the mass of the hemostat is 70 g. Both are made from steel with a specific heat capacity of 450 J/kgK. The specific heat capacity of water is 4200 J/kgK.

(i) Determine, in terms of y, the

1. heat lost by the scalpel and hemostat. [2]

Heat lost = ……

2. heat gained by the sterilized water. [1]

Heat gained = …….

(ii) From **(a)(i),** write an equation relating the heat exchange between the scalpel, hemostat and water. [1]

……

……

(iii) Hence or otherwise, determine y. [1]

y = ……

(b) The apparatus is set up to determine the specific latent heat of fusion of ice as shown in **Fig. 12.1**.

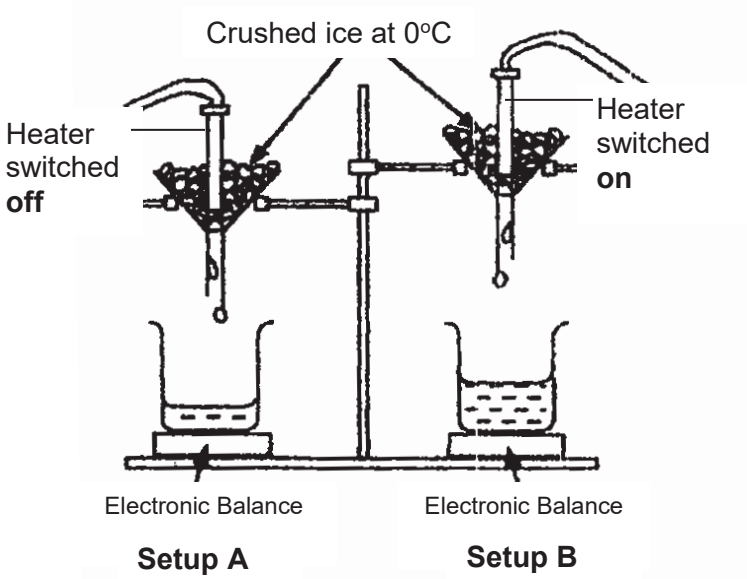


Fig. 12.1

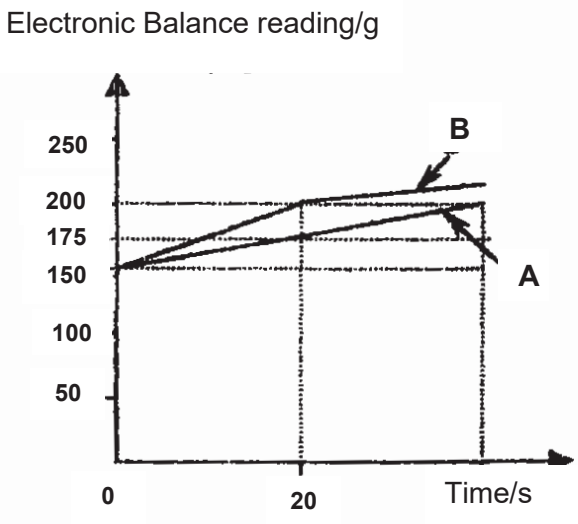


Fig. 12.2

Both setups used similar apparatus and materials. The heater in **A** is switched off while the heater in **B** is switched on. The balance readings are recorded at regular time intervals and the results are plotted against time as shown in **Fig. 12.2**.

(i) State what is meant by the *specific latent heat of fusion* of ice. [2]

……

……

……

……

(ii) Determine the mass of ice melted by the heater in the first 20 s. [1]

Mass of ice = ……

(iii) If energy is being supplied at a rate of 400 Js^{-1}, calculate the specific latent heat of fusion of ice, assuming that all the energy released from the heater is absorbed by the ice. [2]

Specific latent heat of fusion = …….

12 OR

(a) To investigate a layer of rock underground, an explosion is triggered on the surface of the Earth. **Fig. 12.3** below shows the arrangement.

