Name: ..... Register no: ..... Class: .....

NGEE ANN SECONDARY SCHOOL

0

PRELIMINARY EXAMINATION

PHYSICS **6091/01**

PAPER 1 **27 August 2020**

1 h

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number at the top of this cover page.

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 Multiple Choice Answer Sheet (OAS).

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.
Where necessary, take the gravitational field strength, g, to be 10 N/kg.

Checked by student: _____ Date: _____

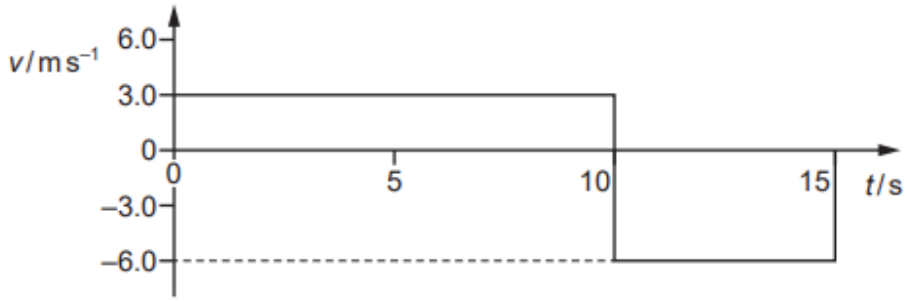
This document consists of **21** printed pages (including this cover page).

1 Which expression gives a base quantity?

A charge per unit time
B force per unit area
C mass per unit volume
D work done per unit distance

2 A radio-controlled toy car travels along a straight line for a time of 15 s.

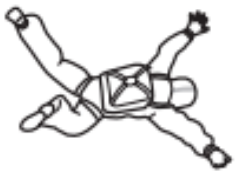
The variation with time t of the velocity v of the car is shown below.



What is the average velocity of the toy car for the journey shown by the graph?

A -1.5 m/s **B** 0.0 m/s **C** 4.0 m/s **D** 4.5 m/s

3 A skydiver falls from rest through the air and reaches terminal velocity.



What is the acceleration of the skydiver during his fall?

A constant at 0 m/s^2
B constant at 10 m/s^2
C starting at 0 m/s^2 and increasing to 10 m/s^2
D starting at 10 m/s^2 and decreasing to 0 m/s^2

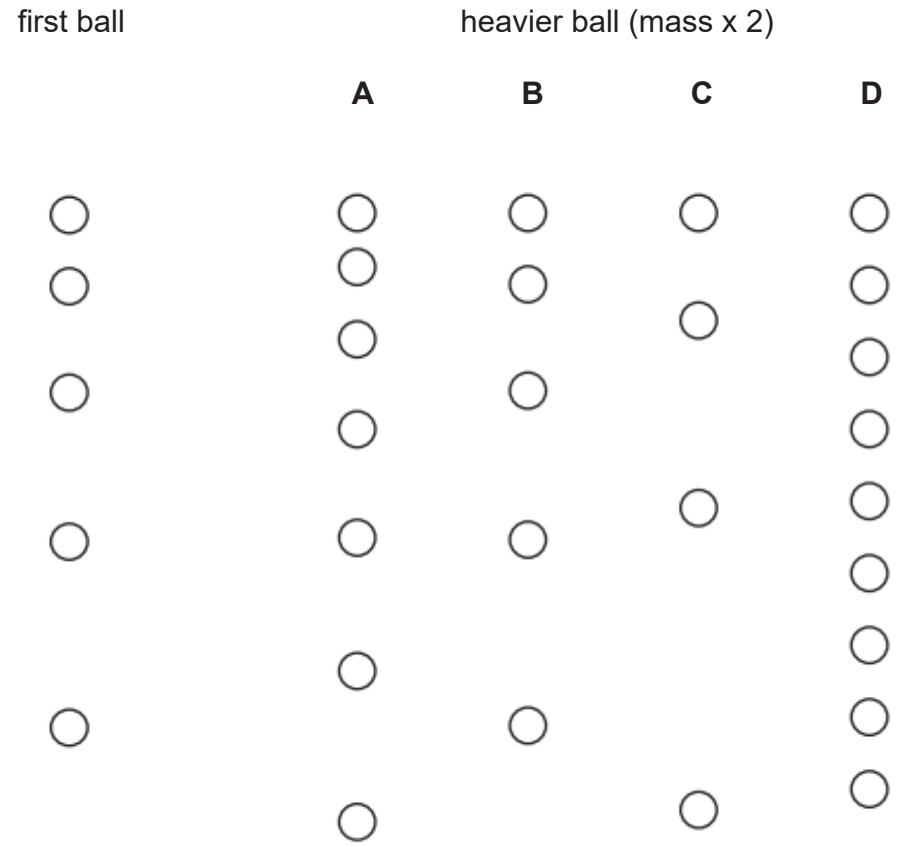
4 A force of 20 N acts on an object of mass 5.0 kg in the forward direction. A second force also acts on the object. The forward acceleration of the object is 3.0 m/s^2.

