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Name	Class				Index Number		

BROADRICK SECONDARY SCHOOL
SECONDARY 4 EXPRESS
PRELIMINARY EXAMINATION 2022

PHYSICS

6091/01

Paper 1 Multiple Choice

September 2022

Additional Materials: Multiple Choice Answer Sheet

1 hour

READ THESE INSTRUCTIONS FIRST

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

There are **forty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate OTAS 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.
The use of an approved scientific calculator is expected, where appropriate.

This question paper consists of **19** printed pages including this page.

Setter: Ms Amanda de Souza

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1 Which expression gives a base quantity?

A charge per unit time
B energy per unit time
C force per unit area
D mass per unit volume

2 A pair of Vernier calipers is used to measure the diameter of a golf ball.

Diagram 1 shows the scale when the jaws are fully closed.
Diagram 2 shows the scale when the golf ball is secured between the jaws.

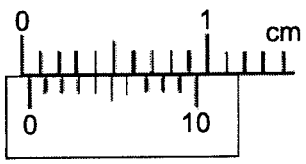


Diagram 1

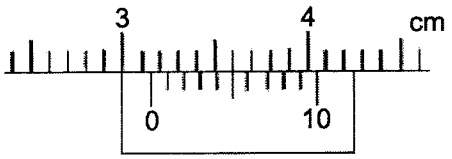


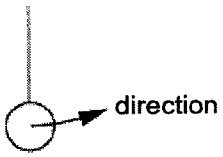
Diagram 2

What is the diameter of the golf ball?

A 3.01 cm **B** 3.11 cm **C** 3.15 cm **D** 3.19 cm

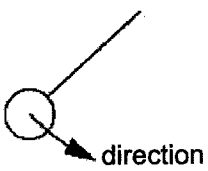
3 A pendulum has a period of 1.6 s.

A stopwatch is started when the pendulum is vertical and moving to the right as shown.

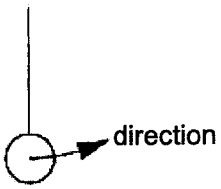


Which diagram shows the position and direction of the pendulum 4.0 s later?

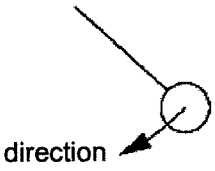
A



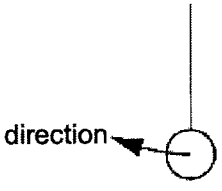
B



C



D



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4 Two vector quantities are added to produce a resultant.

Which statement about the resultant is correct?

A The direction of the resultant is always different from the directions of the two original vectors.
B The direction of the resultant is always the same as the direction of one of the original vectors.
C The magnitude of the resultant is always different from the magnitudes of the two original vectors.
D The magnitude of the resultant may be zero.

5 A car travels east at a velocity of 25 m / s along a straight horizontal track.

At time t = 5 s, its velocity starts to change and its acceleration is – 2.0 m / s^2.

How is the car moving at time t = 15 s?

A travelling east with decreasing speed
B travelling east with increasing speed
C travelling west with constant speed
D travelling west with increasing speed

6 Object X of mass m is released from a height h.

Another object Y of mass $3m$ is released from a height $3h$ simultaneously.

If both objects fall freely, taking air resistance as negligible, which of the following statements is true?

A The acceleration of both objects increases.
B The distance between object X and Y decreases and Y overtakes X.
C The distance between object X and Y remains constant before object X hits the ground.
D The velocities of both objects remain constant.

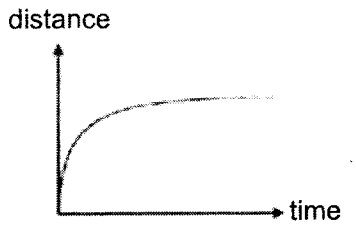
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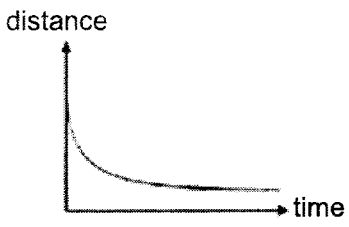
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7 Which distance time graph best represents a sky diver jumping off a plane and reaching terminal velocity?

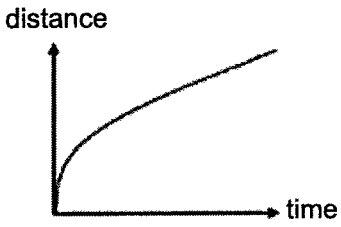
A



B



C



D



8 Four of the gravitational forces that act between bodies in our Solar System are listed below.

P : the force on the Moon due to the Earth
Q : the force on the Earth due to the Sun
R : the force on the Earth due to the Moon
S : the force on the Moon due to the Sun

Which two forces are an action-reaction pair?

A P and R **B** P and S **C** Q and R **D** Q and S

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9 A piece of plasticine is first shaped into a solid sphere, before being rolled out into a sheet.

What can be said about the densities of the sphere and the sheet?

A The densities of the sphere and the sheet are the same.

B The densities of the sphere and the sheet cannot be compared as the volumes are unknown.

C The density of the sphere is greater than the density of the sheet.

D The density of the sphere is less than the density of the sheet.

10 An astronaut lands on a planet where the gravitational field strength at its surface is lower than that on Earth.

Which of the following will remain the same as on Earth?

A The ease with which a stationary pendulum can be made to start moving.

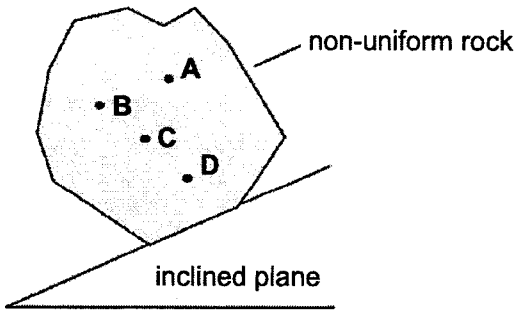
B The height reached by the astronaut when he jumps up with the same initial velocity.

C The period of a simple pendulum.

D The weight of the spacecraft.

11 A non-uniform rock is placed on an inclined plane. The object is just about to topple.

Which position is the centre of gravity of the rock?

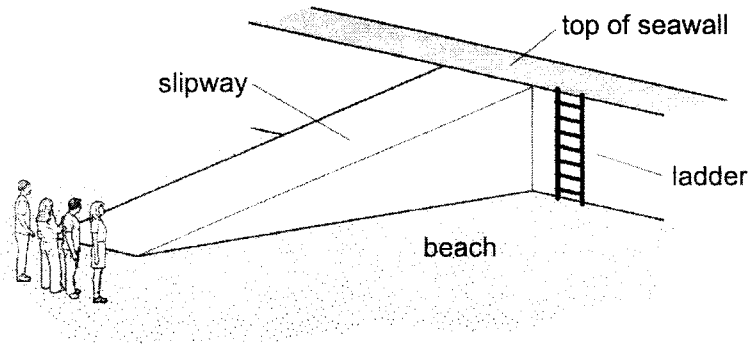


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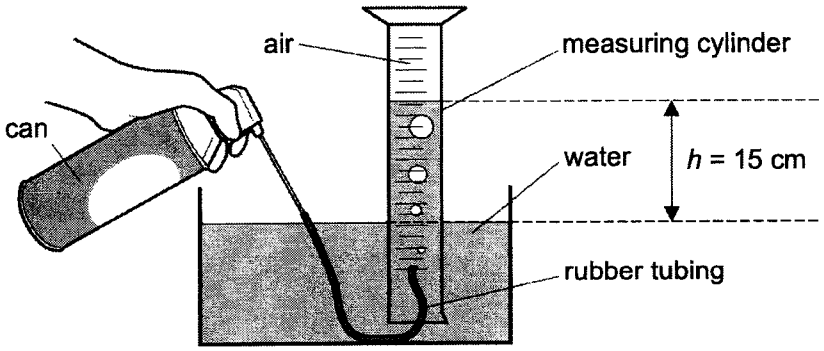
12 Four people of equal weight use different routes to get from a beach to the top of a sea wall.



Which person produces the greatest average power?

person	route	time taken / s
A	runs across the beach, then climbs up the ladder	16
B	runs up the slipway	8
C	walks across the beach, then climbs up the ladder	32
D	walks up the slipway	25

13 A measuring cylinder is inverted in a water trough.



Initially the inverted measuring cylinder is full of water. When the student presses the top of the can, air passes through the rubber tubing into the inverted measuring cylinder until no more air is able to leave the can.

The height h of the water column is 15 cm, the atmospheric pressure is 1.0×10^5 Pa, the density of water is 1000 kg / m^3 and the gravitational field strength is 10 N / kg.

What is the pressure of the air in the measuring cylinder when no more air is able to leave the can?

A 1.50×10^3 Pa **B** 9.85×10^4 Pa **C** 1.00×10^5 Pa **D** 1.02×10^5 Pa

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14 A bowl of hot rice is covered with a lid and left to cool.

Which statement best explains why it is difficult to lift the lid when the rice is cold?

A The force between the water molecules and lid is strong.

B The number of air molecules in the bowl decreases as the rice cools.

C The pressure of the air inside the bowl is lower than the atmospheric pressure.

D The water vapour that condenses on the lid makes the lid heavy.

15 In a Brownian motion experiment involving smoke particles in air, heavy smoke particles settle quickly but very light smoke particles remain suspended for long periods.

Which statement best explains why the smaller smoke particles do not settle?

A Air molecules randomly bombard the very light smoke particles.

B Atmospheric pressure has a smaller effect on very light smoke particles.

C Earth's gravitational field strength does not act on very light smoke particles.

D Very light smoke particles have the same density as air.

16 The particles of a gas, in a container of fixed volume, are supplied with more energy.

What effect does this have on the gas?

A Both the pressure and temperature of the gas increase.

B Neither the pressure nor the temperature of the gas increase.

C Only the pressure of the gas increases.

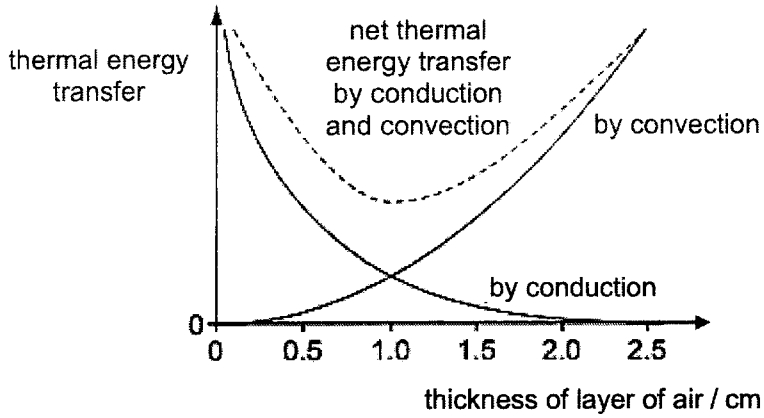
D Only the temperature of the gas increases.

