



# Anglo-Chinese School (Barker Road)

PRELIMINARY EXAMINATION 2020

SECONDARY FOUR EXPRESS

PHYSICS 6091/01  
(PAPER 1 Multiple Choice)

TIME: 1 HOUR

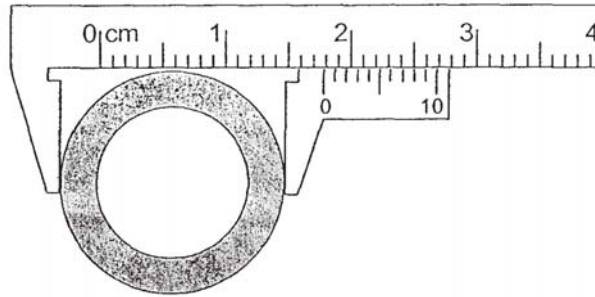
## READ THESE INSTRUCTIONS FIRST

Write your name and Exam Index number on the Answer Sheet in the spaces provided.  
Write in soft pencil.

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

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.

- 1 A pair of Vernier calipers is used to measure the external diameter of a metal pipe.



The metal pipe has an internal diameter 10.2 mm.

What is the thickness of the metal pipe?

- A 2.8 mm
  - B 3.8 mm
  - C 5.6 mm
  - D 7.6 mm
- 2 The Body Mass Index (BMI) of a person is calculated using the following formula.

$$\text{BMI} = \frac{\text{mass}}{\text{height} \times \text{height}}$$

What is the derived SI unit of BMI?

- A kg
  - B  $\text{kgm}^2$
  - C  $\text{kg/m}$
  - D  $\text{kg/m}^2$
- 3 Two forces 6.0 N and 10.0 N act on an object at the same time.

Which force **cannot** be the resultant force on the object?

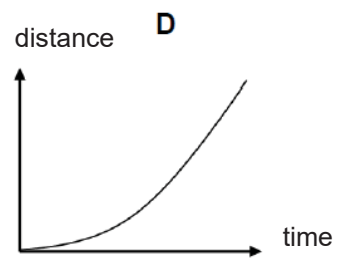
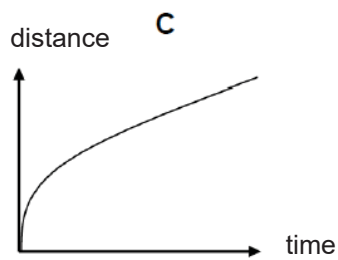
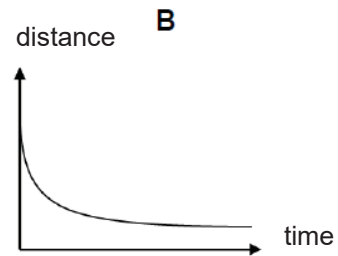
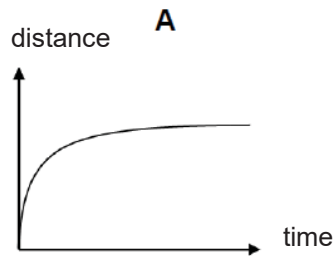
- A 8.0 N
- B 10.0 N
- C 14.0 N
- D 18.0 N

- 4 Two identical balls are dropped from different levels of a building. Ball A takes twice the time than ball B to reach the ground. Ignore air resistance.

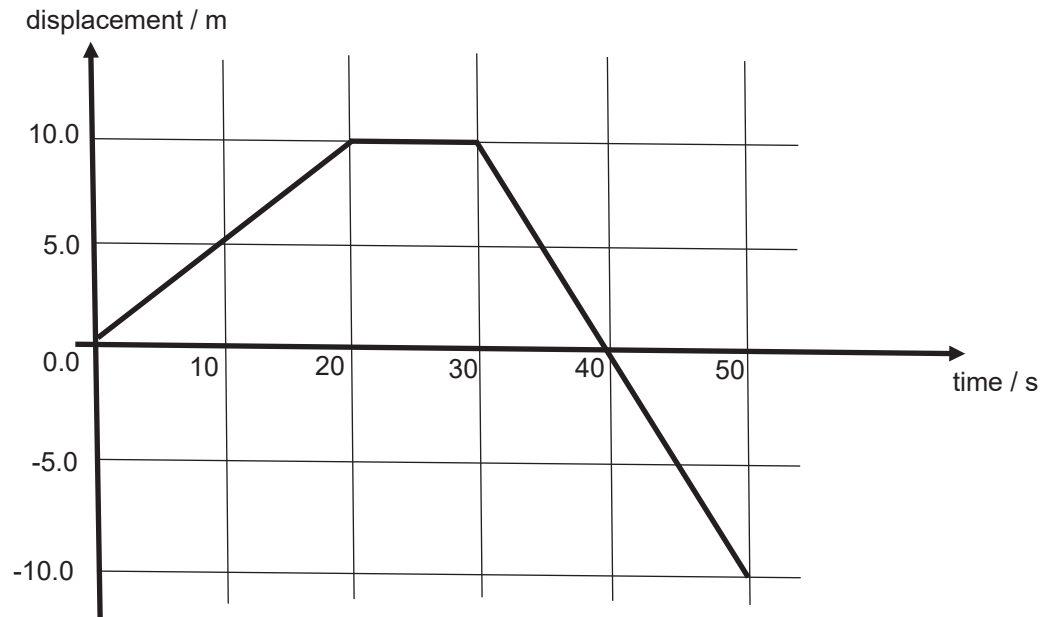
What is the ratio of the acceleration of ball A to ball B?

- A 1:1
- B 1:2
- C 2:1
- D 4:1

- 5 Which distance-time graph best describes a sky diver jumping off an aeroplane till he reaches terminal velocity.



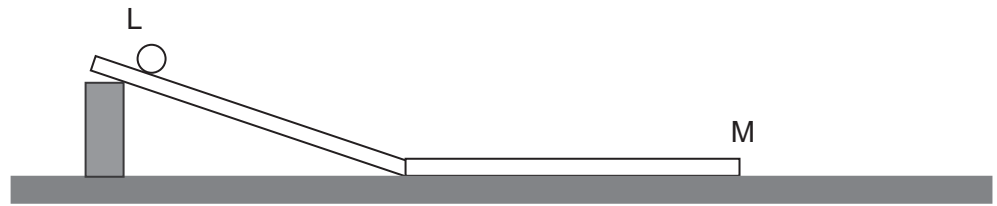
- 6 The diagram shows the displacement-time graph of a car traveling on a straight, horizontal road.



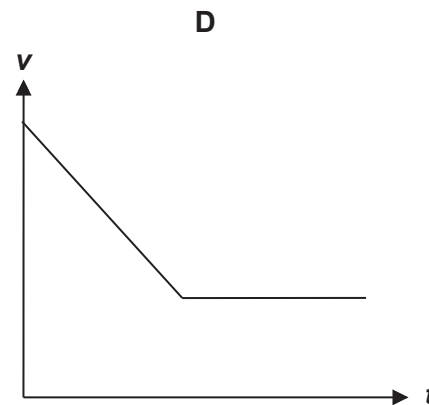
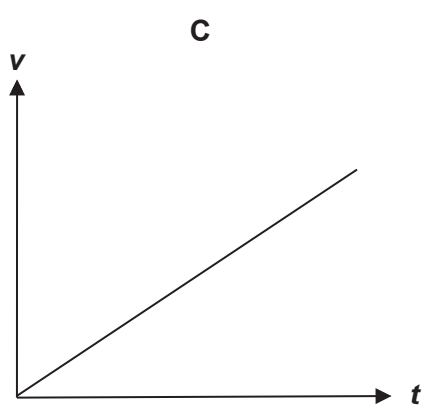
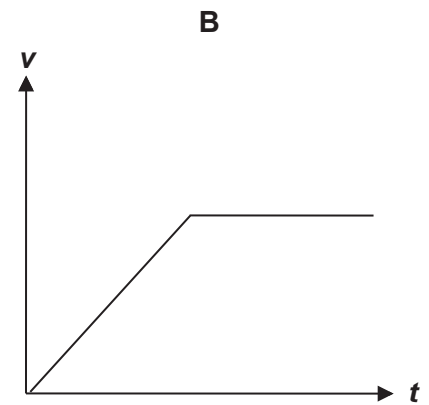
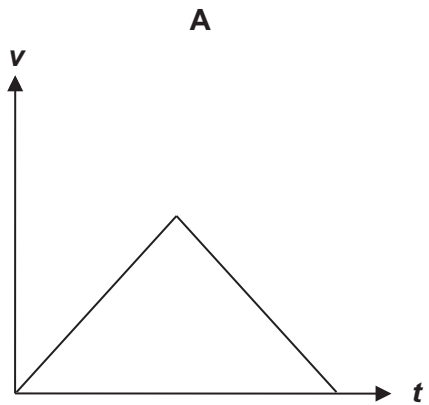
What is the total distance travelled by the car in 50 s?

- A 0 m
- B 30 m
- C 200 m
- D 300 m

- 7 The diagram below shows a ball being released on a track from rest at point L. The track is frictionless and air resistance is negligible.

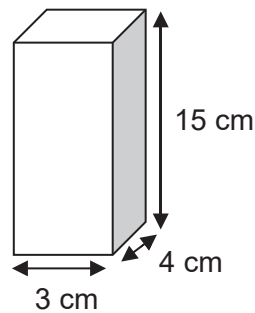


Which graph correctly shows how the speed of the ball varies with time from L to M ?

