TANJONG KATONG GIRLS' SCHOOL
PRELIMINARY EXAMINATION 2019
SECONDARY FOUR

6091/01 **PHYSICS**
Paper 1 Multiple Choice

WEDNESDAY **4 SEP 2019** **1 hour**

Additional materials: OMR answer sheet

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, class and index number on the OMR Answer Sheet.

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 OMR Answer Sheet.

Take gravitational field strength to be 10 N/kg unless stated otherwise in the question.

Read the instructions on the OMR Answer Sheet very carefully.

At the end of the examination, hand in the OMR Answer Sheet.

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.

Answer **ALL** the questions in this paper on the OMR sheet provided.

1 Which of the following is a good estimate for the thickness of a fingernail?

A 1 dm **B** 1 cm **C** 1 mm **D** 1 μm

2 A student intends to determine the volume of a copper pipe which spans several metres long. The pipe has a uniform cross-sectional area. The external diameter of the copper pipe is estimated to be 5 cm.

Which pair of instruments will allow him to measure the necessary dimensions accurately?

A vernier calipers and tape

B micrometre screw gauge and tape

C vernier calipers and rule

D micrometre screw gauge and vernier calipers

3 Three forces 3 N, 4 N and 8 N act on an object. Which of the following cannot be the resultant force acting on the object?

A 0 N **B** 1 N **C** 8 N **D** 14 N

4 A racing car is fitted with an on-board computer which can record the distance travelled by the car for every one second. The computer starts recording when the car passes the starting line and moves along a straight line.

Which set of data shows that the car is accelerating during the next 2 seconds?

A

Time / s	Distance / m
0	0
1	100
2	200

B

Time / s	Distance / m
0	0
1	90
2	180

C

Time / s	Distance / m
0	0
1	100
2	180

D

Time / s	Distance / m
0	0
1	80
2	190

5 The diagram shows a person using a rope to pull a block on a rough surface to the right. The block moves at a constant speed.

Which pair of forces is a pair of action and reaction force?

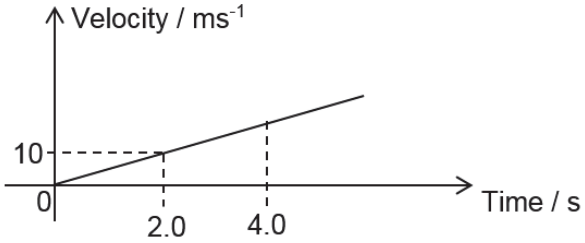
A Frictional force acting on the block by the ground and the pulling force on the block

B The pulling force on the block and the tension force experienced by the rope

C The weight of the block and the normal reaction force acting on the block by the ground

D The frictional force acting on the person by the ground and the frictional force acting on the block by the ground

6 The diagram shows the velocity-time graph of a car. The total resistive force acting on the car is 1000 N. The mass of the car is 1000 kg.



What is the resultant force acting on the car at t = 4.0 s?

A 0 N **B** 4000 N **C** 5000 N **D** 6000 N

7 An astronaut lands on a planet where the acceleration of free-fall at its surface is greater than that on Earth. Which of the following will be the same as that on Earth?

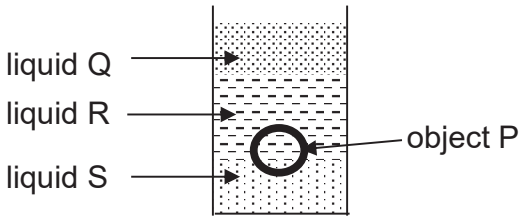
A The weight of the astronaut

B The period of oscillation of a simple pendulum

C The height reached by the astronaut when he jumps with the same initial velocity

D The acceleration of a block when being pushed horizontally by the same force on a smooth surface

8 A circular object P is lowered into a cylinder which contains 3 different layers of immiscible liquids. The diagram shows the position of object P in the cylinder.



Which of the following correctly shows the densities of the substances arranged in increasing order?

A liquid Q, object P, liquid R, liquid S

B liquid Q, liquid R, object P, liquid S

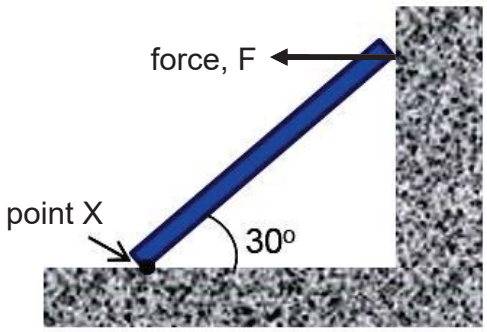
C liquid S , liquid R, object P, liquid Q

D liquid S, object P, liquid R, liquid Q

9 The diagram shows a stationary uniform ladder leaning against a smooth wall and making an angle of 30^o with the ground at point X.

The wall exerts a horizontal force F on the ladder. The weight of the ladder is 500 N.

What is the magnitude of the force F?



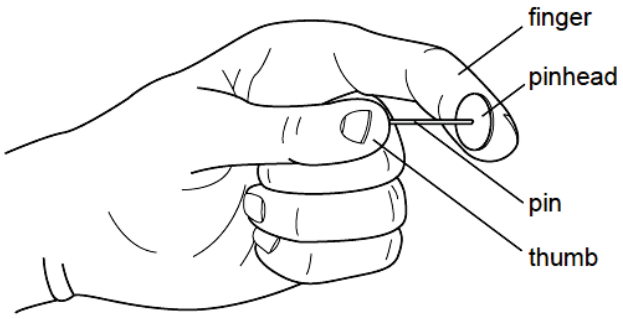
A 144 N **B** 250 N **C** 433 N **D** 500 N

10 The diagram shows a bottle being filled up with water.

What happens to the stability and the centre of the gravity of the bottle (with water) as the bottle is filled with water?

	Stability	**Centre of Gravity**
A	become less stable	centre of gravity is raised
B	become less stable	centre of gravity is lowered
C	become more stable	centre of gravity is raised
D	become more stable	centre of gravity is lowered

11 The diagram shows a pin being squeezed between a finger and the thumb.



Which statement is correct?

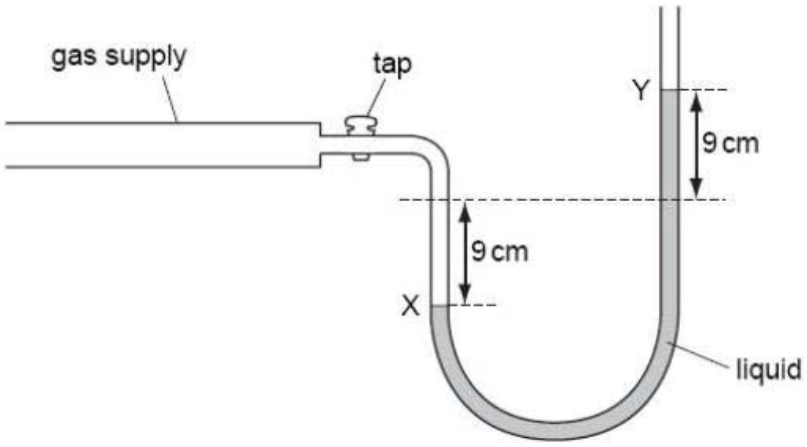
A The force of the pin is larger on the finger than on the thumb.

B The force of the pin is larger on the thumb than on the finger.

C The pressure of the pin is larger on the finger than on the thumb.

D The pressure of the pin is larger on the thumb than on the finger.

12 The diagram shows the levels X and Y in a liquid manometer with the gas tap open.

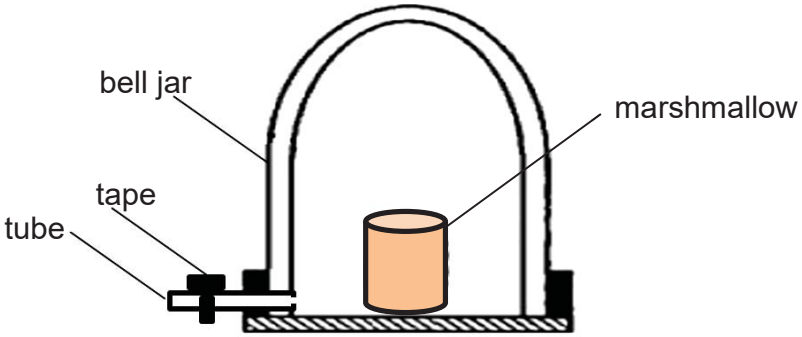


The gas supply is now replaced by a new gas supply which has a pressure that is 2 cm of the liquid above the previous gas supply.

What will be the new difference in height between level X and Y?

A 16 cm **B** 18 cm **C** 20 cm **D** 22 cm

13 The diagram shows a marshmallow placed inside a bell jar with the tap closed.



The pressure of the gas in the bell jar is half of the atmospheric pressure.

The tap is then opened and the air from the surrounding rushes in through the tube.

What happens to the size of the marshmallow and the gas pressure in the marshmallow?

	Size of marshmallow	Gas pressure in marshmallow
A	decreases	increases
B	decreases	decreases
C	increases	increases
D	increases	decreases

14 To calibrate a liquid-in-glass thermometer without using another thermometer, fixed point(s) will be required.

Which statement is correct?

A Only one fixed point is required.

B Both a lower fixed point and an upper fixed point are required.

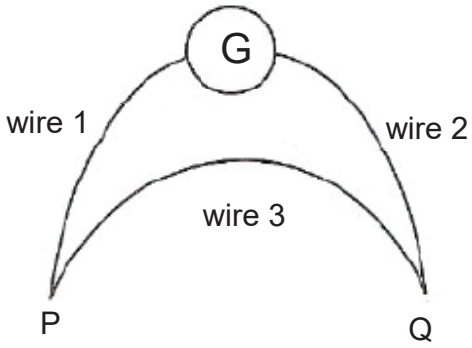
C Any temperature above the melting point of liquid can be used as fixed points.

D The melting point and boiling point of the liquid in the thermometer are always the fixed points.

15 A resistance thermometer has a resistance value of 20 Ω and 80 Ω when the temperature is 10 °C and 90 °C respectively. What will be the expected temperature if the resistance of the thermometer is 100 Ω?

A 90 °C **B** 107 °C **C** 117 °C **D** 133 °C

16 The diagram shows a thermocouple connected to a galvanometer. Two ends of the wires are placed in junction P and Q respectively.



However, the galvanometer does not show any deflection.

Which of the following **is not** a possible reason for the observation?

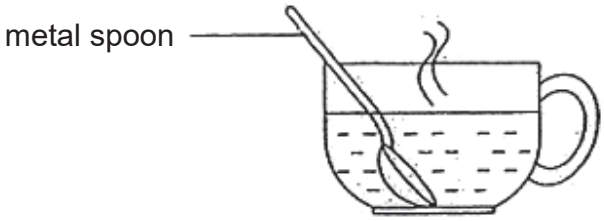
A Wire 1 and wire 2 are made of the same material.

B Wire 1 and wire 3 are made of the same material.

C Both junctions P and Q have same temperature.

D The galvanometer is not sensitive enough to detect the current.

17 The diagram shows a metal spoon in a cup of hot water.



Why does the top end of the metal spoon becomes hot after a while?

A Heat transfers from the hot water to the top of metal spoon by radiation.

B Heat transfers from the hot water to the top of metal spoon by convection.

C Heat transfers from the surrounding air to the top of metal spoon by conduction.

D Heat transfers from the hot water to the top of metal spoon by conduction.

18 A solid object with a mass of 5.0 kg is heated from 30 °C to 40 °C. The heat capacity of the object is 500 J K^{-1}. Which expression gives the amount of thermal energy required to raise the temperature of this object?

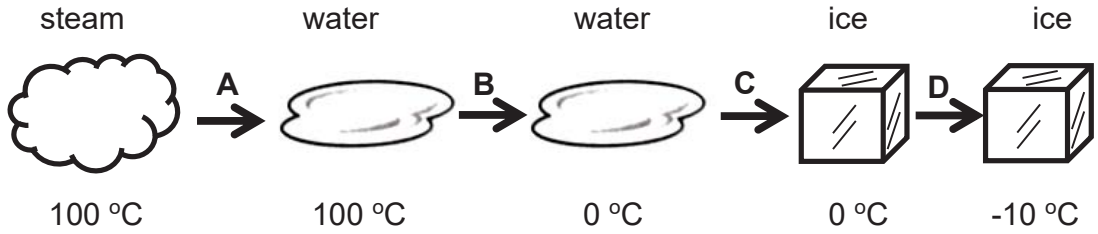
A 500 x 10

B 5.0 x 500 x 10

C 500 x (273 + 10)

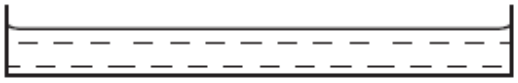
D 5.0 x 500 x (273 + 10)

19 The diagram shows the change of state of matter for 1 kg of steam into ice.



Which stage **A**, **B**, **C** or **D** involves the specific latent heat of vaporisation?