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17 A double-glazed window has two layers of glass separated by a layer of air.

The amount of thermal energy transferred by conduction and convection through the layer of air varies with the thickness of the layer of air, as shown in the graph.



Which thickness of the layer of air is the most effective for a double-glazed window?

A 0.5 cm **B** 1.0 cm **C** 1.5 cm **D** 2.0 cm

18 A cup made from silver is filled with boiling water from a kettle.

Why does the outer surface of the cup feel extremely hot to the touch?

A Boiling water gives out latent heat.

B Convection currents are formed in the boiling water.

C Shiny surfaces are good emitters of infra-red radiation.

D Silver is a good conductor of heat.

19 In which of the following scenarios would a piece of wet cloth dry the fastest?

	cloth is spread out	colour of cloth	humidity	presence of wind
A	no	dark	high	yes
B	no	white	low	no
C	yes	dark	low	yes
D	yes	white	high	no

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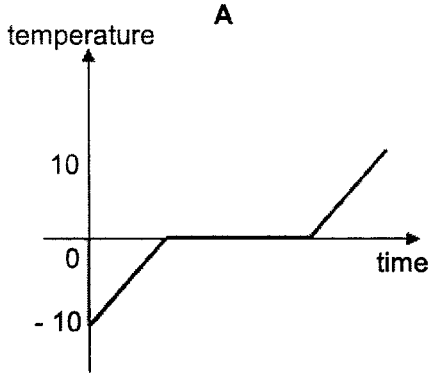
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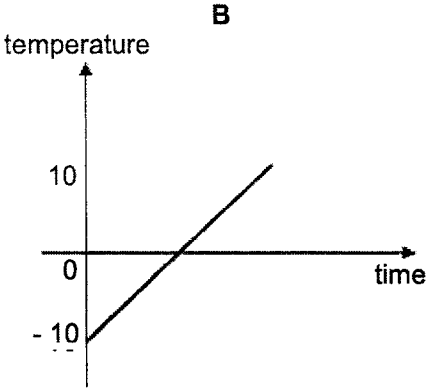
20 A block of ice at – 10 °C was heated to 10 °C.

Given that ice has a lower specific heat capacity than water, which of the following heating curves is correct?

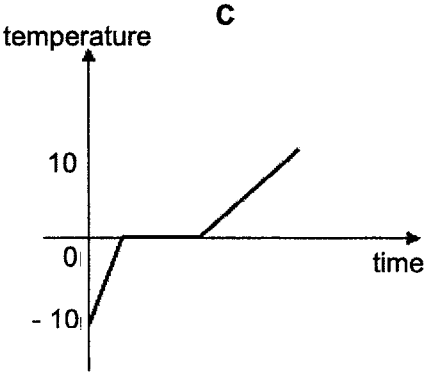
A



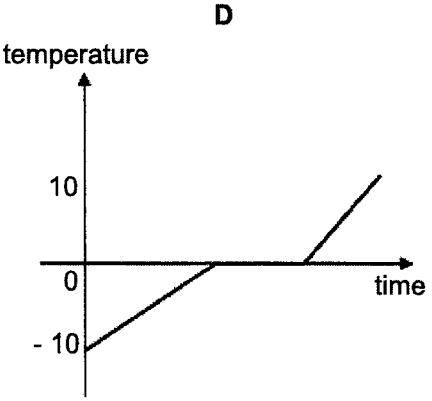
B



C



D



21 Some physical properties of materials can be used to determine the temperature of an object.

Which of the following physical properties is not suitable for this purpose?

A expansion of a metal

B mass of a liquid

C resistance of a metal

D volume of a gas at constant pressure

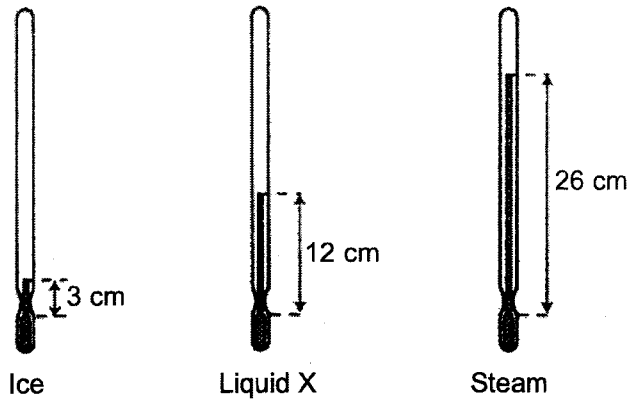
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22 An uncalibrated thermometer is placed in pure melting ice, unknown liquid X and in steam.

The corresponding lengths of alcohol in the thermometer are measured and labelled.

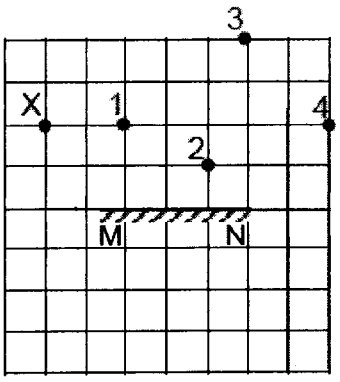


Given that the temperatures of pure melting ice and steam are 0 °C and 100 °C respectively, what is the temperature of unknown liquid X?

A 34.6 °C **B** 39.1 °C **C** 46.2 °C **D** 52.2 °C

23 A student stands at point X as shown.

There are 4 objects placed at positions 1, 2, 3, 4 in front of a mirror labelled MN.



Which objects will the student be able to see in the mirror from point X?

A 1 and 2 only. **B** 1, 2, 3 only **C** 2, 3, 4 only **D** 1, 2, 3, 4

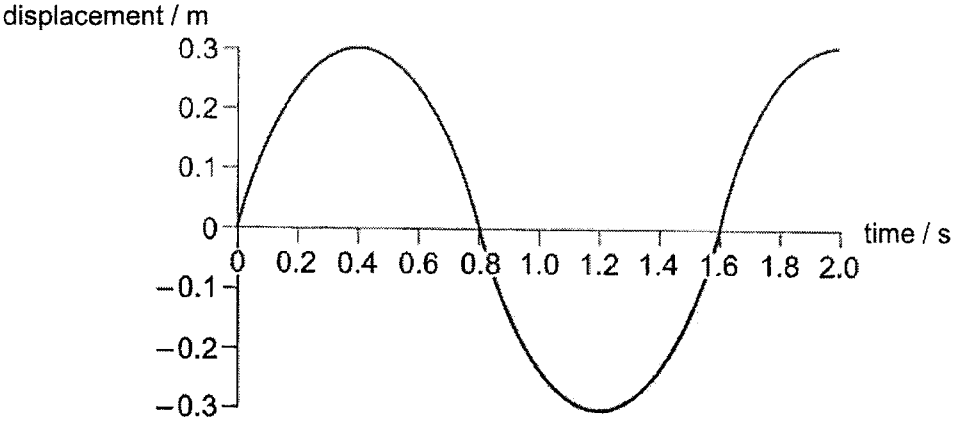
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24 A buoy oscillates on a water wave.

The graph shows how the displacement of the buoy from its equilibrium position varies with time.



What characteristics of the wave can be deduced from the graph?

A The amplitude is 0.3 m and the frequency is 0.625 Hz.

B The amplitude is 0.6 m and the period is 1.6 s.

C The period is 1.6 s and the speed is 0.375 m / s

D The wavelength is 1.6 m and the speed is 0.188 m / s.

25 In the electromagnetic spectrum shown below, which quantity decreases from left to right?

Radio waves	Microwaves	Infra-red radiation	Visible light	Ultraviolet radiation	X rays	Gamma rays

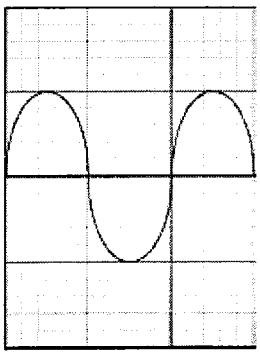
A amplitude **B** frequency **C** velocity **D** wavelength

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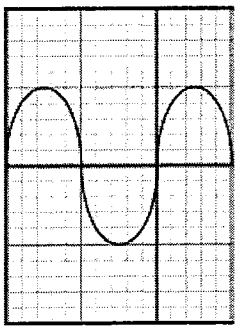
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26 The diagram shows the trace on a cathode-ray oscilloscope (c.r.o.).

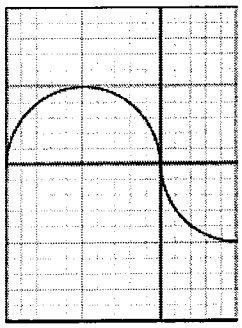


Which trace is obtained when the sound wave is change to a louder sound of lower pitch?

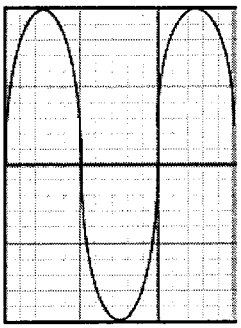
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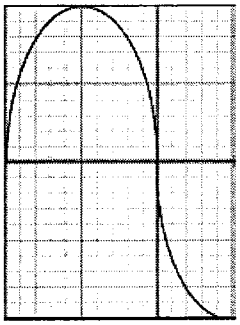
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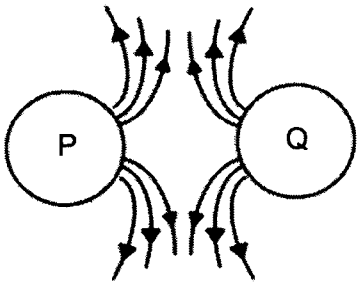
C



D



27 The electric field pattern between two electric charges P and Q is shown.



Which statement is correct?

A P and Q are both negative charges.

B P and Q are both positive charges.

C P is a negative charge while Q is a positive charge.

D P is a positive charge while Q is a negative charge.

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28 Which quantity is equivalent to electromotive force?

A The power used in driving a unit charge around a complete circuit.

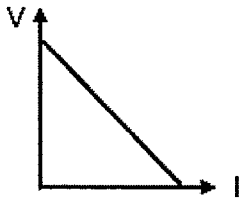
B The power used in driving one electron around a complete circuit.

C The work done in driving a unit charge around a complete circuit.

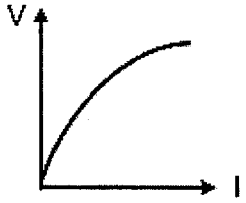
D The work done in driving one electron around a complete circuit.

29 Which of the following graphs shown how voltage varies with current for a filament lamp?

A



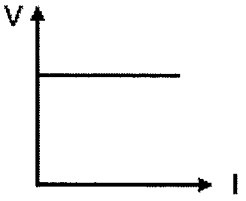
B



C



D



30 Four lamps have filaments made from the same material. The lamps are connected in series with a battery.

Which lamp converts the most energy into heat and light per second?