What is the size and direction of the second force?

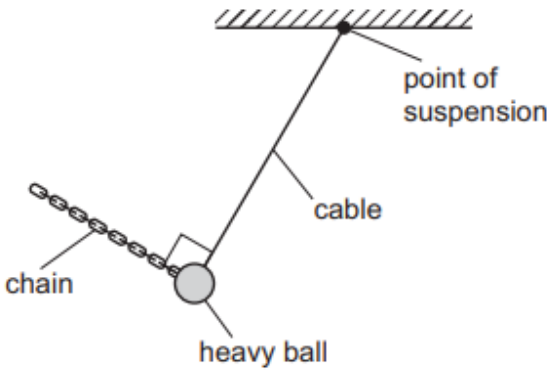
	size of force /N	**direction of force**
A	5.0	forwards
B	5.0	backwards
C	35	forwards
D	35	backwards

5 A ball is dropped in an evacuated tube. A series of photographs is taken at equal time intervals from the time of release. Another ball of the same size but twice the mass is also dropped in the same evacuated tube and photographed.

Which diagram shows the motion of the heavier ball?

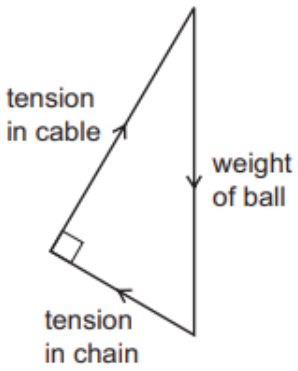


6 A heavy ball hanging from a cable is held in equilibrium by a chain.

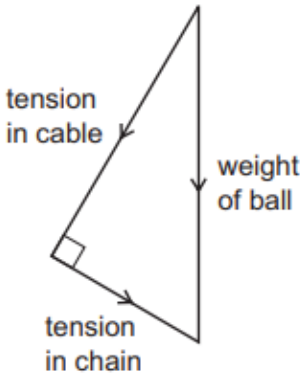


Which vector diagram shows the three forces acting on the ball?

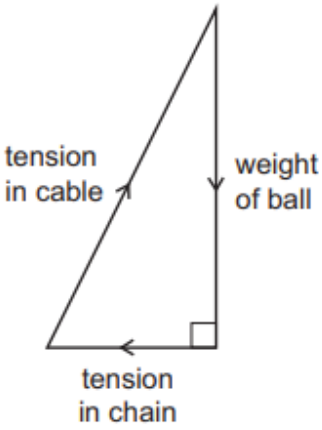
A



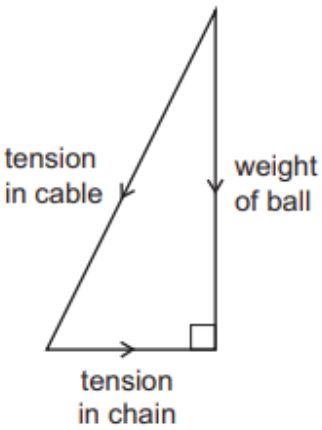
B



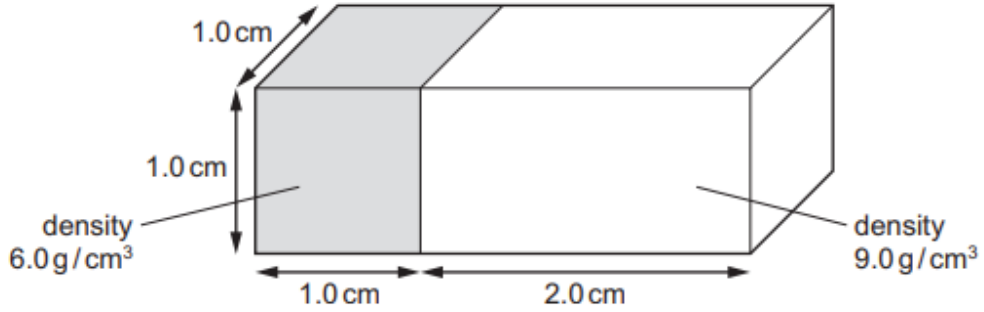
C



D



7 Two blocks are joined together.

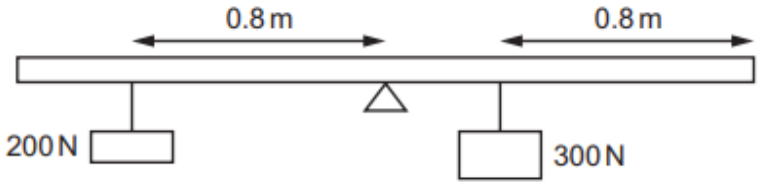


One block has a density of 6.0 g/cm^3 and the other has a density of 9.0 g/cm^3.