20 A student is investigating the rate of evaporation of water.



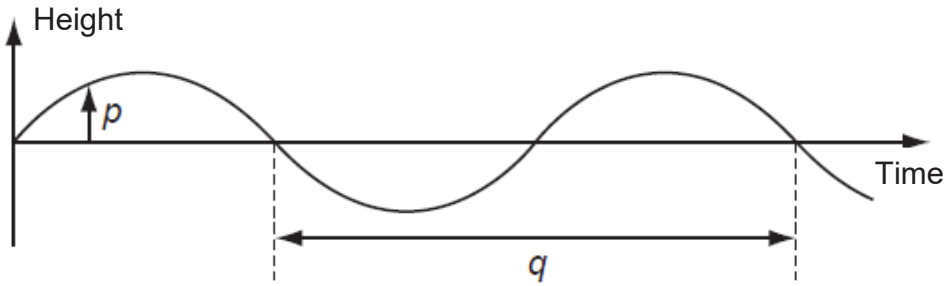
The student can change the following:

1. the depth of the water;
2. the atmospheric pressure;
3. the temperature of the water.

How many of these changes, if any, would alter the rate at which evaporation occurs?

A 0 **B** 1 **C** 2 **D** 3

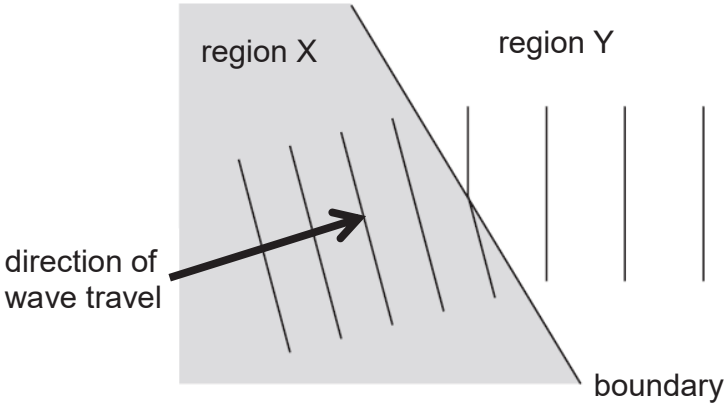
21 The graph shows how the height of a water surface at a point in a harbour varies with time as waves pass the point.



What are *p* and *q*?

	p	*q*
A	displacement	period
B	displacement	wavelength
C	amplitude	period
D	amplitude	wavelength

22 A ripple tank is used to demonstrate refraction of plane water waves.



Which statement is true?

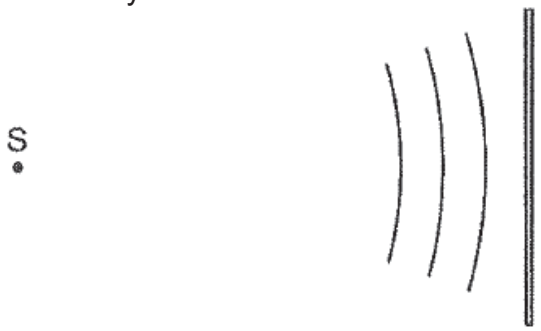
A Region X is deeper than region Y and the direction of wave travel bends towards the normal at the boundary.

B Region X is deeper than region Y and the direction of wave travel bends away from the normal at the boundary.

C Region X is shallower than region Y and the direction of wave travel bends towards the normal at the boundary.

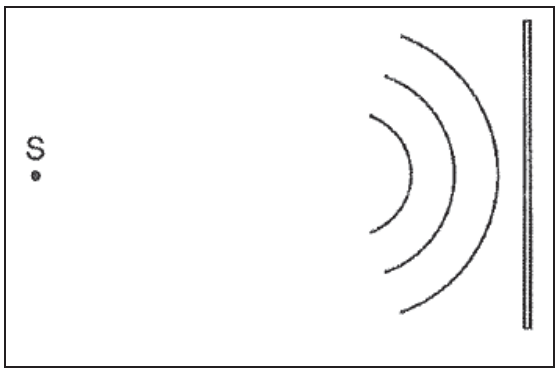
D Region X is shallower than region Y and the direction of wave travel bends away from the normal at the boundary.

23 The diagram represents circular wavefronts coming from point S. The wavefronts are about to strike a solid boundary.

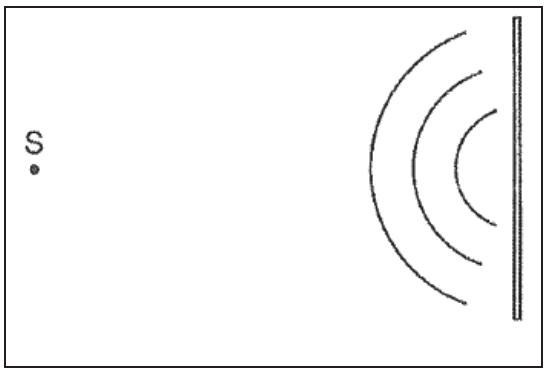


Which diagram correctly shows the reflected wavefronts?

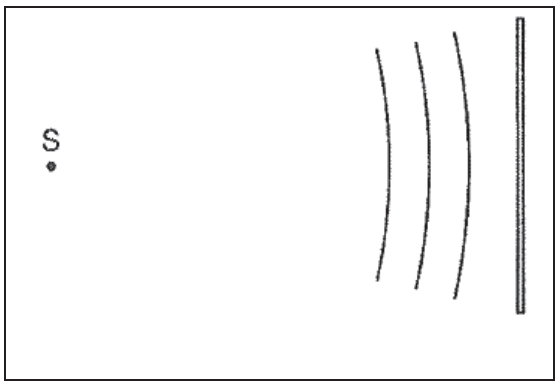
A



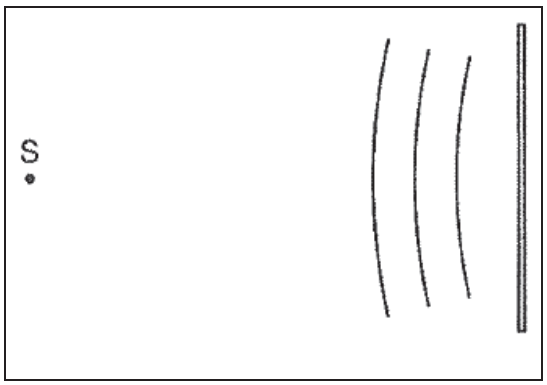
B



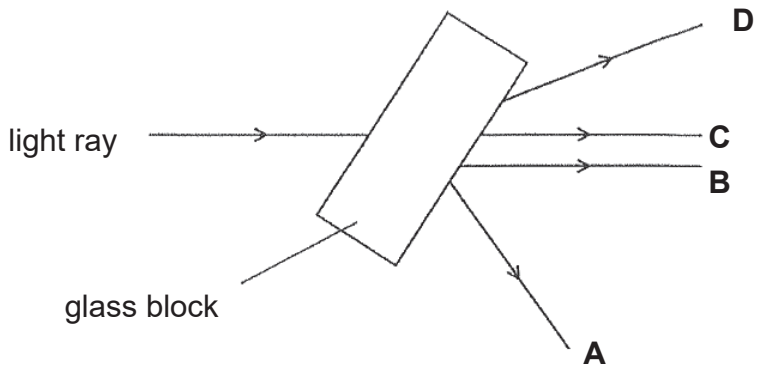
C



D



24 Which line shows the path of light ray after it passes through the glass block?



25 Which coloured light, red or violet, has a higher frequency and which one has a longer wavelength?

	Higher frequency	Longer wavelength
A	violet	violet
B	violet	red
C	red	violet
D	red	red

26 The diagram shows a contactless payment system which involves the consumers tapping their credit cards or debit cards on the card reader to make their payment. In the process, a particular electromagnetic wave will be sent between the card and the card reader.

What is likely to be this electromagnetic wave?

A Radio wave

B Ultrasound

C Ultra-violet radiation

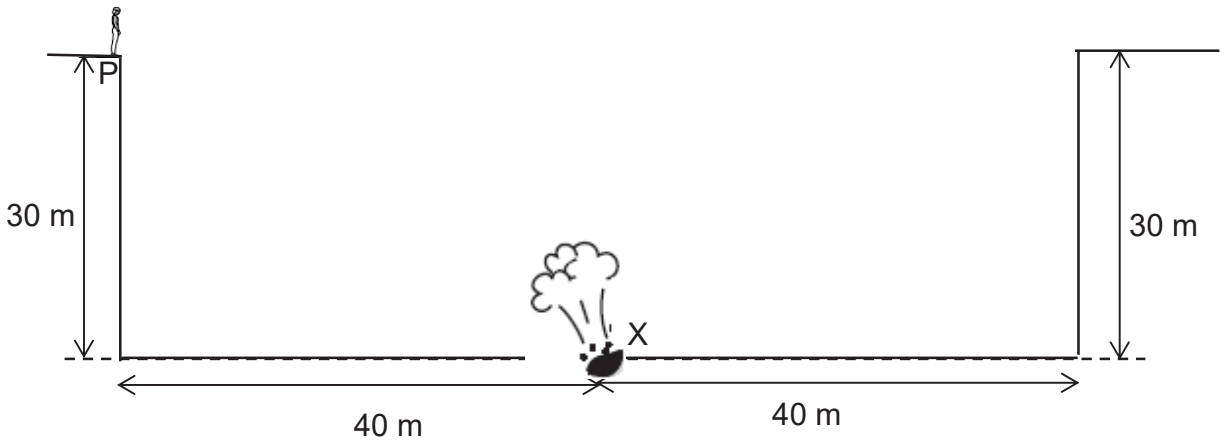
D X-ray

27 A person strikes a tuning fork near a wall.

What will happen to the frequency and speed of the sound as it travels from air and through the wall?

	Frequency	Speed of Sound
A	increases	increases
B	decreases	decreases
C	unchanged	decreases
D	unchanged	increases

28 The diagram shows an engineer standing at P overlooking an explosion at X.

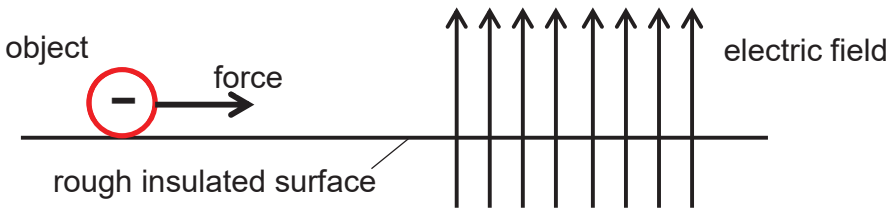


After the explosion, she hears two bangs. The speed of sound in the air is 300 m s^{-1}.

What is the time lapse between the two bangs?

A 0.12 s **B** 0.17 s **C** 0.25 s **D** 0.34 s

29 The diagram shows a negatively charged object subjected to a constant pulling force and is moving to the right on a rough insulated surface at a uniform speed before entering a uniform electric field. The electric force exerted on the charged object due to the electric field is greater than the weight of the charged object.



Which statement describes the motion of the charge in the electric field?

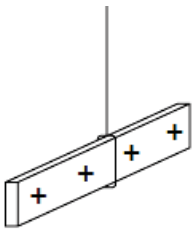
A The object will decelerate along the rough surface.

B The object will accelerate along the rough surface.

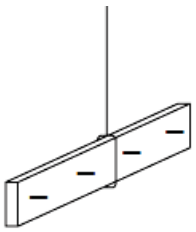
C The object will move along a curved path towards the top of paper.

D The object will move in the direction that is perpendicular to the plane of this paper.

30 The diagram shows a positively charged acetate strip and a negatively charged polythene strip that are freely suspended.



acetate strip



polythene strip

When an object is brought either to the acetate strip or polythene strip, the strip moves towards the object.

What is the state of charge of the object?

A Neutrally charged

B Positively charged

C Negatively charged

D Cannot be determined

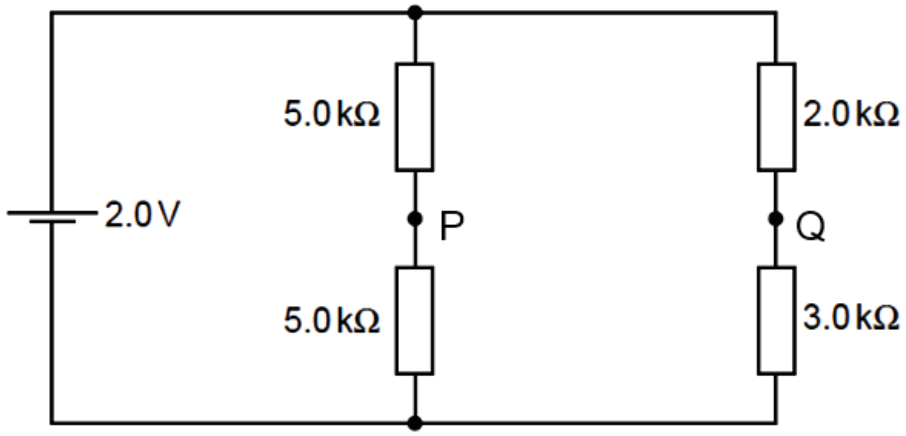
31 The diagram shows an electroshock gun that law enforcement officers use to immobilise a person. The gun delivers electric current to a person and disrupts voluntary control of muscles in the person.