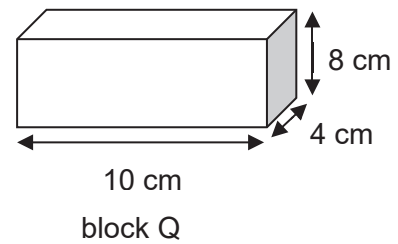


- 8 The diagram below shows two blocks.

Block P has a density two times that of block Q.



block P

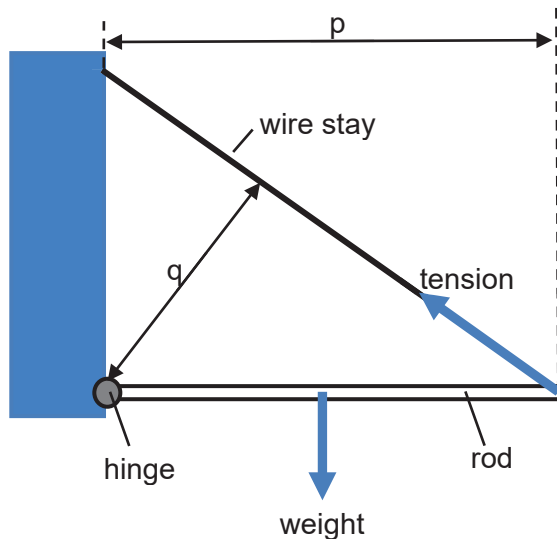


block Q

Which statement about the mass of the blocks is correct?

- A Blocks P and Q have the same mass.
  - B 8 blocks of P have the same mass as 9 blocks of Q.
  - C 9 blocks of P have the same mass as 8 blocks of Q.
  - D 16 blocks of P have the same mass as 9 blocks of Q.
- 9 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 remain the same as on the Earth?
- A ease to make a stationary object start moving
  - B height reached by the astronaut when he jumps with the same initial velocity
  - C period of a simple pendulum
  - D weight of the astronaut
- 10 Which situation illustrates the effect of inertia?
- A A force applied to the shopping cart gives the cart an acceleration.
  - B A moving shopping cart will eventually come to rest.
  - C It is difficult to stop a moving shopping cart full of groceries immediately.
  - D The groceries inside a shopping cart are jerked forward when the shopping cart starts moving forward.

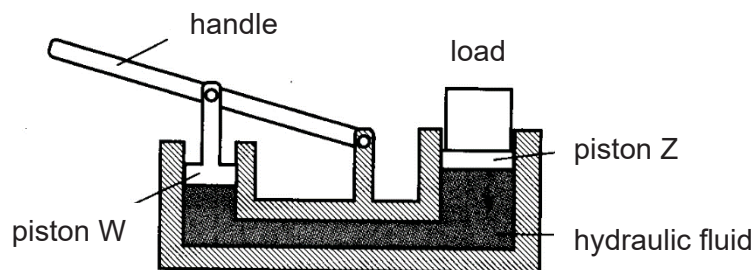
11 The diagram below shows a hinged uniform rod that is held horizontal by a wire stay.



Which expression to calculate the tension in the wire stay is correct?

- A tension = weight  $\times$  (p / 2)  $\div$  p
- B tension = weight  $\times$  (p / 2)  $\div$  q
- C tension = weight  $\div$  (p / 2)  $\times$  q
- D tension = weight  $\div$  (p / 2)  $\div$  q

12 The diagram below shows a simple hydraulic jack.



Which modifications will enable heavier loads to be lifted?

	diameter of W	diameter of Z
<b>A</b>	doubled	halved
<b>B</b>	doubled	remains the same
<b>C</b>	halved	doubled
<b>D</b>	remains the same	halved

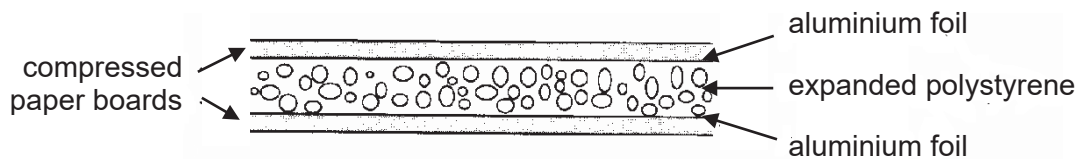
13 The input power to a motor is 300 W. In 20 s, it lifts a load of 400 N through a height of 6.0 m.  
What is the efficiency of the motor?

- A 12 %
- B 25 %
- C 40 %
- D 75 %

14 In the Brownian experiment, smoke is used because smoke particles

- A are big enough to be seen and light enough to be affected by the air particles.
- B are black and can be easily identified through the microscope.
- C can restrict the motion of the air particles.
- D serve as a good contrast for the air particles to be seen.

15 The diagram shows a section through a particular type of building board.



Which best explains why such boards provide good heat insulation?

	aluminium foil	expanded polystyrene	compressed paper boards
A	is a good conductor	is a good reflector	has high thermal conductivity
B	is a good conductor	is a poor reflector	has high thermal conductivity
C	is a good reflector	is a good conductor	has low thermal conductivity
D	is a good reflector	is a poor conductor	has low thermal conductivity

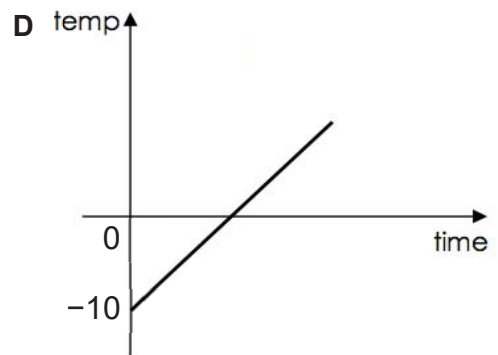
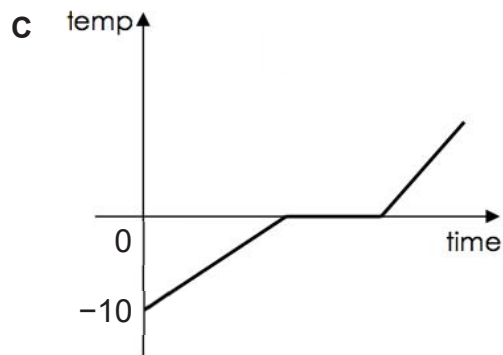
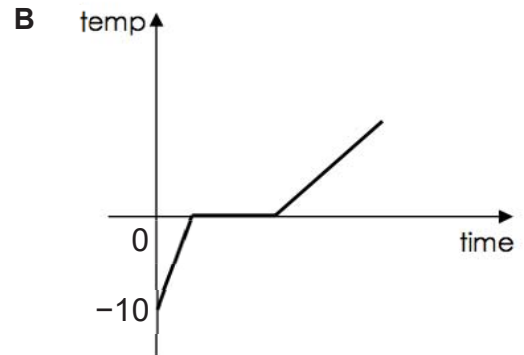
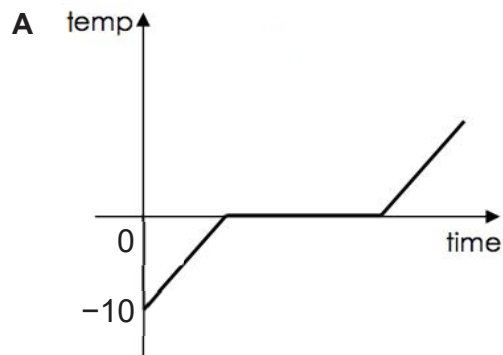
16 The contents of a cooking pot continue to boil for a long time after it is removed from the stove.  
What could be a possible explanation?

- A The pot has a very high specific heat capacity.
- B The pot has a very low specific heat capacity.
- C The pot is made of a very good conductor material.
- D The pot is made of a very good insulator material.



- 17 A block of ice at  $-10\text{ }^{\circ}\text{C}$  was heated. Ice has a lower specific heat capacity as compared to water.

Which correctly illustrates the heating curve?



- 18 A fixed mass of gas is kept at constant temperature. When the volume of the gas increases, the pressure decreases.

Why is this?

- A** The molecules are further apart and they collide less frequently.  
**B** The molecules are further apart and they move slower.  
**C** The molecules move more slowly and they collide less frequently.  
**D** The molecules move more slowly and they hit each other less forcefully.
- 19 A sample of candle wax of mass 200 g completely melted in 4 minutes when thermal energy is supplied at a constant rate of 12 000 J / minute.

What is the latent heat of fusion of the candle wax.

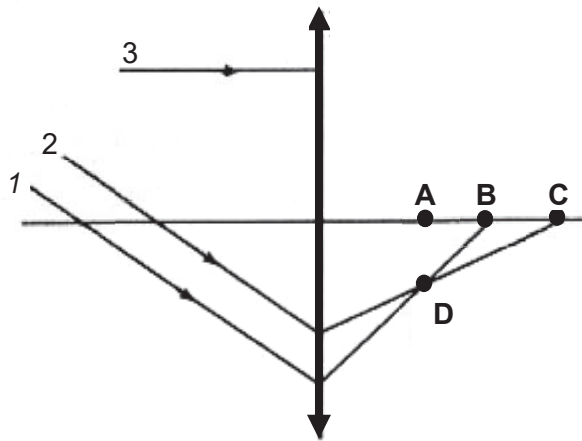
- A** 180 J / g  
**B** 240 J / g  
**C** 420 J / g  
**D** 600 J / g

20 Which changes of state occur as a result of a gain in thermal energy?

- A boiling and melting
- B boiling and solidification
- C condensation and melting
- D condensation and solidification

21 The diagram below shows two incoming parallel light rays 1 and 2 which pass through a thin converging lens.

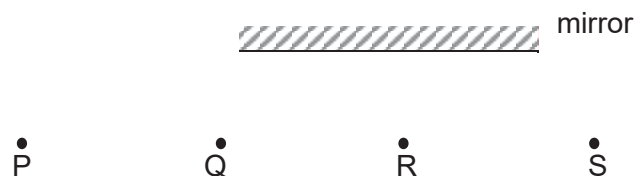
Which of the points **A**, **B**, **C** or **D** will the light ray 3 pass through?