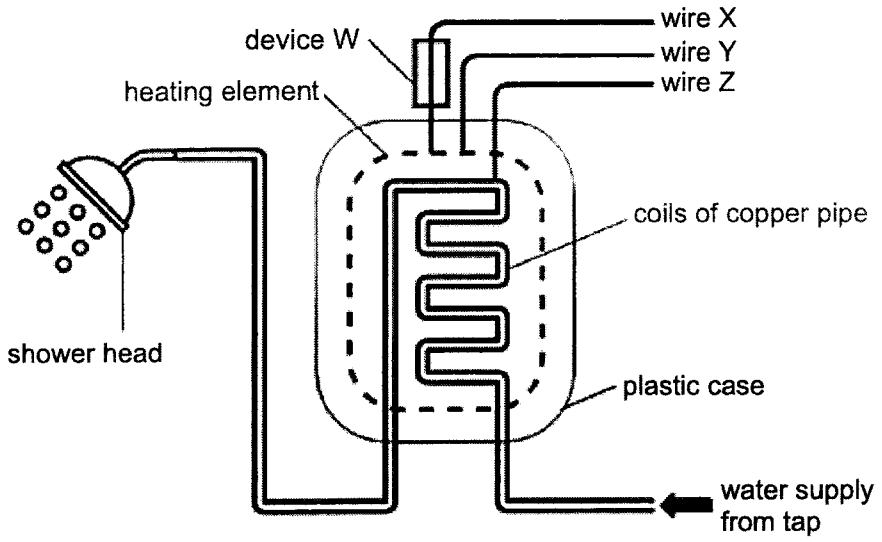
lamp	length of filament	cross-sectional area of filament
A	l	A
B	l	4A
C	$2l$	A
D	$2l$	2A

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31 An electric heater is used to heat up water for hot showers.



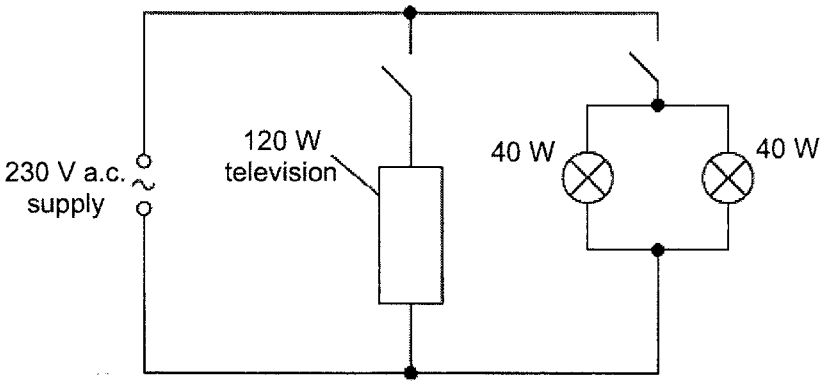
Which row describes device W, wire X, Y and Z correctly?

	device W	wire X	wire Y	wire Z
A	fuse	live	earth	neutral
B	fuse	live	neutral	earth
C	thermistor	earth	live	neutral
D	thermistor	neutral	live	earth

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32 A circuit containing a 230 V a.c. supply is connected to a 120 W television and two 40 W lamps.

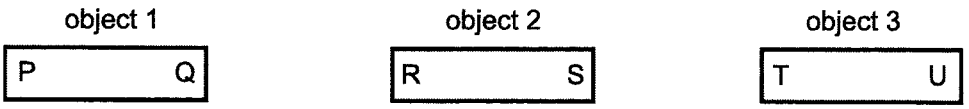


In normal operation, both switches are closed.

What is the cost of using this circuit in normal operation for 24 hours if the cost of electricity is 30.17 cents per kilowatt-hour?

A $ 1.16 **B** $ 1.45 **C** $ 144.82 **D** $ 217.22

33 Three objects are tested for their magnetic properties.



She made the following observations:

P repels T.
P attracts U.
R is attracted by both P and U.

Which of the following conclusions is true?

A Object 1 and 2 are magnets while object 3 is a magnetic material.

B Object 1 and 3 are magnets while object 2 is a magnetic material.

C Object 2 and 3 are magnets while object 1 is a magnetic material.

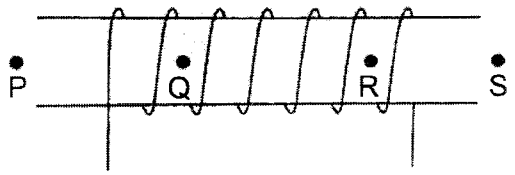
D Object 1, 2 and 3 are all magnets.

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34 A steady current is passed through a solenoid.

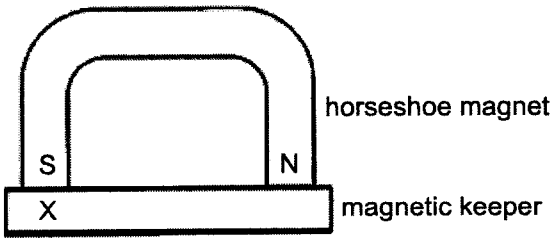


P, Q, R and S are four points on the axis of the solenoid. Q and R are inside the solenoid.

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

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

35 A permanent horseshoe magnet and soft magnetic keeper are arranged as shown.



Which row describes the materials used and polarity of end X correctly?

	magnet	keeper	polarity of X
A	iron	iron	north
B	iron	steel	south
C	steel	iron	north
D	steel	steel	south

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36 Each of the diagrams below is a cross-section of two parallel current-carrying conductors.

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

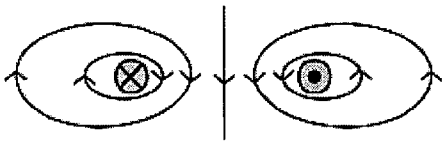
A



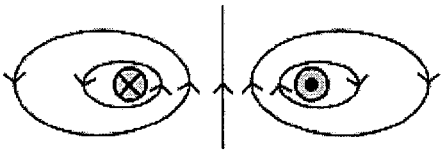
B



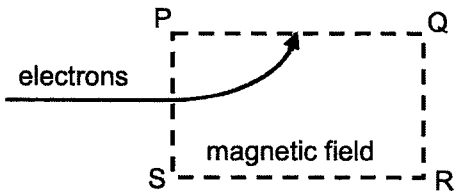
C



D



37 The motion of a stream of fast-moving electrons is changed when it enters a magnetic field in the dotted area PQRS as shown.



What is the direction of the magnetic field in the dotted area PQRS?

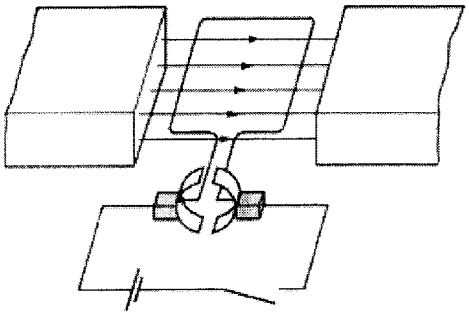
A into the page **B** out of page **C** side PS to QR **D** side QR to PS

[Turn over

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38 In a simple d.c. motor, the switch is closed and the coil rotates within the poles of a magnet.



Which of the following changes will make the coil rotate in the opposite direction and at a faster rate?

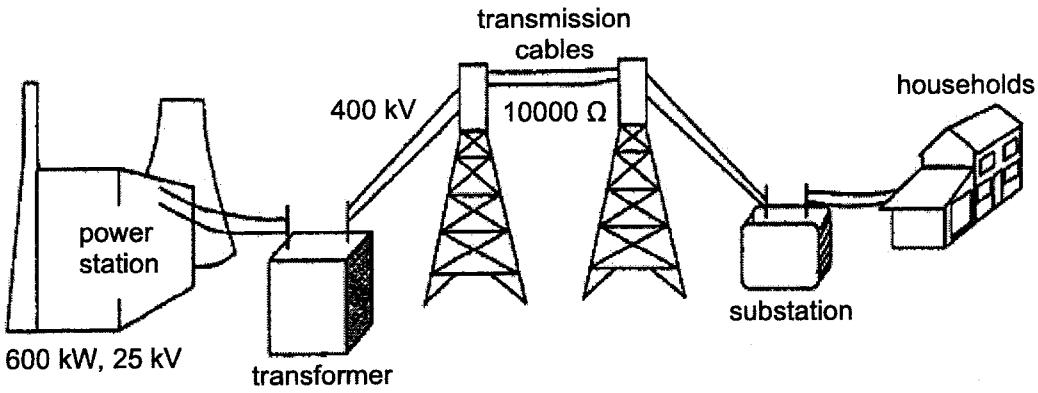
A Decrease the current in the coil and reverse the magnetic field.

B Increase the current in the coil and insert a soft iron core.

C Reverse both the magnetic field and the direction of the current in the coil.

D Reverse the magnetic field and increase the number of turns in the coil.

39 Electricial energy generated in power stations is transmitted through overhead cables to subtations for household usage.



600 kW of electrical power is supplied by the power station at a voltage of 25 kV. During transmission, the voltage is stepped up to 400 kV and the resistance of the overhead transmission cables is 10000 Ω.

What is the power loss in the overhead transmission cables?

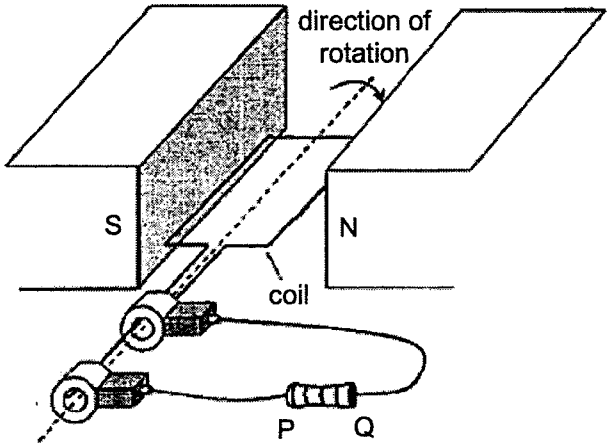
A 15.0 kW **B** 16.0 kW **C** 22.5 kW **D** 37.5 kW

[Turn over

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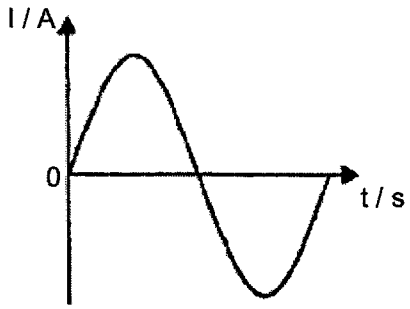
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40 The position of the coil in an a.c. generator at time $t = 0$ s is shown.