During a single activation that last for 5.0 s, the electroshock gun can deliver a charge of 100 mC with an average voltage of 350 V to the person.

What is the electrical energy transferred to the person?

A 7 J **B** 35 J **C** 7000 J **D** 35 000 J

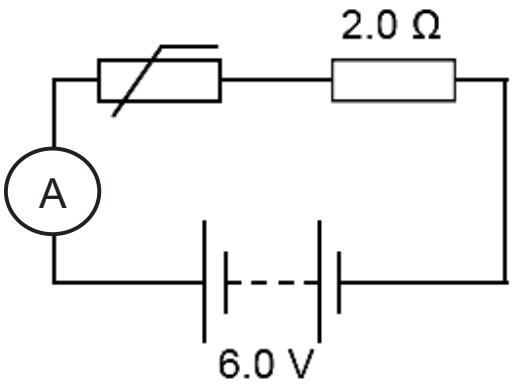
32 A cell of e.m.f. 2.0 V is connected to a network of resistors shown.



What is the potential difference across P and Q?

A 0.2 V **B** 0.5 V **C** 0.8 V **D** 1.0 V

33 The diagram shows a 6.0 V battery connected to a transducer and a fixed resistor.



The following information is provided:

Transducer	Range of Resistance / Ω
Light dependent resistor	4.0 to 10.0
Thermistor	3.0 to 7.0

What is the reading of the ammeter when the transducer is exposed to high temperature?

A 0.50 A **B** 0.67 A **C** 1.0 A **D** 1.2 A

34 What will happen to a bar magnet if it is dropped too often?

A The poles of the magnet will switch position.

B Both ends of the magnet will have the same pole.

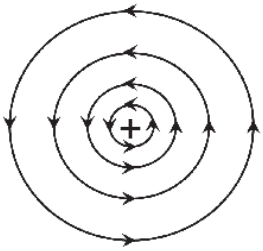
C The strength of the magnet will increase.

D The strength of the magnet will decrease.

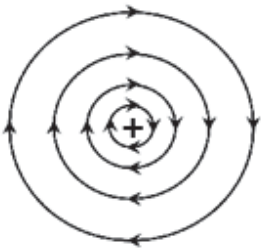
35 A positive charge is moving into the plane of this paper.

Which diagram shows the magnetic field produced by the positive charge when viewed from the top of this paper?

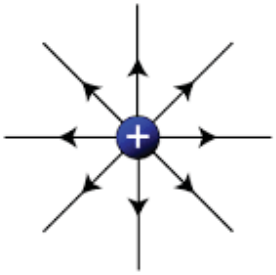
A



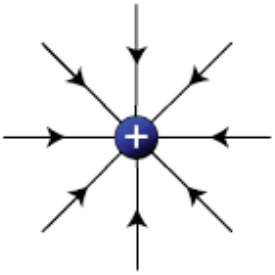
B



C



D



36 What is the purpose of the split-ring commutator in a motor?

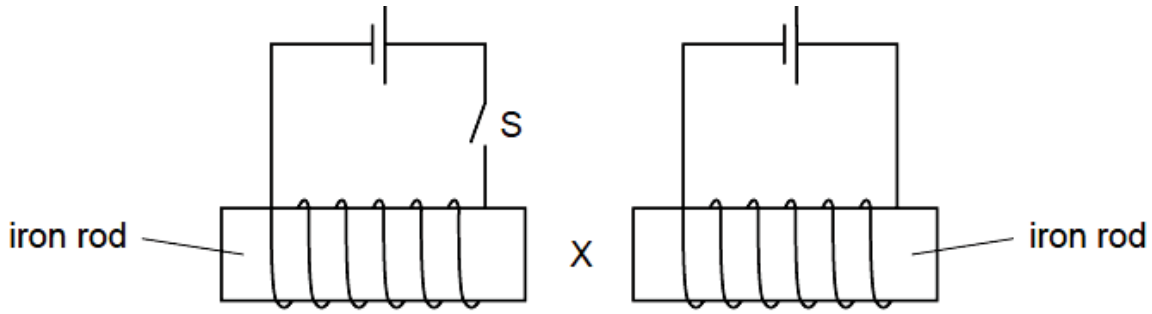
A To ensure that the current produced is a direct current.

B To ensure that the current produced is an alternating current.

C To ensure that the forces acting on the coil will always rotate the coil in the same direction.

D To ensure that there is continuous electrical contact between the coil and the external circuit at all times.

37 Two circuits are set up as shown. The iron rods are placed close together, and are free to move.



What happens to the size of the gap at X when switch S is closed?

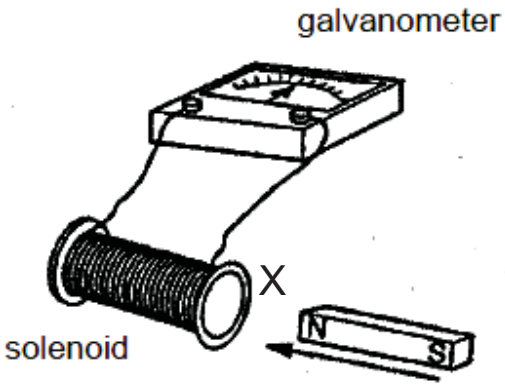
A It decreases.

B It decreases and then increases.

C It increases.

D It does not change.

38 The North pole of a bar magnet is pushed into a solenoid via end X, as shown in the diagram. An electromotive force is induced which moves the galvanometer needle to the left.



Which action, using the same end of the solenoid, would produce the same deflection in the galvanometer?

A Pulling a North pole out of the solenoid via end X

B Pushing a South pole out of the solenoid via end X

C Pulling the solenoid away from a North pole

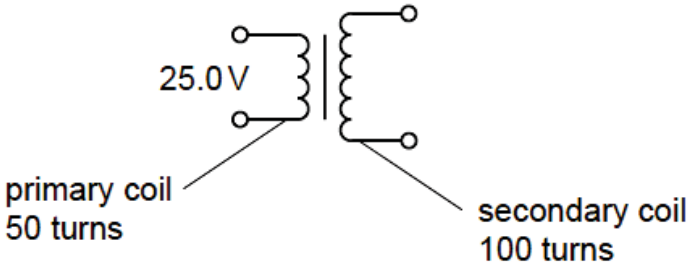
D Pulling the solenoid away from a South pole

39 An a.c generator is able to produce a peak voltage of V when the coil is rotated with a frequency of F.

What will be the new peak voltage if the number of turns of the coil is now three times as before and the coil is rotated with a frequency of $2F$?

A $3V$ **B** $5V$ **C** $6V$ **D** $8V$

40 A transformer has 50 turns on its primary coil and 100 turns on its secondary coil. An alternating voltage of 25.0 V is connected across the primary coil.



What is the voltage across the secondary coil?

A 12.5 V **B** 50 V **C** 175 V **D** 200 V

—— END OF PAPER ——

Class | Register No.

Candidate Name ……..

TANJONG KATONG GIRLS' SCHOOL
PRELIMINARY EXAMINATION 2019
SECONDARY FOUR

6091/02 **PHYSICS**
Paper 2

MONDAY **2 SEP 2019** **1 hour 45 minutes**

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, class and register number in the spaces at the top of this page and on any separate answer paper used.

Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Take gravitational field strength to be 10 N/kg, unless specified in the question.

Section A
Answer **all** questions. Write your answers in the spaces provided on the Question Paper.

Section B
Answer **all** questions. Question 11 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.

The use of an approved scientific calculator is expected, where appropriate.

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

Setter : Mr Koh Meng Hong

This question paper consists of 22 printed pages including this cover page.

SECTION A [50 marks]

Answer **ALL** questions from this section.

For Examiner's Use

1 Fig 1.1 shows a hot-air balloon rising with a constant velocity of 15 m s^{-1}. A sandbag was dropped by the pilot at time t = 0 s. Air resistance acting on the sandbag is considered to be negligible.

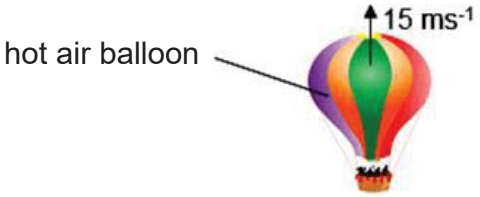


Fig 1.1

(a) A person at ground level observed that the sandbag was moving up with an initial velocity of 15 m s^{-1} at the time of drop. Explain this observation.

……

……[1]

(b) Sketch the velocity-time graph of the sandbag for the first 3.0 s. [2]

(c) Calculate the distance travelled by the sandbag between time t = 0 s and when it reaches its highest point.

Distance travelled = ……[1]

(d) Determine the distance between the sandbag and the hot air balloon at time t = 3.0 s. Show your workings clearly.

Distance = ……[2]

For Examiner's Use

2 Fig 2.1 shows a side view of a windmill.

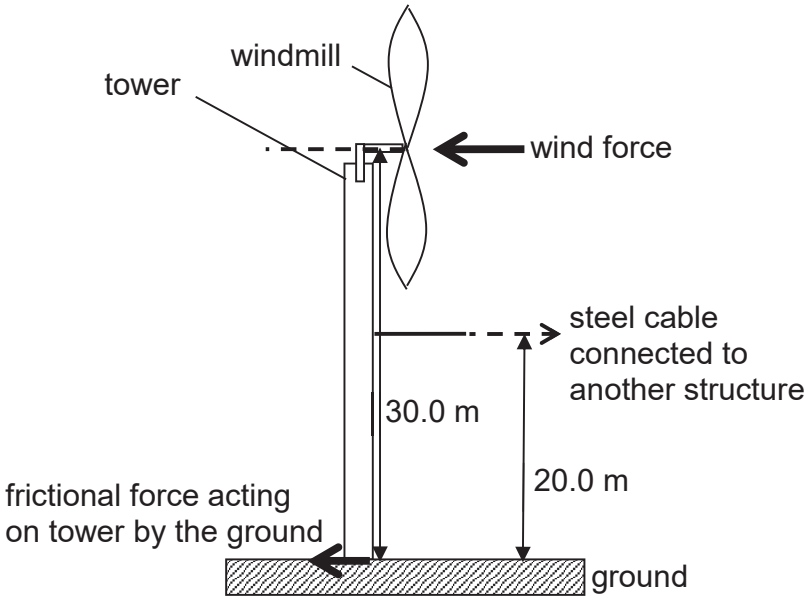


Fig 2.1

The windmill stands on a tower whose base is anchored into the ground. The centre of the windmill is 30.0 m from the ground. The tower is held in place and connected to another structure (not shown in the diagram) via a horizontal steel cable. The steel cable is 20.0 m from the ground. The position of the combined centre of mass of the tower and the windmill is within the tower.

(a) State *the principle* of *moments*.

.....

.....

.....[1]

(b) It can be modelled that the wind force acts through the centre of the windmill. When a wind force of 2000 N is acting horizontally on the windmill, the windmill and the tower remains in equilibrium.

Calculate the magnitude of the frictional force acting on the tower by the ground.

Magnitude of frictional force = ……[2]

(c) The combined weight of the tower and the windmill is 5000 N. The frictional force acting on the tower by the ground is 3000 N. Using a scaled diagram, determine the magnitude and the direction of resultant force acting on the tower by the ground.

For Examiner's Use

Magnitude = ……

Direction = ……

[3]

For Examiner's Use

3 In the movie *Spiderman*, Spiderman attempted to use two flexible flag poles to shoot himself into the sky as if like a catapult. Fig 3.1 shows the set-up which Spiderman attaches his web to the top of the flag poles. He then moves backwards to his final position (as shown in Fig 3.2) just before shooting up into the sky.

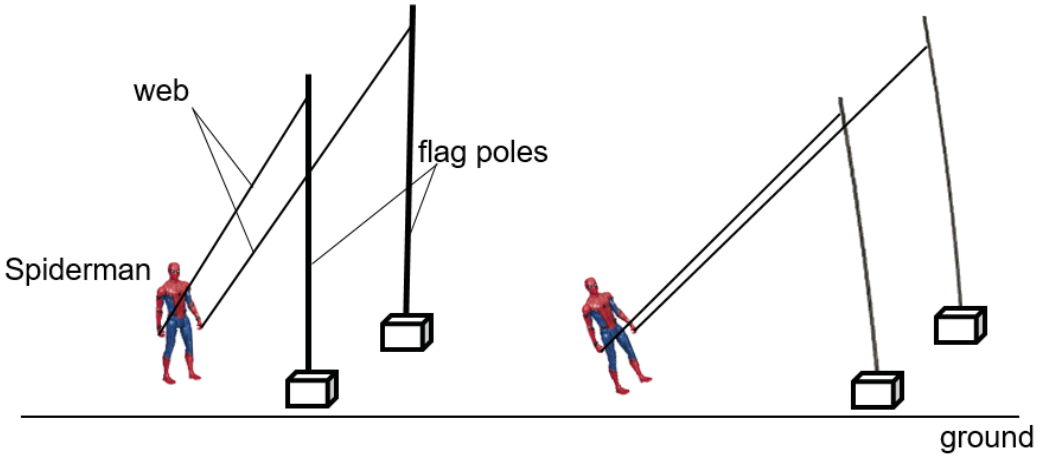


Fig 3.1 Fig 3.2

(a) Describe the energy changes that have occurred when Spiderman moves backward from his original to his final position as shown in Fig 3.1 and Fig 3.2 respectively. Assume the web is not stretchable.