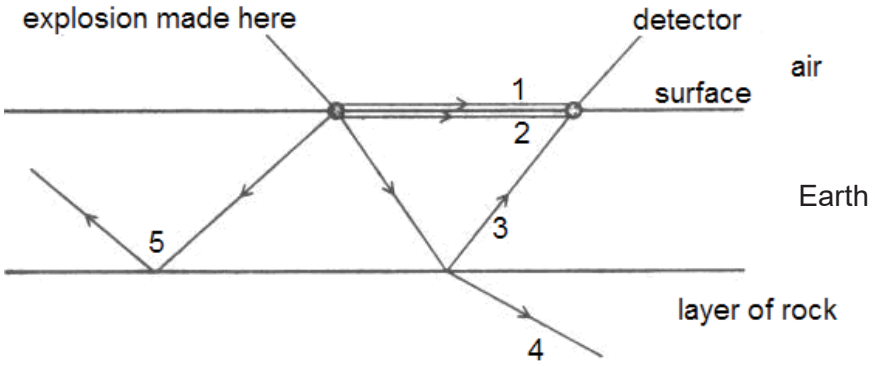


Fig. 12.3

Sound wave from the explosion may travel to the detector through air (**path 1**) or through Earth (**path 2**). It can also be transmitted into the layer of rock by **path 4** with part of wave being reflected at the boundary between the Earth and the layer of rock as indicated by **path 3**.

The time taken for the sound to reach the detector is shown in **Table 12.4**.

Path	**1**	**2**	**3**
Time taken (in seconds) for sound to travel from the source to the detector	0.100	0.020	0.300

Table 12.4

(i) Explain why sound wave takes the shortest time to reach the detector along **path 2**. [1]

……

……

(ii) Given that the speed of sound in air is 330 ms^{-1}, calculate the distance between the source of sound and the detector. [2]

Distance = ...

(iii) Use the answer in part **(ii)** to calculate the speed of sound in Earth. [2]

Speed of sound = ...

(iv) Referring to **path 4**, explain how the speed of sound changes when it travels from Earth to the layer of rock. [1]

……

……

(b) **Fig. 12.5** shows ultrasound being used to study an unborn baby.

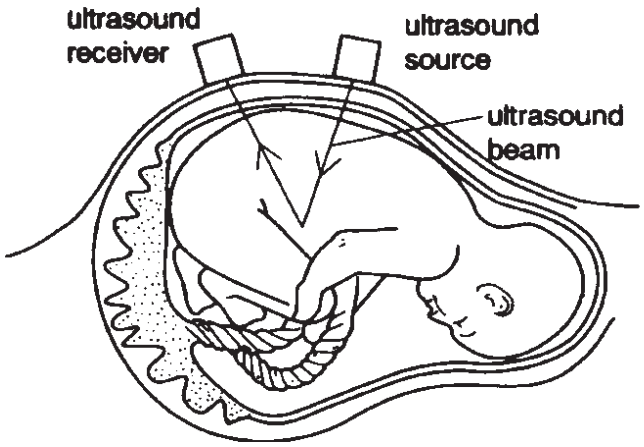


Fig. 12.5

(i) Explain how the vibrations of the source produce waves of ultrasound and suggest how these waves are transmitted through the body tissue to the receiver. [3]

……

……

……

……

……

(ii) Ultrasound used in medicine has a frequency which is 100 times higher than the maximum frequency that can be heard by humans.

Estimate the frequency that might be used for ultrasound in medicine. [1]

Frequency = ...

COMMONWEALTH SECONDARY SCHOOL
SECONDARY FOUR EXPRESS PHYSICS
PRELIMINARY EXAMINATION 2018
ANSWER KEY

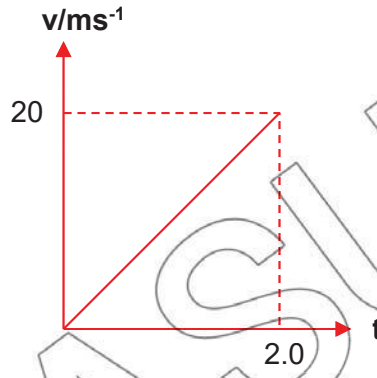
1	D	11	A	21	A	31	A
2	B	12	C	22	A	32	B
3	B	13	D	23	D	33	B
4	D	14	A	24	A	34	C
5	D	15	B	25	B	35	B
6	B	16	B	26	C	36	A
7	A	17	C	27	D	37	C
8	B	18	B	28	D	38	C
9	B	19	B	29	C	39	B
10	C	20	D	30	C	40	C

