ZHONGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY 4E

Candidate's Name	Class	Register Number

PHYSICS **6091 /01**

31 August 2021
1 hour

Additional Materials: OTAS

READ THESE INSTRUCTIONS FIRST

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

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

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
Where necessary, take acceleration due to gravity, $g = 10\ m/s^2$.

Set by: Mr Tan Jun Hong and Mr Lawrence Tang
Vetted by: Mrs Ngiam-Fok Kar Yin

This document consists of **19** printed pages, including this cover page.

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1 A vernier caliper with zero error is used to measure the inner diameter of a glass cup. Diagram 1 shows the zero error and diagram 2 shows the reading when the cup is measured.

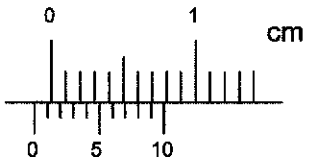


diagram 1

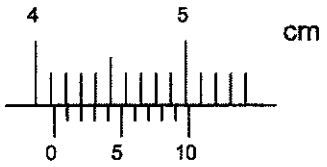


diagram 2

What is the actual inner diameter of the cup?

A 4.04 cm **B** 4.10 cm **C** 4.14 cm **D** 4.20 cm

2 Which pair of units both measure the same quantity?

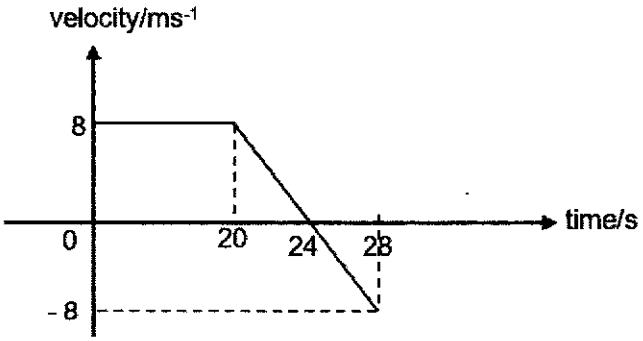
A J/s and W

B N/m and Pa

C kgm/s^2 and J

D Nm and Js

3 What is the average speed of the cyclist shown in the graph below?

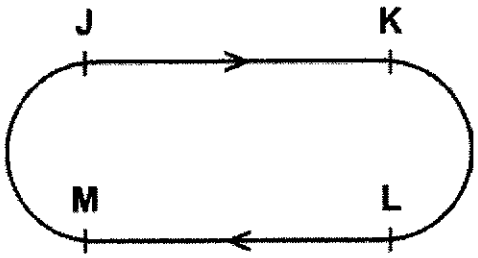


A 5.3 m/s **B** 6.7 m/s **C** 6.9 m/s **D** 8.0 m/s

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4 A car drives at a constant speed around the racing track JKLM as shown.



Which sections of the racing track will the car experience a resultant force?

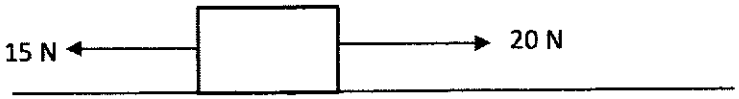
A JK and LM

B JK and KL

C KL and MJ

D LM and MJ

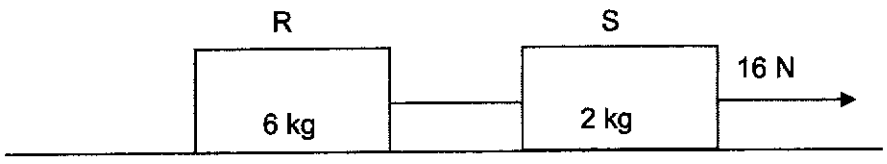
5 The following block is pulled by two forces along a rough floor as it moves at a constant speed of 2.0 m/s to the right.



Which of the following describes the friction force exerted on the block by the floor?

	magnitude of friction force	direction of friction force
A	35 N	towards the right
B	2.5 N	towards the right
C	5 N	towards the left
D	5 N	towards the right

6 A 16 N force acts on blocks R and S as shown in the figure. Assuming that the floor is frictionless, what is the tension in the string between blocks R and S?



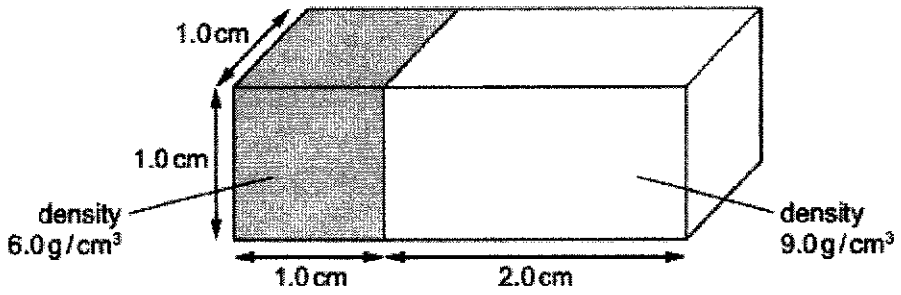
A 6 N **B** 12 N **C** 16 N **D** 48 N

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7 Two blocks are joined together.

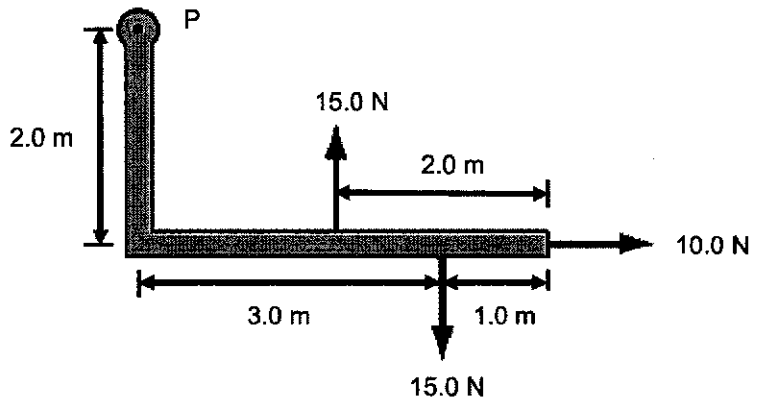


One block has a density of 6.0 g/cm^3 and the other has a density of 9.0 g/cm^3.

What is the overall density of the two blocks joined together?

A 7.0 g/cm^3 **B** 7.5 g/cm^3 **C** 8.0 g/cm^3 **D** 15 g/cm^3

8 An L-shaped rigid lever arm is pivoted at point P. Three forces act on the lever arm, as shown in the diagram.



What is the magnitude of the resultant moment due to the three forces about point P?

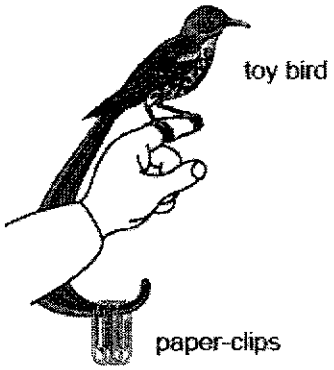
A 0 Nm **B** 5.0 Nm
C 15 Nm **D** 20 Nm

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9 A girl uses paper clips to balance a toy bird on her finger as shown in the diagram below.



What is the purpose of the paper clips?

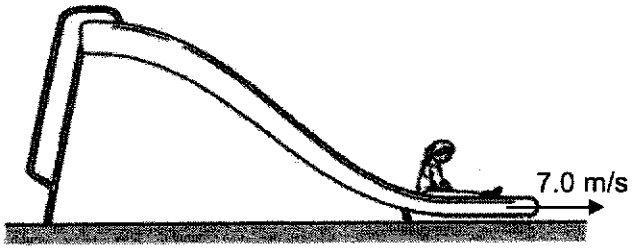
A They help to raise the centre of mass above her finger.

B They help to raise the centre of mass to her finger.

C They help to lower the centre of mass below her finger.

D They do not affect the centre of mass but increase the weight.

10 A child of mass 30 kg slides down from the top of a smooth slide. Her initial speed is 0.65 m/s. Her speed at the bottom of the slide is 7.0 m/s.



What is the height of the slide?

A 0.65 m **B** 2.43 m **C** 2.45 m **D** 6.35 m

11 A filament bulb, rated at 40 W has an efficiency of 10%. What is the rate of thermal energy loss?

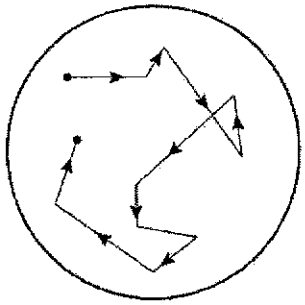
A 4.0 W **B** 4.4 W **C** 36 W **D** 76 W

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



What does this experiment demonstrate about air molecules?

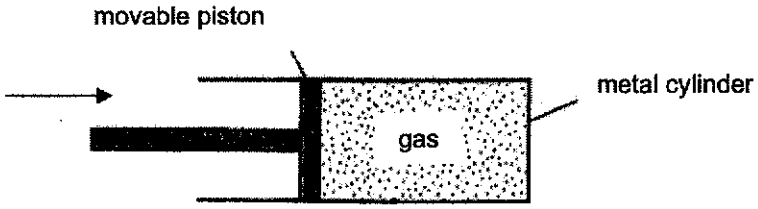
A They move because of collisions with the smoke particles.

B They move faster when they are heated.

C They are in continuous random motion.

D They can reflect light.

13 A fixed mass of gas is trapped in a metal cylinder by a movable piston. The piston is moved inwards slowly. The volume of the gas decreases but its internal energy is unchanged.