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 A rigid uniform bar of length 2.4 m is pivoted horizontally at its midpoint.

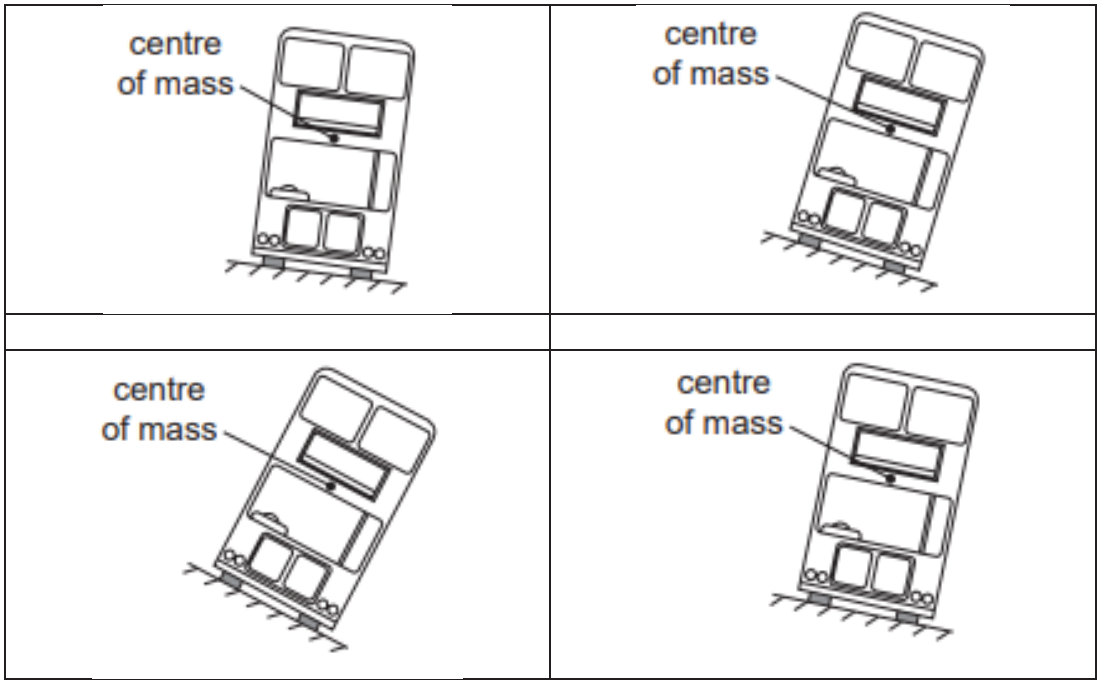


Weights are hung from two points on the bar as shown in the diagram. To maintain equilibrium, a force is applied to the bar.

What is the moment of this force and its direction?

	moment / Nm	**direction**
A	40	clockwise
B	40	anticlockwise
C	80	clockwise
D	80	anticlockwise

9 The diagram shows four models of buses placed on different ramps.

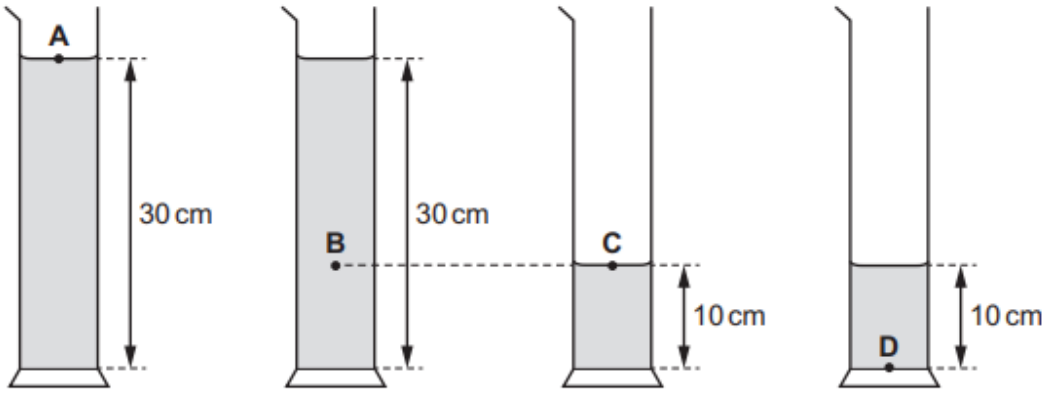


How many of these models will fall over?

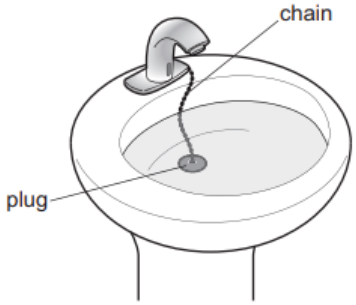
A 0 **B** 1 **C** 2 **D** 3

10 Four measuring cylinders are filled with the same liquid to the heights shown.

At which position is the pressure the greatest?