.....

.....

.....

.....

.....

.....[3]

(b) The mass of Spiderman is 65.0 kg. When he released his foot grip from the ground, he shot up to the sky with an initial speed of 40.0 m s^{-1}. When he is at his highest point, he had a speed of 15.0 m s^{-1}. The work done against air resistance during this journey is 5000 J.

(i) Determine the loss in kinetic energy from the time he leaves the ground to the time he reaches the highest point.

Loss in kinetic energy = ……[2]

For Examiner's Use

(ii) Determine the distance of Spiderman from the ground when Spiderman is at his highest point.

Height = ……[2]

4 (a) Fig 4.1 shows a plastic container with a lid cover. A lid tightener is used to control the movement of the base of the lid. As a person flips down the lid tightener, the base of the lid moves up and increases the volume of air in the container. The container is air tight and it becomes difficult to remove the lid cover.

Fig 4.1

(i) Using the kinetic model of matter, explain why the air pressure in the container decreases as the base of the lid moves up.

.....

.....

.....

.....

.....

.....

.....[2]

For Examiner's Use

(ii) Explain in terms of pressure, why it is difficult to remove the lid cover when the base of the lid moves up.

.....

.....

.....[1]

(b) Fig 4.2 shows a hydraulic press that is used to lift up the body of the car during the replacement of a car tyre. A force of 30 N is exerted on piston A.

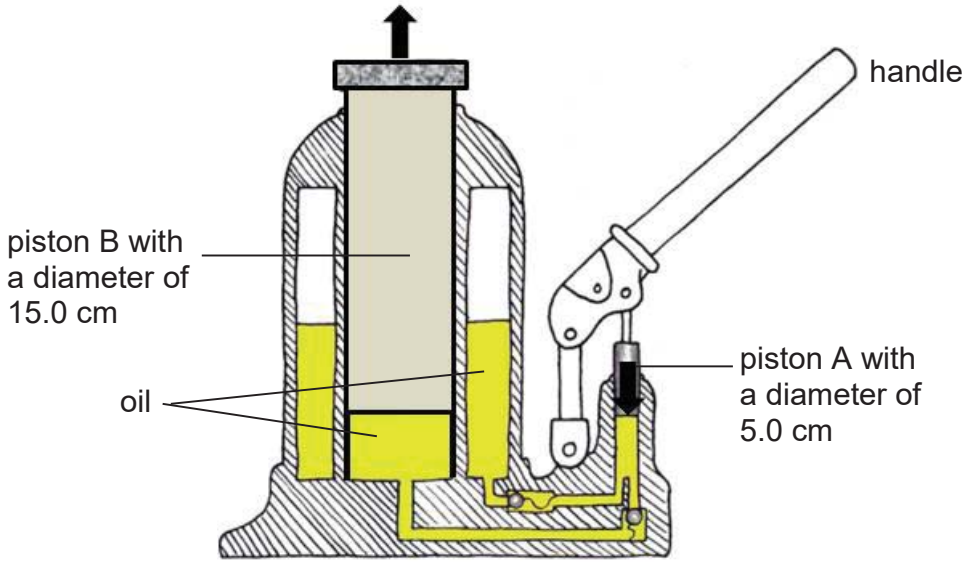


Fig 4.2

(i) Using the idea of molecules, explain why a liquid, such as oil, is used in the hydraulic press.

……

……[1]

(ii) Calculate the force exerted on piston B.

Force = ……[2]

For Examiner's Use

5 Fig 5.1 shows a light dependent resistor (LDR) connected to a circuit. Fig 5.2 shows the relationship between the potential difference V across and the current I flowing through the LDR.

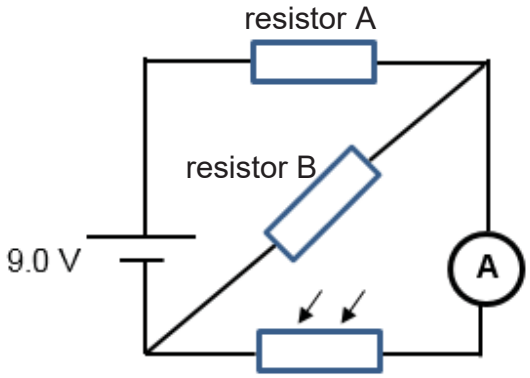


Fig 5.1

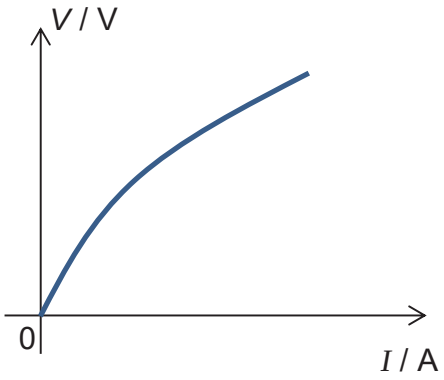


Fig 5.2

(a) Describe how the resistance of the LDR changes with light intensity.

……...

……...[1]

(b) Explain how the graph in Fig 5.2 shows that the LDR is a non-ohmic conductor.

……...

……...

……...[1]

(c) The resistances of resistor A and B are 1000 Ω and 3000 Ω respectively. When the resistance of the LDR is 2000 Ω,

determine, by showing detailed workings,

(i) the effective resistance of resistor B and LDR.

Effective resistance = ……[2]

(ii) the potential difference across resistor A.

For Examiner's Use

Potential difference = ……[2]

(iii) the current through the LDR.

Current = ……[2]

For Examiner's Use

6 A 2.4 kW water heater is connected to a 240 V main supply.

(a) Calculate the current in the heating element of the water heater when it is working normally.

Current = ……[2]

(b) The water heater is protected by a 13 A fuse.

Explain how the fuse works.

……...

……..

……...

……..

……..[2]

(c) The water heater has double insulation. Explain whether it is necessary for the water heater to have an earth wire connected to the casing.

……...

……..

……...

……..

……..

……..[2]

For Examiner's Use

7 Fig 7.1 shows the use of an electromagnetic relay switch to switch on another secondary circuit that is connected to a high voltage power supply.

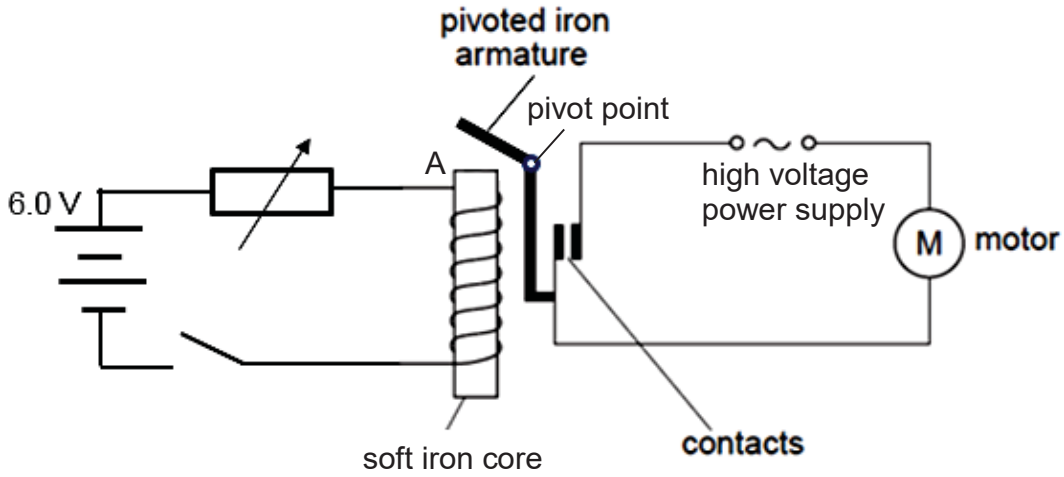


Fig 7.1

(a) Explain how, by adjusting the resistance of a variable resistor, the motor in the secondary circuit can be switched on.

……

……

……

……

……

……[2]

(b) State the pole at end A of the soft iron core when current is flowing through the coil.

……[1]

For Examiner's Use

(c) Fig 7.2 shows a simplified diagram of the motor which is connected to the high voltage supply. Points P and Q are two corners of a copper coil.

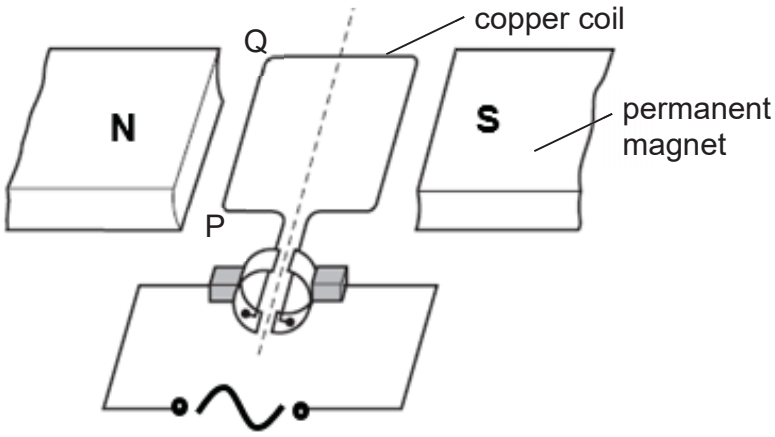


Fig 7.2

(i) Name one electrical device that can be included into the circuit to ensure that the coil in the motor will only turn in one direction.

……...[1]

(ii) At a particular instant, the magnetic force acting on the wire between points P and Q is in the upward direction. Using the idea of magnetic fields, explain why this is so.

……

……..

……..

……..

……..

……[2]

For Examiner's User

8 Fig 8.1 shows a set-up with two coils of wire wound around a soft iron core.

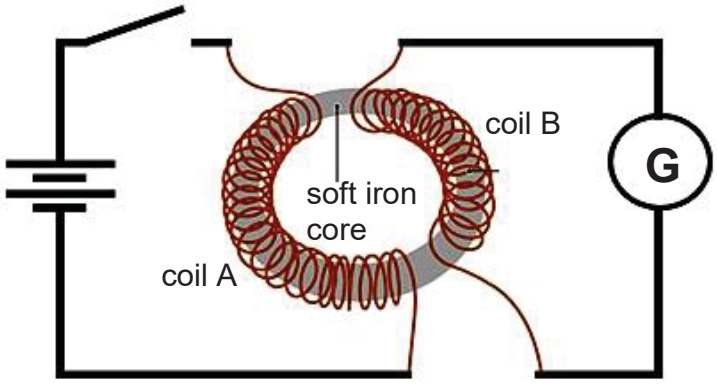


Fig 8.1

(a) State *Faraday's law of electromagnetic induction*.

……...

……..

……..[1]

(b) Explain why the galvanometer shows a deflection when the switch is just closed.

……...

……..

……..

……..

……..[2]

(c) Suggest one change to be made to the set-up if

(i) the galvanometer is to have a continuous deflection at all times.

……...[1]

(ii) the galvanometer is to show a larger deflection with the same power input.

……...[1]

Section B [30 marks]

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

For Examiner's Use

9 I-Fly is an indoor skydiving facility which uses high air speeds to keep a person floating in the air. Fig 9.1 shows a simplified setup of how high air speeds are projected onto the person (flyer). Air is drawn into the chamber using the wind blade. The shape of the chamber allows air to move upward at high speed. The speed of the air is regulated by the speed of the wind blade.

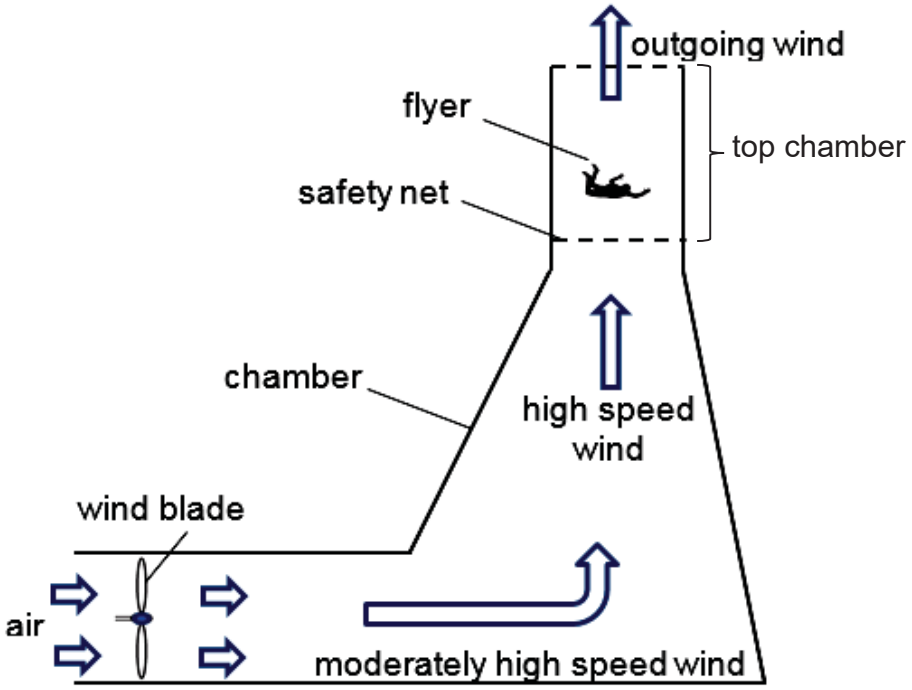


Fig 9.1

Fig 9.2 shows the power of the wind blade and the average wind force acting on a person.