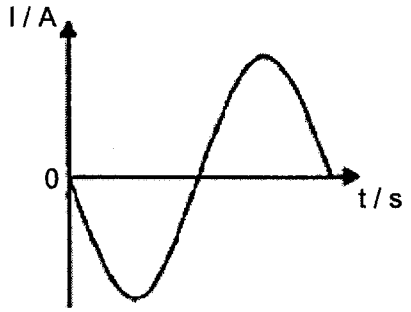


If the current is positive when it flows from P to Q through the load, which of the following graphs shows the variation of the current with time as the coil rotates?

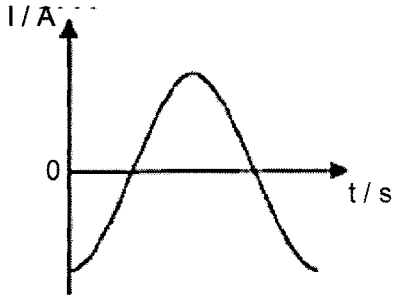
A



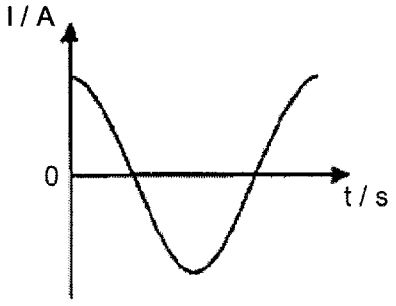
B



C



D



End of paper

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Name	Class				Index Number		

BROADRICK SECONDARY SCHOOL
SECONDARY 4 EXPRESS
PRELIMINARY EXAMINATION 2022

PHYSICS

6091/02

Paper 2 Theory

September 2022

Candidates answer on the Question Paper

1 hour 45 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.

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

Candidates are reminded that all quantitative answers should include appropriate units.
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 sound use of Physics than for correct answers.

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

For Examiner's Use		
Paper 1		/40
Paper 2	Section A	/50
	Section B	
	Q 9	/12
	Q 10	/8
	Q 11	/10
Total		/120

This question paper consists of **20** printed pages including this page.

Setter: Ms Amanda de Souza

[Turn over

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Section A [50 marks]
Answer **all** questions in the spaces provided.

1 (a) (i) Circle the value of the prefix *Mega*.

10^{-9} 10^{-6} 10^{-3} 10^{-2} 10^{-1} 10^{3} 10^{6} 10^{9} [1]

(ii) Rearrange the following prefixes in order from the largest to the smallest value.

μ d G n

_____ [1]

(b) Fig. 1.1 and Fig. 1.2 show two ways of hanging a picture frame, weighing 16 N, on a wall.

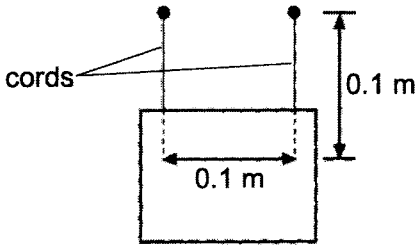


Fig. 1.1

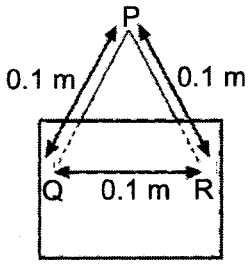


Fig. 1.2

In Fig. 1.1, the frame is hung from two identical cords, each of length 0.1 m, spaced 0.1 m apart. In Fig. 1.2, a similar cord, of length 0.2 m, is used to suspend the frame from a single point P, such that points Q and R are also spaced 0.1 m apart.

(i) State the tension in each cord in Fig. 1.1.

tension = ... [1]

(ii) In the space below, draw a labelled diagram to determine the tension in the parts of the cord, PQ and PR, in Fig. 1.2.

tension in PQ = ...

tension in PR = ... [3]

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2 Fig. 2.1 is a graph describing the motion of a car.

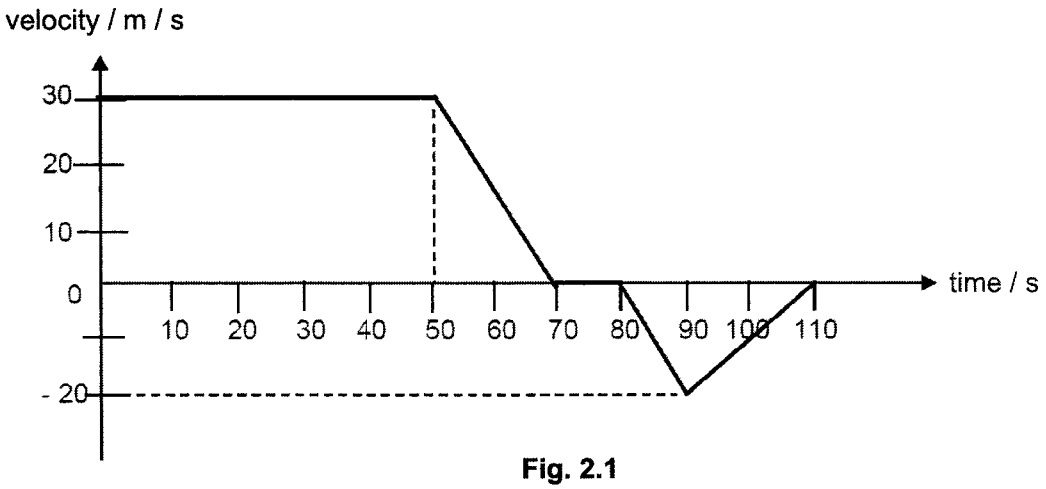


Fig. 2.1

(a) Explain, in terms of forces acting, why the car moves at constant speed for the first 50 seconds.

_____

_____ [1]

(b) Describe the motion of the car from the 50th to the 90th second.

_____

_____

_____ [3]

(c) Calculate the displacement of the car at 110 s.

displacement = ... [2]

(d) Calculate the average speed of the car for the entire journey.

average speed = ... [2]

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3 Fig. 3.1 shows a bird cage hanging on a uniform wooden pole of length 1.8 m and mass 10 kg.

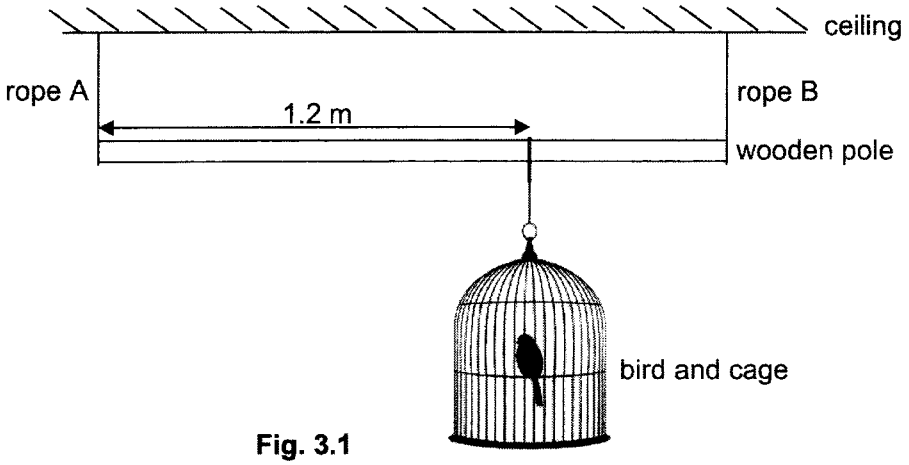


Fig. 3.1

The pole is kept horizontal by two ropes, A and B, each tied at the ends of the pole.
The bird and the cage have a total mass of 6 kg and is suspended 1.2 m away from rope A.
The gravitational field strength g is 10 N / kg.

(a) Describe the difference between *mass* and *weight*.

_____

_____ [1]

(b) Using the principle of moments or otherwise, calculate the tension in rope A and B.

tension in rope A = ...

tension in rope B = ... [3]

(c) The bird keeper wants to suspend another bird cage of weight 30 N on the pole without increasing the tension in rope B as he is afraid rope B will snap.

Suggest and explain where he should suspend this second bird cage.

_____

_____ [2]

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4 Fig. 4.1 shows a water gun that makes use of pressure exerted on a trigger to spray water out of a nozzle.

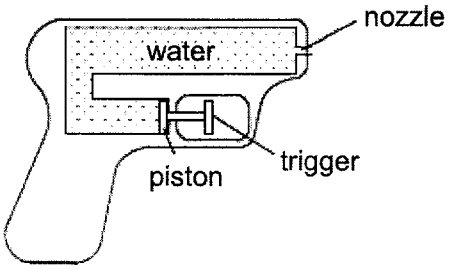


Fig. 4.1

(a) The cross-sectional areas of the piston and nozzle are 2.0 cm^2 and 0.08 cm^2 respectively.

If a force of 5 N is exerted on the trigger, calculate the force exerted on the water leaving the nozzle.

force = ... [2]

(b) When the force of 5 N is applied, the piston moved a distance of 0.6 cm.

(i) Determine the mass of water moved by the piston, given that the density of water is 1 g / cm^3.

mass = ... [1]

(ii) Calculate the work done on the water in the water gun.

work done = ... [1]

(iii) Hence, determine the speed of the water leaving the nozzle.

speed = ... [2]

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5 One type of renewable energy source is shown in Fig. 5.1.

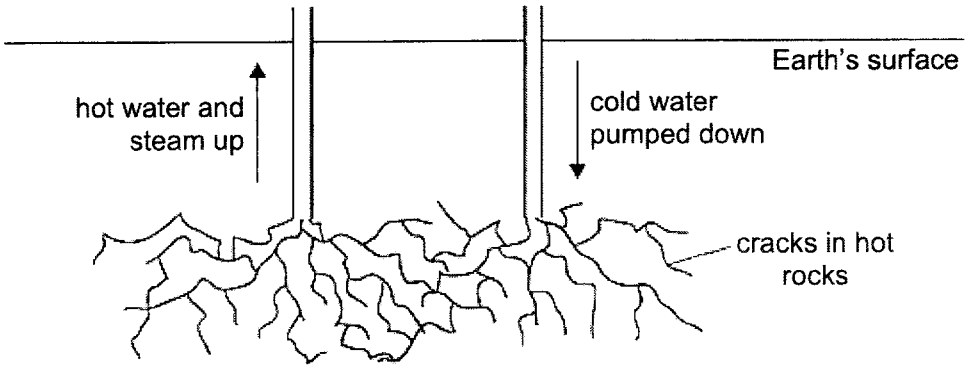


Fig. 5.1

(a) State the name of the renewable energy source shown in Fig. 5.1.

_____ [1]

(b) 100 kg of cold water of a temperature of 20 °C is pumped down to the hot rocks.
The water returns partly as steam and partly as hot water, both at a temperature of 100 °C.
The specific heat capacity of water is 4200 J / (kg °C).
The specific latent heat of vaporisation of water is 2200 kJ / kg.