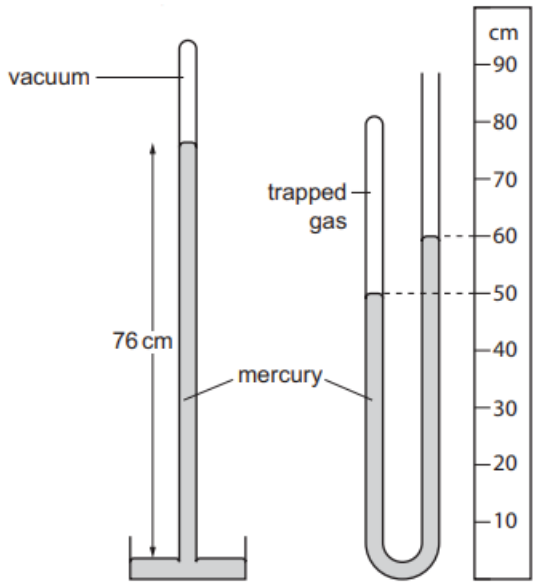
11 A washbasin has an exit pipe covered with a plug of area 12 cm^2. A chain is attached to the centre of the plug to assist in pulling the plug away from the exit hole. The washbasin contains water to a depth of 0.080 m. The density of the water is 1000 kg/m^3.



What is the force acting on the plug due to the water?

A 0.96 N **B** 800 N **C** 9600 N **D** 80 000 N

12 The diagram shows a simple mercury barometer alongside a mercury manometer. The manometer contains some trapped gas.



What is the pressure of the trapped gas?

A 10 cm of mercury
B 50 cm of mercury
C 66 cm of mercury
D 86 cm of mercury

13 A ball of mass 1.2 kg is dropped from a height of 30 m. As it falls, 25% of its initial gravitational potential energy is transferred to thermal energy.

What is the kinetic energy of the ball just before it hits the ground?

A 27 J **B** 90 J **C** 270 J **D** 360 J

14 A student does work by pulling a box across a horizontal floor. She now pulls a second box along the same floor.

Which row indicates that the student is now doing twice as much work?

	force used to pull box	**distance the box is pulled**
A	is doubled	is doubled
B	is doubled	is halved
C	stays the same	is doubled
D	stays the same	is halved

15 The particles of a gas, in a container of fixed volume, are given more energy.

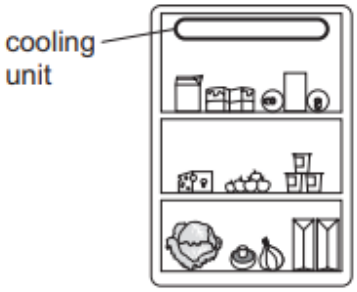
Which effect does this have on the gas?

A Neither the pressure nor temperature of the gas increases.
B Both the pressure and temperature of the gas increase.
C Only the temperature of the gas increases.
D Only the pressure of the gas increases.

16 Which statement about thermal radiation is correct?

A In a vacuum, thermal radiation travels at the speed of light.
B Thermal radiation is a longitudinal wave.
C Thermal radiation travels as an ultra-violet wave.
D White surfaces are better emitters of thermal radiation than black surfaces.

17 The diagram shows the inside of a refrigerator.



When the refrigerator is first switched on, what happens to the air near the cooling unit?

	the particles of this air	the density of this air
A	become smaller	increases
B	become smaller	decreases
C	move closer together	increases
D	move closer together	decreases

18 A liquid-in-glass thermometer has a mercury level of 2.0 cm at -10 ^{0}C and a mercury level of 10.0 cm at 110 ^{0}C.

What will be the mercury level when the temperature is 100 ^{0}C?

A 7.3 cm **B** 8.8 cm **C** 9.1 cm **D** 9.3 cm

19 Two cold metal containers X and Y are both filled with the same mass of hot water at the same temperature. Both containers are well insulated.