What happens to the speed of the gas molecules and their rate of collision with the piston?

	speed of gas molecules	rate of collision
A	unchanged	unchanged
B	increases	decreases
C	unchanged	increases
D	deceases	increases

14 0.10 kg of ice at its melting point is dropped into 0.80 kg of water at 15 ^{0}C. What is the final temperature of the mixture? The specific heat capacity of water is 4200 J/kgK and the specific latent heat of fusion of ice is 336 000 J/kg.

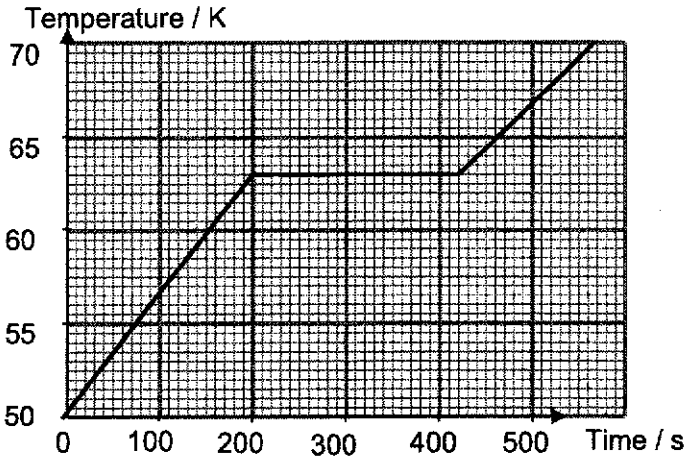
A 2.4 ^{0}C **B** 4.4 ^{0}C **C** 8.8 ^{0}C **D** 10.0 ^{0}C

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15 The graph below refers to an experiment in which an initially solid specimen of nitrogen absorbs heat at a constant rate.

The specific heat capacity of solid nitrogen is 1.6×10^3 J/(kgK).



What is the specific latent heat of fusion of nitrogen?

A 1 280 J/kg

B 2 288 J/kg

C 12 800 J/kg

D 22 880 J/kg

16 The hot junction of a thermocouple is placed in melting ice and the other in steam. The voltage reading registered is +2.50 mV. The hot junction is now removed from steam and placed in a liquid X. The voltage reading shows -1.50 mV.

What is the temperature of liquid X?

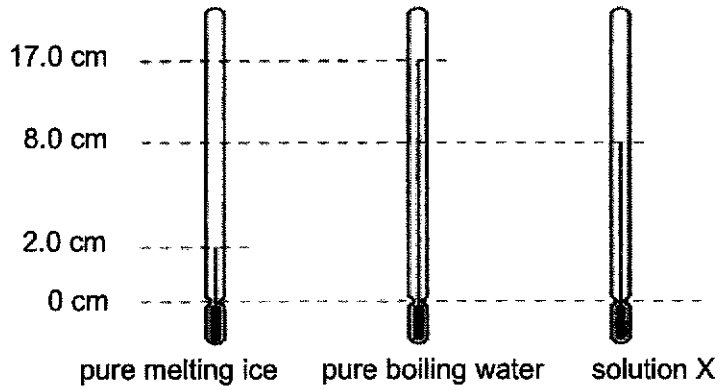
A - 167 ^{0}C **B** - 60 ^{0}C **C** 60 ^{0}C **D** 167 ^{0}C

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17 The diagram below shows the lengths of the mercury column in a laboratory thermometer placed in pure melting ice, boiling water and solution X.



What is the temperature of solution X?

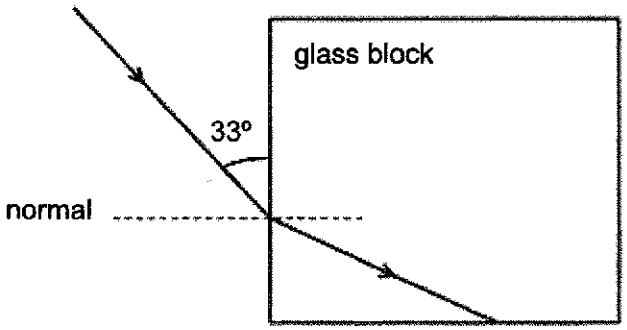
A 35.3 °C

B 40.0 °C

C 47.0 °C

D 53.3 °C

18 The diagram shows a light ray passing from air into a glass block of refractive index 1.5.



What is the angle of refraction in the glass and critical angle of the glass?

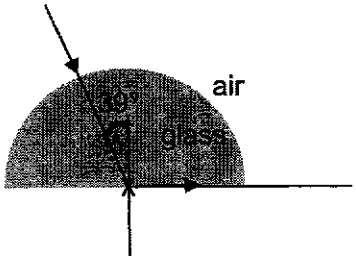
	angle of refraction	critical angle
A	34°	42°
B	34°	60°
C	38°	42°
D	38°	60°

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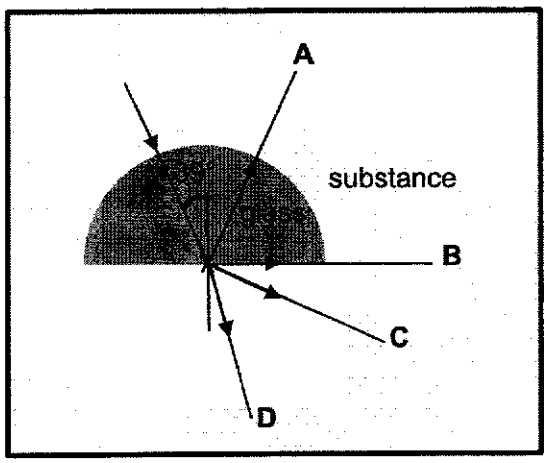
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19 A ray of light is incident on a crown glass hemisphere from air as shown. X is the centre of the hemisphere.



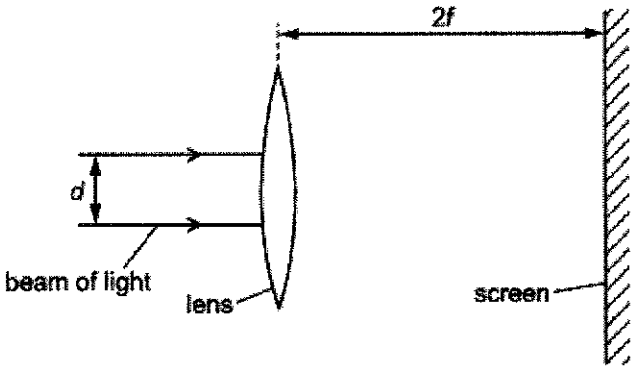
Which of the following shows how the ray of light will travel when the glass is enclosed in a substance of refractive index 1.7?



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20 The diagram shows a parallel, cylindrical light beam of diameter d incident on a thin converging lens. A screen is placed a distance equal to two focal lengths $2f$ from the lens.

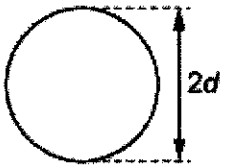


Which diagram shows the size of the spot of light seen on the screen?

A 

B 

C 

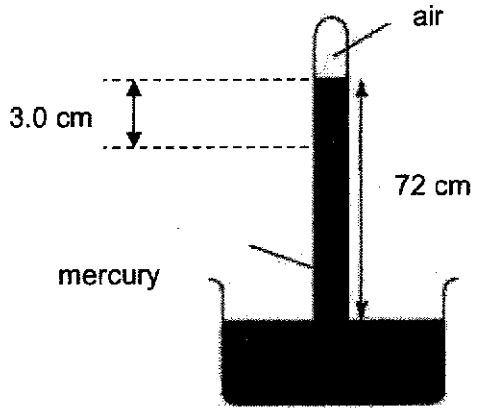
D 

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21 The barometer below contains air in the space above the mercury column. X is a point 3.0 cm below the surface of the mercury in the tube.

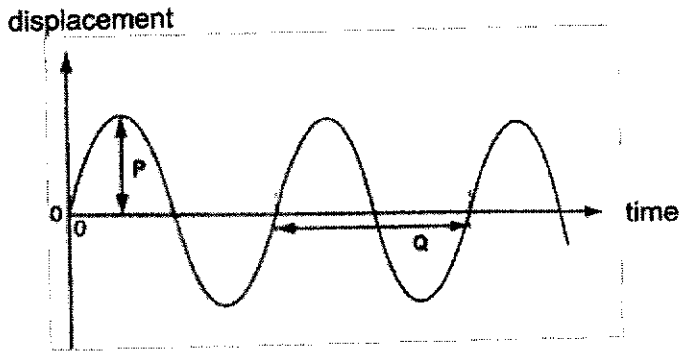


Atmospheric pressure = 76 cmHg.

What is the magnitude of the pressure of point X in the mercury?

A 1.0 cmHg **B** 7.0 cmHg **C** 69 cmHg **D** 73 cmHg

22 The diagram shows a graph of wave motion.



Which of the following correctly describes P and Q?

	P	Q
A	half the amplitude	period
B	half the amplitude	wavelength
C	amplitude	period
D	amplitude	wavelength

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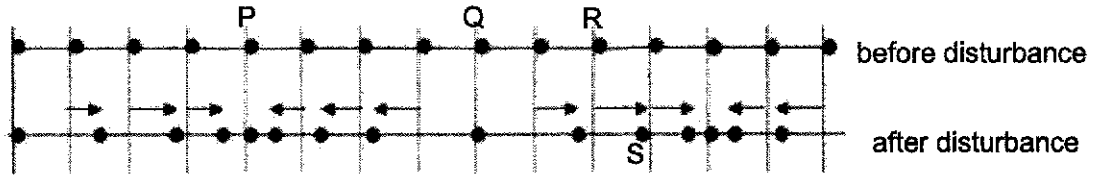
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23 What happens to the speed, frequency and wavelength of a light wave when it moves from air to glass?

	frequency	wavelength	speed
A	remains constant	changes	changes
B	remains constant	remains constant	changes
C	remains constant	remains constant	remains constant
D	changes	remains constant	changes

24 The following shows the air particles both before and after they were disturbed by a vibrating guitar string.

Points P, Q and R are positions where particles were initially before disturbance. Point S is where a particle is currently after the disturbance.