Average Wind Force / N	200	400	640	800	900
Power of Wind Blade / MW	2.0	3.0	4.0	5.0	8.0

Fig 9.2

For Examiner's User

(a) State *Newton's 1st Law of Motion*.

.....

.....[1]

(b) Draw the free body diagram acting on the flyer when he is floating in the air. Label and name all the forces. [2]

(c) Using the data shown in the Fig 9.2, plot a graph of the average wind force acting on the flyer against the power of the wind blade in Fig 9.3 . [2]

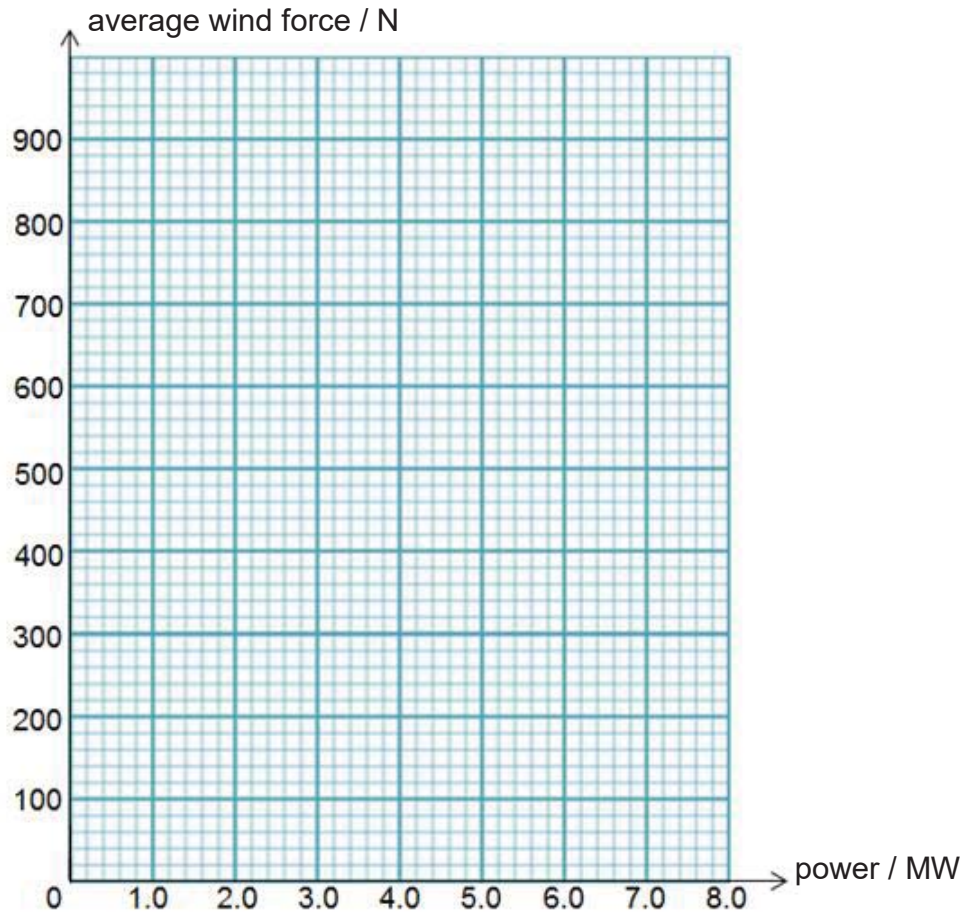


Fig 9.3

For Examiner's User

(d) A person with a mass of 75 kg has signed up to be a flyer.

(i) State the weight of the person.

Weight = ……[1]

(ii) Using the plotted graph in Fig 9.3, determine the minimum power of the wind blade required to keep the person floating in the air.

Minimum power = ……[1]

(iii) The power of the wind blade is adjusted to 5.0 MW. Using the data in Fig 9.2, calculate the initial acceleration of the person.

Acceleration = ……[2]

(e) Explain why it is important to have a safety net installed at the base of the top chamber.

.....

.....[1]

For Examiner's Use

10 (a) Fig 10.1 shows a light ray travelling from diamond to medium X. The diamond has a refractive index of 2.4.

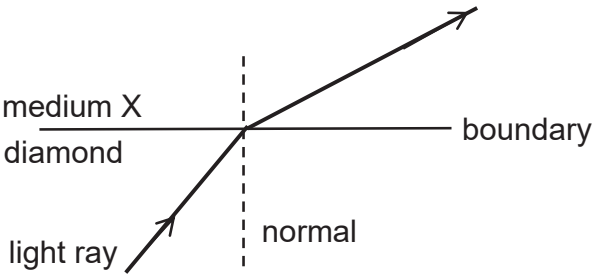


Fig 10.1

(i) Compare the refractive index of medium X to that of the diamond. Use Fig 10.1 to explain how you reach the answer.

……..

……..

……..

……..[2]

(ii) If medium X is glass, the critical angle is found to be 39°.

1. State what is meant by critical angle.

……

……..[1]

2. A light ray strikes the boundary with an angle of incidence 42°. State and explain what will happen to this light ray.

……

……

……

……..[2]

3. If medium X is water which is optically less dense than glass, state, if any, the changes to the critical angle.

……..[1]

For Examiner's Use

(b) Fig 10.2 shows a slanted lens with a focal length of 2.0 cm. The height of the object is 1.5 cm. The intersection point between the horizontal line and the lens is the optical centre of the lens. The diagram is drawn to scale.

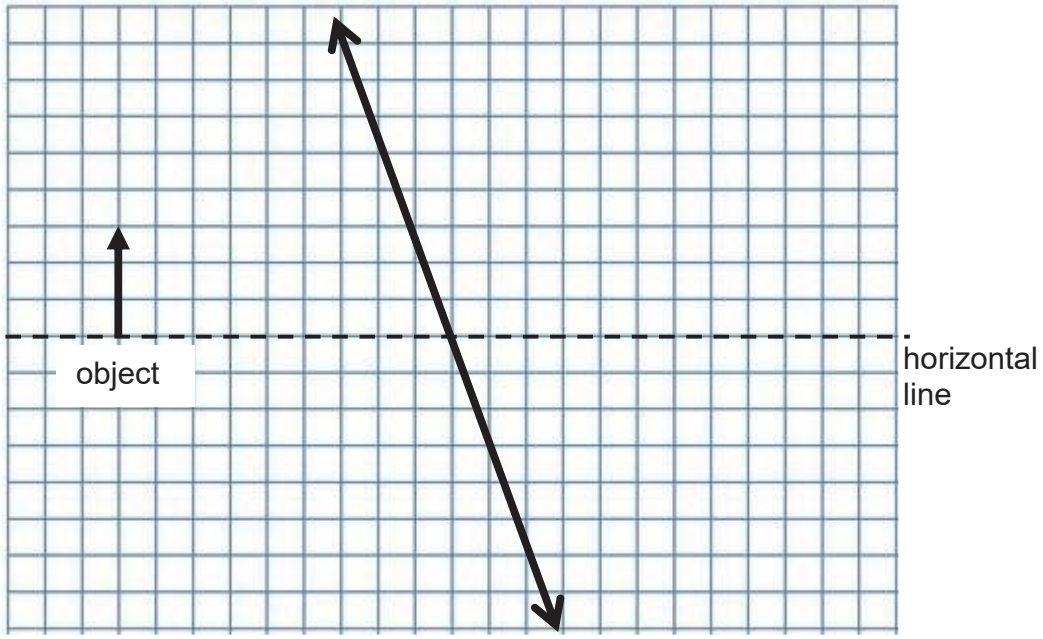


Fig 10.2

(i) Define *principal axis*.

……..

……..

……..…[1]

(ii) In Fig 10.2,

1. sketch the principal axis and label the principal focal points of the lens as f_1 and f_2.

[1]

2. sketch two rays from the tip of the object to locate the image of the tip of the object. Mark this point with "X". [2]

Either

11 Fig 11.1 shows a car equipped with a reverse parking sensor at the car's back bumper.

For Examiner's Use

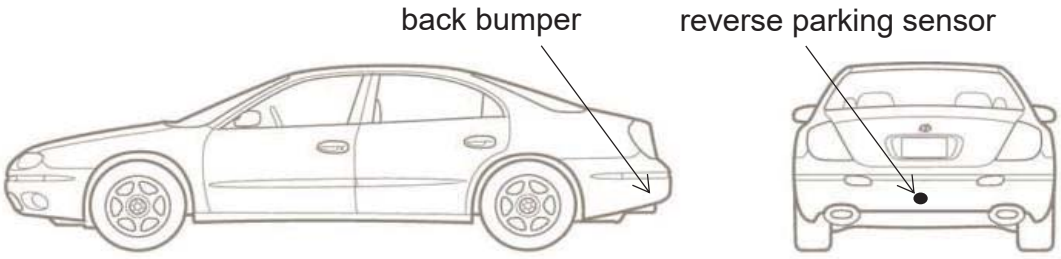


Fig 11.1

The reverse parking sensor uses ultrasound to measure the distance between the car's bumper and nearby objects. The sensor is connected to a sound buzzing system which will provide beep sounds in the car to alert the driver of the obstacles while parking the car.

(a) Define *ultrasound*.

……..

…….[1]

(b) Fig 11.2 shows a screen displaying the signal of one set of pulses picked up by the reverse parking sensor.

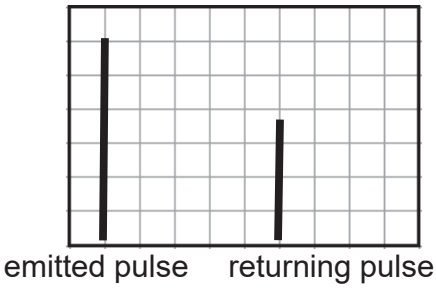


Fig 11.2

The time interval between the two pulses is 800 μs. The ultrasound has a frequency of 25 kHz and the speed of ultrasound is 330 m s^{-1}.

(i) Using the idea about the molecular motion in air, describe what is meant by "a frequency of 25 kHz".

……...

……...[1]

For Examiner's Use

(ii) Calculate the distance (in cm) between the back bumper and the obstacle.

Distance = ……cm [2]

(iii) On Fig 11.2, sketch the returning pulse for the same emitting pulse if the distance between the back bumper and the obstacle is smaller than the value calculated in part **(b)(ii).** [1]

(c) Sound wave comprises regions of compression and rarefaction.

(i) Explain, in terms of pressure, the meaning of region of rarefaction.

……...

……...[1]

(ii) In Fig 11.3, line X represents the position of the air molecules in a sound wave at a particular instant. The sound wave is travelling to the right.

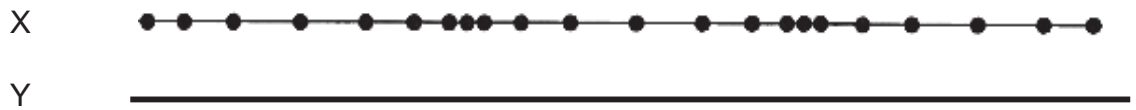


Fig 11.3

1. In Fig 11.3, mark a distance equal to the wavelength of the sound wave on line X. [1]

2. In Fig 11.3, mark the position of the centre of all compressions after another 1½ period on line Y. [1]

3. Describe how you obtained your answer in part **2.**

……..……..…

……..……..…

……..……..…

……..……..

……..……[2]

Or

For Examiner's Use

11 (a) Fig 11.1 shows a simplified diagram of a power station that involves the combustion of natural gas to generate electricity. Water is directed into combustion chamber via a pipe.

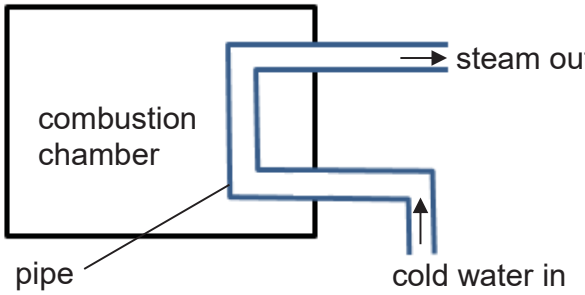


Fig 11.1

(i) Suggest an appropriate material for the pipe. Explain your answer.

……...

……..[1]

(ii) "Using natural gas to generate electricity is an environmentally friendly method".

Do you agree with this statement? Justify your answer.

……...

……..[1]

(iii) In 1.0 minute, 2.0 kg of water at 30^{o}C is converted to steam at 100^{o}C. The specific heat capacity of the water and the specific heat latent heat of vaporisation are 4200 J kg^{-1} ^{o}C^{-1} and 2.1 MJ kg^{-1} respectively.