22 What is the refractive index of glass?

- A the ratio of the speed of light in air to the speed of light in glass
- B the ratio of the speed of light in glass to the speed of light in air
- C the ratio of the speed of light in glass to the speed of light in vacuum
- D the ratio of the speed of light in vacuum to the speed of light in glass

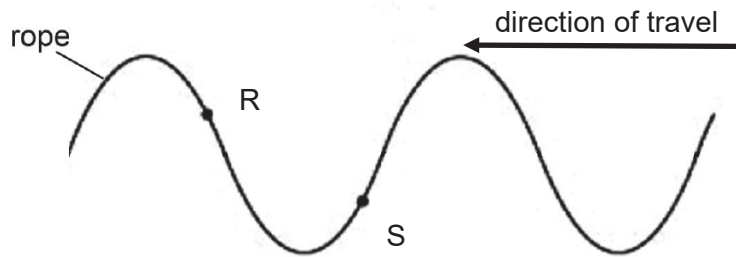
23 Four students, P, Q, R and S, are standing in front of a plane mirror as shown below.



Who can Q see in the mirror?

- A P and Q only
- B Q and R only
- C R and S only
- D P and S only

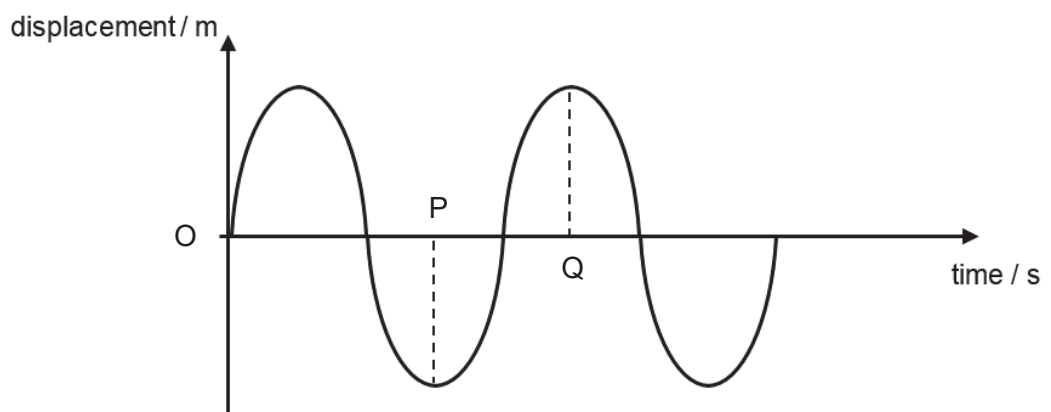
24 The diagram shows a transverse wave traveling from the right to the left.



In which direction are the particles R and S moving?

	movement of R	movement of S
<b>A</b>	downwards	downwards
<b>B</b>	downwards	upwards
<b>C</b>	upwards	downwards
<b>D</b>	upwards	upwards

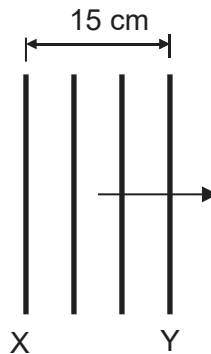
25 The diagram shows the variation of displacement of a wave with time.



What does the segment PQ on the time axis represent?

- A** half the period
- B** half the wavelength
- C** twice the period
- D** twice the wavelength

- 26 The figure below shows a water wave travelling in a ripple tank. The wavefront at X travels to Y in 5.0 s.



What is the frequency of the water wave?

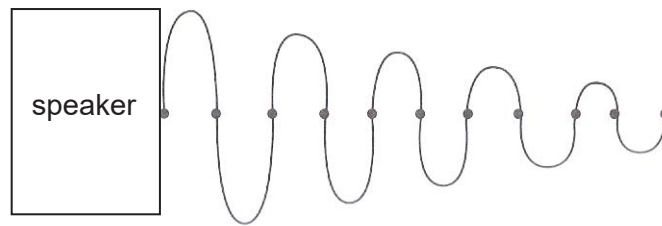
- A 0.60 Hz  
 B 3.0 Hz  
 C 15 Hz  
 D 75 Hz
- 27 Which row does **not** show a correct application of the stated electromagnetic wave?

	electromagnetic wave	application
A	x-rays	detection of cracks in buildings
B	radiowaves	satellite television
C	gamma-rays	medical treatment
D	ultraviolet radiation	sterilisation

- 28 What is the likely speed of sound in air, in water and in concrete?

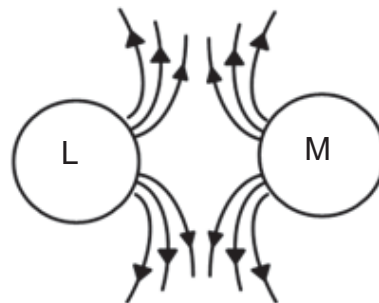
	speed in air / m/s	speed in water / m/s	speed in concrete / m/s
A	330	1500	5000
B	330	5000	1500
C	5000	330	1500
D	5000	1500	330

- 29 The diagram shows the resulting sound wave produced by a speaker.



How does the sound produced by the speaker vary as time passes?

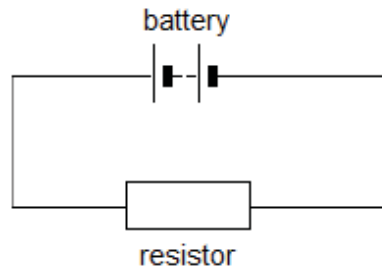
- A The pitch of the sound becomes higher.  
 B The pitch of the sound becomes lower.  
 C The sound becomes less loud.  
 D The sound becomes louder.
- 30 Which statement about electrostatic charges is correct?
- A An electron will move at a constant speed in an electric field.  
 B An electron will always move towards a positively charged object in a straight line.  
 C The direction of an electric field at any point is the direction of the force on a small positive charge placed at the point.  
 D When two electrons are brought close to each other, their electric fields interact and result in attractive forces between the electrons.
- 31 The diagram shows the electric field pattern between two electric charges L and M.



Which statement is correct?

- A L and M are both positive charges.  
 B L and M are both negative charges.  
 C L is a positive charge and M is a negative charge.  
 D L is a negative charge and M is a positive charge.

- 32** The diagram shows a resistor connected to a battery. 40 J of energy are delivered by the battery to the resistor. 5 C of charge flow through the resistor in 1.25 s.

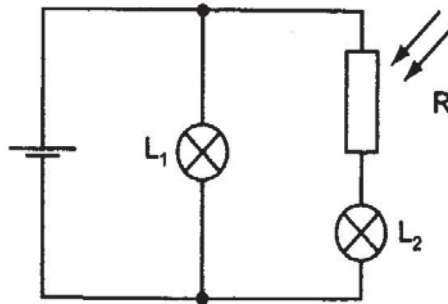


- Which statement is correct?
- A** The current flowing through the battery is 6.25 A.
  - B** The electromotive force is 8 V.
  - C** The power dissipated by the resistor is 50 W.
  - D** The resistance of the resistor is 32  $\Omega$ .
- 33** A wire has a resistance of 8  $\Omega$ . A second wire, made of the same material, has half the length and twice the diameter.
- What is the resistance of the second wire?
- A** 1  $\Omega$
  - B** 2  $\Omega$
  - C** 8  $\Omega$
  - D** 16  $\Omega$
- 34** How much charge passes through a point in a conductor if 60 mA flows through the point in 10 minutes?
- A** 0.00010 C
  - B** 6.0 C
  - C** 36 C
  - D** 600 C

- 35 A bird can stand on an overhead high-voltage transmission line without getting electrocuted.

Which statement explains the situation?

- A Both feet of the bird are at the same voltage.  
 B The bird's body has very high resistance.  
 C The bird's feet are very good insulators.  
 D The air trapped between the bird's feathers act as insulators.
- 36 In the circuit shown, R is a light-dependent resistor.



What effect does an increase of light intensity on R have on the brightness of the two lamps  $L_1$  and  $L_2$ ?

	$L_1$	$L_2$
A	decrease	decrease
B	decrease	increase
C	stays the same	decrease
D	stays the same	increase

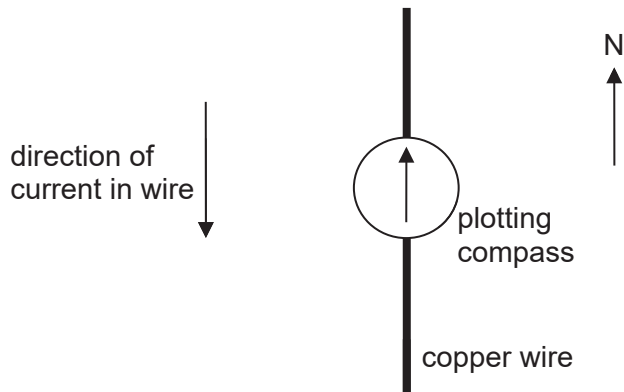
- 37 The metal case of an electric heater is earthed. The plug to the heater contains a 5 A fuse. There is a current of 4 A when the heater works normally.

The cable to the heater becomes so worn that the live wire makes electrical contact with the case.

What happens?

- A The current flows to earth and the fuse is not affected.  
 B The fuse melts and switches off the circuit.  
 C The metal case becomes live and dangerous.  
 D The metal case becomes very hot.