Calculate the total energy needed to raise the temperature of the water from 20 °C to 100 °C and to vaporise 40 kg of the water into steam.

total energy needed = ... [3]

(c) Using ideas about molecules and internal energy, explain why more energy is released when 1 kg of steam cools to 20 °C than when 1 kg of hot water cools to 20 °C.

_____

_____

_____

_____

_____

_____ [4]

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6 A thin converging lens, with a focal length of 3.0 cm, is shown in Fig. 6.1.
An object O is placed in front of the lens.

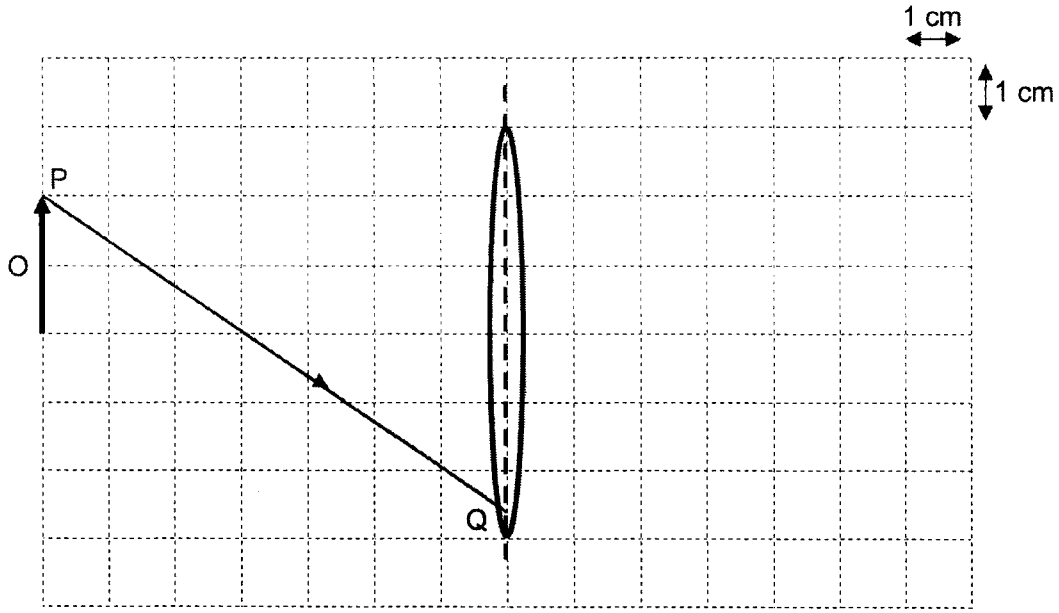


Fig. 6.1

(a) On Fig. 6.1,

(i) draw 2 more rays from the top of the object to locate the top of the image. Draw the whole image and label it as I. [2]

(ii) complete the path of the ray PQ. [1]

(b) The object is moved closer to the lens.

Describe two possible changes this causes to the image.

_____

_____

_____

_____ [2]

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7 Fig. 7.1 shows a Van de Graaff generator which is used to produce charges.

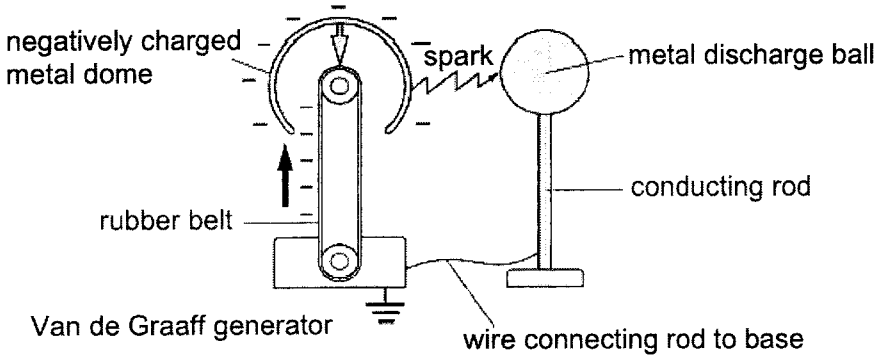


Fig. 7.1

The rubber belt carries negative charges to the dome, making it negatively charged.
When a metal discharge ball is moved near the metal dome, sparks are produced.

(a) On Fig. 7.1, draw the charges induced on the metal discharge ball just before a spark is produced. [1]

(b) Explain how these charges are induced on the metal discharge ball.

_____

_____

_____

_____ [2]

(c) When sufficient negative charges have accumulated on the dome, a spark will jump from the metal dome to the discharge ball. For each spark, a charge of 0.57 mC moved through the spark in 0.013 s.

Calculate the average current in each spark.

current = ... [2]

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8 **(a)** Fig. 8.1 shows the structure of a relay.
Fig. 8.2 shows a circuit that includes the relay shown in Fig. 8.1.

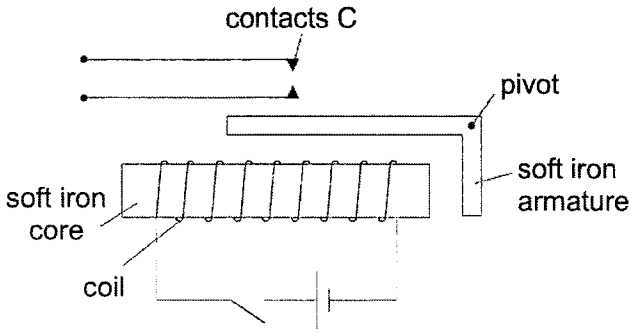


Fig. 8.1

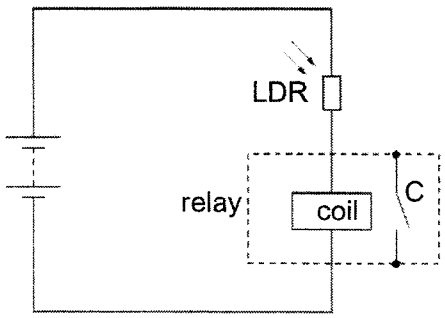


Fig. 8.2

When light shines on the light-dependent resistor (LDR), the relay contacts C close.

(i) Deduce what happens to the resistance of the LDR when light shines on it.

_____

_____ [1]

(ii) Hence, explain why the relay contacts C close when light shines on the LDR.

_____

_____

_____

_____

_____

_____ [3]

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(b) Fig. 8.3 shows a coil ABCD suspended between two poles of a magnet.

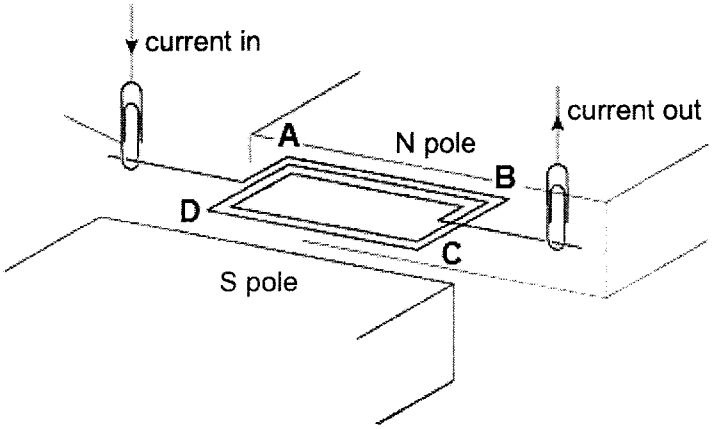


Fig. 8.3

The coil ABCD is free to turn on two bare metal paper clips which support and pass current into and out of the coil.

Fig. 8.4 shows a conversation between two students, Adrien and Benny.

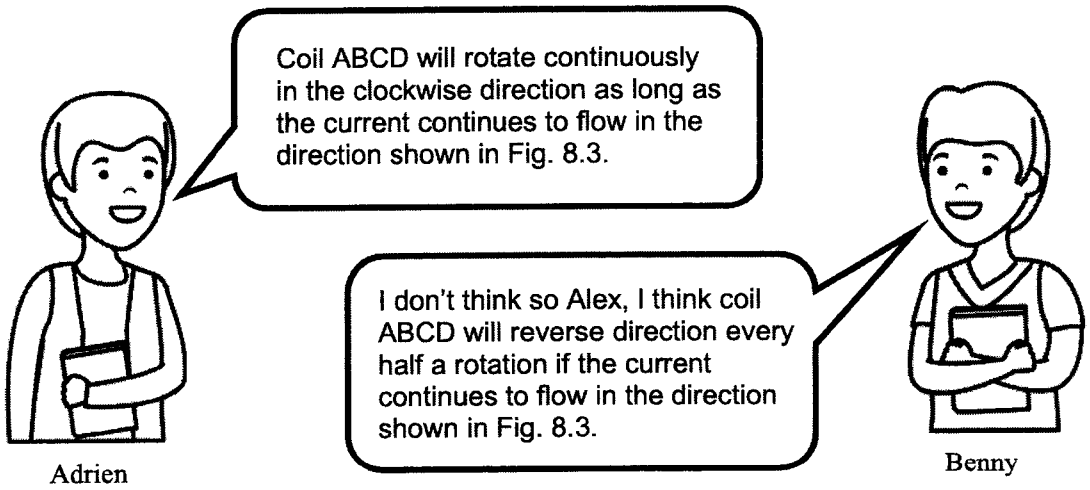


Fig. 8.4

Explain whether Adrien's or Benny's description of the rotation of coil ABCD is correct.

_____

_____

_____

_____

_____ [2]

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Section B [30 marks]

Answer **all** questions in this section.

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

9 Fig. 9.1 shows an optical fibre made of glass of uniform refractive index coated in a layer of cladding.

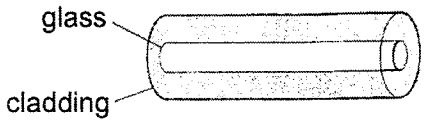


Fig. 9.1

Fig. 9.2 shows three rays of light entering the fibre from air. Each of these rays follows one of three possible paths through the fibre.

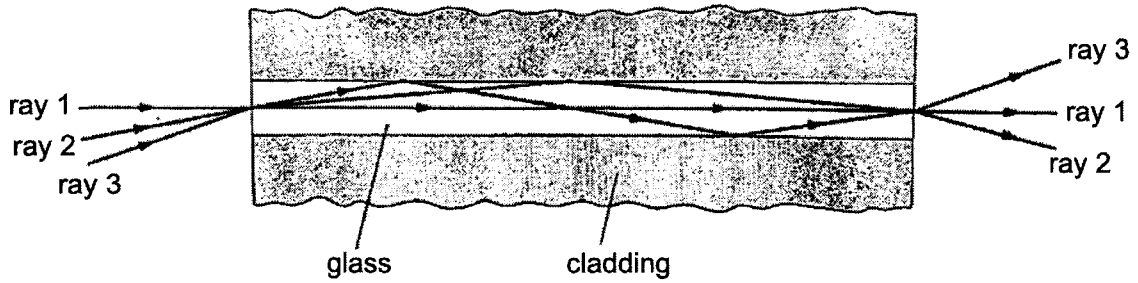


Fig. 9.2

The three rays travel different distances and take different times to pass through the fibre.