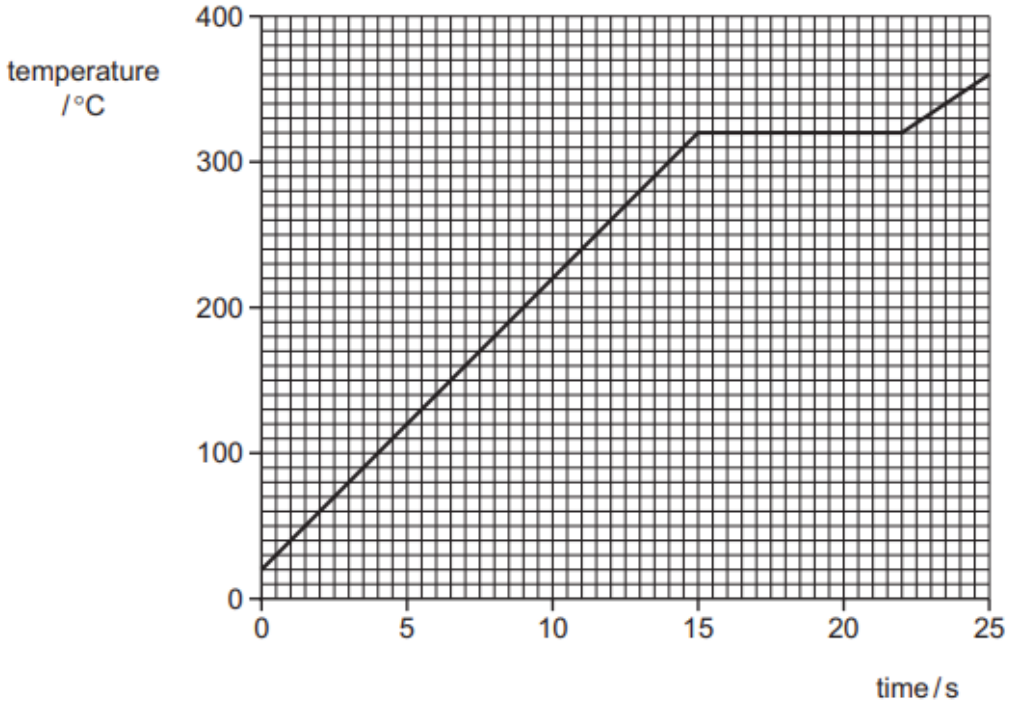
The heat capacity of container X is greater than that of container Y.

How do the final temperatures of the water in X and in Y compare?

A The temperature in X is higher than in Y.
B The temperature in X is lower than in Y.
C The temperatures in X and in Y are equal but lower than the initial temperature of the water.
D The temperatures in X and in Y are the same as the initial temperature of the water.

20 A 100 g piece of solid lead at room temperature is heated. After 22 s, it has all become liquid. The power of the heater is 320W.

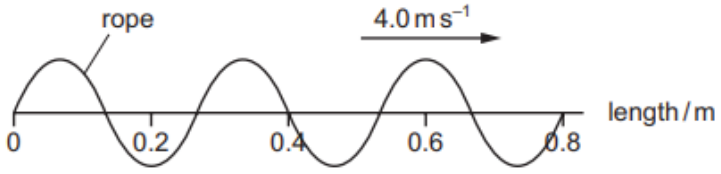
The graph shows how its temperature varies with time.



Which is the specific latent heat of the lead?

A 22.4 J/kg **B** 70.4 J/kg **C** 22400 J/kg **D** 70400 J/kg

21 A vibration generator produces a progressive wave on a rope. The diagram shows the rope at one instant. The wave travels at a speed of 4.0 ms^{-1}.



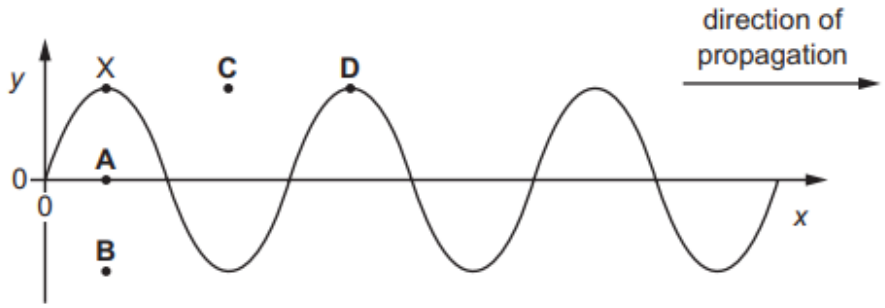
What are the wavelength and the frequency of the wave?

	wavelength / m	frequency /Hz
A	0.13	15
B	0.13	30
C	0.27	15
D	0.27	30

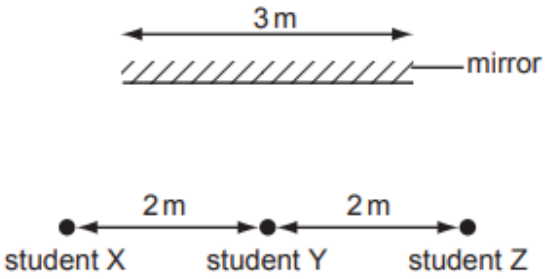
22 The variation with distance x of the displacement y of a transverse wave on a rope is shown at time t = 0 s. The wave has a frequency of 0.5 Hz.

A point X on the rope is marked. The diagram shows the original position of X and four possible new positions.

What is the position of X at time t = 1 s?