- 38 The figure shows a small plotting compass placed above a copper wire. When there is no current in the wire, the plotting compass points to the North.



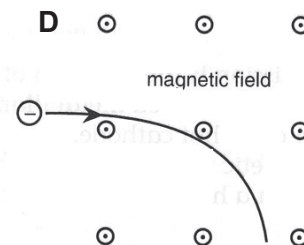
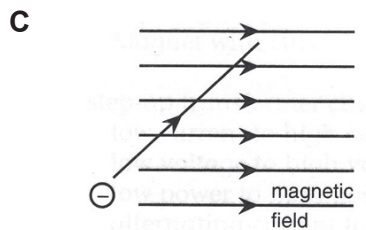
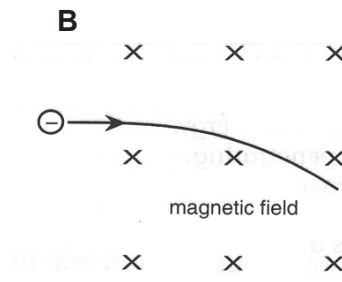
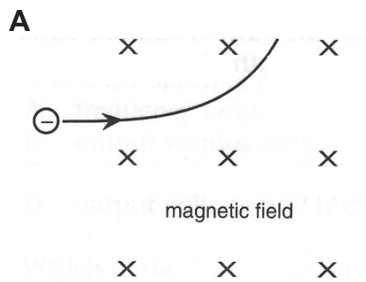
A large current is passed through the wire. The direction of the current is shown above.

Which of the following shows what happens to the compass needle when the current is passed through?



- 39 The diagrams below show an electron passing through a magnetic field.

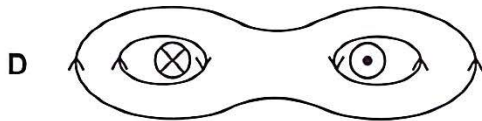
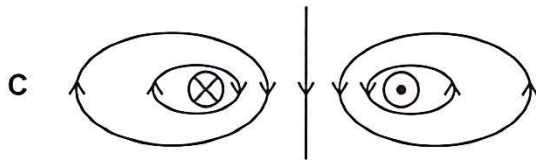
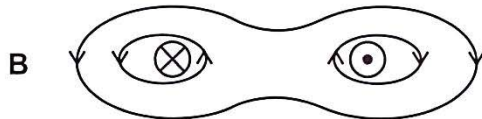
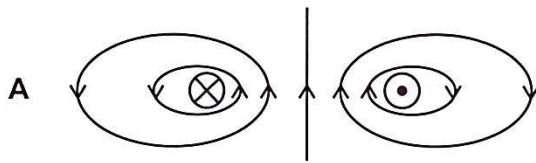
Which diagram is correct?





40 Each diagram below is a cross-section through two parallel current-carrying conductors.

Which diagram correctly shows the magnetic field pattern formed by the currents in the two conductors?



current into plane of diagram

current out of plane of diagram

<b>Name:</b>	<b>Class:</b>	<b>Exam Index No.:</b>
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# Anglo-Chinese School (Barker Road)

**PRELIMINARY EXAMINATION 2020**

**SECONDARY FOUR EXPRESS**

**PHYSICS 6091**

**PAPER 2**

**TIME: 1 HOUR 45 MINUTES**

**READ THESE INSTRUCTIONS FIRST**

Write your name, class & exam index number in the box provided at the top of this page.

Write in dark blue or black pen.

You may use a pencil for any diagrams or graphs.

Do not use glue or correction fluid.

**Section A**

Answer **all** questions.

**Section B**

Answer **all** questions. Question 13 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.

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

Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for the sound use of Physics than correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

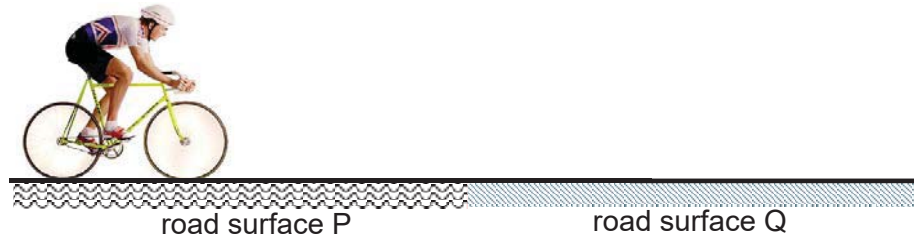
<b>For Examiner's Use</b>	
<b>Section A</b>	
<b>Section B</b>	
<b>Total</b>	<b>/ 80</b>

*This question paper consists of **22** printed pages.*

**SECTION A (50 marks)**

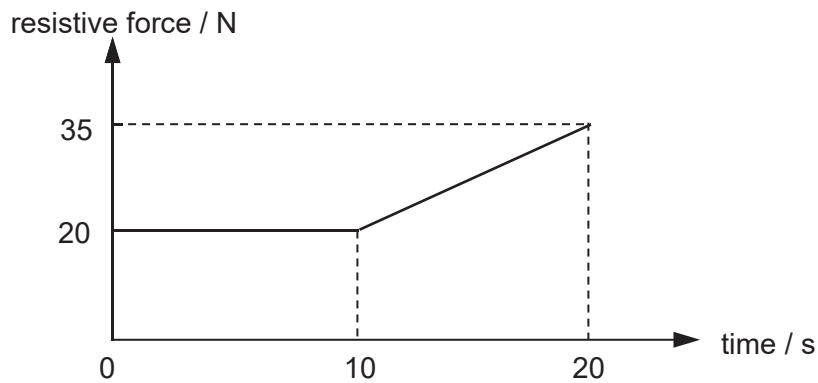
Answer **all** the questions in this section.

- 1 Fig. 1.1 shows a man cycling forward on a straight road surface P. After cycling for 10 s, he enters a road surface Q. Throughout the entire journey, the man exerts a constant forward driving force of 600 N.



**Fig. 1.1**

Fig. 1.2 shows a graph of the resistive force acting on the bicycle against time.



**Fig. 1.2**

- (a) Describe the acceleration of the bicycle from  $t = 0$  s to 20 s.

.....  
 ..... [2]

- (b) The man and his bicycle have a combined mass of 150 kg. His initial speed is 2.0 m/s.

- (i) Calculate the acceleration of the man and his bicycle at  $t = 5$  s.

acceleration = ..... [2]

- (ii) Calculate the speed of the bicycle at  $t = 10$  s.

speed = ..... [2]

2 Fig. 2.1 shows a uniform rectangular block on a flat horizontal surface.

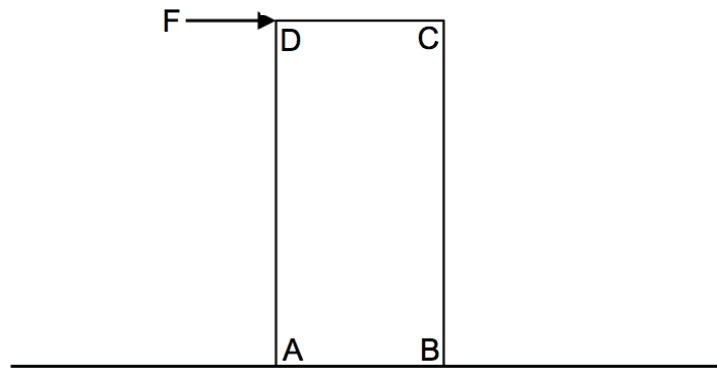


Fig. 2.1

A force  $F$  acts on the block and it tilts the block at edge  $B$ .

(a) On Fig. 2.1, mark with a cross ( $x$ ), the position of the centre of gravity of the block. [1]

(b) In the space below, draw a diagram to show how far the block can be tilted about  $B$  just before it topples. Draw and label the weight as  $W$ .

\_\_\_\_\_ [2]

(c) State and explain how your answer to (b) will differ if the height of the block is reduced

.....  
 ..... [1]

- 3 A round-bottomed flask is connected to a mercury manometer. The air inside the flask is warm. The setup is shown in Fig. 3.1.

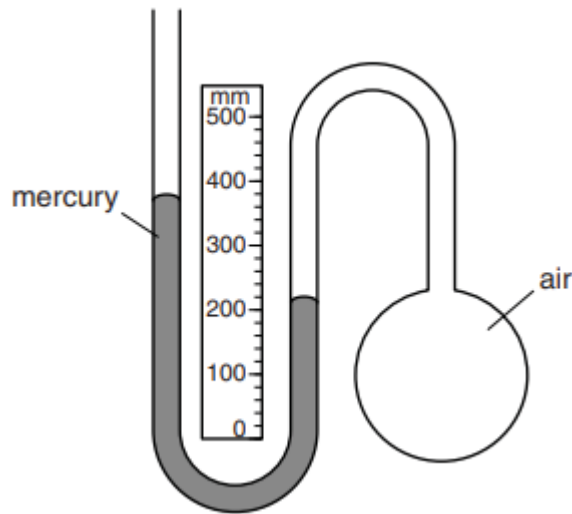


Fig. 3.1

- (a) The mercury in the manometer has a density of  $13\,600\text{ kg/m}^3$ . Atmospheric pressure is  $1.0 \times 10^5\text{ Pa}$  and the gravitational field strength is  $10\text{ N/kg}$ .

Calculate the pressure of the air in the flask.

pressure = ..... [3]

- (b) The difference in mercury levels decreases as the air in the flask starts to cool.

Explain, using ideas about molecules, why this occurs.

.....  
 .....  
 ..... [2]

- 4 Fig. 4.1 shows a ball rolling at uniform speed of 5.0 m/s along AB before it rolls down a smooth ramp to C. Assume that the air resistance is negligible.