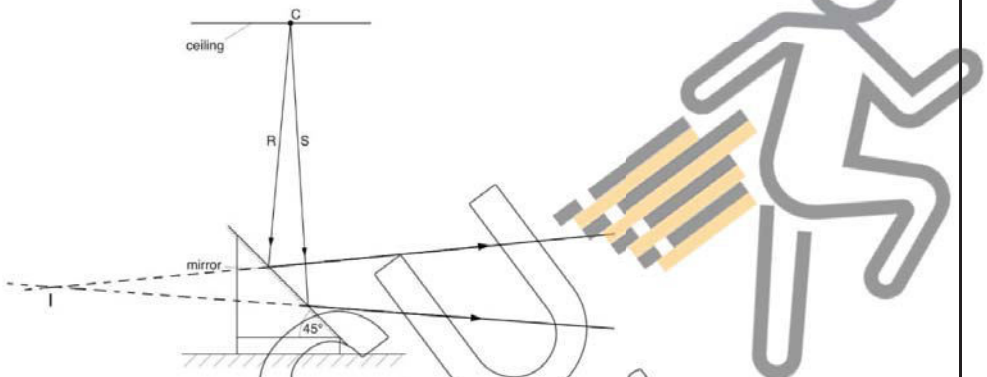
COMMONWEALTH SECONDARY SCHOOL
SECONDARY FOUR EXPRESS PHYSICS
PRELIMINARY EXAMINATION 2018
MARK SCHEME

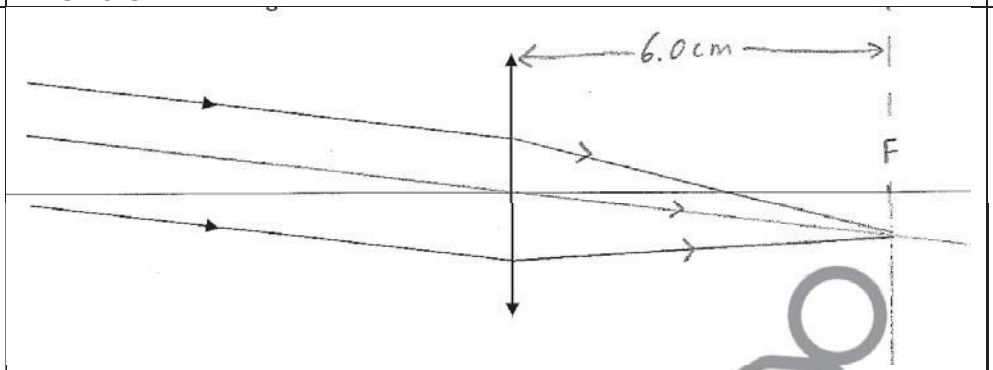
Section A (50 marks)

To deduct one mark per question for errors in significant figures.

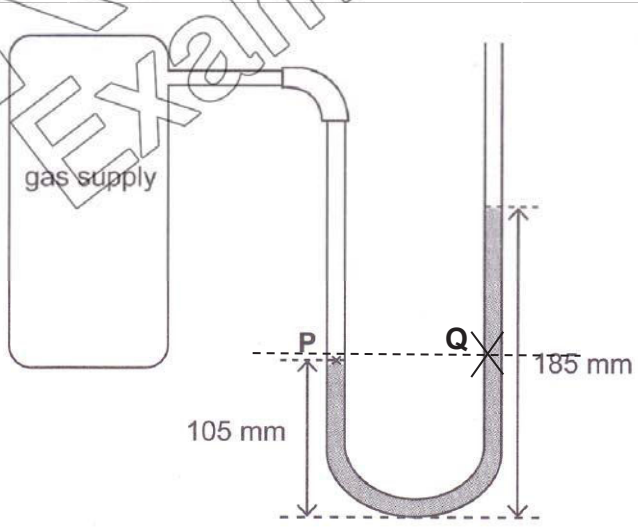
Qn	Answers	Mark
1ai	**Air resistance** is **negligible** Or: No air resistance or resistive force Or: the only force acting is the weight or gravitational force or gravity Or: Resultant force is (due to) the weight or gravitational force	1
1aii	**Air resistance increases** as speed increases **Resultant force decreases** Accept: F_R decreases	1 1
1b	Resultant force = ma = 90 kg x 7.5 ms^{-2} = **675 N** Do not give the first mark if student puts resultant force as the resistive force. Total resistive force = Weight – resultant force = 900 N – 675 N = 225 N = **230 N** (2 sf) Or: Resultant force = ma = 90 kg x 7.5 ms^{-2} = 675 N = **680 N** (2 sf) [1] Total resistive force = Weight – resultant force = 900 N – 680 N = **220 N** (2 sf) [1]	 1 1
	Total mark for Q1	**5**
2a	**Gravitational force per unit mass**.	1