1. Calculate the amount of thermal energy required to change 2.0 kg of water at 30^{o}C to steam in 1.0 minute.

Leave your answer to the appropriate number of significant figures.

Amount of thermal energy = ……[3]

2. The efficiency of the system is 80%.

For Examiner's Use

Calculate the power input.

Power input = ……[2]

(b) Nuclear energy is considered as a good source of energy to generate electricity, however, the gamma radiation produced is extremely dangerous.

(i) Explain why some countries continue to use nuclear energy to generate electricity despite the danger.

……...

……..[1]

(ii) Gamma radiation belongs to a family of waves. Name this family.

……..[1]

(iii) Suggest why gamma radiation is extremely dangerous.

……...

……...

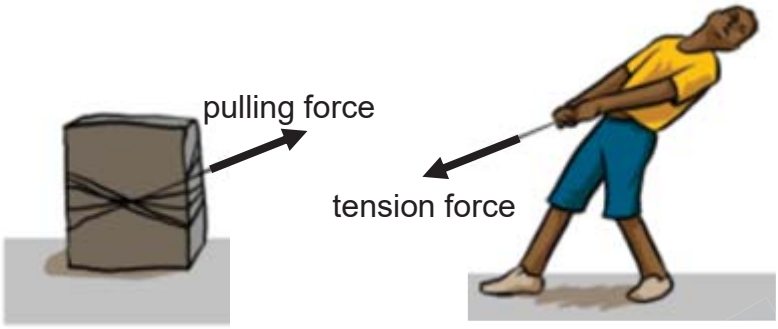
……..[1]

—— END OF PAPER ——

Solution to Sec 4 Physics Prelim Exam 2019 Paper 1

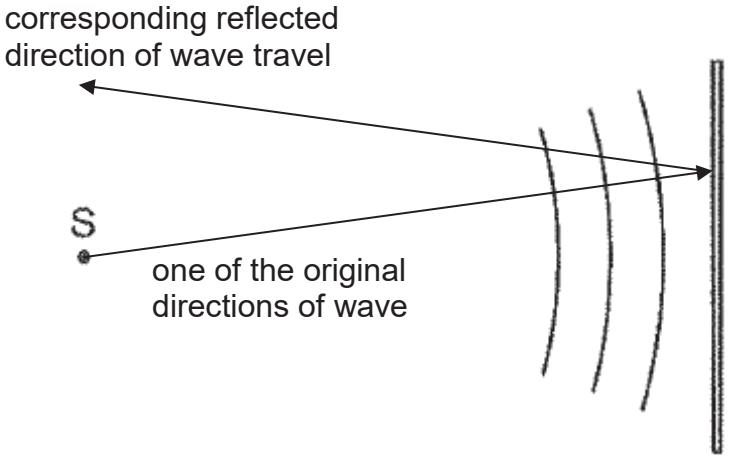
1	**C**	6	**C**	11	**D**	16	**A**	21	**A**	26	**A**	31	**B**	36	**C**
2	**A**	7	**D**	12	**C**	17	**D**	22	**D**	27	**D**	32	**A**	37	**A**
3	**A**	8	**B**	13	**A**	18	**A**	23	**D**	28	**C**	33	**D**	38	**D**
4	**D**	9	**C**	14	**B**	19	**A**	24	**B**	29	**A**	34	**D**	39	**C**
5	**B**	10	**A**	15	**C**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

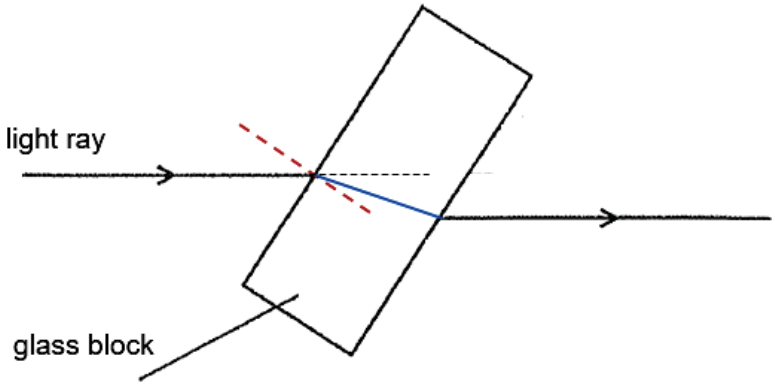
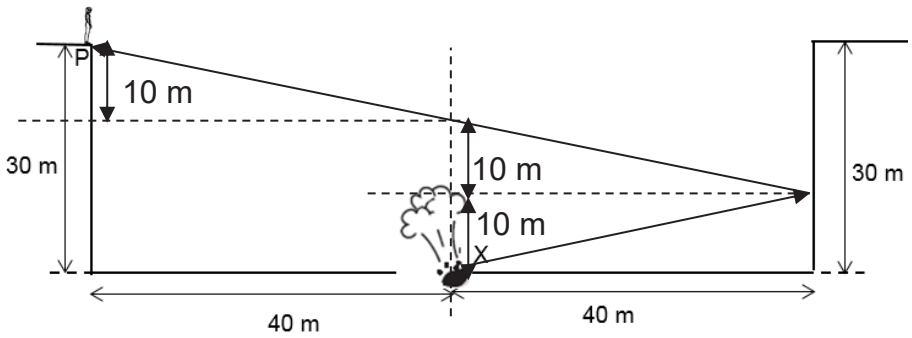
Qn	Solution	Ans
1	Thickness of a fingernail is approximately 1 mm. Note: A student can use his existing ruler to estimate that the fingernail must be around 1 mm.	**C**
2	To measure a length of several metres, the measuring instrument will have to be measuring tape. Other measuring instruments can only measure up to 1 m. To determine the volume of the pipe, both external and internal diameter of the pipe is needed. Thus, the best measuring instrument will be vernier caliper. Laboratory micrometer screw gauge can only up to 25.0 mm and only for external diameter.	**A**
3	Maximum resultant force occurs when all the three forces are in the same direction and the value is 3+4+8+15 N. Thus, option D is possible resultant force. By elimination, option A will be the not be a possible value of the resultant force. Note: We can always pair up two forces and determine the maximum and minimum value. Thus, if we pair up 3 N and 4 N forces, their resultant force will be in the range of 1 N to 7 N. When this resultant force is combined with 8 N force, then the total resultant force will be in the range of 1 N and 15 N.	**A**
4	When the car is accelerating, this means that the speed of the car is increasing. This implies that the distance travelled by the car per unit time (in this case, for every one second interval) should be increasing. Note: For option D, the distance travelled in the 1st second (from t=0 s to t =1 s) = 80 m the distance travelled in the 2nd second (from t=1s to t=2 s) = 110 m	**D**

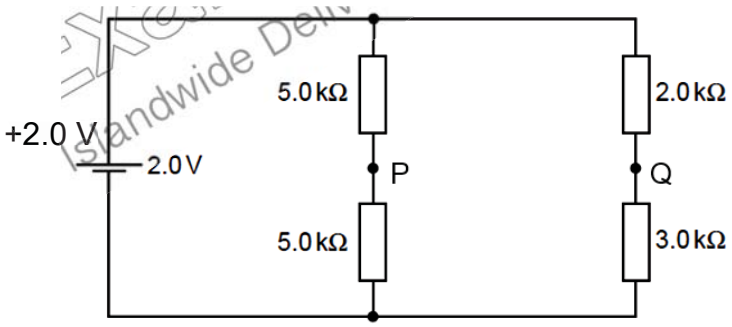
5	Action-reaction forces must be acting on mutually opposite bodies and cannot be on the same body. For option A, the pulling force on the block is due to the rope. The tension (always acting away from the body of interest) experienced by the rope is due to the block. See free body diagram below illustrating the two forces  	**B**
6	Acceleration of the car (through the journey) = rate of change in velocity = 10/2.0 = 5.0 m s^{-2} Using Newton's 2nd Law, Resultant force, F_{net} = m x a = 1000 x 5.0 = 5000 N	**C**
7	The question is focus on the effect of gravitational field strength on mass and weight. Mass of a body will be constant and hence with the same amount of applied force and hence resultant force acting on the block, the acceleration of the block will be constant. Note: Although the period of pendulum T is not dependent on the mass, it is dependent on gravitational field strength g. $T^2 = 4\pi^2 l / g$.	**D**
8	Concept of flotation: Object or liquid of a smaller density will float above the liquid of larger density. Thus, liquid Q must have the smallest density and liquid S must have the largest density. Since liquid R floats on top of object P, density of object P must be larger than liquid R.	**B**

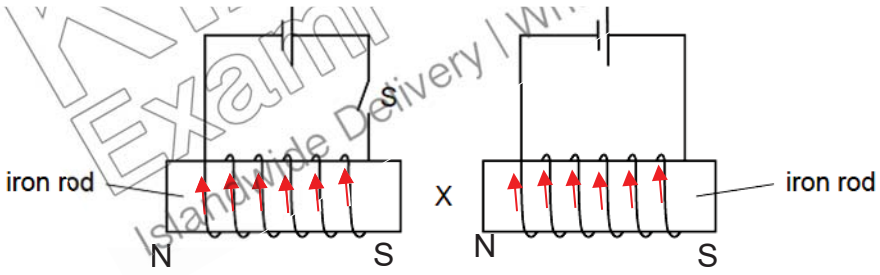
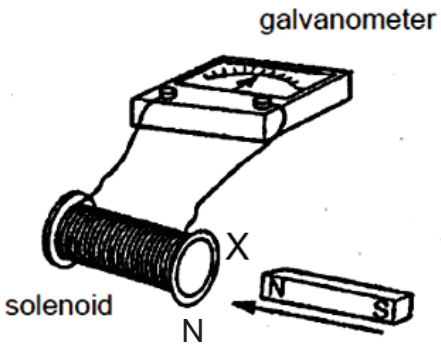
9	Let the length of ladder by l m. By principle of moment, taking moment about point X, anti-clockwise moment due to force F = clockwise moment due to weight of the ladder F x l sin 30° = 500 x ½ l cos 30° F sin 30° = 250 cos 30° F = 433 N Note: (1) Perpendicular distance between line of action of the force F and the pivot point X is l sin 30° (2) Since the c.g of the ladder is at the mid-point of the ladder, perpendicular distance between line of action of the force F and the pivot point X is ½ l cos 30°	**C**
10	As more water is added to the bottom, the combined centre of gravity will be raised as the centre of gravity of the water will be raised. There is no change in the base area. Thus, with a higher centre of gravity, the bottle with water will be less stable as the line of action of the weight of the bottle with water is likely to be outside the base area of the bottle when displaced slightly.	**A**
11	The pin is not moving. Thus, the pin is at equilibrium. The force of the pin is equal on the finger and on the thumb. Since pressure = force / area of contact, and the area of contact between the pin and the thumb is smaller as compared to that at the finger, the pressure of the pin is larger on the thumb.	**D**
12	The pressure of the gas supply = pressure due to a liquid column of 18 cm + atmospheric pressure. The new pressure of the gas supply = pressure due to a liquid column of 20 cm + atmospheric pressure. Thus, the difference in level X and Y = 20 cm Note: Level X will have dropped by 1 cm and level Y have risen by 1 cm.	**C**
13	As air rushes in, the external pressure acting on the marshmallow increases. The resultant pressure hence produces a resultant force acting inward towards the centre of marshmallow. The size of the marshmallow decreases. With a reduction in the size of the marshmallow, the area of contact between the gas particles in the marshmallow and the internal surface of the marshmallow decreases. Pressure in the marshmallow increases.	**A**

14	Fixed points must be easily reproducible and obtainable through any physical processes. Two fixed points are required so that the length of the liquid can be divided into equal intervals. Note: Option C is not entirely correct as the fixed point must be below the boiling point so that the substance remains in liquid state.	**B**
15	The two given temperatures are not 0°C and 100°C. Thus, the temperature formula cannot be used. Using the underlying concept that the change in the thermometric property is directly proportional to the change in the temperature. change in resistance ≡ change in temperature (80 – 20) Ω ≡ 90°C - 10°C 60 Ω ≡ 80°C Using 10°C as the reference temperature, When resistance changes from 20 Ω to 100 Ω, change in resistance = 80 Ω. Corresponding change in temperature = 80 / 60 x 80 = 107 °C Thus, the expected temperature = 107 + 10 = 117 °C	**C**
16	For thermocouple, to have deflection for galvanometer, two conditions must be met: (1) There is a temperature difference between the hot and the cold junctions. (2) The wires connecting at the two junctions must be of different metal.	**A**
17	The focus of the question is the metal spoon which is gaining heat from the hot water which has a higher temperature. Since the spoon is a metal which a good conductor of heat and the spoon is in physical contact with the water, the main process of heat transfer is conduction. Note: The initial temperature of the metal spoon is assumed to be the same as the surrounding air.	**D**
18	In this case, the heat capacity of the object is given, rather than the specific heat capacity. Using $Q = C \Delta\theta$, Amount of heat, Q = 500 x (40 – 30) = 500 x 10	**A**