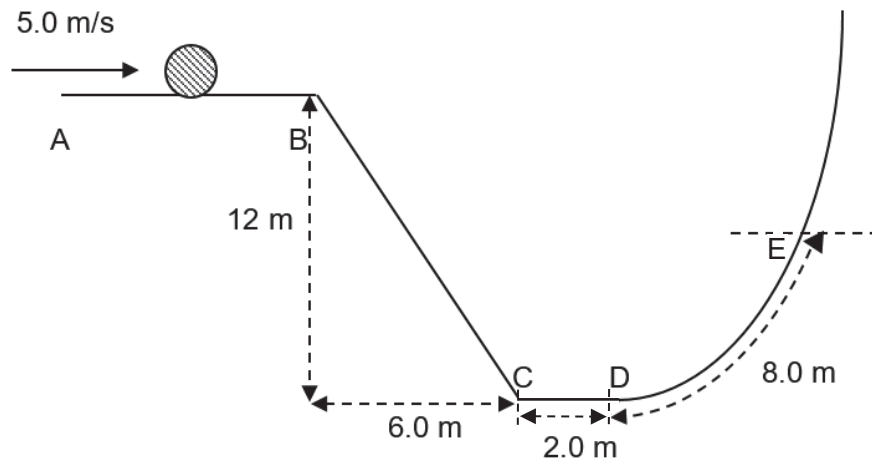


Fig. 4.1

- (a) Define *work*.

.....  
 .....

[2]

- (b) Calculate the speed of the ball at position C. The gravitational field strength is 10 N/kg.

speed = ..... [2]

- (c) The ball continues to roll from C until it stops at E. The total frictional force along CDE is 10 N.

- (i) Calculate the total work done against frictional force by the ball along CDE.

work done = ..... [1]

(ii) The total energy of the ball at any position between B and C is 265 J.

Calculate the total energy the ball possesses at E.

energy of ball = ..... [1]

(d) Assuming that path CDE is now smooth, mark with a cross (x) on Fig. 4.1 to indicate the possible new position where the ball stops. [1]



5 (a) A thermocouple gives a reading of 5.0 mV when the cold junction is placed in melting ice and the hot junction is placed in steam.

(i) The cold junction is now placed in a liquid of an unknown temperature and the hot junction is left in the surrounding air. The thermocouple gives a reading of 3.0 mV.

Explain why the potential difference measured above is not useful in identifying the temperature of the surrounding air.

.....  
 .....

[1]

(ii) The cold junction is placed back in melting ice and the other junction is left in the surrounding air. The thermocouple now gives a reading of 1.2 mV.

Calculate the temperature of the surrounding air.

temperature = ..... [2]

(b) Fig. 6.1 shows the capillary of a liquid-in-glass thermometer with a manufacturing fault.

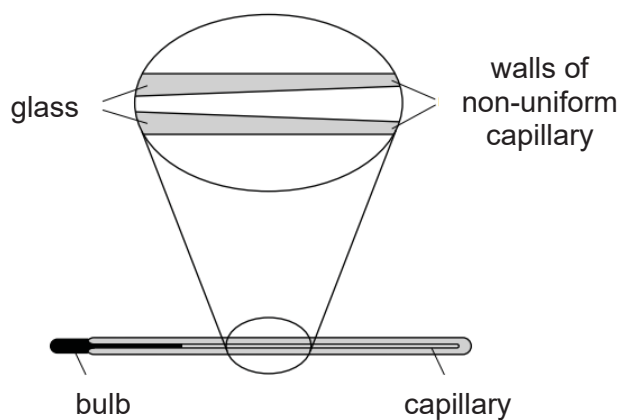


Fig. 6.1

State and explain the effect this fault has on the thermometer

.....  
 .....

[2]

- 6 Every element will absorb a unique set of electromagnetic waves. Based on this characteristic of each element, we can predict the elements present in any planet and star in the universe.

Fig. 6.1 shows five of the wavelengths of the electromagnetic waves that are absorbed by four elements, predicted to be present in the Sun.

element	wavelength absorbed / nm
iron	300
hydrogen	430 and 650
helium	580
sodium	720

**Fig. 6.1**

- (a) Calculate the frequency of the electromagnetic wave with the lowest frequency that is being absorbed by the elements.

frequency = ..... [2]

- (b) The wavelength of visible light is between 400 nm and 700 nm.

- (i) State the component of the electromagnetic spectrum that are absorbed by sodium.

..... [1]

- (ii) State an application of this component.

.....  
 ..... [1]

- 7 (a) The diagram below shows two light rays,  $R_1$  and  $R_2$ , entering the bottle at different angles. The refractive index of water is 1.33. Assume that the thickness of the bottle wall is negligible.

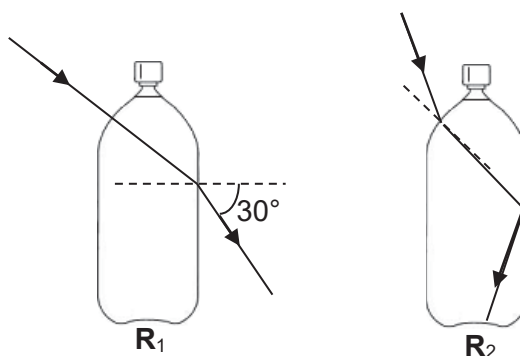


Fig. 7.1

- (i) Calculate the angle of incidence at the point where  $R_1$  exits the bottle

angle of incidence = ..... [2]

- (iii) Explain why  $R_2$  does not exit the bottle after the first refraction.

.....  
 .....  
 ..... [2]

- (b) Fig. 7.2 and Fig. 7.3 shows two houses fitted with 2 different types of modified roof to allow sunlight into the house. The arrows indicate the direction of sunlight at a certain point in the day.

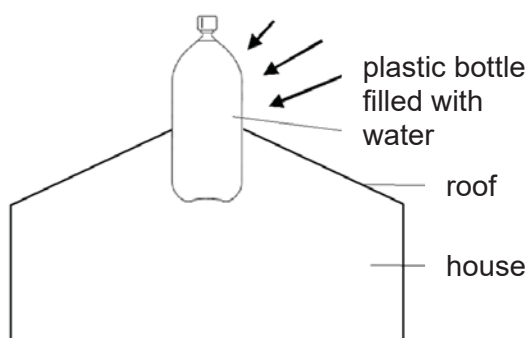


Fig. 7.2

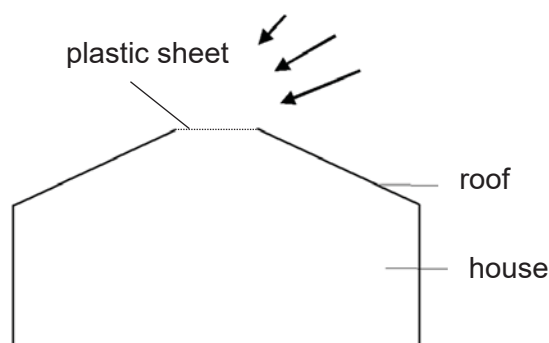


Fig. 7.3

Explain why the modified roof in Fig. 7.2 is better than the roof in Fig. 7.3 in lighting up the entire room. You may draw on Fig. 7.2 and 7.3 if you wish.

.....  
 ..... [1]

- (c) A boy stands in the room of the house in Fig 7.2. After some time, the boy feels warm.

State the process in which thermal energy is transferred from the sun to the boy.  
Explain your answer

.....  
.....

[1]

8 Fig. 8.1 shows 2 magnets being placed near each other.

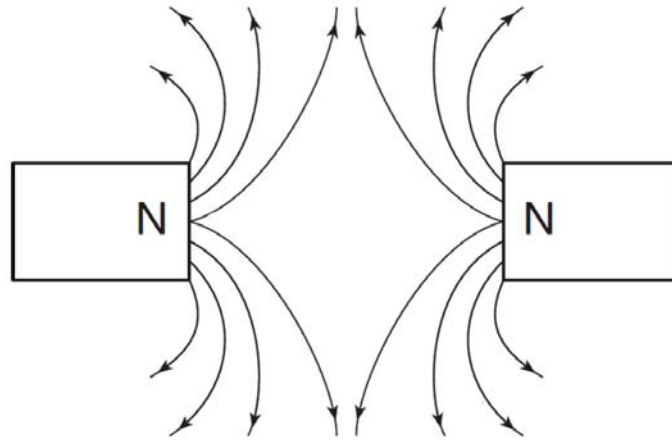


Fig. 8.1

(a) Complete Fig. 8.1, indicating

- (i) the missing magnetic poles and field lines around these two poles, [1]
- (ii) the position of the neutral point with a cross (x). [1]

(b) Fig. 8.2 shows a speaker. As current flows through the coil, material A is attracted and repelled by the permanent magnet, causing vibrations in the cone.

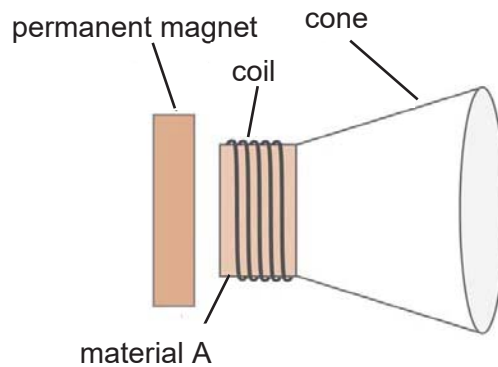


Fig. 8.2

- (i) Suggest a suitable material for A.  
 ..... [1]
- (ii) Explain why the suggested material in (b)(i) is suitable.  
 .....  
 ..... [1]

- 9 A car is fitted with a parking system that warns the driver as to how close objects are behind the car. Equipment on the rear bumper of the car transmits sound waves and receives the reflected waves, as shown in Fig. 9.1.