Qn	Answers	Mark
2bi	a = (v-u)/t **10 ms^{-2} = (v – 0 ms^{-1})/2.0s** v = **20 ms^{-1}**	 1 1
2bii	**Straight line** graph with **positive gradient starting from origin.** Correct values of **velocity** of **20 ms^{-1}** and **corresponding time** of **2.0 s** clearly indicated on graph. **Axes labelled with units.**  	1 1
2biii	Area under the graph = **½ x 2.0 s x 20 m/s** = **20 m** The height from which the ball is dropped is 20 m. e.c.f. from (b) (i), (ii)	1 1
	Examiners' comments: Generally well done apart for some students who still sketch the graph with wrong initial speed of 20 m/s. These students need to underline key phrase such as "released from rest" in the question stem to remind themselves.	
	Total mark for Q 2	**7**
3a	**Rate of work done** or **Rate of energy conversion** •	1
3b	**½ (9.7 X 10^5 kgs^{-1}) (3.0 ms^{-1})^2** = **4.4 X 10^6 J/s** or **W** (2 sf)	1 1
3c	**(1.2 x 10^6 / 4.37 x 10^6) x 100%** = 27.5% = **28 %** (2sf) e.c.f. from (b) Or: **(1.2 x 10^6 / 4.4 x 10^6) x 100%** = 27.3% = **27 %** (2sf)	1 1

Qn	Answers	Mark
3d	Any of the following: ○ There is current or water moving throughout the day (but not so for wind blowing in the correct direction). ○ **No noise pollution** for tidal energy. ○ **Do not require large clearance of land space**. ○ Does not obstruct the flight path of **birds**	1
	Total mark for Q 3	**6**
4a	 Image located **correctly and accurately (+/- 1 mm)** and labelled as **I**.	1
4b	Reflected rays drawn correctly (accept either extension to **I** or from measurement of angle of incidence = angle of reflection +/- 1°). One mark for each ray.	2
	Total mark for Q 4	**3**
5a	The **distance between the optical centre**/centre of converging lens/lens axis **and Principal Focus**/Focal Point is **6.0 cm.**	1
5b	A ray is drawn **parallel** to the other two rays and **passing through the optical centre undeviated.** All 3 rays **brought to a focus** on the focal plane. Don't accept image formed at Principal Focus F. at **6.0 cm** (+/- 0.1 cm) **away from the lens**	1 1 1

Qn	Answers	Mark
		
5c	Image becomes **less bright or dimmer**.	1
	Examiners' comments: Many students thought that the image will be halved or image will disappear or become blur. Students need to know that when the half the lens is cut, all the rays that used to be converged by this halve of the lens will no longer reach the image, rays incident on the other half is not affected. Since less light rays reach the image, the image will be less bright.	
	Total mark for Q 5	**5**
6a	Shape: **Vertical straight lines** are drawn from one plate to another with **equal spacing** between them. +/- 1 mm in spacing is allowed Direction: The **arrows** point from bottom plate to top plate	1 1 1
6bi	**Positive.**	1
6bii	The **electrostatics** or electric force (of attraction from the top plate and repulsion from the bottom plate) is **acting upwards** on the oil drop and is **equal to the weight** of the oil drop which acts downwards. As there is **no resultant force** acting on the oil drop, the oil drop remains at rest.	1 1 1
	Total mark for Q 6	**7**
7a	$R = V^2/P$ $= \mathbf{(12\ V)^2 / 24\ W}$ $= \mathbf{6.0\ \Omega}$	1 1
7bi	Maximum current $= \frac{12}{6.0}$ $= \mathbf{2.0\ A}$	1

Qn	Answers	Mark
	Minimum current $= \frac{12}{6+6}$ = **1.0 A**	1
7bii	Maximum current $= \frac{12}{6.0}$ = **2.0 A** Minimum current $= \frac{0}{6.0}$ (accept if working is not written) = **0 A**	1 1
	Total mark for Q 7	**6**
8a	λ = 0.550 m – 0.150 m = **0.400 m**	1
8b	V = λ/T = **0.400 m/0.33 s** = **1.2 ms^{-1}**	1 1
8c	The piece of Styrofoam would be **0.500 m** (horizontally) from the origin. This is because the wave is a **transverse wave** or the movement of styrofoam is perpendicular to the direction of the wave each part of the wave **only oscillates up and down** and not left and right or the Styrofoam vibrates perpendicularly to the direction of the wave Or: waves transfer energy [1] without transferring matter [1] Hence its horizontal distance would remain constant.	1 1 1
	Total mark for Q 8	**6**
9a	100 mm x 0.20 ms/mm = **20 ms** or **0.020 s** or **2.0 x 10^{-2} s**	1
9b	Divide time by 2: e.g. $\frac{0.012}{2}$ or $\frac{12ms}{2}$ d = 3.0 x 10^{8} m/s x 0.006 s = **1 800 000 m** or **1.8 x 10^{6} m**	1 1
9c	Energy is **absorbed** by the surrounding air. Thus **less energy is received** by the radar.	1 1