19	Specific latent heat of vaporisation = amount heat absorbed by 1.0 kg of liquid as it changes from liquid to gas at boiling point = amount of heat absorbed by 1.0 kg of gas as it changes from gas to liquid at condensation point. Boiling point = condensation point.	**A**
20	Rate of evaporation depends on how readiness the liquid molecules at the surface of the liquid is able to leave the liquid, and this depends on whether the liquid molecules have sufficient energy to escape from the surface of the liquid. In this case, atmospheric pressure and temperature of the liquid are the only two factors that affect the rate of evaporation.	**C**
21	In this case, it is noted that *p* is not the maximum height of the water surface at a particular point. Thus, *p* is the displacement of the water. This is the displacement-time graph, and hence the graph only provide the information on period (the time taken for the particle to complete one oscillation).	**A**
22	The wavelength has increased as it travels from regions X to Y. Frequency of wave remains constant (as there is no change in the source). Using $v = f \times \lambda$, this implies that the speed of the wave increases. Thus, region X is shallower and region Y. Using the concept of refraction, the direction of wave travel will bend away from the normal as speed of the wave increases.	**D**
23	Strategy: (1) Sketch a direction of wave travel and use the concept of reflection (2) Wavefronts always perpendicular to the direction of wave travel.  	**D**

24	Light ray bends towards the normal as it travels from optically less dense medium to more dense medium, and vice versa.  	**B**
25	Using infra-red radiation and ultra-violet as reference, red light will have a larger wavelength and smaller frequency than the violet light.	**B**
26	The electromagnetic waves must be safe for usage and hence must not have high ionisation energy (or high frequency). Note: Ultrasound is not an electromagnetic wave.	**A**
27	Due to atoms or molecules are closer to each other in solid as compared to that in the air, the speed of sound is larger in solid than in the air. However, as there is no change in the source, the frequency of the sound remains unchanged.	**D**
28	The first sound heard by the engineer is the sound that travels directly from the source to him. Distance travelled by this sound to reach the engineer $= \sqrt{30^2 + 40^2}$ $= 50$ m The second sound heard by the engineer is the sound that reflected on the vertical wall on the right. Distance travelled by this sound to reach the engineer (See below) $= 3 \times \sqrt{10^2 + 40^2}$ ≈ 124 m  	**C**

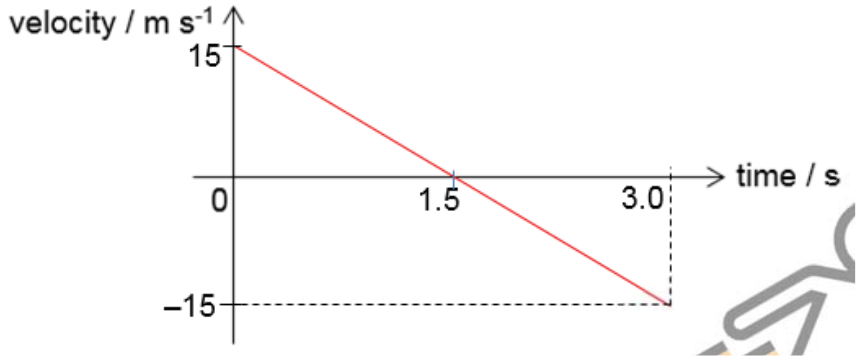
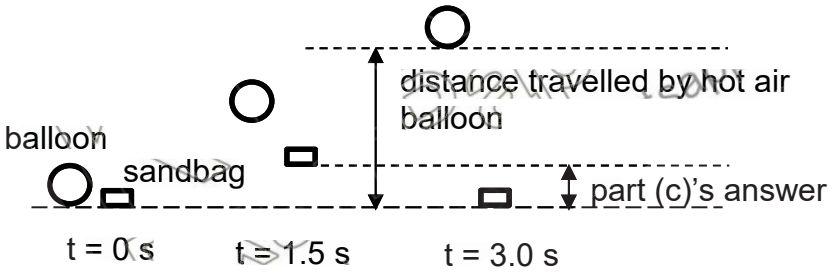
	Time lapse between the two sounds = (124 – 50) / 300 = 0.25 s	
29	Initially, the force applied on the object is equal to the frictional force (since the object is moving with constant speed). When the negative charged object enters the electric field, there will be a downward electric force acting on the object and pressing the object against the rough surface. The frictional force acting on the object will increase. By Newton's 2nd Law, as there is a now resultant force acting on the object opposing the motion. The object will decelerate. Note: The direction of electric field shows the direction of the electric force acting on the positively charged object.	**A**
30	When an object is neutrally charged, induced separation of charges can cause an object to be attracted to a charged object. On the other hand, an object that is oppositely charged can also be attracted to a charged object. Thus, only repulsion can determine the state of charge of an object.	**A**
31	Using definition of electromotive force, $\varepsilon = W / Q$ Amount of electrical energy transferred, W $= \varepsilon \times Q$ $= 350 \times 100 \times 10^{-3}$ $= 35$ J	**B**
32	 Potential at P = 2.0 – potential difference across 5.0 kΩ = 2.0 – 1.0 = 1.0 V Potential at Q = 2.0 – potential difference across 2.0 kΩ $= 2.0 - \frac{2.0}{2.0 + 3.0} \times 2.0$ = 1.2 V Potential difference across P and Q = 1.2 – 1.0 = 0.2 V	**A**

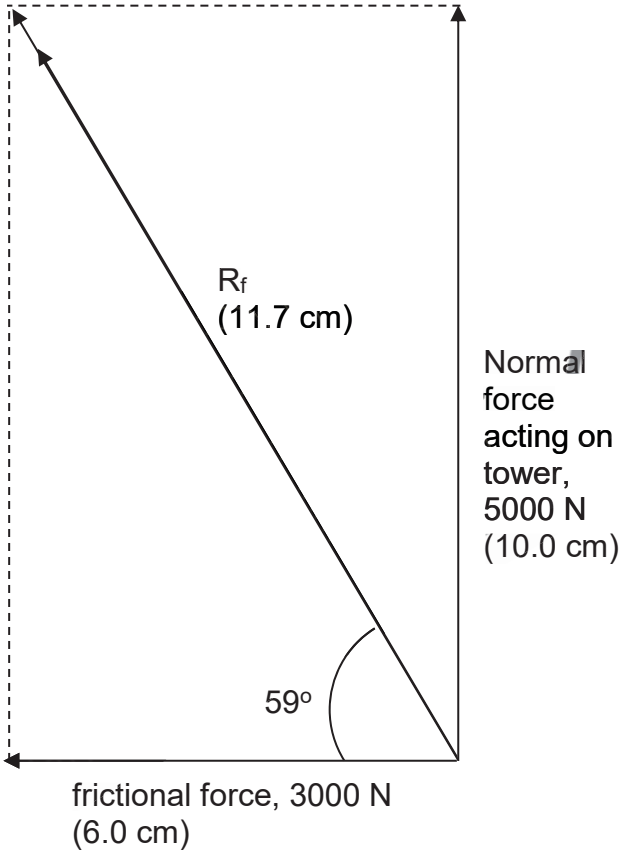
33	The symbol shown is the symbol for thermistor. At high temperature, thermistor will have low resistance. Total effective resistance in the circuit = 3.0 + 2.0 = 5.0 Ω Using R = V / I, ammeter reading = R / V = 6.0 / 5.0 = 1.2 A	**D**
34	This is one of the method to demagnetise a magnet. When the magnet is dropped onto the floor, the energy absorbed by the magnet will disorientate the atomic magnets and hence the atomic magnets will no longer align themselves in the same direction. Thus, the magnet will lose magnetism.	**D**
35	This is a recall question. Flow of positive charge is equivalent to the flow of conventional current and hence the motion of positive charge will create a magnetic field. Using right hand grip rule with the thumb pointing into the paper, the direction of magnetic field will be in clock-wise direction (as given by the fingers).	**B**
36	This is a recall question. The ultimate function of split ring commutator is to ensure the direction of current in the coil is always in the same direction so that the coil will always turn in the same direction at all times. Note: A motor is to convert electrical energy to mechanical energy, rather than producing electrical energy.	**C**
37	Direction of current when switch S is closed:  Both iron rods will be magnetised with opposite polarities as shown above. Since unlike poles attracts, the spacing at X will decrease.	**A**
38	 The induced current in the solenoid will flow such that it can induce a	**D**

	N-pole at X when the magnet moves into the solenoid at X. Thus, to create the same deflection, the cause should be able to create a N-pole at X, that is, pulling a S-pole of the magnet out from X and pulling a solenoid away from a S-pole.	
39	By Faradays' Law of electromagnetic induction, the magnitude of the induced emf is directly proportional to the rate of cutting of magnetic field lines by the conductor. Thus, when the number of coils increases to three times as before, the induced emf will be 3V. When the frequency of rotation is now 2F (twice of the original rate of rotation), the induced emf will be 2 times of 3V, that is 6V.	**C**
40	Using $\frac{N_s}{N_p} = \frac{V_s}{V_p}$, Voltage across secondary coil, V_s = 100 / 50 x 25 = 50 V	**B**

Solution to 2019 Sec 4 Physics Prelim Paper 2

Section A

Qn	Solution	Marking Scheme
1(a)	Due to inertia, the sandbag will have a reluctancy to change its state of motion and will appear to move with an initial velocity of 15 m s^{-1}.	B1
(b)		B1 – straight line with gradient of 10 m s^{-2} B1 – coordinates of all the critical points.
(c)	Distance travelled = area under the v-t graph from t = 0 s to t = 1.5 s = ½ x 15 x 1.5 ≈ 11 m (also accept 11.3 m)	B1
(d)	 At t = 3.0 s, the sandbag is back at the original drop off point. Distance between the sandbag and the hot air balloon = distance travelled by the hot air balloon from the original drop off point = 3.0 x 15 = 45	M1 – student shows attempts to find this value A1
2(a)	Principle of moment states that when an object is in equilibrium, the total clockwise moments about a point is equal to the total anti-clockwise moments about the same point.	B1

(b)	By principle of moment, taking moment about the point at which the steel cable is connected to the windmill, $f_r \times 20.0 = 2000 \times (30.0 - 20.0)$ $f_r = 1000$ N	M1 A1
(c)	Normal reaction force on the tower = 5000 N Frictional force on the tower = 3000 N (to the left) Scale: 1.0 cm to 500 N  Resultant force = 11.7 x 500 = 5850 N (also accept 5550 N to 6150 N) Direction = 59° clockwise from the frictional force (also accept 56° to 62°)	M1 – correct drawing A1 – correct magnitude A1 – correct direction

3(a)	The chemical potential energy possessed by Spiderman is converted to work done on the ground by his foot as Spiderman is walking backwards. This energy is then converted to elastic potential energy of the flag pole. The total energy in the system remains a constant. The loss in chemical potential energy of Spiderman is equal to the gain in the elastic potential energy of the pole.	B1 B1 B1
(b)	Loss in kinetic energy = initial kinetic energy – final kinetic energy = ½ x 65.0 x 40.0^2 - ½ x 65.0 x 15.0^2 = 44687.5 ≈ 44 700J	 M1 A1 – accept only 3 sf
(c)	By conversation of energy, loss in kinetic energy = gain in GPE + work done against air resistance 44687.5 = 65.0 x 10 x h + 5000 h ≈ 61.1 m	 M1 A1
4(a) (i)	As the base of the lid moves up, this increases the surface area at which the air molecules hitting the internal surface of the container. The number of air molecules hitting per unit area of the internal surface of container (that is, the frequency of collisions of the air molecules with the internal surface of the container) decreases. Since the amount of force exerted by each air molecules on the internal surface of container remains unchanged during collision, the pressure of the air in the container decreases.	B2 – student's answer contains all the three points B1 – student's answer contains all one to two points B0 – student's answer does not contains any of these three points
	Note: $\text{Pressure} = \frac{\text{Total force exerted by molecules}}{\text{Total surface area}}$ $\text{Pressure} = \frac{\text{Force exerted by one molecule} \times \text{Total no. of molecules}}{\text{Total surface area}}$	

	$\text{Pressure} = \text{Force exerted by one molecules} \times \text{frequency of collision}$	
(ii)	The atmospheric pressure acting on the lid is much larger than the pressure of the air in the container. A large upward force is needed to overcome this pressure difference.	B1