Which of the following correctly shows the lengths associated with PQ and RS?

	PQ	RS
A	half a wavelength	an amplitude
B	a wavelength	an amplitude
C	half an amplitude	half a wavelength
D	an amplitude	half a wavelength

25 A sound pulse P_1 is transmitted via an echo sounder towards the sea floor. The time taken for the pulse to hit the sea floor and to reflect back to the ship as pulse P_2 is 0.30 s. The speed of sound in water is 1500 m/s.

Which of the following shows the distance between the ship and the sea floor as well as the amplitude of pulses P_2 compared to the pulse P_1?

	distance/m	amplitude of pulse P_2
A	225	lower than P_1
B	225	same as P_1
C	450	lower than P_1
D	450	same as P_1

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26 A low pitched note in a guitar string is changed to a high pitched note by decreasing the length of the vibrating string. Which of the following statements correctly describes the change in the note?

A Its speed decreases

B Its speed increases

C Its wavelength decreases

D Its wavelength increases

27 Statements 1 and 2 are about signals passing through an optical fibre of refractive index 1.5.

Statement 1: The speed of the signal in the optical fibre is equals to the speed of light in the fibre.

Statement 2: There is more signal loss in a copper cable than in optical fibre.

Which statements are correct?

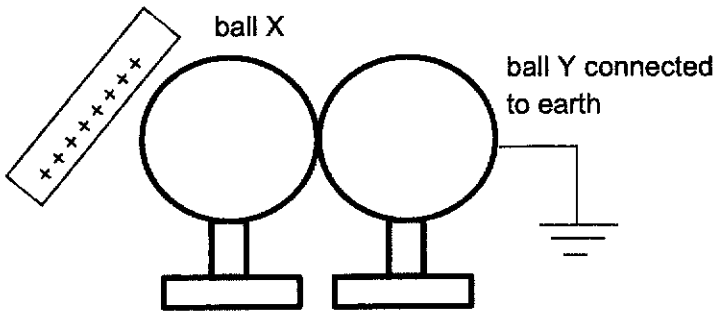
A statement 1 only

B statement 2 only

C neither of the statements

D both statements 1 and 2

28 A positively charged rod is brought near to two conducting balls, X and Y, which are touching each other. Ball Y is then connected to earth.



If the rod is still placed near ball X, which of the following describes the subsequent flow of electrons when Y is connected to earth?

A Electrons flow from earth to ball Y only.

B Electrons flow from earth to Y and to X.

C Electrons flow from earth to ball X only.

D Electrons flow to earth from balls X and Y.

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29 The following negative charge in an electric field experiences an electric force in the direction shown.



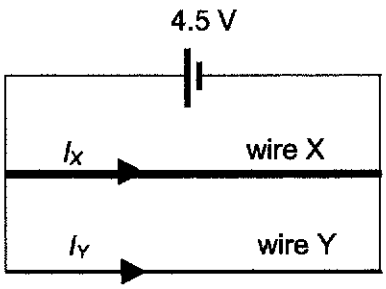
What is the direction of the electric field?

A horizontally to the right
B horizontally to the left
C vertically downwards
D vertically upwards

30 A 9.0 V battery moves a charge of 60 C in 25 s. Which of the following shows correctly the work done *W* and the current *I* through the battery?

	W/J	*I*/A
A	540	0.15
B	540	2.4
C	13500	0.15
D	13500	2.4

31 Two high resistance wires X and Y, are connected across a 4.5 V electric cell. Both wires have the same material and length. However, wire Y has a diameter that is half that of wire X. Currents I_X and I_Y flows through resistors X and Y respectively.



What is the ratio of I_Y:I_x?

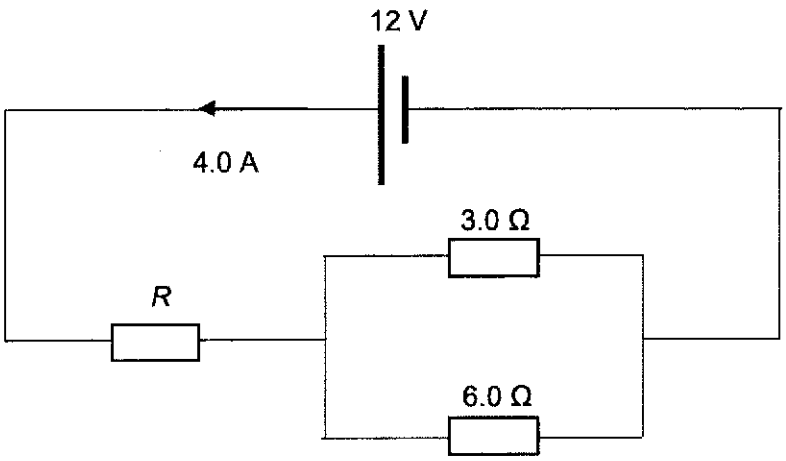
A 1:4
B 1:2
C 2:1
D 4:1

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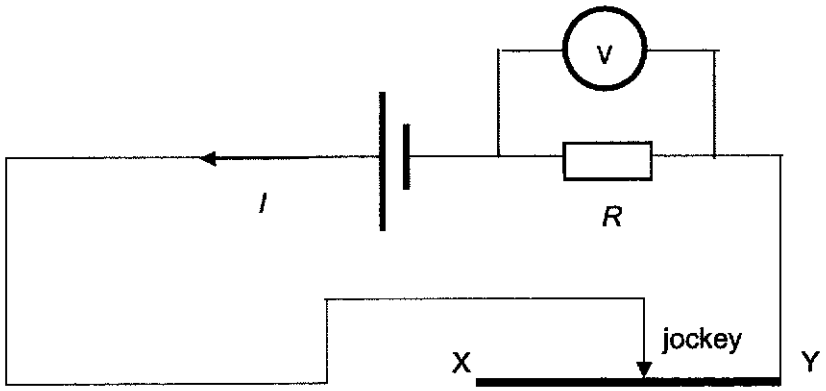
32 An electric cell of 12 V is connected to 3 resistors.



Which of the following shows the current I in the 3.0 Ω resistor and the value of *R*?

	I/A	*R*/Ω
A	1.3	2.5
B	1.3	1.0
C	2.7	2.5
D	2.7	1.0

33 The following circuit shows how a voltmeter reading V and ammeter reading I is measured as a jockey is moved from X to Y.



high R wire

Which of the following shows how *I* and *V* change as the jockey is moved from X to Y?

	I/A	*V*/V
A	constant	constant
B	increase	increase
C	increase	decrease
D	decrease	increase

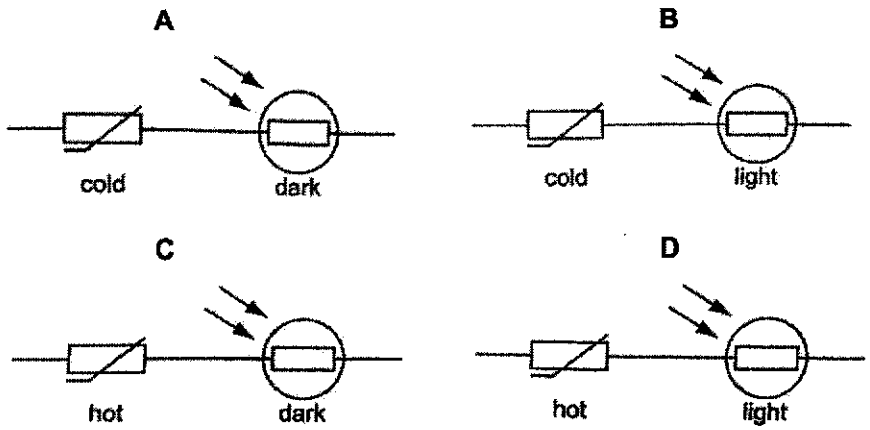
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34 A thermistor and a light dependent resistor are connected in series.

Which conditions give the smallest resistance?



35 An electrical cable contains three wires: live, neutral and earth. The cable is correctly wired to a plug, which contains a 3 A fuse. A child pulls the wires and the copper wires from the pins come loose and are exposed.

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

Four possible events can occur.

How many of these four events cause the fuse to blow?

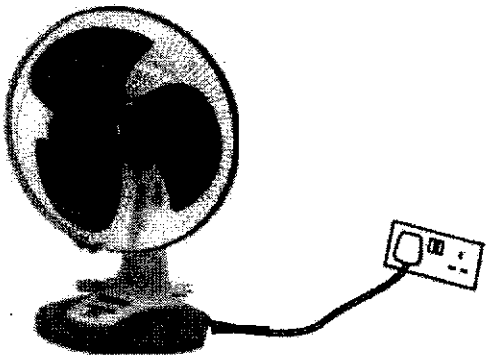
A 1 **B** 2 **C** 3 **D** 4

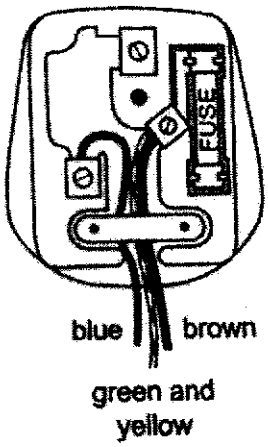
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36 The diagram shows an old standing fan with a plastic base and a metal casing. The plug of the vacuum cleaner is wrongly wired as shown.