Table 9.3 gives information about the three rays and their paths in two cables of lengths 1 km and 2 km respectively.

ray	angle of incidence on entry / °	angle of refraction on entry / °	distance covered in 1 km cable / m	time spent in 1 km cable / μs	distance covered in 2 km cable / m	time spent in 2 km cable / μs
1	0	0	1000	5.0	2000	10.0
2	20	*X*	1020	5.1	2060	10.3
3	35	*Y*	1080	5.4	2180	10.9

Table 9.3

(a) Using ideas about refractive index, angle of incidence and critical angle, explain why rays 1, 2 and 3 take the paths shown in Fig. 9.2.

_____

_____

_____

_____

_____ [3]

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(b) Using the data in Table 9.3, calculate

(i) the refractive index of the glass, given that the speed of light in air is 3.0×10^8 m / s,

refractive index = ... [2]

(ii) the angle of refraction *X* for ray 2.

angle of refraction = ... [2]

(c) At time t = 0, a single pulse of light enters the optical fiber of length 2 km. The pulse lasts 0.1 μs. A photodiode is used to convert the pulses of light that leave the fibre into electrical pulses.

Fig. 9.4 shows the voltage trace obtained on a c.r.o. with a time base set at 0.1 μs / div.

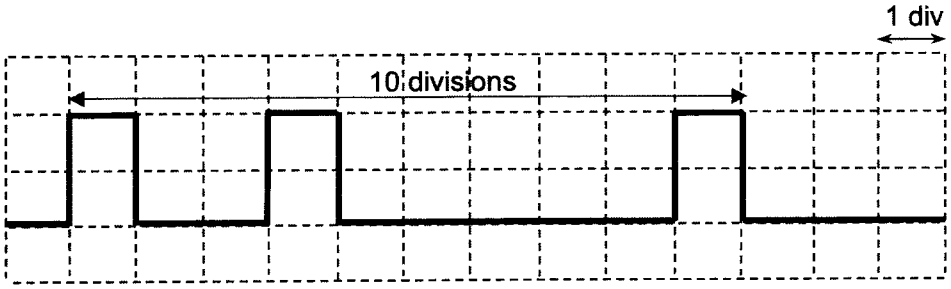
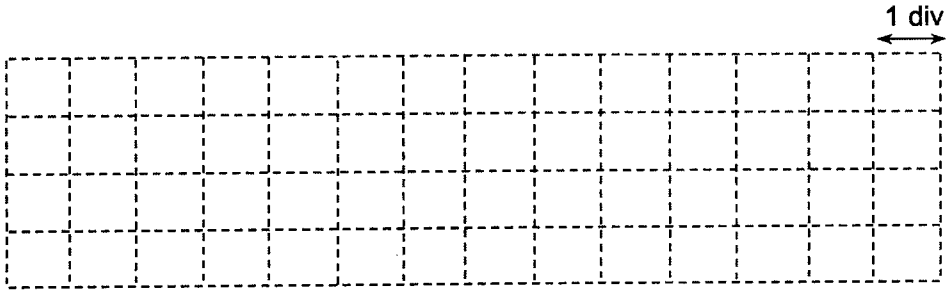


Fig. 9.4

(i) At t = 0, a single pulse of light enters the optical fibre of length 1 km. This pulse also lasts 0.1 μs.

On Fig. 9.5, draw the corresponding voltage trace obtained on a c.r.o. with the same Y-gain as Fig. 9.4 but a time base set at 0.05 μs / div.



[2]

Fig. 9.5

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(ii) Fig. 9.4 shows that a pulse of light, lasting 0.1 μs when it enters the 2 km optical fibre, becomes three pulses lasting in total 1.0 μs when it leaves.

In the transmission of data, it is important that no light from one pulse overlaps light from the next pulse. A second pulse of 0.1 μs must enter the fibre at least 1.0 μs after the first pulse.

Determine the maximum number of pulses of light that can enter the 2 km optical fibre in one second.

number of pulses per second = ... [1]

(d) State two advantages of using optical fibres over copper wires in the transmission of information.

1. _____

_____

2. _____

_____ [2]

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10 Fig. 10.1 shows the structure of a transformer.

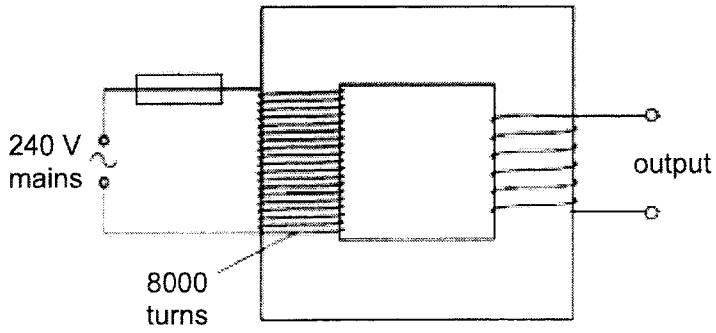


Fig. 10.1

The primary coil is connected to an alternating current supply of voltage 240 V and an output voltage is induced in the secondary coil. There are 8000 turns on the primary coil.

(a) Describe what is meant by *alternating current*.

_____

_____ [1]

(b) Explain why an output voltage is induced in the secondary coil.

_____

_____

_____

_____

_____

_____ [2]

(c) The output voltage is 6 V.

Calculate the number of turns on the secondary coil.

number of turns = ... [2]

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(d) A 200 mA fuse is connected in series with the primary coil.

(i) Explain why the fuse is connected in series rather than in parallel with the primary coil.

_____

_____ [1]

(ii) A maximum of three identical lamps rated 6 V, 12 W can be connected in parallel across the secondary coil.

Calculate the maximum efficiency of the transformer when the three lamps are connected.

efficiency = ... [2]

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11 EITHER

(a) Fig. 11.1 shows a ship traveling above a seabed from positions A to F.

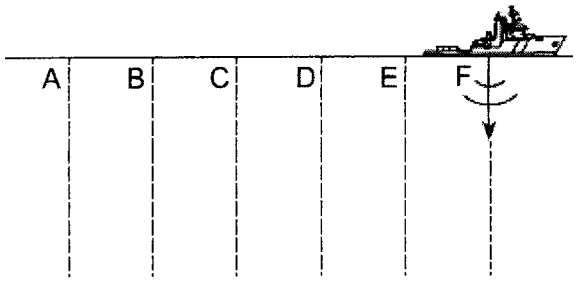


Fig. 11.1

At each point, the ship transmits an ultrasound pulse of frequency 50 kHz to the seabed to determine its depth. The speed of sound in sea water is 1500 m / s.

Fig. 11.2 is the intensity time graph which shows the time interval between each transmitted pulse and reflected pulse received by the ship.

The thick lines represent the transmitted pulse while the thin lines represent the reflected pulse.

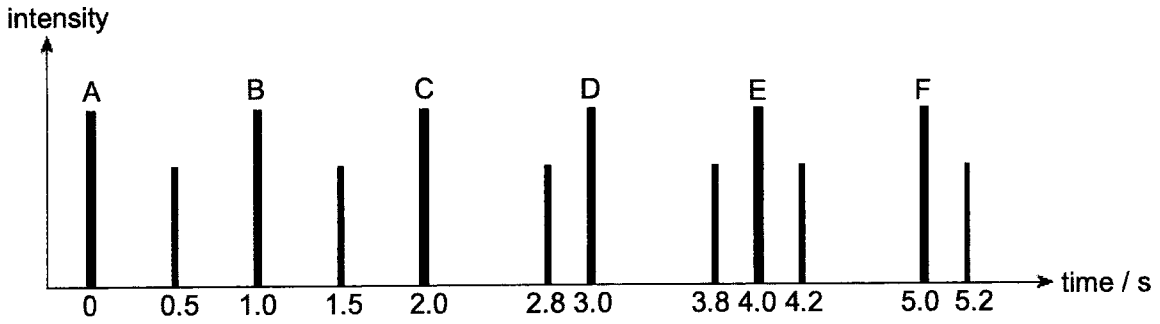


Fig. 11.2

(i) Explain why there is a difference in the amplitude of the transmitted pulse and the reflected pulse.

_____

_____ [1]

(ii) Calculate the deepest depth of the seabed between points A and F.

depth = ... [2]

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(iii) Determine the number of wavelengths within the distance calculated in **(a)(ii).**

number of wavelengths = ... [2]

(iv) Explain how the number of wavelengths will change if the ultrasound waves were transmitted through solid rock instead of water, for the same distance calculated in **(a)(ii)**.

_____

_____

_____

_____ [2]

(b) Line X in Fig. 11.3 represents the water particles at time *t* when the ultrasound wave from the ultrasound transceiver travels from the surface of the water to the seabed.

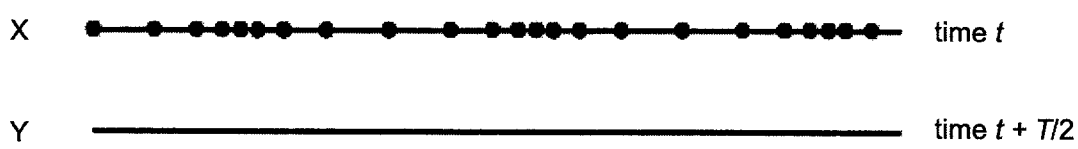


Fig. 11.3

The time taken for one complete vibration of a particle is *T*.

On line Y in Fig. 11.3, mark the centres of two compressions at time $t + T/2$.
Label these positions as "C". [1]

(c) State one similarity and one difference between ultrasound waves and ultraviolet rays.

_____

_____

_____

_____ [2]

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11 OR

(a) In the circuit diagram in Fig. 11.4, a current of 12 A is flowing into junction J and out of junction M.

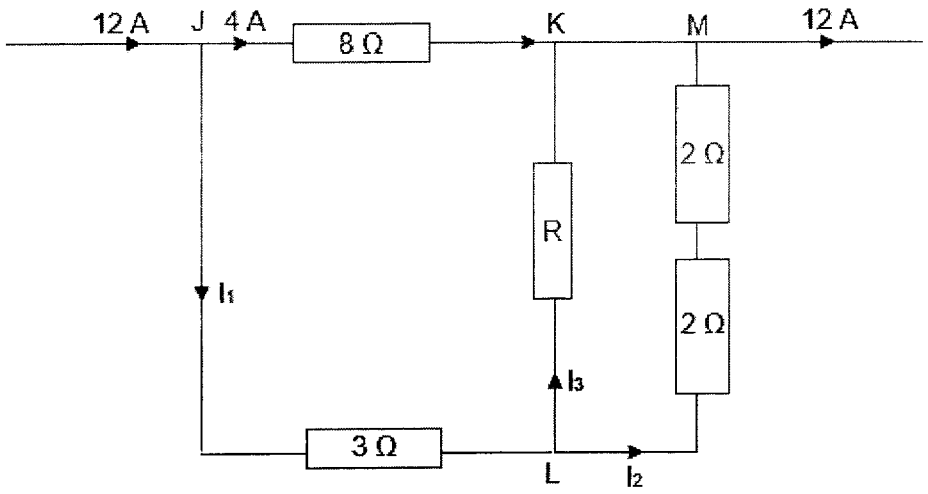


Fig. 11.4

Calculate the currents I_1, I_2, I_3 and the unknown resistance, R.