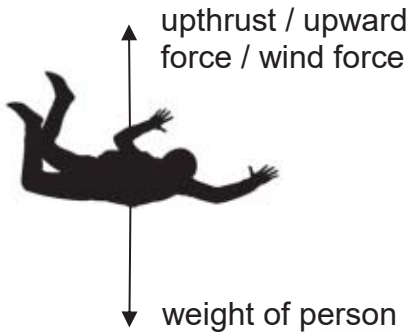
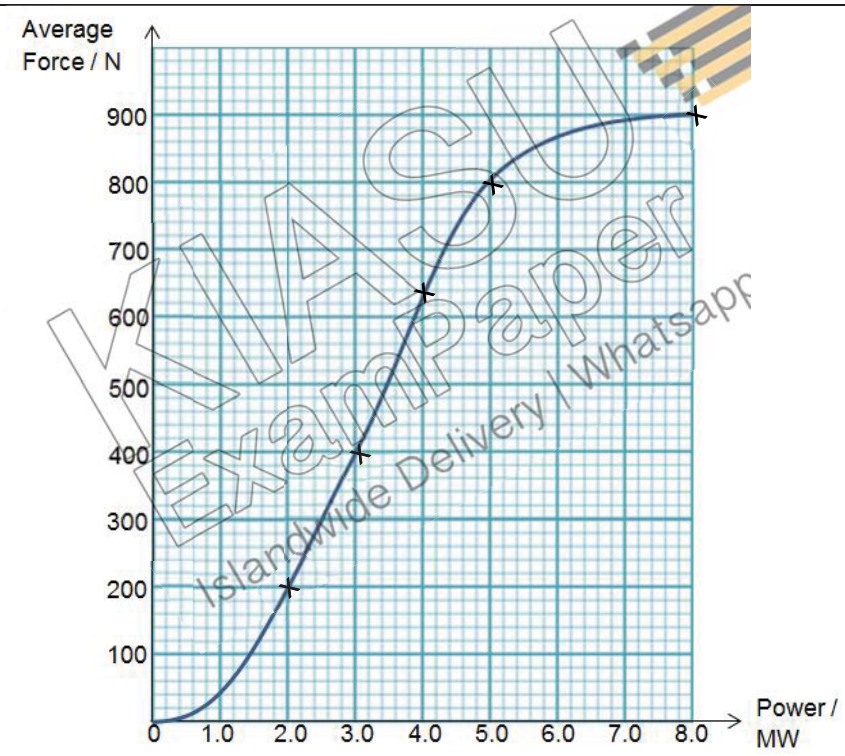
(b) **(i)**	Molecules are closely packed due to strong intermolecular forces of attraction, however, the molecules are still free to move.	B1
(ii)	Pressure on piston A = Pressure on piston B $F_A / A_A = F_B / A_B$ $\frac{30}{\pi (2.5)^2} = \frac{F_B}{\pi (7.5)^2}$ $F_B = 9 \times 30$ $F_B = 270$ N	M1 A1
5(a)	As the light intensity increases, the resistance of LDR decreases or vice versa.	B1
(b)	The graph does not shows a straight line passing through the origin, that is, potential difference across LDR is not directly proportional to the current flowing through it.	B1
(c) **(i)**	Resistor B and LDR are connected parallel to each other. $\frac{1}{R_{eff}} = \frac{1}{3000} + \frac{1}{2000}$ $\frac{1}{R_{eff}} = \frac{1}{1200}$ $R_{eff} = 1200\ \Omega$	M1 A1
(ii)	Using potential divider concept, p.d across resistor A $= \frac{1000}{1000+1200} \times 9.0$ ≈ 4.1 V	M1 A1 - accept 2 sf only
(iii)	p.d across LDR = 9.0 – 4.1 = 4.9 V Using R = V / I, Current through LDR = V / R = 4.9 / 2000 = 0.00245 A ≈ 0.0025 A	M1 A1 – sf must be consistent with part (ii)

6(a)	Using P = I V, Current through the heating element = P / V = (2.4 x 10^3) / 240 = 10 A	 M1 A1
(b)	When there is a current exceeding 13 A, the fuse will be heated up and melt when the melting point is reached. This cause the circuit to be an open circuit and current will no longer flow through the appliance. Hence, this protect the appliance which can be damaged due to over-heating.	B1 B1
(c)	When the water heater has double insulation, this means that the outer-casing is made of non-electrical conducting material. Hence, even if there is an electrical fault such that live wire touching the casing, the casing remains at low potential. A person touching the casing will not get electricl shock. Thus, earth wire is not required to be connected to the casing.	B1 B1
7(a)	By adjusting the resistance of variable resistor to a smaller value, this will increase the current flowing through the coil wounding around the soft iron core. The increase in the current will increase the magentic field strength in the coil and the soft iron core will be magnetised and become a stronger magnet. Due to induced magnetism, one end of the iron armature will be attracted towards the soft iron core and the turning effect on the iron armature will close the contacts and close the circuit connecting to the motor and motor is switched on.	B2 – student's answer contains all the three points B1 – student's answer contains all one to two points B0 – student's answer does not contains any of these three points
(b)	South pole. Note: Student needs to first establish the direction of current flowing in the coil and then apply right hand grip rule.	B1
(c) **(i)**	Diode Note: Diode only allows current to flow in a single direction.	B1

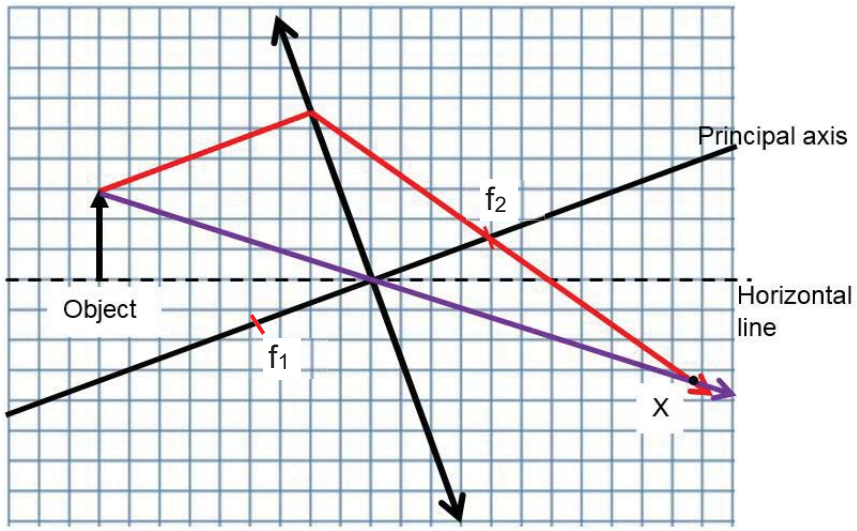
(ii)	The magnetic force on the wire PQ is in the upward direction as the magnetic field strength below the wire PQ is larger than that above the wire PQ. The difference in the magnetic field strength is due to the interaction of the magnetic field due to the current that is flowing from Q to P and the magnetic field due to the permanent magnet.	B1 B1 – student is required to state the direction of the current in wire PQ
8(a)	Faraday's law of electromagnetic induction states that the magnitude of the induced emf is directly proportional to the rate of cutting of magnetic field lines by the conductor. or Faraday's law of electromagnetic induction states that the magnitude of the induced emf is directly proportional to the rate of change magnetic flux linkage with the conductor.	B1
(b)	When the switch is first closed, the increase in the current flowing through coil A result in an increase in the magnetic field strength experienced by coil B. By Faraday's Law, there is an induced emf in coil B. Since it is a closed circuit between coil B and the galvanometer, there is an induced current flowing through galvanometer which shows a deflection.	B1 B1
(c) (i)	The batteries is replaced by an alternating current supply. Also accept any changes that can produce a continuous changing magnetic field in coil A.	B1

(ii)	One of the following: - decreasing the number of turns in coil B (explanation: use $N_s/N_p = V_s/V_p$ and $P = I_sV_s$, since V_s decreases) - increasing the number of turns in coil A (expalanation: use $N_s/N_p = V_s/V_p$ and $P = I_sV_s$, since V_s decreases) - Use a more sensitive galvanometer (explanation: greater deflection for the same amount of current flow through the galvanometer) - Use connecting wire of a lower resistance (explanation: will give a larger amount of current flow for the same power output, use $P = I^2R$) (Do not accept open and close the switch faster as this will not affect the rate of cutting of magnetic field lines by the conductor. The mangetic field is produced at the instant when the switch is just close)	B1

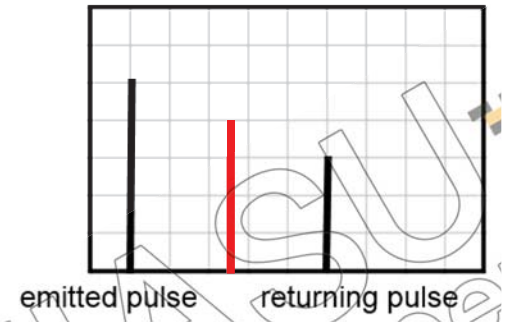
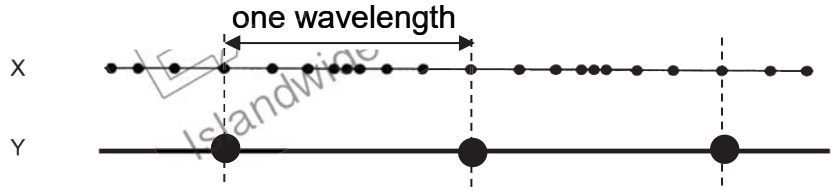
Section B

Qn	Solution	Marking Scheme
9(a)	Newton's 1st law of motion states that an object will remain at rest or continue to move with a constant speed along a straight line unless a resultant force acts on the object.	B1
(b)		B1 – students name the two forces correctly B1 – both arrows must have the same length
(c)		B1 – correct plotting of points B1 – correct shape of graph (no marks if student draws a straight line)
(d) (i)	750 N	B1
(ii)	From the graph, the power required = 4.6 MW	B1 – allow ecf from part (c)

(iii)	Corresponding wind force = 800 N Using Newton's 2nd Law, $F_{net} = m \times a$ $800 - 750 = 75 \times a$ $a \approx 0.067 \text{ m s}^{-2}$ (2 sf)	 M1 A1 – accept only 2 sf
(e)	As the wind force can be smaller than the weight of the person, the person will descend vertically and a safety net will be able to prevent the person from any impact with the base of the chamber.	B1
10(a) (i)	The light ray is moving away from the normal as it across the boundary. This implies that the speed of light ray in the medium X is higher than the speed of the light ray in the diamond. Thus, the refractive index of medium X is smaller than of the diamond.	M1 A1
(ii) 1.	Critical angle is the angle of incidence when the light ray is travelling from an optically denser medium to a less dense medium and the angle of refraction is 90°.	B1
(ii) 2.	As the angle of incidence is larger than the critical angle, the light ray will go through total internal reflection. Using law of reflection, the angle of reflection will be equal to the angle of incidence.	B1 B1
(ii) 3.	Critical angle is smaller than 39°. Note: For the same angle of incidence, the light ray will bend more away from the normal if medium X is water. Thus, this implies that the critical angle will not need to reach 39° for angle of refraction to be 90°.	B1
(b) (i)	Principal axis is defined as a straight line passing through the optical centre and perpendicular to the vertical plane of the lens.	B1

(ii)	 Marking points: 1. Correct construction of principal axis and labelling of focal points 2. - **Ray** from object passing through optical centre - **Ray** parallel to principal axis and passing through focal point. - **Direction** of rays from object - **Labelling** of image X	B1 mark B2 marks –all 4 correct marking point B1 marks – only 2 or 3 correct (allows ecf from part **(ii)1.)**

Either

11(a)	Ultrasound is defined as sound with a frequency that is greater than 20 000 Hz.	B1
(b) **(i)**	It means that for every one second, the particle will make 25000 complete oscillations about its undisturbed position. Note: Do not accept the source generates 25000 completes waves in one second.	B1
(ii)	Distance between the obstacle and the back bumper = ½ x total distance travelled by the ultrasound = ½ x (speed of sound x time taken) = ½ x 330 x 800 x 10^{-6} = 0.132 m = 13.2 cm	M1 A1
(iii)		B1 – the returning pulse should have a larger amplitude and nearer to the emitter pulse.
(c) **(i)**	Rarefaction is the region in the sound wave which has the lowest air pressure (the adjacent particles are the furthest apart).	B1
(ii) **1.** **2.**		B1 B1
3.	After 1 period, all the particles will have returned back to the original position. When another ½ period has progressed, all the rarefaction zone will be changed to compression zone. The particle at the centre of rarefaction would have moved to its furthest point and returned back to its undisturbed position and will now be at the centre of compression zone.	B1 B1

Or

11(a) (i)	Copper metal. Copper is a good conductor of heat and resistant to corrosion.	 B1
(ii)	Agree. Comparing to generate electricity using burning of fossil fuel, the by-products generated are less harmful. Disagree. Natural gas is a non-renewable source of energy and will be depleted. There are by-products released to the environment during the combustion and this can pollute the environment.	Either one. B1
(iii) 1.	Amount of thermal energy to change 2.0 kg of water to steam in 1.0 minute = amount of energy to increase the temperature of water + amount of energy to convert water at 100°C to steam = $m c \Delta\theta + m l_v$ = 2.0 x 4200 x (100 – 30) + 2.0 x 2.1 x 10^6 ≈ 590 000 (2 sf) + 4 200 000 = 4 790 000 J	 M1 – correct $m c \Delta\theta$ M1 – correct $m l_v$ A1 - accept 3 sf only.
2.	Efficiency = useful power output / power input x 100% 80% = useful power output / power input x 100% Therefore, power input = (100 / 80) x useful power output = (100 / 80) x (4 790 000 / 60) ≈ 100 000 W (2 sf)	 M1 – finding useful power output A1 – 2 sf
(b)(i)	A small amount of the raw material (radioactive substance) can help to generate a large amount of electrical energy.	B1
(ii)	Electromagnetic wave	B1
(iii)	Gamma radiation has extremely high frequency and hence ionising power. Exposure of gamma radiation can lead to mutation of cells, cause cancer and lead to death.	B1