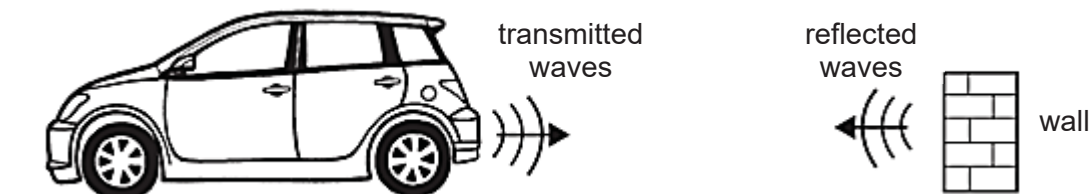


Fig. 9.1

For the parking system to work properly, the object must not be too near or too far from the rear bumper. A sensor in the parking system detects the time delay between the transmitted sound wave and the reflected wave.

The sensor can only detect a time delay between  $500 \mu\text{s}$  to  $1100 \mu\text{s}$ .

- (a) Calculate the minimum distance an object must be from the rear bumper to be detected. Take the speed of sound in air to be  $330 \text{ m/s}$ .

distance = ..... [2]

- (b) The equipment on the rear bumper is replaced with another equipment which transmits and receives radio waves. The sensor for the new equipment can detect the same time delay as the sensor that uses sound wave

By repeating the calculation in (a) for the new equipment, determine and explain which equipment would be more useful in helping a driver to park the car.

.....

..... [2]

- 10 Fig. 10.1 shows a 200 V electrical circuit with lamps 1, 2 and 3 connected in the circuit. A person switches on these three lamps in sequence.

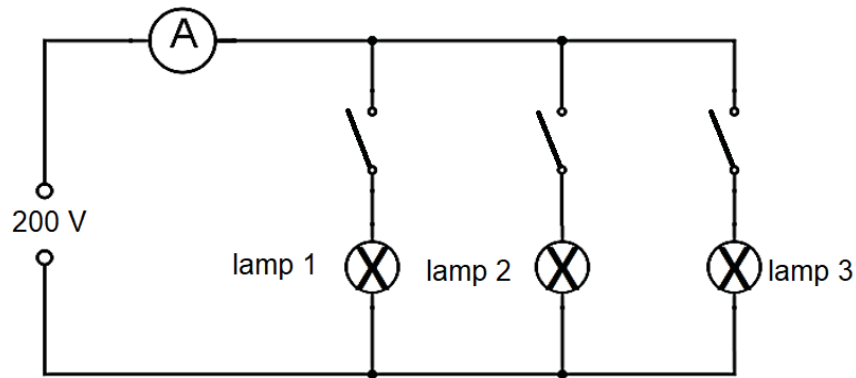


Fig. 10.1

An ammeter connected in the circuit shows that the current is 0.40 A when only lamp 1 is switched on. When both lamp 1 and 2 are switched on, the ammeter reading is 1.90 A. When all three lamps are in use, the ammeter reading is 7.60 A.

- (a) Calculate the resistance of lamp 3.

resistance = ..... [2]

- (b) Calculate the weekly cost of electricity if all three lamps are in use at the same time for 110 minutes each day. The cost of 1 kWh of electrical energy is \$0.22.

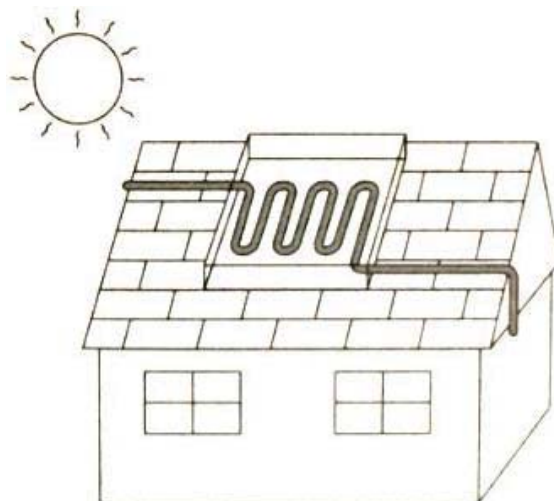
cost = ..... [3]

**SECTION B (30 marks)**

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

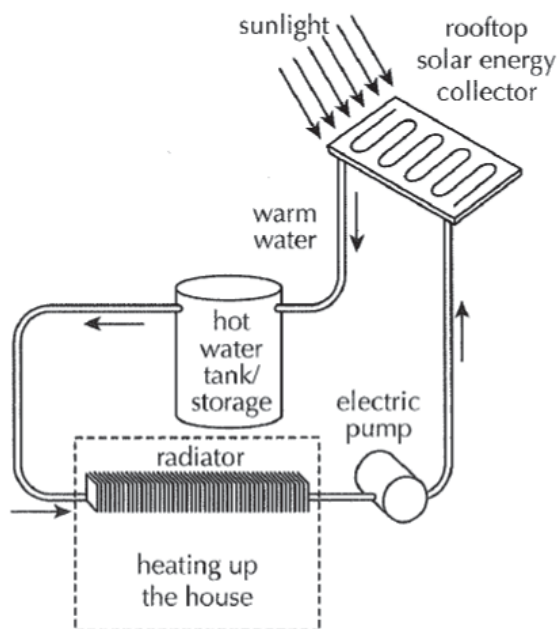
Answer only one of the two alternative questions in **Question 13**.

- 11** In many countries, where the average outdoor temperature can vary from  $-3^{\circ}\text{C}$  to  $19^{\circ}\text{C}$ , solar energy is used for heating up the interior of the house. Solar energy is absorbed by cool water running through coiled pipes located on rooftops as shown in Fig. 11.1.



**Fig. 11.1**

The warm water is then stored in an insulated water tank as shown in Fig. 11.2.



**Fig. 11.2**

In passing through the radiator, the water in the pipe will reach the same temperature as the required indoor temperature in the house. After moving through the electrical pump, the water will reach the same temperature as the outdoor temperature.



Data relevant to the usage of the heating system is given in the box.

Temperature of warm water: 45°C
Specific heat capacity of water: $4.2 \times 10^3 \text{ J/ kg}^\circ\text{C}$
Power of the rooftop solar energy collector: 12 kW
Average thermal energy required to maintain indoor temperature of 25°C for 24 h : 200 MJ

Fig. 11.3 shows the average outdoor temperature and average daily sunshine duration in France and Fiji for the month of May.

	France	Fiji
average outdoor temperature / °C	14	19
average daily sunshine duration / hr	7.5	4.0

**Fig. 11.3**

- (a) The heating system is installed in a house in France.
- (i) Determine the average mass of warm water required daily to maintain the indoor temperature at 25 °C.

average mass of warm water = ..... [2]

- (ii) Calculate the total solar energy required to heat up the cool water daily to maintain the room temperature at 25 °C.

total solar energy = ..... [2]

- (iii) Calculate the time needed by the solar collector to absorb the amount of solar energy calculated in (a)(ii).

time = ..... [2]

**(b)** With reference to Fig 11.3, explain why the heating system is not able to maintain the indoor temperature at 25 °C for Fiji.

.....  
.....  
.....  
.....  
.....

[2]

**(c)** Suggest a material for making the coiled water pipes at the rooftop and explain the reason for your choice.

.....  
.....  
.....

[2]

- 12 Fig. 12.1 shows an electrical circuit and Fig. 12.2 shows the graph of current against potential difference for the lamp.

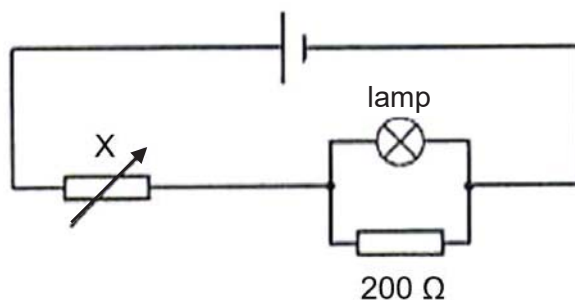


Fig. 12.1

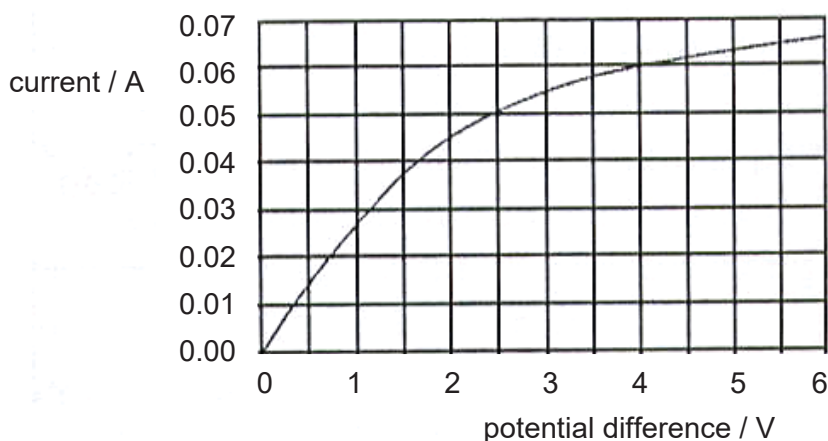


Fig. 12.2

- (a) State Ohm's law.

.....  
 .....  
 .....

[2]

- (b) Explain why the filament lamp does not obey Ohm's law.

.....  
 .....