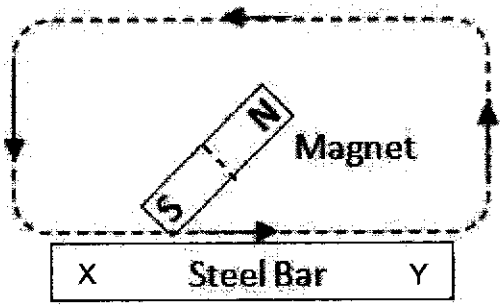




What is the effect of using the plug wired this way?

A The vacuum worker does not work
B The fuse in the plug blows
C The metal case becomes live
D The vacuum cleaner catches fire

37 A steel bar can be magnetised by stroking it with a magnet.



When the magnet strokes the steel in the direction shown, which poles are produced at X and Y?

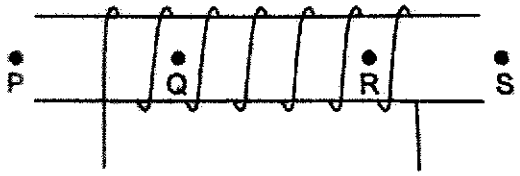
	X	Y
A	S	S
B	S	N
C	N	S
D	N	N

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38 A steady current is passed through a solenoid.



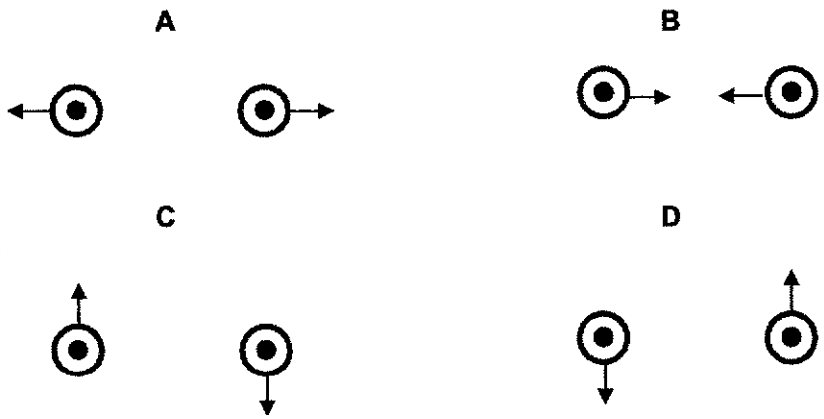
P, Q, R and S are four points on the axis of the solenoid.

Which row indicates a possible direction of the magnetic field due to the current?

	P	Q	R	S
A	→	→	←	←
B	→	→	→	→
C	→	←	→	←
D	→	←	←	→

39 Each diagram is a cross-section through two parallel current-carrying conductors. The current direction in the two wires are indicated in the diagram.

Which diagram shows the forces on the two conductors?



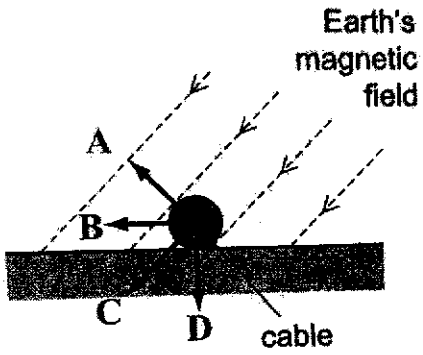
[Turn over

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40 The diagram shows, in cross section, a wire lying on the ground. There is a direct current in the cable. The earth's magnetic field is as shown.

Which arrow gives a possible direction for the magnetic force on the cable?



END OF PAPER

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ZHONGHUA SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2021
SECONDARY 4E

Candidate's Name	Class	Register Number

PHYSICS **6091 /02**

17 September 2021
1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

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

Write in dark blue or black pen.

You may use a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper

Section B

Answer all **three** questions, the last question is in the form either/or.

Write your answers on the spaces provided on the question paper.

You are advised to spend no longer than one hour on **Section A** and no longer than 45 minutes on **Section B**.

At the end of the examination, fasten all your work securely together.

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

All essential working must be shown clearly.

Where necessary, take acceleration due to gravity, g = 10 m/s^2.

For Examiner's Use	
Section A	/50
10	/10
11	/10
12 ___	/10
Total	/80

Set by: Mr Lawrence Tang and Mr Tan Jun Hong
Vetted by: Mrs Ngiam-Fok Kar Yin

This document consists of **22** printed pages, including this cover page.

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Section A

Answer **all** the questions.

Write your answers in the spaces provided on the question paper.

1 Fig. 1.1 shows a modern Formula One car. It is a single-seat and open cockpit race car with substantial front and rear wings, and its engine is positioned behind the driver.

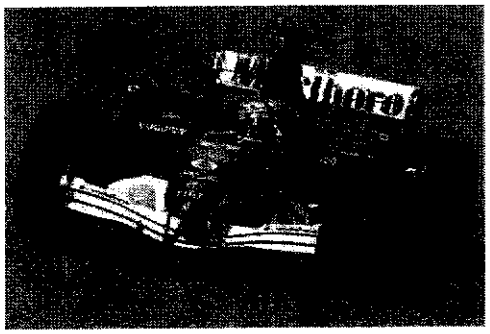


Fig. 1.1

A F1 car with a mass of 600 kg can accelerate from 0 to 100 km/h over a distance of 37 m.

(a) Calculate the time required for the F1 car to accelerate to 100 km/h.

time = _____ [2]

(b) Calculate the acceleration of the F1 car.

acceleration = _____ [1]

(c) Hence, calculate the driving force which the car experiences. Assume that there is no frictional force acting on the car.

driving force = _____ [1]

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(d) Explain, in terms of forces acting, why the F1 car will reach a maximum top speed even though the driving force in **(c)** is constantly applied.

_____

_____

_____

_____

_____ [2]

(e) After travelling at its top speed for 2 seconds, the F1 car encounters a sharp bend.

The car undergoes a decreasing deceleration for 3 seconds before approaching the bend and then travels at an increasing acceleration for the next 2 seconds while negotiating the bend.

On Fig. 1.2, complete the speed-time graph to show the motion of the F1 car. Numerical values on the vertical axis are not required.

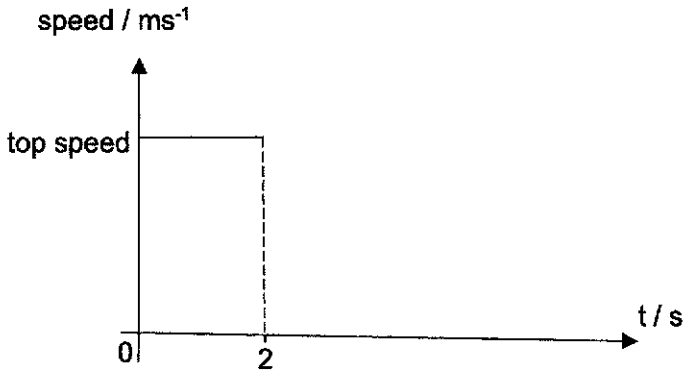


Fig. 1.2

[2]

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2 When two forces F_1 and F_2, each of magnitude 5.0 N, are added, they may produce a resultant force R that has any value from 0 N to 10 N.

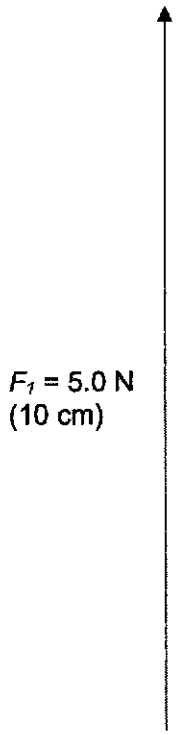
(a) Describe how it is possible to produce a zero resultant force R from these two forces of 5.0 N.

.....

..... [1]

(b) In the space below, draw a vector diagram to show how a resultant force R = 5.0 N may be obtained from the two forces F_1 and F_2, each with a magnitude of 5.0 N.

Force F_1 has been drawn for you.



[3]

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3 Fig. 3.1 shows a worker pulling up a load of mass 150 kg along a 3.0 m inclined wooden plank onto a lorry. The load is initially at rest. The tension in the rope is 600 N.

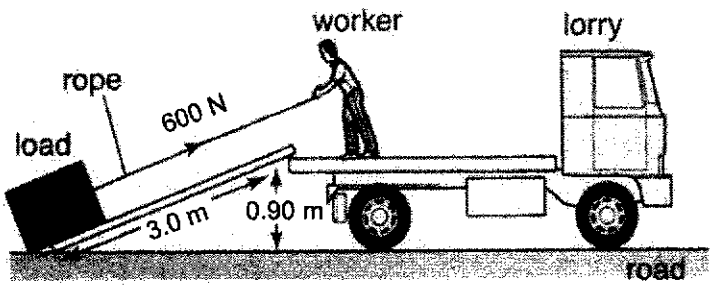


Fig. 3.1

(a) Define *work done*.

_____

_____ [1]

(b) The load remains at rest after it is pulled up on the lorry. Calculate the work done by the worker on the load.

work done = _____ [1]

(c) Calculate the gain in gravitational potential energy in the load when it is loaded onto the lorry.

gain in gravitational potential energy = _____ [1]

(d) Hence, calculate the frictional force acting on the load due to the plank.

frictional force = _____ [1]

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4 Fig. 4.1 shows an illuminated object with a base, B, and a tip, T, placed in front of a converging lens. Ray X shows a light ray travelling from B and through the converging lens.