Qn	Answers	Mark
	Total mark for Q 9	**5**
10a	The **current** in the primary coil is **alternating/changing** The **magnetic flux in the secondary coil** is **changing** continuously**,** hence inducing an emf in the secondary coil.	1 1
b	To **concentrate the magnetic field lines**	1
ci	**B** because the **the output voltage is 12.0 V when the input voltage is 3.00 V.**(as shown on the graph)	1
cii	**N_s/50 = 12.0 V/6.00 V** N_s = **100**	1 1
ciii	**48.0 V/ 6.00 V = 0.500 A/I_s** I_s = **0.0625 A** (3 sf)	1 1
civ	**D** because it is a **step-down** transformer or **current is stepped up** resulting in a **higer power loss in the cables**.	1 1
	Total mark for Q 10	**10**
11ai	The gas molecules are **moving randomly** and **continuously** at high speed. Accept: **constant and random** or **constant random** They **collide with the walls of the container/mercury** thus exerting a **force** on the walls/mercury. The force per unit area is the pressure.	1 1
11aii		1

Qn	Answers	Mark
11aiii	185 mm – 105 mm = **80 mm** or **Pressure difference is 80 mmHg** P = 760 mmHg + 80 mmHg = 840 mmHg P = ρgh = **0.840 m x 13600 kgm^{-3} x 10 Nkg^{-1}** = 114 240 = **110 000 Pa** (2 sf) or **114 000 Pa** (3 sf) or **1.14 x 10^{5} Pa**	1 1 1
11aiv	The liquid **levels** in **both sides** of the tube will **fall**. However, the **difference** in the two levels will **remain unchanged**.	1 1
11b	As air is pumped into the bell jar, the **pressure of the bell jar increases** above atmospheric pressure. As such, mercury would be forced in to the glass tube making the **mercury column taller/longer**.	1 1
	Total mark for Q 11	**10**
12 **EITHER** **ai1**	Heat lost by scalpel and hemostat = **(0.050 kg + 0.070 kg) x (450 J/kgK) x (100°C -*y*)** = (0.120 x 450 x 100) J - (0.12 x 450 x *y*) J = **(5 400- 54 *y*) J** or **54(100 –y) J**	 1 1
ai2	Heat gained by the sterilized water, Q = mcθ = 0.200 kg x 4 200 J/kgK x (*y*-28°C) = **(840*y* - 23 520) J** or **840(*y* -28) J**	 1
aii	**Heat lost by scalpel and hemostat = heat gained by water** Or: **54(100 –y) = 840(y -28)**	1
aiii	5 400 - 54y = 840*y* - 23520 5 400 + 23520= 840 *y* + 54 *y* 28920 = 894*y* *y* = **32** (2 sf)	 1
bi	Specific latent heat of fusion of ice is the **amount of thermal energy required** to change **unit mass of ice** from its **solid to liquid state,** without a change in temperature.	1 1

Qn	Answers	Mark
bii	Mass of ice melted by the heater alone in the first 20 s = 200 g – 175 g = **25 g**	 1
biii	Latent heat gained by ice = heat supplied by heater Specific latent heat of fusion = Pt / m = (**400 J/s × 20s) / 25g** = **320 J/g**	 1 1
	Total mark for Q 12 EITHER	**10**
12 OR ai	Sound travels **faster in solid** (earth or ground) compared to air.	1
aii	Distance = **330 ms^{-1} x 0.100 s** = **33 m** or **33.0 m**	1 1
aiii	Speed = **33 m /0.020 s** or **33.0 m /0.020 s** = **1700 ms^{-1}** (2sf) or **1650 ms^{-1}** (3sf)	1 1
aiv	The **speed of sound increases**. The refracted wave **bends away from the normal**.	1
bi	Production of ultrasound: **Vibration of the source** at high frequency to and fro **along the direction of the** propagation of the **wave** (or longitudinal wave) produces ultrasound. Transmission through body tissues: The **molecules** of the **body tissue vibrate** backward and forward **in the direction parallel** to the direction of the propagation of **sound** or **wave**. Or: The vibrations of the source results in the formation of a series of **compressions (or region of high pressure) and rarefactions (or region of low pressure)** in the **body tissue.** Transmission to the receiver: When the ultrasound hits the denser part of the tissue, it is **reflected** through the body tissue and is detected by the **receiver (**or go back to the **receiver**).	1 1 1
bii	**2 MHz** or **2 x 10^{6} Hz** or **2000 kHz**	1
	Total mark for Q 12 OR	**10**