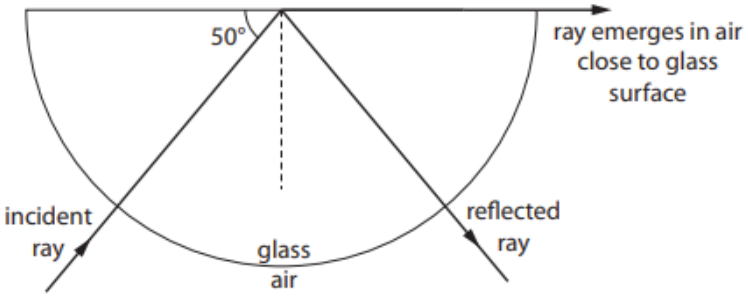
23 Three students stand 2 m apart in front of a plane mirror which is 3 m long. Student Y is standing opposite the mid-point of the mirror.



How many students can see the images of the other two?

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

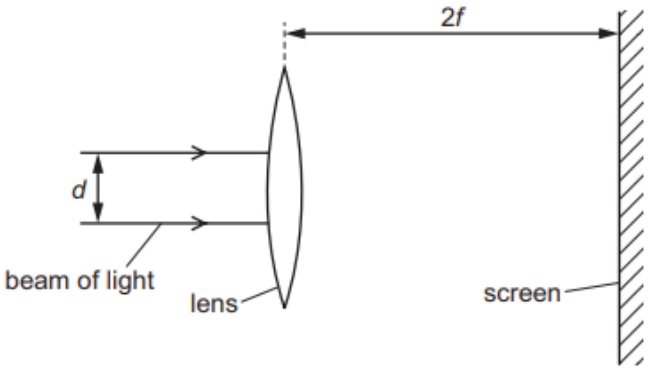
24 The diagram shows a ray of monochromatic light passing through a semi-circular glass block.



What is the refractive index of the glass?

A 0.64 **B** 0.77 **C** 1.31 **D** 1.56

25 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.



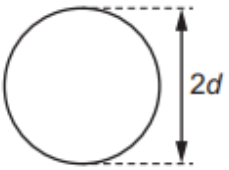
Which diagram shows the size of the spot of light seen on the screen?

A

B

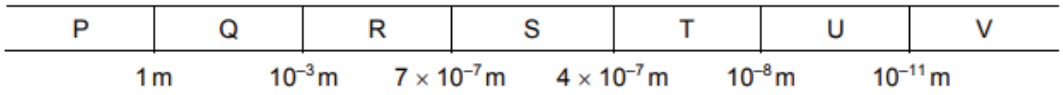
C

D



26 The diagram shows the electromagnetic spectrum. The numbers indicate the approximate wavelength at the boundaries between the various regions of the spectrum.

For a device to be able to make use of electromagnetic radiation, it needs an aerial of approximately the same size as the radiation it is designed to work with.

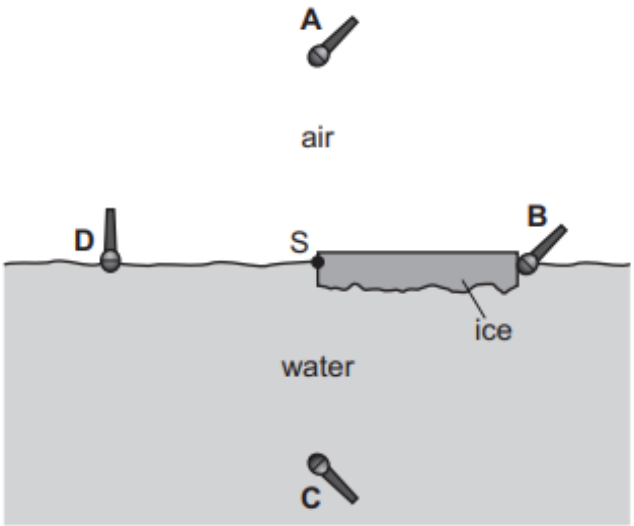


Which statement is correct?

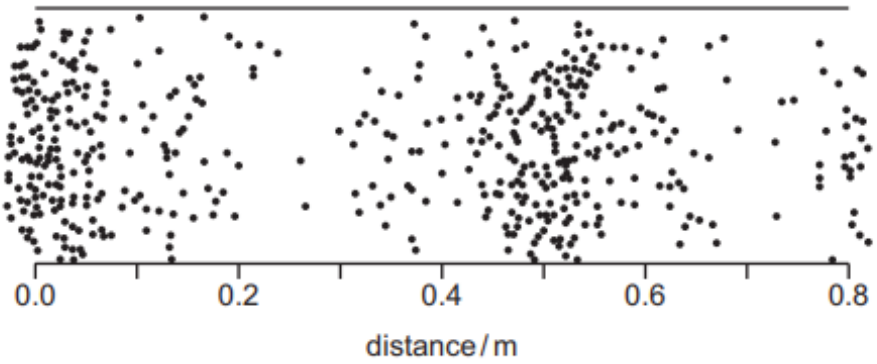
A A television satellite dish uses radiation from region Q.
B A mobile phone uses radiation from region P.
C The receptor cells in an eye use radiation from region R.
D The remote controller for a television uses radiation from region U.