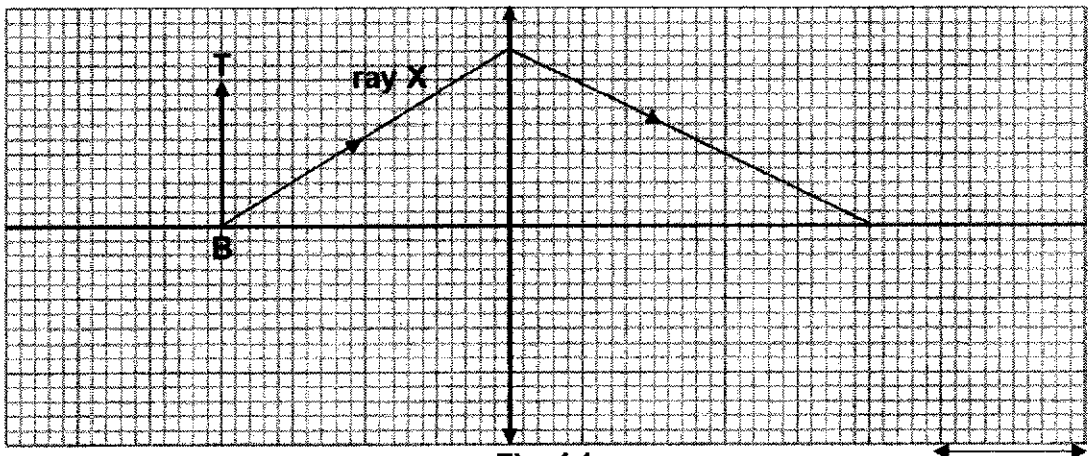


Fig. 4.1

The object is placed between $2f$ and f from the lens, where f is the focal length of the lens.

(a) State three properties of the image formed.

_____

_____ [2]

(b) Locate the image of B and label it as P on Fig. 4.1. [1]

(c) On Fig. 4.1, draw two rays from T to locate the image of T and label it as Q. [2]

(d) Hence, determine the focal length of the lens.

focal length = _____ [1]

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5 Fig. 5.1a shows a beaker of water which is fitted with a cooling coil. The initial temperature of the water is 20 °C. The cooling coil is maintained at a temperature of -10 °C and the temperatures recorded by mercury-in-glass thermometers A and B are illustrated in Fig. 5.1b.

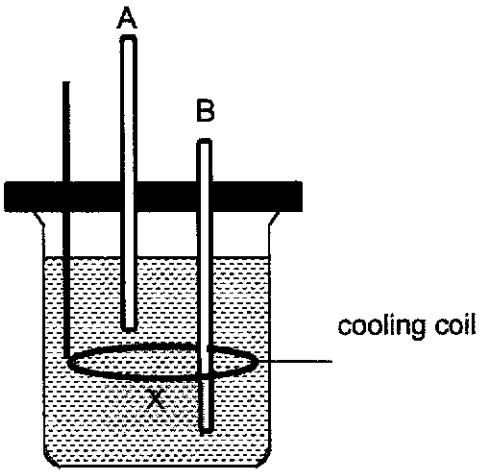


Fig. 5.1a

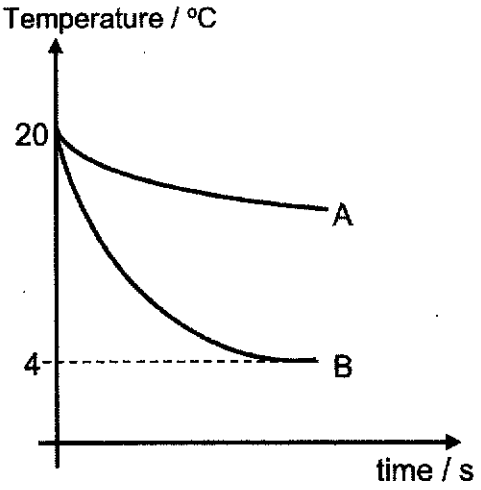


Fig. 5.1b

(a) **(i)** Draw at point X on Fig. 5.1, the direction of the convection current formed in the water due to the cooling coil.

[1]

(ii) Describe how this convection current is set up in the water.

.....

.....

.....

.....

..... [2]

(b) Explain why the temperature recorded by thermometer A decreases at a slower rate than that recorded by thermometer B.

.....

.....

.....

.....

..... [2]

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6 Fig 6.1 shows a sphygmanometer, a device used to measure blood pressure of a patient using mercury in a manometer.

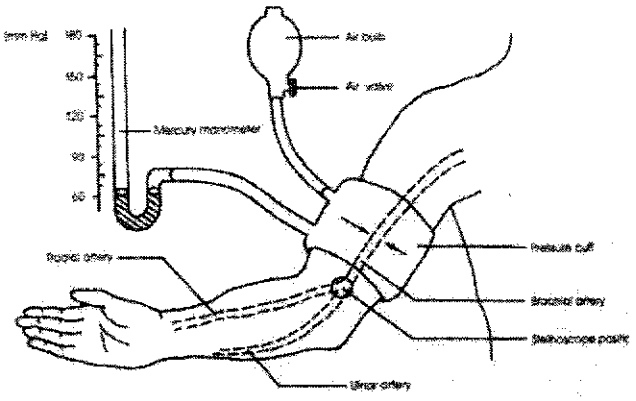


Fig. 6.1

Fig 6.2 shows an enlarged view of the manometer after the doctor has depressed the air bulb that is connected to the sphygmanometer. The right arm of the manometer is open and exposed to atmospheric pressure. P is the air pressure that is equal to the blood pressure of the patient. P_0 = atmospheric pressure = 1.01×10^5 Pa.

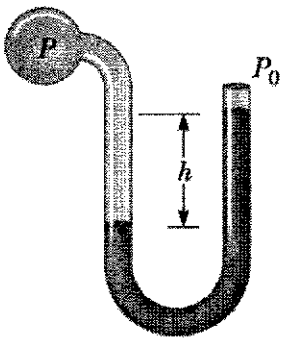


Fig 6.2

(a) The doctor observes that h = 115 mm. Calculate the blood pressure of the patient. Assume the density of mercury to be 13600 kg/m^3.

pressure = _____ [2]

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(b) The doctor proceeds to draw a liquid vaccine from a bottle. Fig 6.3 shows a syringe with the vaccine in it. The syringe has a piston with cross-section area 0.80 cm^2 and a nozzle with a cross sectional area of 0.13 cm^2.

The liquid pressure of the vaccine is 1.31×10^5 Pa.

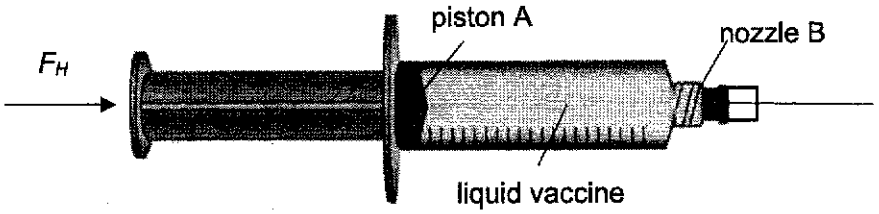


Fig 6.3

Calculate the force F_H required to just push in piston A.
Assume atmospheric pressure = 1.01×10^5 Pa.

force = _____ [2]

(c) Explain, without calculation, how the magnitudes of the force at the piston A, F_A differs from the force at the nozzle B, F_B.

_____

_____

_____

_____ [2]

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7 Visible light is a form of wave that transfers energy through the oscillation of particles. Table 7.1 shows how the different colours of visible light are arranged in ascending order of wavelength.

Table 7.1

colour	wavelength/nm
violet	389-450
blue	450-495
green	495-570
yellow	570-590
red	620-750

Visible light consisting of various colours that is incident on the ocean surface are absorbed by different amounts at different depths of the ocean. Fig 7.2 shows the percentage of surface sunlight that is left at different depths of the ocean.

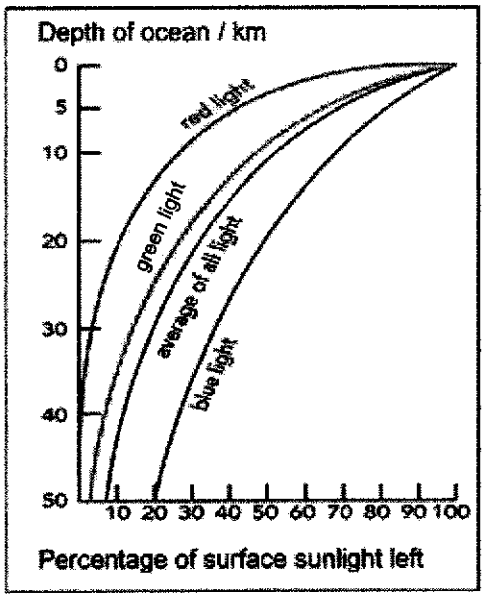


Fig 7.2

(a) State the relationship between the direction of the oscillation of visible light particles and the direction of energy transfer.

_____

_____ [1]

(b) Use Fig 7.2 to explain why fish and coral deep beneath the ocean appear blue.

_____

_____ [1]

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(c) Use Table 7.1 to deduce why the frequency of light makes the fish and coral deep beneath the ocean appear blue.

_____

_____ [1]

(d) Visible light travels at a speed of 2.31×10^8 m/s in water. Calculate the minimum frequency of blue light in water.

minimum frequency = _____ [2]

8 Photocopiers make use of electrostatic forces of attraction between toner powder and a copier drum to print images on paper.

Fig 8.2 shows the surface of a copier drum that is coated with a photo-sensitive material. The surface is given a negative charge initially.

Light is reflected off the print of a paper and hits the surface of the drum in the middle region B as shown.