I_1 = ...

I_2 = ...

I_3 = ...

R = ... [4]

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(b) Fig. 11.5 shows how the resistance, R, of a thermistor varies with temperature, T.

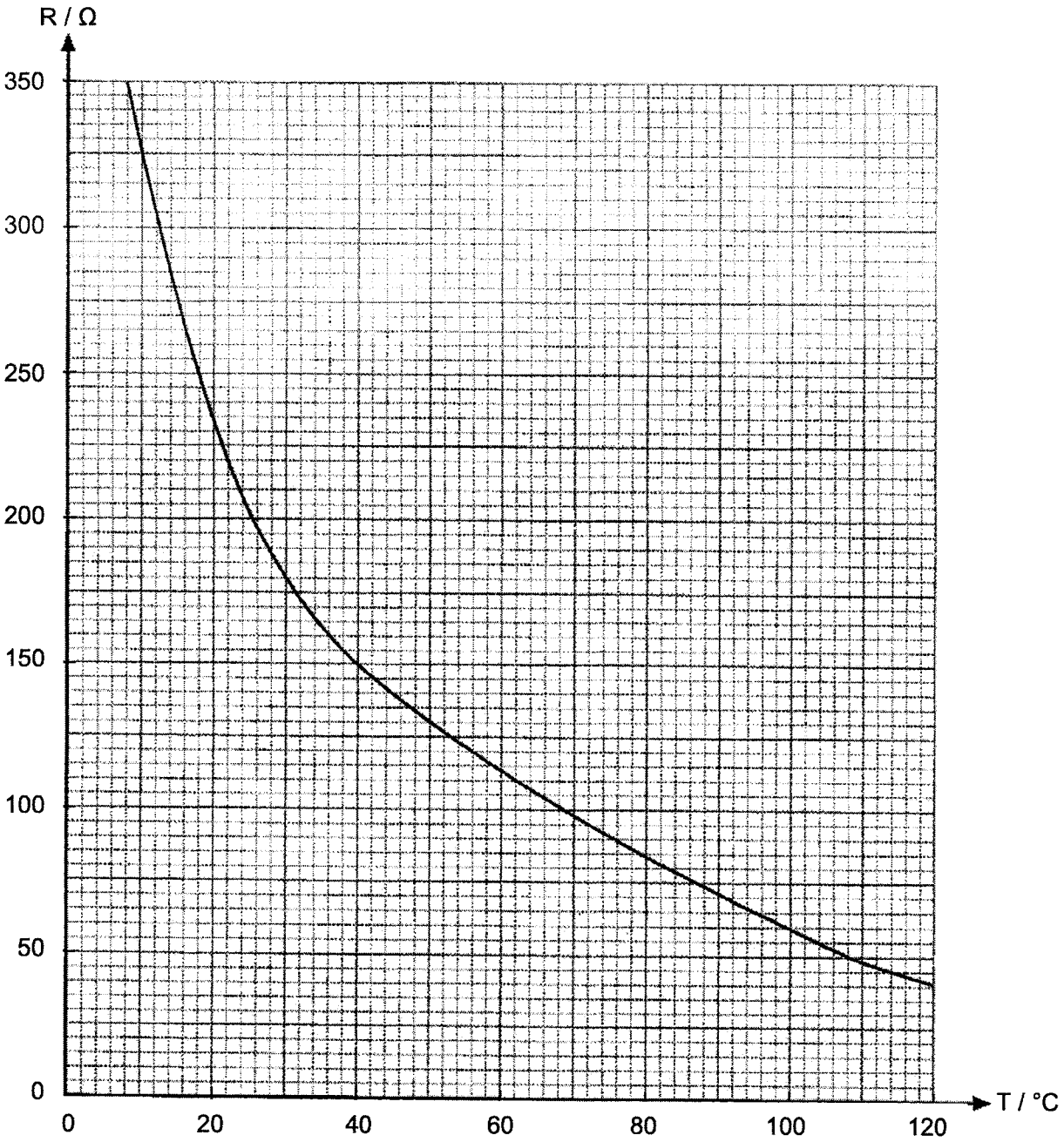


Fig. 11.5

[Turn over

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Fig. 11.6 shows the thermistor connected in a circuit.
The e.m.f. of the battery is 9 V and the resistance of the fixed resistor is 200 Ω.

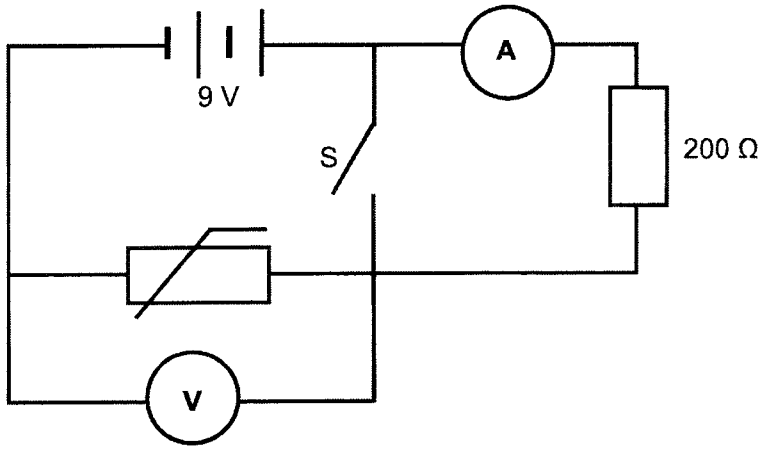


Fig. 11.6

(i) Explain why the ammeter reading decreases to zero when switch S is closed.

_____

_____ [1]

(ii) Determine the potential difference across the 200 Ω fixed resistor when the temperature of the thermistor is at 40°.

potential difference = ... [2]

(iii) The voltmeter is replaced with a bulb.

Determine how the brightness of the bulb will change as the temperature of the thermistor increases.

_____

_____

_____

_____

_____ [3]

End of Paper 2

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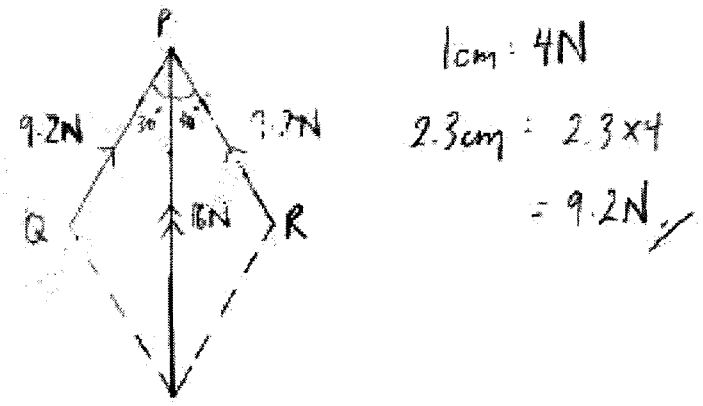
4E Physics Prelim 2022 Marking Scheme

Paper 1 (40 Marks)

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

Paper 2 Section A (50 Marks)

Qn		Solution	Marks
1	(ai)	10^8	[1]
	(aii)	G d μ n	[1]
	(bi)	Tension = 16 ÷ 2 = 8 N	[1]
	(bii)	Vector Diagram	



Correct parallelogram / tip-to-tail diagram drawn [M1] [1]

Resultant force labelled with double arrowhead, tensions labelled with arrowhead [A1] [1]

Tension in PQ = Tension in PR = 9.2 N (+/- a range) (both answers) [1]

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Qn		Solution	Marks
2	(a)	When the **driving force is equal to the frictional forces and air resistance acting on the car**, the car experiences **zero resultant force and zero acceleration**, hence it moves at constant speed.	[1]
	(b)	From 50 s – 70 s, the car moves with a **constant deceleration of 1.5 m / s^2 until it comes to a stop**,	[1]
		From 70 s – 80 s, the car **remains stationary / at rest**,	[1]
		From 80 s – 90 s, the car moves with **constant acceleration of 2 m / s^2 but in the opposite direction**.	[1]
	(c)	Displacement = area under graph A – area under graph B	
		$= \frac{1}{2}(50+70)(30) - \frac{1}{2}(30)(20)$	[1]
		= 1500 m	[1]
	(d)	Average speed = total distance / total time	
		$= \frac{\frac{1}{2}(50+70)(30)+\frac{1}{2}(30)(20)}{110}$	[1]
		= 19.1 m / s	[1]
3	(a)	**Mass is the amount of matter in a body** while **weight is the gravitational force acting on the mass.**	[1]
	(b)	Taking moments about the pivot at rope B, sum of anticlockwise moments = sum of clockwise moments	
		Tension A × 1.8 = 60 × 0.6 + 100 × 0.9	[1]
		Tension A = $\frac{60 \times 0.6 + 100 \times 0.9}{1.8}$ = **70 *N***	[1]
		Tension B = 100 + 60 – 70 = **90 N**	[1]
	(c)	He should suspend this second bird cage **directly below rope A**.	[1]
		Taking moments about the pivot at rope A, since there is **no perpendicular distance between the pivot and the weight of the second bird cage, there will not be an additional turning effect about A**, hence it will not increase the tension in Rope B.	[1]
		i.e. suspending the second bird cage directly below rope A only increases the tension in rope A by 30 N.	