27 A sheet of ice floats on water. A source of sound S is positioned at the edge of the ice sheet. Four microphones are placed equal distances from S.

Which microphone detects the sound from S first?



28 When a guitar string is plucked, it causes a longitudinal sound wave in the air. The figure shows the distribution of air particles.

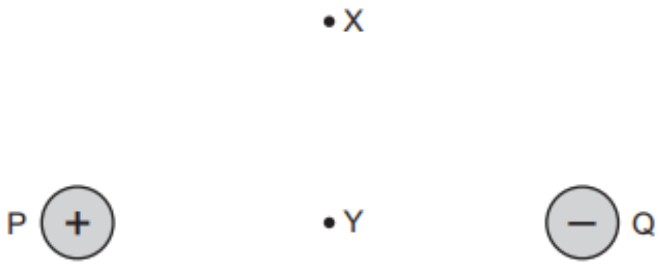


The speed of sound in the air is 340 ms^{-1}.

What is the approximate frequency of the sound wave shown?

A 430 Hz **B** 680 Hz **C** 1100 Hz **D** 1400 Hz

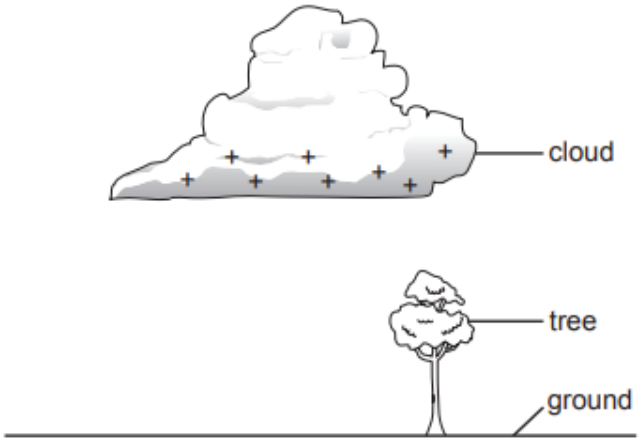
29 An electric field is formed by two isolated, equal and opposite charges P and Q.



How does the field at X compare with the field at Y?

A It is stronger at X than at Y and is in the opposite direction.
B It is stronger at X than at Y and is in the same direction.
C It is weaker at X than at Y and is in the opposite direction.
D It is weaker at X than at Y and is in the same direction.

30 On a stormy day, a large, positively-charged cloud is above a tree. An electrical charge is induced on the tree as charged particles flow through it.



What is the charge induced on the tree and how do the charged particles move?

	charge on tree	**movement of charged particles through tree**
A	positive	positively charged particles move up the tree
B	positive	positively charged particles move down the tree
C	negative	negatively charged particles move up the tree
D	negative	negatively charged particles move down the tree

31 A charge of 7.5 C flows through a resistor in 5.0 s. A student has ammeters with different ranges that he can use to measure the current in the resistor.

Which ammeter range is the most appropriate?

A 0 – 1 A **B** 0 – 2 A **C** 0 – 5 A **D** 0 – 10 A

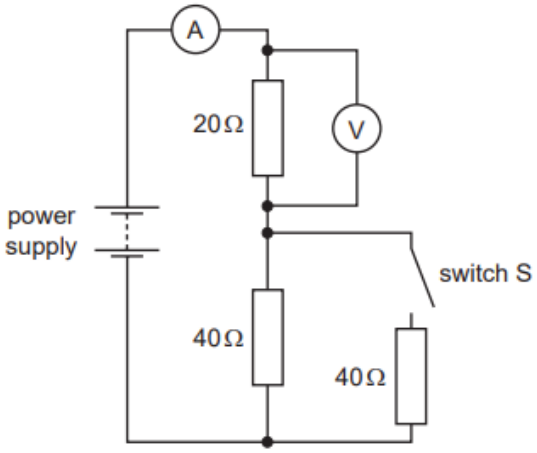
32 Four lamps have filaments made from the same material. The lamps are connected in parallel across a battery.

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

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

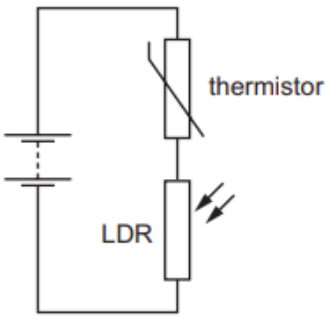
33 A circuit is connected as shown below.

What will happen to the readings on the voltmeter and ammeter when switch S is closed?



	voltmeter reading	ammeter reading
A	increase	decrease
B	decrease	increase
C	decrease	decrease
D	increase	increase

34 In the circuit shown, the temperature of the room and the amount of light affect the current.



Under which conditions is the current in the circuit the largest?