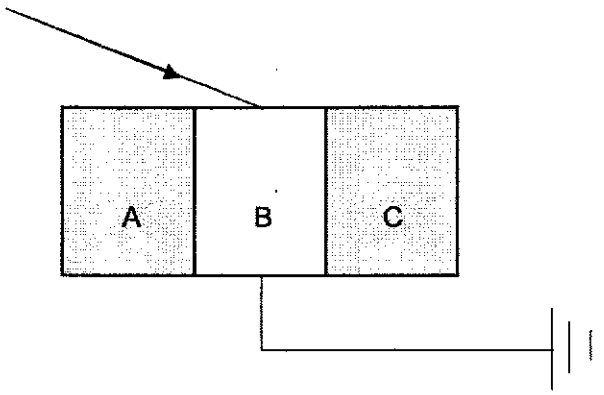


Fig 8.2

(a) Draw the distribution of the charges on the surfaces of regions A, B and C after the light is incident on B. [2]

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(b) Explain how you obtained the charge distribution in **(a)**

[2]

(c) Toner powder is now sprayed on to the surface. Fig 8.3 shows two toner particles. Deduce the charge of the particle and hence draw the electric field pattern between these two particles.



Fig. 8.3

[2]

9 Fig. 9.1 shows a circuit with a 10 kΩ thermistor and a variable resistor connected to a 9.0 V DC electric cell. A lamp is connected in parallel with the variable resistor and would light up under certain temperature conditions. The variable resistor is now at 5000 Ω.

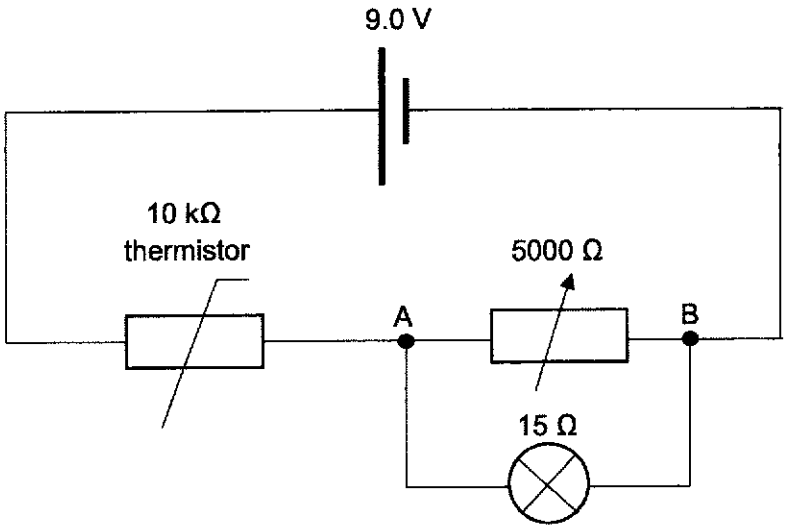


Fig. 9.1

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(a) Calculate the effective resistance across AB and hence the potential difference across the lamp in Fig 9.1.

resistance = _____

p.d across lamp _____ [2]

(b) State and explain the temperature conditions (hot or cold) which would lead to the lamp being lit.

_____

_____

_____

_____ [2]

(c) Another design is used to vary the p.d across the lamp using a potentiometer. Sketch in the space below a circuit diagram with a 9.0 V cell, a potentiometer and a lamp so that the p.d of the lamp can be varied from 0 - 9.0 V.

[2]

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Name: _____ ( )

Class: _____

Section B

Answer all **three** questions, the last question is in the form either/or.
Write your answers in the spaces provided on the question paper.

10 Fig 10.1 shows part of a ring circuit in which an electric heater draws its power. The heater has a rating of 240 V, 1.5 kW. An electrician is in the process of connecting the heater to the electrical supply in the ring circuit.

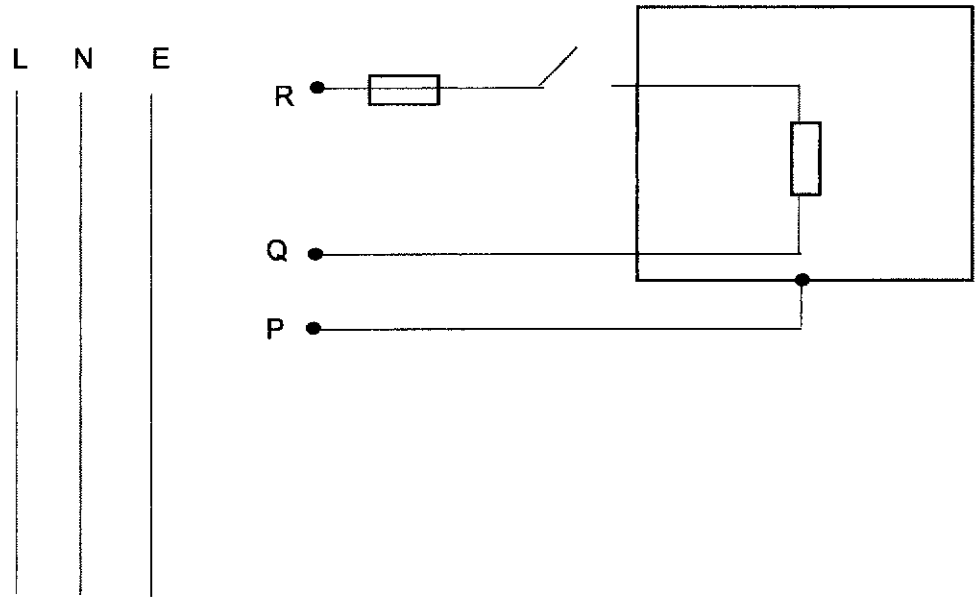


Fig. 10.1

(a) Explain why the switch and the fuse is connected to wire R.

_____

_____ [1]

(b) Complete the connection of the heater by drawing lines from points P, Q and R to the appropriate L, N and E wires. [2]

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(c) Table 10.1 shows the specifications of the heater.

Table 10.1

AR 15 Model	
Specific heat capacity of water	4200 J/(kg°C)
Capacity (volume)	15 /
Mass flow rate	3 kg / min
Power	1.5 kW
Heating performance	25 minutes for a temperature change of 5°C
Maximum working temperature	67°C
Heating element	copper

(i) Calculate the cost of using the heater for 25 minutes. You may assume one unit of electricity costs $0.24.

cost = _____ [1]

(ii) The owner of the house is considering changing the heater in Table 10.1 to another heater with an efficiency of 60%. Explain with calculations if this is a wise choice.

_____

_____ [3]

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(d) Solar heaters can also be used as power sources to power water heaters. Fig 10.2 shows how the current *I* through a heater (resistor) changes with the voltage *V* generated by a solar cell.

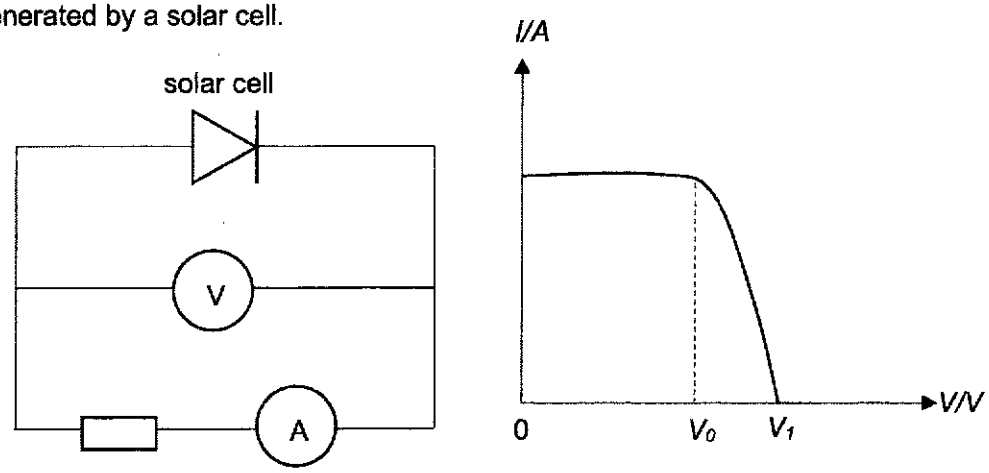


Fig 10.2

(i) Describe how the current changes as the voltage varies.

_____

_____ [1]

(ii) Describe how the resistance changes as the voltage increases.

_____

_____

_____

_____ [2]

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11 Fig. 11.1 shows an electric motor whose coil is rotating clockwise.

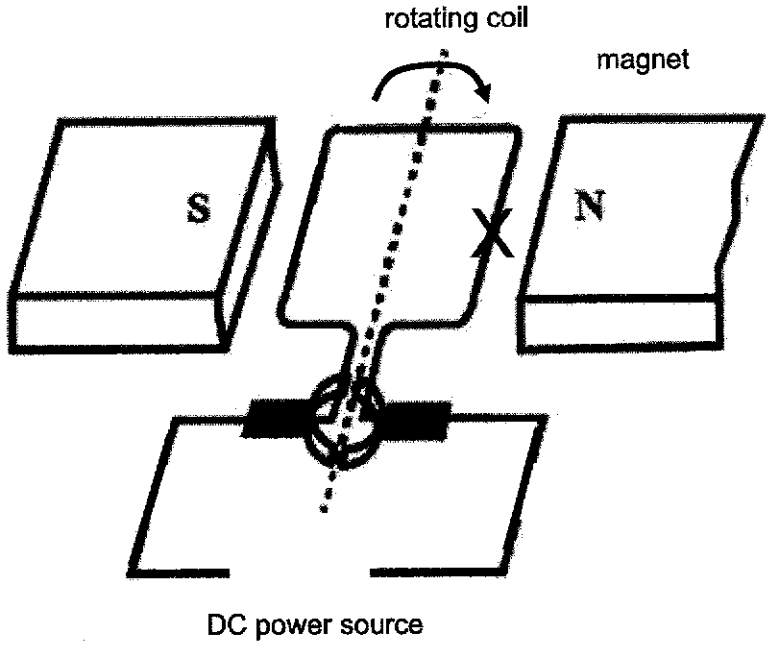


Fig 11.1

(a) State the function of the split ring commutator.