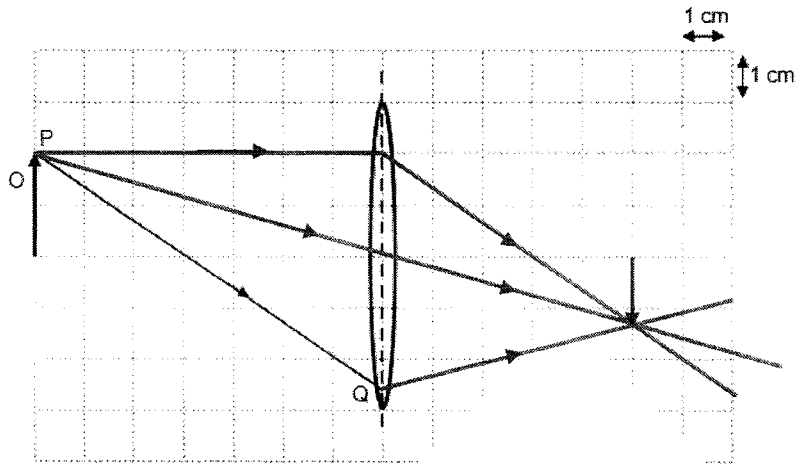
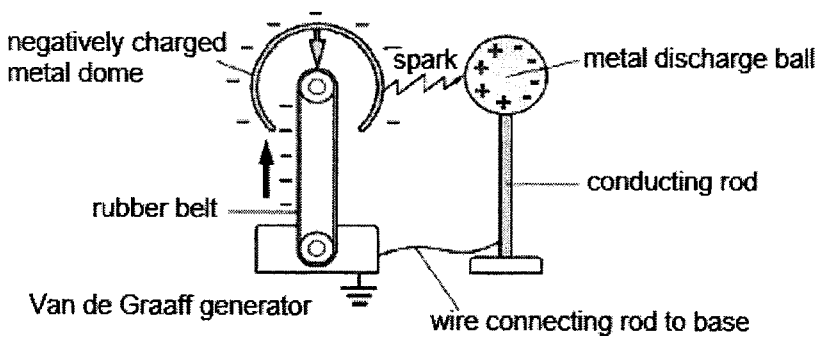
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Qn		Solution	Marks
4	(a)	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$ $\frac{5}{2} = \frac{F_2}{0.08}$ $F_2 = \frac{5}{2} \times 0.08 = \mathbf{0.2\ N}$	[1] [1]
	(bi)	Mass = density × volume = 1 × 2 × 0.6 = **1.2 g**	[1]
	(bii)	Work done = force × distance = 5 × 0.6 x 10^{-2} = **0.03 J**	[1]
	(biii)	By principle of conservation of energy, KE of water = work done $\frac{1}{2}mv^2 = 0.03$ $\frac{1}{2}\left(\frac{1.2}{1000}\right)v^2 = 0.03$ $v = \sqrt{\frac{0.03}{\frac{1}{2}\left(\frac{1.2}{1000}\right)}} = \mathbf{7.07\ m/s}$	[1] [1]
5	(a)	**Geothermal energy**	[1]
	(b)	Energy needed = $mc\Delta\theta + ml_v$ = (100)(4200)(100-20) + (40)(2200 × 1000) = **121600000 J = 1.216 × 10^8 J**	[1], [1] [1]
	(c)	When 1 kg of steam cools to 20 °C, it first experiences a **change of state from gaseous to liquid state** to become hot water which cools to 20 °C. As the molecules which are **very far apart** in the gaseous state **come closer together to form strong bonds** in the liquid state, the **internal potential energy of the molecules decreases,** and latent heat of vaporisation of 2200 kJ / kg is released. When 1 kg of hot water cools to 20 °C, there is **no change of state.** As the **molecules move less vigorously within the liquid,** the **internal kinetic energy of the molecules decreases,** releasing only 4200 J / °C.	[1] [1] [1] [1]

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Qn	Solution		Marks
6	(ai) (aii)		[1] - rays [1] - image [1] - PQ
	(b)	If the object is moved to a **distance > f**, - **image becomes larger** - **image distance from centre of the lens increases** If the object is moved to a **distance < f**, - **image becomes magnified** - **image becomes virtual** - **image becomes upright** - **image is on same side of lens as object** *(any of these two corresponding changes)*	[1] [1]
7	(a)		[1]
	(b)	Since **like charges repel**, the negative charges on the metal dome **repel the electrons on the metal discharge ball away, leaving excess positive charges** on the side of the metal discharge ball near the dome.	[1] [1]
	(c)	$I = \frac{Q}{t}$ $= \frac{0.57 \times 10^{-3}}{0.013}$ $= \mathbf{0.0438}\ \boldsymbol{A}$	[1] [1]

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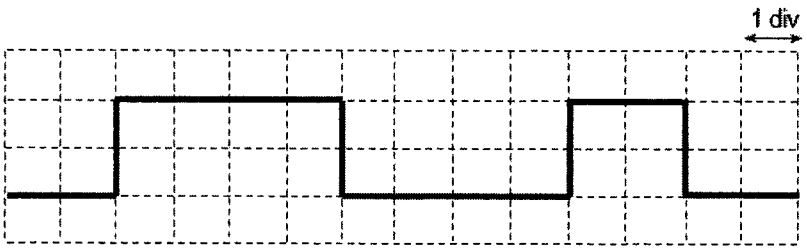
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Qn	Solution		Marks
8	(ai)	The **resistance of the LDR decreases** when light shines on it.	[1]
	(aii)	When light shines on the LDR, the **effective resistance of the circuit decreases** and **current flowing through the relay coil increases**. The current flowing through the coil turns the **soft iron core into an electromagnet** and **creates a magnetic field**. The **soft iron armature becomes an induced magnet** and is **attracted** to the soft iron core in the coil. As it **turns about the pivot, it pushes the relay contacts C close**.	[1] [1] [1]
	(b)	**Benny**'s description of the rotation of coil ABCD is correct. When the current flows in the direction shown in Fig. 8.3, **by Fleming's left hand rule**, side **AB will experience downward force** while side **DC will experience an upward force**, causing the coil to **turn in a clockwise direction**. When side AB rotates to the other side, the current direction remains the same and side **AB will still experience a downward force** while side **DC will still experience an upwards force**, causing the coil to **turn in an anticlockwise direction after half a rotation**. *i.e. the coil will reverse direction every half a rotation if the current continues to flow in the direction shown in Fig. 8.3.*	[1] [1]

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Paper 2 Section B (30 marks)

Qn	Solution		Marks
9	(a)	Ray 1 passes straight through the glass as the **angle of incidence between the air-glass boundary is 0°**, so the light ray does not bend. Ray 2 and 3 experience **total internal reflection** within the glass as the **angle of incidence at the glass-cladding boundary is more than the critical angle** and the **refractive index of the glass is higher than that of the cladding**.	[1] [1] [1] - both pts
	(bi)	Speed of light in glass = $\frac{distance}{time} = \frac{1000}{5.0\times10^{-6}} = 2\times10^{8}$ m / s Refractive index = $\frac{c}{v} = \frac{3.0\times10^{8}}{2.0\times10^{8}} = \mathbf{1.5}$	[1] [1]
	(bii)	$n = \frac{\sin i}{\sin r}$ $1.5 = \frac{\sin 20}{\sin r}$ $r = \sin^{-1}(\frac{\sin 20}{1.5}) = \mathbf{13.2°}$	 [1] [1]
	(ci)		[1] -Y-gain [1] - time-base
	(cii)	Number of pulses per second = $\frac{1}{1.0\times10^{-6}} = \mathbf{1000000}$	[1]
	(d)	1. **Higher carrying capacity** (ability to carry larger amounts of information) 2. **Less signal degradation** (information integrity and quality is better maintained) 3. **Lightweight** 4. **Lower costs** *(any two advantages)*	[1] [1]

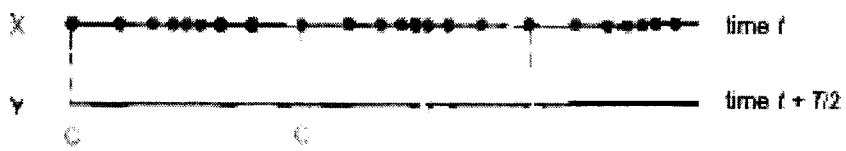
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Qn	Solution		Marks
10	(a)	An alternating current is a **current that reverses directions at a regular frequency**.	[1]
	(b)	The alternating voltage in the primary coil **produces a constantly changing magnetic field within the soft iron core**. The secondary coil in turn experiences **constantly changing magnetic flux** which **induces an emf** in the secondary coil. *i.e. by Faraday's law of Electromagnetic Induction, the induced emf is proportional to the rate of change of magnetic flux in the secondary coil.*	[1] [1]
	(c)	$\frac{Ns}{Np} = \frac{Vs}{Vp}$ $\frac{Ns}{8000} = \frac{6}{240}$ $Ns = \frac{6}{240} \times 8000 = \mathbf{200}$	[1] [1]
	(di)	The function of the fuse is to disconnect the transformer from the mains in the event of a surge of current in the primary coil. It must be connected in series with the primary coil **to experience the surge in current and break the circuit when the current exceeds the fuse rating**. It will not work if it is connected in parallel and does not experience the same surge in current.	[1]
	(dii)	Input power = VI = 240 × 200 × 10^{-3} = 48 W Output power = 3 × 12 = 36 W Efficiency = $\frac{output\ power}{input\ power} \times 100\%$ $= \frac{36}{48} \times 100\% = \mathbf{75\%}$	[1] - for both [1]

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Qn	Solution		Marks
11 E	(ai)	As the transmitted pulse travels to and from the seabed, **some energy is dissipated to the water and seabed**, hence the reflected pulse is weaker than the transmitted pulse.	[1]
	(aii)	Deepest depth at C or D $= \frac{s \times t}{2} = \frac{1500 \times 0.8}{2}$ $= 600\ m$	[1] [1]
	(aiii)	$v = f\lambda$ $\lambda = \frac{1500}{50000} = 0.03\ m$ number of wavelengths $= \frac{600}{0.03} = 20000$	[1] [1]
	(aiv)	As the **speed of sound wave in solid rock increases**, the **wavelength of the wave in solid rock increases**. Hence, there **will be a smaller number of wavelengths** in the same **distance of solid rock**.	[1] [1]
	(b)	 *(any **two**)* *i.e. **the compression will** move into the place of the next rarefaction after **half a period***	[1]
	(c)	**Similarity**: **Ultrasound waves and ultraviolet rays both transfer energy from one point to another.** Difference: **Ultrasound waves cannot travel in a vacuum while ultraviolet rays can travel in a vacuum.** **Ultrasound waves are longitudinal waves while ultraviolet rays are transverse waves.** **The speed of ultrasound waves in air is much lower than the speed of ultraviolet rays in air.** *(any difference)*	[1] [1]

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Qn	Solution		Marks
11 O	(a)	$I_1 = 12 - 4 = 8$ A	[1]
		p.d. across JK = IR = 4 × 8 = 32 V	
		p.d. across JL = IR = 8 × 3 = 24 V	
		p.d. across LM = 32 – 24 = 8 V	
		I_2 = V / I = 8 ÷ (2 + 2) = 2 A	[1]
		$I_3 = 8 - 2 = 6$ A	[1]
		R = V / I = 8 ÷ 6 = 1.33 Ω	[1]
	(bi)	When switch S is closed, current will flow through switch S instead of through the resistor and ammeter and cause a short circuit.	[1]
	(bii)	p.d. = $\frac{200}{200+150} \times 9$	[1]
		= 5.14 V	[1]
	(biii)	As the temperature of the thermistor increases, the resistance of the thermistor decreases and the potential difference across the thermistor decreases too.	[1]
		Since the bulb is arranged in parallel to the thermistor, the potential difference across the bulb will also decrease.	[1]
		By V = RI, when potential difference decreases, current decreases and the brightness of the bulb drops.	[1]

End of marking scheme

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