[1]

- (c) Using Fig.12.2, state and explain the change to the resistance of the lamp when the potential difference is increased.

.....  
 .....  
 .....

[2]

**(d)** The current and potential difference for the lamp can be changed when component X is being adjusted.

**(i)** Name component X.

..... [1]

**(ii)** Explain how component X can decrease the current through the lamp.

.....  
.....  
..... [2]

**(e)** The potential difference across the lamp is 2.5 V.

**(i)** Determine the electric current through the lamp.

electrical current = ..... [1]

**(ii)** Calculate the electric current through the 200  $\Omega$  resistor.

electrical current = ..... [1]

13 EITHER

Fig. 13.1 shows an incomplete structure of a direct current (d.c.) motor. A rectangular coil ABCD is connected to component X. The coil is placed between two permanent magnets. The coil is observed to rotate in a clockwise direction.

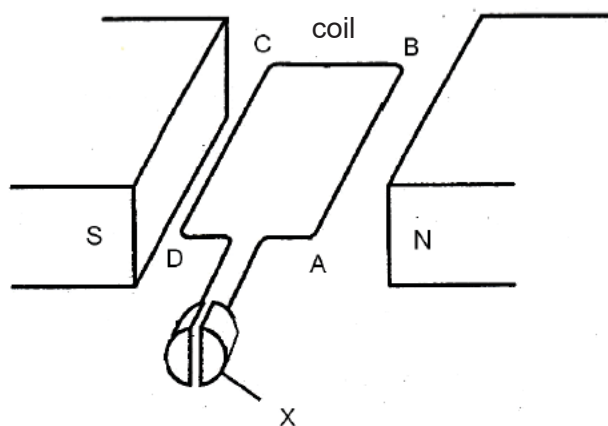


Fig.13.1

- (a) State the direction of current flow in the coil and explain how the direction of the current is determined.

.....

.....

.....

.....

[3]

- (b) On Fig. 13.1, complete the structure of the d.c. motor by drawing the external circuit comprising of carbon brushes, a direct current supply and a switch.

[2]

(c) Name component X and explain clearly how X ensures the coil rotates continuously in the clockwise direction.

.....  
.....  
.....  
.....  
.....

[3]

(d) The coil ABCD rotates faster in the reversed direction.  
Suggest the changes made to the d.c. motor to achieve this.

.....  
.....  
.....

[2]

13 OR

A small conducting sphere is suspended by a non-conducting string at S. It is deflected  $20^\circ$  from the vertical when a positively charged plate is placed nearby as shown in Fig. 13.2.

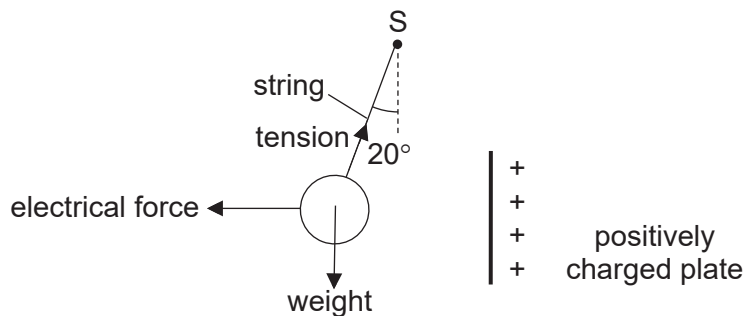


Fig. 13.2

(a) (i) State the net charge on the sphere.

..... [1]

(ii) There are three forces acting on the sphere. The tension in the string is 5N.

In the space below, draw a vector diagram, with an appropriate scale, to determine the magnitudes of the electrical force and the weight.

magnitude of electrical force = .....

magnitude of weight = ..... [4]

(iii) State the force that is the action-reaction pair of the weight of the sphere.

.....  
 .....

[1]

(b) The sphere is earthed with the charged plate still held near as shown in Fig. 13.3.

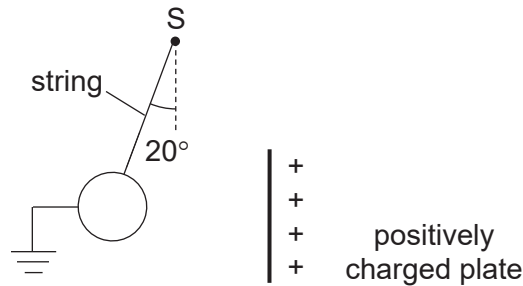


Fig. 13.3

(i) Describe the movement of charges in the sphere when it is being earthed.

.....  
 .....

[1]

(ii) The earth is now removed.

Describe and explain the change to the position of the sphere after it is earthed.

.....  
 .....

[2]

(iii) The charged plate is moved far away from the sphere.

On Fig. 13.4, draw how the charges will be distributed on the sphere.

[1]

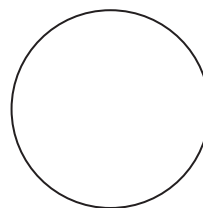


Fig. 13.4

END OF PAPER



**Anglo-Chinese School (Barker Road)**  
**2020 Sec 4 Physics (6091) Preliminary Examination Marking Scheme**


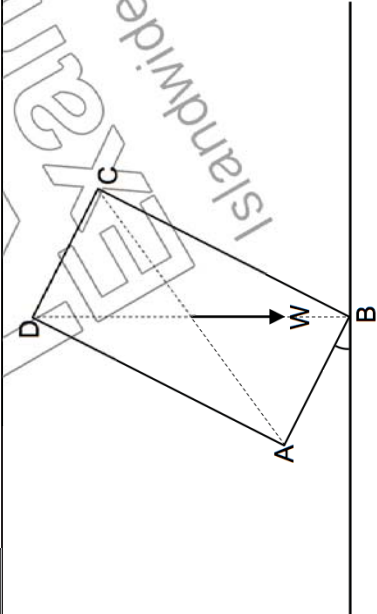
**Paper 1**

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

## Paper 2

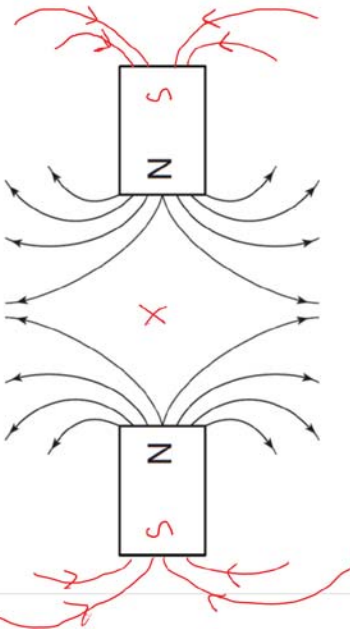
Overall remarks:

- Students who give answers in fractions will get 1 mark deducted off the whole paper.
- 1 mark is deducted for every different incorrect unit.

	Answers	Marks	Examiner's Comments
1	<p>(a) <math>t = 0.0 \text{ s} - 10.0 \text{ s}</math> : Bicycle was travelling with <b>constant acceleration</b>.</p> <p><math>t = 10.0 \text{ s} - 20.0 \text{ s}</math> : Bicycle was travelling with <b>decreasing acceleration</b>.</p>	A1 A1	
	<p>(i) <math>F = ma</math>  <math>600 - 20 = (150)(a)</math>  <math>a = 3.87 \text{ m/s}^2</math></p>	M1 A1	
	<p>(ii) <math>a = (v-u)/t</math>  <math>3.87 = \frac{V - 2}{10}</math>  <math>v = 40.7 \text{ m/s}</math></p>	M1 A1	ECF allowed
2	<p>(a) </p>	A1	As long as the cross is placed somewhat in the centre
	<p>(b) </p>	A1 A1	Arrow to indicate weight and label W (as long as perpendicular down) W arrow to pass through B