_____

_____ [1]

(b) **(i)** Complete Fig 11.1 by drawing a DC source with the terminals of the correct polarity so that current will flow in the coil and it rotates clockwise.

(ii) Draw an arrow at X to indicate the current direction of the coil due to the DC power source you have drawn in **(b)(i)**. [2]

(c) Explain how the current in the coil leads to the clockwise rotation in the coil.

_____

_____

_____

_____

_____

_____ [3]

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(d) Fig 11.2 shows how the moment of the coil varies with time, starting from the instant when the coil is horizontal as shown in Fig 11.1.

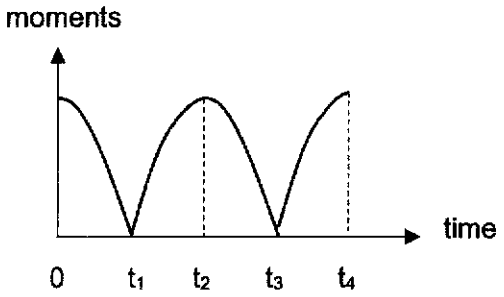


Fig. 11.2

(i) Explain how magnitude of the moments is related to the position of the coil as it rotates. Comment on the significance of the positive moment as well.

[2]

(e) A soft iron core is usually added in between the coil. Explain why this is done as well as why a steel core is not used instead.

[2]

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12 EITHER

A steam iron has a body that is made of white plastic and it is rated at 1.5 kW. It contains a tank that holds 5.0×10^{-4} m^3 of water at 30 ^{0}C. Inside the iron is a heating element which quickly boils the water. Steam is produced at 100 ^{0}C and together with water at very high temperature, is forced out of small holes in the iron's sole aluminium plate. The holes are strategically placed to direct the steam and water evenly onto the fabric being ironed.

specific heat capacity of water = 4200 J/kgK
specific latent heat of vaporisation = 2.26×10^6 J/kg
density of water = 1000 kg/m^3

(a) Calculate the thermal energy that is provided by the heating element to heat up the water to 100 ^{0}C.

heat energy = _____ [2]

(b) After using the iron for a while, 0.15 kg of water turns to steam. Calculate the time taken for this change in state.

time = _____ [1]

(c) Anyone using the steam iron must be careful not to injure themselves. Explain why a jet of steam is more dangerous than the same mass of water at 100 ^{0}C.

_____

_____

_____

_____ [2]

(d) When the iron is switched off, the water in the iron cools down. Explain in molecular terms, how evaporation causes a loss of energy from the water.

_____

_____

_____

_____ [2]

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(e) Another steam iron that has a body that is made of shiny silver-coloured metal is used for ironing. As compared to the iron that is made of white plastic, discuss the suitability of each material in reducing heat losses from the irons when their tanks contain heated water.

[2]

(f) Water is often sprayed on clothes to remove creases. It is observed that the water marks made on the clothes disappear when a hot iron is pressed down on it. Explain why these water marks disappear more quickly when a higher temperature setting is used.

[1]

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12 OR

Fig 12.1 shows a scaled diagram of Tricia using a hammer to remove a nail from a piece of wood. The force that she applied is 30 N. The hammer is pivoted at position X.

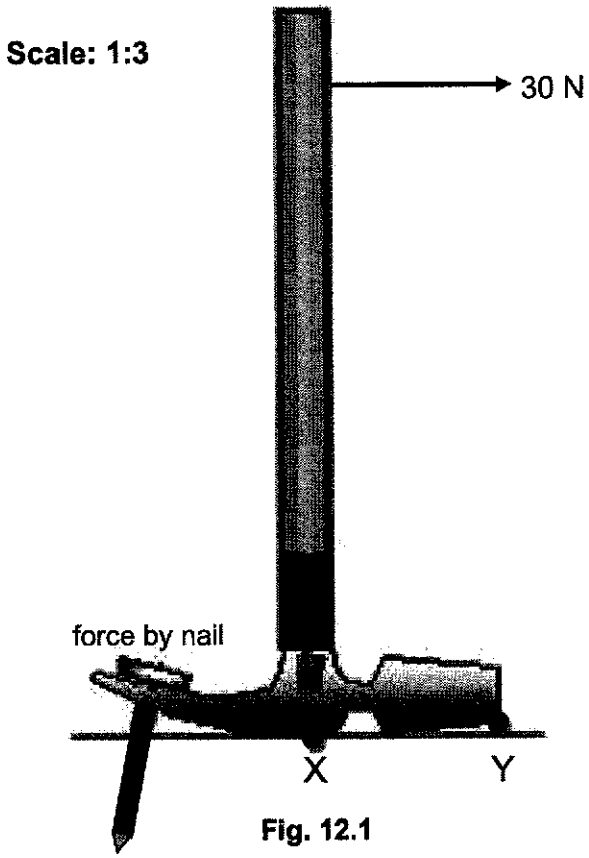


Fig. 12.1

(a) State the conditions for a body to be in static equilibrium.

_____

_____

_____ [2]

(b) Indicate the perpendicular distance in Fig. 12.1 between the

(i) force applied by Tricia and pivot X.

(ii) force exerted by the nail and pivot X. [1]

(c) Measure and state the actual perpendicular distance between the

(i) force applied by Tricia and pivot X. _____

(ii) force exerted by the nail and pivot X. _____ [1]

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(d) Calculate the force exerted by the nail.

force = _____ [1]

(e) State an assumption in your calculation of the applied force in **(d)**.

_____

_____ [1]

(f) When the nail has been pulled out a short distance, point Y of the hammer touches the wood. Describe and explain how this changes the force that is applied by Tricia.

_____

_____

_____

_____ [2]

(g) The head of the hammer is now loose and Tricia would like to tighten it. She held it vertically and banged the lower end of the hammer against the top of a work bench as shown in Fig. 12.2.

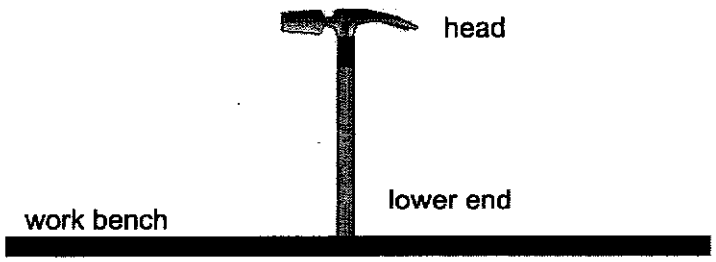


Fig. 12.2

Given that the head of the hammer is made of heavy iron and the handle is made of light wood, explain how the head of the hammer is tightened using concepts of inertia.

_____

_____

_____

_____ [2]

END OF PAPER

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2021 4E Physics 6091 Prelim Exam
Paper 1 Answers

1	C	6	B	11	C	16	B
2	A	7	C	12	C	17	B
3	C	8	B	13	C	18	A
4	C	9	C	14	B	19	D
5	C	10	B	15	D	20	C

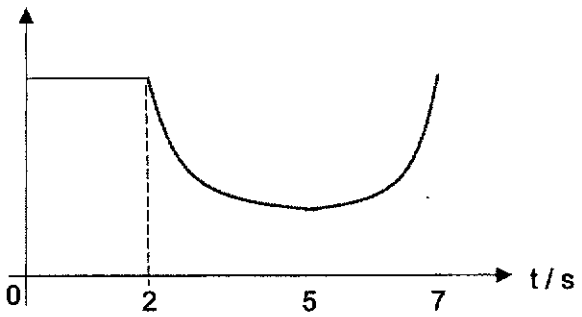
21	B	26	C	31	A	36	C
22	C	27	D	32	D	37	B
23	A	28	B	33	B	38	B
24	A	29	C	34	D	39	B
25	A	30	B	35	B	40	A

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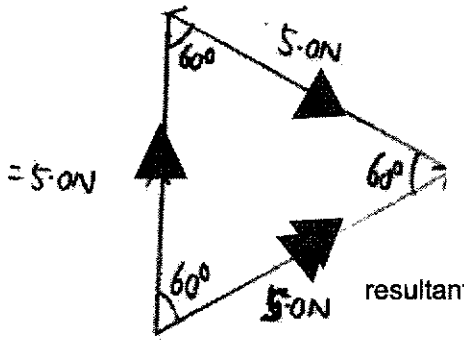
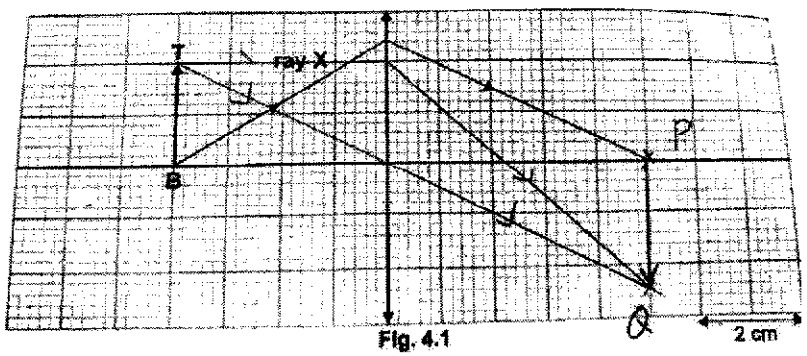
ZHSS 4E Physics 6091 2021 Prelim Exam
Marking Scheme

Section A

1	**a**	100 km/h = 27.78 m/s ½ x 28 x t = 37 t = 2.66 s (or 0.0074 hrs)	1 1
	b	(27.78 – 0)/2.66 = 10.4 m/s^2 (or 13500 km/h^2)	1
	c	F = ma = 600 x 10.4 = 6270 N	1
	d	As the F1 car accelerates, its speed increases and the <u>air resistance R acting on the car increases.</u> Since <u>resultant force = forward force – R</u>, the resultant force decreases as the resistive force increases. This causes the acceleration to decrease. When R increases until it is <u>equals to the forward force</u>, the resultant force is zero and the <u>acceleration is zero</u>, causing the velocity to become constant and not be able to increase further, hence a maximum top speed.	1 1 Idea of Forward F = R gets min of 1 m
	e	speed / ms^{-1}  	1 for each shape - 1 if time values missing
2	**a**	The 2 forces of 5.0 N must be acting in <u>opposite</u> direction	1

1

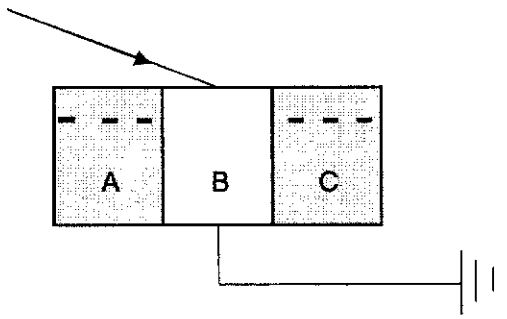
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	b	Equilateral triangle Forces and at least one 60° angle labelled Arrows  resultant force	1 1 1
3	**a**	Product of force and the distance moved in the direction of the force.	1
	b	Work = 600 x 3 = 1800 J	1
	c	GPE = mgh = 150 x 10 x 0.9 = 1350J	1
	d	Work = GPE + work done against friction Work against friction = 1800 – 1350 Friction x 3 = 450 Friction = 150 N	1 1
4	**a**	Real, inverted, magnified	2
	b,c	 Fig. 4.1	1 for each ray
	d	2.2 cm (2.0 to 2.4 cm)	
5	**ai**	Downwards arrow	1

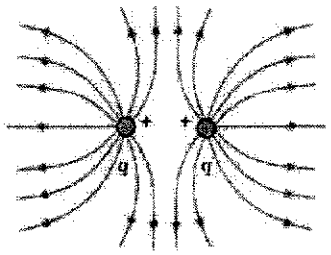
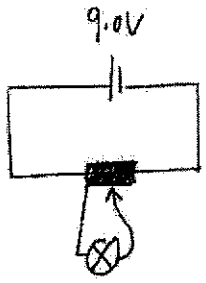
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	ii	Water near the coil cools down and contracts. Density of the cooler water increases and sinks. Warmer water at the bottom, which is less dense, rises to replace the water near the coil. The cycle continues forming a convection current.	1 1
	b	Thermometer A is located above cooling coil, where convection current is not set up / cooler water is located only in the bottom half of beaker / bottom half of beaker is cooled by both conduction and convection, whereas top half is only cooled by conduction / B is located in the region where cold water sinks to. Water at A is cooled by conduction. Water is a poor conductor of thermal energy, hence cooling of water takes a longer time.	1 1

6a	Blood pressure = $P_0 + hpg$ $= (1.01 \times 10^5) + (115 \times 10^{-3})(1.36 \times 10^4)(10)$ $= 1.17 \times 10^5$ Pa	1 for hpg term 1
b	$F_H + P_{atm}A = P_{liquid}A$ $F_H + (1.01 \times 10^5)(0.80 \times 10^{-4}) = (1.31 \times 10^5)(0.80 \times 10^{-4})$ $F_H = 2.4$ N	1 (for correct equation) 1
c	$P_A = P_B$ $F_A/A_A = F_B/A_B$ (mention F larger as A larger —> 1 m) Since $A_A > A_B$, $F_A > F_N$.	1 1
7a	They are perpendicular to each other	1
b	At great depths below ocean, the percentage of blue light that is left is more than the other colours	1
c	Blue has a lower wavelength and hence higher frequency than wavelengths of the other colours, so it can penetrate to great depths.	1
d	$f_{min} = v/\lambda_{max}$ $= (2.31 \times 10^8) / (495 \times 10^{-9})$ $= 4.7 \times 10^{14}$ Hz	1 –formula OR use of 495 1 – correct f
8a		1 -A and C 1-B (accept equal + and -)

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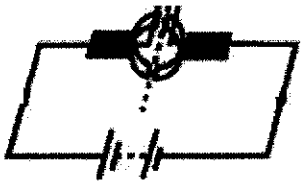
b	Region B <u>becomes conducting</u> when exposed to light. <u>Electrons flow to earth in region B</u> (but not in region A and C)	1 1
c	 If –ve -> 1 m max	1 – positive 1 – ecf correct field
9a	$R_{AB} = (1/5000 + 1/15)^{-1} = 15\ \Omega$ $V_{AB} = 15/ (15+10\ 000) \times 9.0\ V = 0.0135\ V$	1 1
b	When it is <u>hot,</u> R_{therm} <u>is low</u>. V_{therm} is low as <u>$V_{therm} = R_{therm}/ R_{total}$ x emf (or $V_{therm} \alpha R_{therm}$)</u> V_{AB} rises and lights lamp as <u>V_{AB}= emf - V_{therm} (or idea of how emf is shared among 2 components)</u>	1 (hot with consistent logic of R low) 1 (for the rest)
c		1 - potentiometer 1-Lamp and cell

Section B

No	Answer	marks
10a	When switch or fuse opens switch, <u>it is disconnected from the high voltage L wire.</u>	1
b	R to L, Q to N and P to E	1 m for one correct 2 m for all 3 correct
ci	E = P(kW) x t(h) = 1.5 kW x (25/60) hr = 0.625 kWh Cost = 0.625 kW x \$0.24 / hr = \$0.15 (nearest cent)	1

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cii	<u>Using power::</u> $n = P_{out}/P_{in} \times 100\ \%$ $P_{out} = (m\ c\Delta\theta)\ /\ t$ and P_{in} = electrical power = 1500 W $P_{out} = (3 \times 25)(4200)(5)\ J\ /\ (25 \times 60)\ s = 1050\ W$ $n = 1050/\ 1500 \times 100\% = 70\%$ He is replacing a 70% efficient heater with a 60% efficient heater – not a wise choice. <u>Using energy:</u> E out = Q in 25 min $= mc\Delta\theta =$ $= (3\ kg\ /min \times 25\ min)\ (4200 J/kg°C)(5°C)$ $= 1575000\ J$ E in = electrical $E = Pt = (1.5 \times 1000\ J/s)\ (25 \times 60\ s)$ $= 2250000\ J$ Efficiency $n = (1575000\ /\ 2250\ 000) \times 100\% = 70\%$	Equation of n = (thermal E/elec E) x 100 1 m – n = 70% 1 (ecf)
di	Current is <u>constant</u> initially then <u>decreases</u> when V increases beyond V_0.	1
dii	<u>R increases</u> initially for $V < V_0$ (R =V/I, V increases but I is constant) <u>R increases</u> even more (V increases, I decreases)	1 1
11a	To allow current direction in each branch to change every half revolution so that coil rotate continuously	1
bi		1
bii		1

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c	• Magnetic field caused by current interacts with external magnetic field to produce a combined field, with a higher field density on one side of wire compared to other side, • This produces an upward force on left branch and downward force on right branch (to show why CW) • and a moment to turn the coil	1 1 (or FLHR) 1
di	When coil goes from horizontal to vertical, the perpendicular distance d between forces and pivot are decreases, M (=Fd) is decreases. (When coil is horizontal, M maximum. When it is vertical at times t_1 and t_3, d=0 , hence M=0) M is always positive as coil rotates in the same direction always.	1 (idea of of how d affects M) 1
e	A soft iron core concentrates the magnetic field lines. This increases the force (or moment) to turn the coil and the coil turns faster (impact). A steel core is not used, as it is a hard magnetic material and hence will not concentrate field lines as much and it will not turn as fast Ideas of 1. field line concentration (or ease of magnetisation/ demagnetisation) and force (mere mention of hard/soft no credit) 2. impact on rotation speed must be stated for both iron and steel for full credit.	1 1

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12 EITHER a	Mass of water = $1000 \times 5.0 \times 10^{-4}$ = 0.50 kg Q = 0.50 × 4200 × (100-30) = 147 kJ	1 1
b	P=ml/t t = (0.15 × 2.26×10^6) / 1500 = 226 s	1
c	- Steam has more internal energy (or more potential energy or great latent heat since energy was absorbed by water to overcome intermolecular forces of attraction to form steam) than water at 100 ^{0}C) - When steam condenses, its latent heat is released to cause great harm.	1 1
d	- At the liquid surface, water molecules that have enough energy to overcome atmospheric pressure and attractive forces of other molecules escape into the environment - The less energetic molecules are left behind. The average KE decreases and average temperature falls.	1 1
e	- White: bad emitter of radiant heat; Plastic: bad conductor of heat - Shiny: bad emitter of radiant heat; Metal: good conductor of heat Therefore white plastic is a better choice.	1 1
f	Water evaporates faster when the surrounding temperature is higher (or idea of greater energy available for liquid to become gas)	1

12 OR a	The net forces about any direction is zero The sum of clockwise moments equals the sum of anti-clockwise moments about any point.	1 1
c	i) 9.0 × 3 = 27.0 cm (26.4 cm to 27.0 cm) ii) 2.4 × 3 = 7.2 cm (6.9 cm to 7.5 cm)	1
d	30 × 27 = F × 7.2 F = 113 N (ecf based on c values)	1
e	The weight of the hammer is directly above the pivot **X**.	1

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f	Force by Tricia must increase. As the perpendicular distance between the force at nail and pivot **Y** has increased therefore the anti-clockwise moment increased. The clockwise moment will have to increase (by increasing Tricia's force) to equal the increased anti-clockwise moment.	1 1
g	The hammer head has great mass and high inertia. When entire hammer hits the work bench, the head which was initially moving will continue its state of motion and move into the handle which has stopped moving.	1 1

8

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