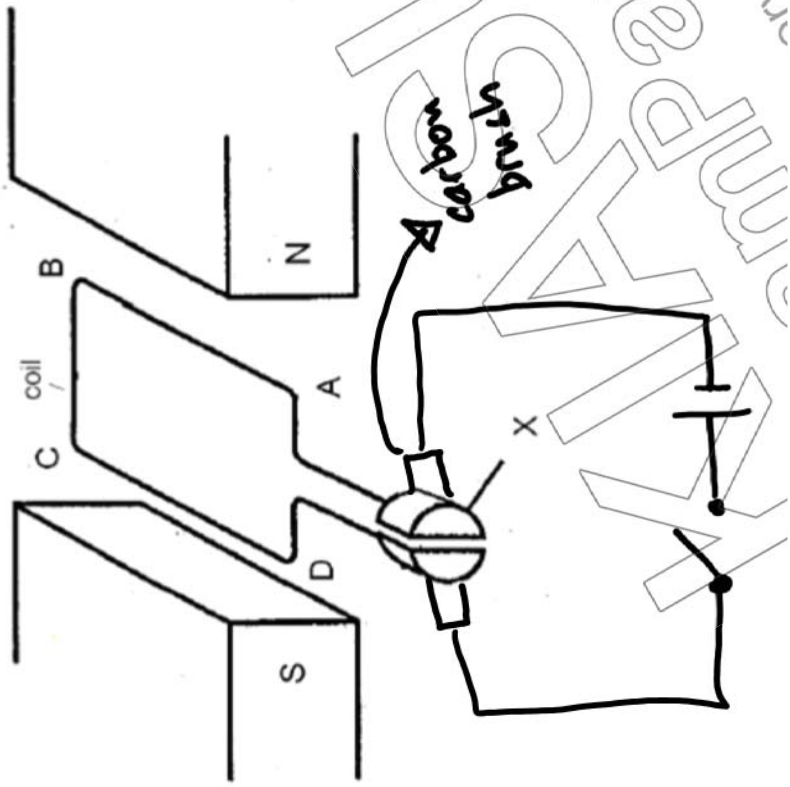
	(c)	The block must be tilted more as the CG is now lowered and hence the block is more stable	A1	More stable is not a marking point
3	(a)	Pressure due to Hg height difference $= h\rho g$ $= 0.16 \times 13600 \times 10$ $= 21\,760 \text{ Pa}$ Pressure in the flask = $21\,760 + 100\,000 = 121\,760 \text{ Pa}$ $= 122\,000 \text{ Pa}$ (3.s.f.)	M1 A1 A1	
	(b)	As it cools, <b>KE of molecules of air decreases</b> and <b>the velocity of the molecule decreases</b> resulting in molecules hitting the surface of the flask <b>less frequently and less forcefully</b> . Since Pressure is force per unit area, <b>this results in a lower air pressure</b> in the flask	A1 A1	Velocity is required
4	(a)	<b>Product of force and distance travelled by object in the direction of the force.</b>	A1 A1	
	(b)	Energy at B = energy at C $0.5mv^2 + mgh = 0.5mv^2$ $0.5 \times 5^2 + 10 \times 12 = 0.5 \times v^2$ $v = 16.3 \text{ m/s}$	M1 A1	
	(c)	(i) Work done = $10 \times 10 = 100 \text{ J}$	A1	
	(ii)	Energy of ball at E = Energy of ball at B – Work done agst friction $= 265 - 100$ $= 165 \text{ J}$	A1	
	(d)	<b>Above AB level, indicated with X</b>	A1	
5	(a)	(i) The potential difference measures <b>the temperature difference between the two junctions</b> and is not able to tell the temperature of the surrounding air. $5.0 \text{ mV} \rightarrow 100^\circ\text{C}$ $1.2 \text{ mV} \rightarrow 100 \times (1.2/5)$ $= 24^\circ\text{C}$	A1	Temperature of liquid is unknown is not suitable
	(ii)		M1 A1	

(b)	The temperature reading after the fault <b>will be lower than the actual reading / Inaccurate</b>	M1	
	The <b>height of the liquid column will not change linearly with temperature</b> OR a larger increase in volume will be required to produce the same change in height	A1	
6	frequency = $v / \lambda$ $= 3 \times 10^8 / 720 \times 10^{-9}$ $= 4.17 \times 10^{14}$ Hz	M1 A1	
(b)	(i) <b>Infrared</b>	A1	
	(ii) <b>Cooking, remote control, intruder alarms etc.</b>	A1	<b>Added intruder alarms</b>
7	(i) $\sin 30 / \sin i = 1.33$ $i = 22.1^\circ$	M1 A1	
	(ii) The ray R <sub>2</sub> travels from a <b>more optically dense medium to a less optically dense</b> medium, and is incident at the boundary with <b>an incident angle that is greater than the critical angle of water. Total internal reflection</b> occurs.	A1 A1	
(b)	In Fig. 7.2, light is able to be <b>totally internally reflected</b> and will light up the whole room while in Fig. 7.3, light enters the house and is only able to light a portion of the room. <b>Allow explanation to be supported by light rays and TIR must be seen</b> drawn in Fig. 7.2 and Fig. 7.3 if written explanation is not clear.	A1	
(c)	The boys feels warm due to <b>radiation</b> from the sun. <b>Only radiation is able to pass through a vacuum</b>	A1	

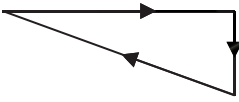
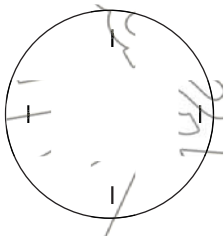
8	<p>(a)</p> <p>(i)</p>  <p>(ii)</p>	B1  B1	
(b)	<p><b>Iron.</b> It is a <b>soft magnetic material</b> and you want a material that is able to <b>magnetise</b> and <b>demagnetise easily</b></p>	B1 B1	Insist on both magnetise and demagnetise easily
9	<p>(a)</p> <p>Minimum distance  <math display="block">= \frac{330\text{m/s} \times 0.0005\text{s}}{2}</math> <math display="block">= 0.0825\text{m}</math></p>	M1 A1	
(b)	<p>(b)</p> <p>Minimum distance  <math display="block">= \frac{300000000\text{m/s} \times 0.0005\text{s}}{2}</math> <math display="block">= 75\ 000\ \text{m}</math></p> <p>The minimum distance <b>would increase to 75000 m and the proximity warning will not work in normal parking situation, so the sensor with sound would be better</b></p>	A1    A1	No ecf for this? But allow marking for second point

10	(a)	$R = V/I$ $= 200 / (7.6 - 1.9)$ $= 35.1 \Omega$	M1 A1	
	(b)	$P = IV$ $= 7.6 \times 200$ $= 1520 \text{ W}$  $\text{Energy} = P \times t$ $= 1.52 \text{ kW} \times [(110/60) \times 7]$ $= 19.5 \text{ kWh}$  $\text{Cost} = 19.5 \times 0.22$ $= \$4.29$	M1  M1  A1	See 7.6 x 200, mark can be given
11	(a)i)	$Q = mc\Delta\theta$ $200 \times 10^6 = m (4.2 \times 10^3) (45 - 25)$ $m = \underline{2380 \text{ kg}}$	M1 A1	
	aii)	$Q = mc\Delta\theta$ $= 2380 \times 4200 \times (45 - 14)$ $= \underline{3.10 \times 10^8 \text{ J}}$ or <b>310 MJ</b>	M1 A1	Ecf allowed
	aiii)	$E = Pt$ $t = \frac{3.10 \times 10^8}{(12 \times 10^3)}$ $= \underline{25800 \text{ s}}$ or <b>7.17 h</b> or <b>7.18 h</b>	M1 A1	Accept 7.18h Ecf allowed
	(b)	<p>The temperature difference between warm water and outdoor temperature is 31 °C for France and 26 °C for Fiji. The <b>amount of solar energy required to heat up water in Fiji is 0.84 of France.</b></p> <p><b>Fiji will need (7.17 x 0.84) = 6 hrs</b> of daily sunshine to gather the amount of solar energy required. However, <b>Fiji receives only 4 hrs</b> of daily sunshine and is unable to accumulate enough solar energy to maintain a temperature of 25 °C</p>	B1  B1	No data – 1

	(c)	The water pipes can be made of metal as metal is a <b>good conductor of heat.</b>	B1 B1	
12	(a)	Ohm's Law states that the <b>current flowing</b> through a conductor is <b>directly proportional to the potential difference</b> , provided <b>all physical conditions remain constant.</b>	B1 B1	
	(b)	As the <b>current increases</b> , the <b>temperature of the wire increase</b> , which affects the resistance of the circuit.	B1	
	(c)	As <b>V increases</b> , the <b>gradient decreases</b> <b>Gradient = <math>I/V = 1/R</math>. So, R increases.</b> OR <b>Ratio of <math>V/I</math> increases.</b> Since <b><math>R=V/I</math>, R increase</b>	<del>B1</del> <del>B1</del>	
	(d)	(i) Component X is a <b>rheostat or a variable resistor</b> (ii) If the resistance of X is higher, <b>the total resistance in the circuit increases.</b> Since <b>voltage of the circuit remains the same</b> , and <b><math>I=V/R</math></b> , the current in the circuit will decrease	M1 <del>B1</del> B1	OR accept. Increasing R of X will increase V at x, decreasing voltage at lamp. By $V=IR$ , since Voltage decrease, and R remains the same, I will decrease
	(e)	(i) Electric current = 0.05 A (ii) $I = V / R$ $= 2.5 / 200$ $= 0.0125 A$	M1  A1	
13 E	(a)	Current flows in the <b>direction of DCBA/ clockwise</b> around the coil. The force acting on <b>DC is acting upwards / AB is acting downwards.</b> Using your <b>thumb to represent direction of force</b> , <b>index finger to represent direction of magnetic field</b> and <b>middle finger to represent the direction of the current.</b>	B1 B1 B1	

		The magnetic field is perpendicular to the current and the force is perpendicular to both of them		
(b)	 <p>B1 – Correct circuit symbols B1 – Correct connection. Split Ring Commutator.</p>	B1 B1	Complete connection to get 1m Correct circuit symbols except for carbon brush 1m	
(c)	<p>It reverses the direction of the current every half a revolution.</p> <p>So that the direction of the force switches direction when the coil is in the vertical position, allowing in to complete a full rotation</p> <p><b>Reverse Direction – Switch direction of cell / Swap the polarity of magnets.</b></p>	B1 B1 B1		
(d)			A1	



13 O	(a)	<p><b>Rotate faster – Increase current in the coil, increase voltage of battery, in soft iron core in the coil, increase strength of permanent magnet</b></p> <p>(i) <b>Positively charged</b></p> <p>(ii) [1] – Scale <b>1cm:1N or 2cm:1N</b>  [1] – Arrowhead correct  [1] – Correct Diagram  [1] – Correct values of weight and repulsion  Weight: <math>4.7 \pm 0.3 \text{ N}</math>  Repulsion force: <math>1.7 \pm 0.2 \text{ N}</math></p>	B1 B4		
					
	(b)	<p>(iii) It is the <b>gravitational force of the sphere on the earth</b></p> <p>(i) <b>Negative charges/electrons will move from Earth to the sphere.</b></p> <p>(ii) <b>Sphere moves towards the charge plate.</b>  <b>Sphere has a net negative and unlike charges attract</b></p> <p>(iii) </p>	B1 B1 B1 A1		