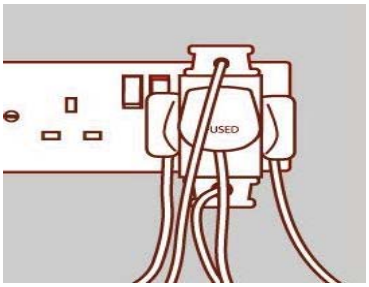
	temperature	amount of light
A	high	in bright light
B	high	in the dark
C	low	in bright light
D	low	in the dark

35 The power of an electrical heater is 3.0 kW. The heater is switched on for a time of 2 hours and 30 minutes. The cost of using the heater for this time is 120 cents.

What is the cost of 1.0 kWh of electrical energy?

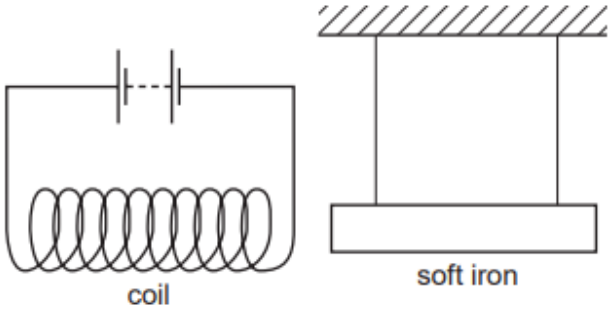
A 16 cents **B** 17 cents **C** 40 cents **D** 48 cents

36 What may happen when a multi-plug adaptor is used to connect many appliances to the same power socket?



A The voltage across the live and neutral wires increases and overheating may occur.
B The current drawn from the mains gets higher and overheating may occur.
C The flow of current will be slowed and the power to each appliance will be reduced.
D The appliances will be damaged due to the higher current in each appliance.

37 A coil is connected to a battery and a soft iron bar is hung near to it.

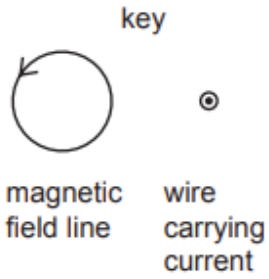


The current is then reversed by reversing the battery connections.

How does the soft iron bar behave in the two cases?

	with the battery as shown	**with the battery reversed**
A	attracted to the coil	attracted to the coil
B	attracted to the coil	repelled from the coil
C	repelled from the coil	attracted to the coil
D	repelled from the coil	repelled from the coil

38 The diagrams show the forces F between two wires carrying currents. The magnetic fields close to the wires are also shown.

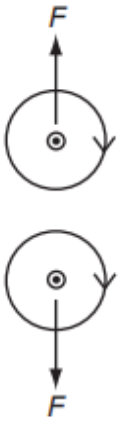


Which diagram is correct?

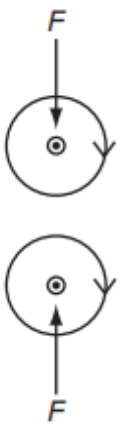
A

B

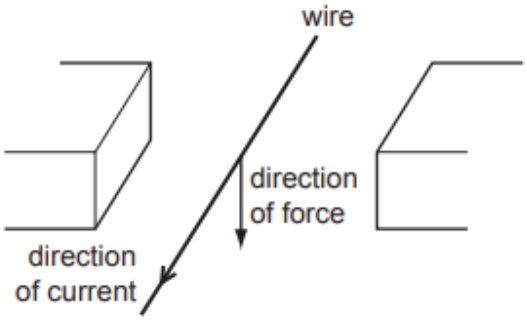
C



D



39 The diagram shows a wire placed between two magnetic poles of equal strength. A current passes through the wire in the direction shown. The current causes a downward force on the wire.



What is the arrangement of the magnetic poles?

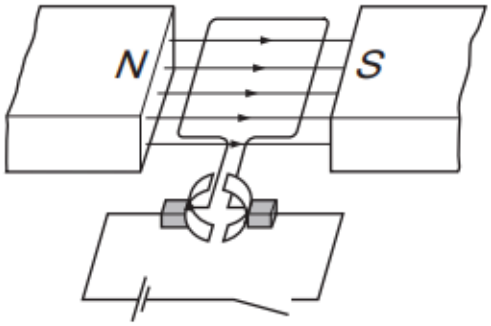
A

B

C

D

40 The diagram shows a simple d.c. motor.



The switch is closed and the coil rotates.

Which change makes the coil rotate in the opposite direction and at a faster rate?

A increase the current in the coil and increase the number of turns in the coil
B reverse both the magnetic field and the current in the coil
C reverse the magnetic field and decrease the current in the coil
D reverse the magnetic field and increase the current in the coil

--- End of Paper ---

Name: …….. Index no: ……..... Class: ……

NGEE ANN SECONDARY SCHOOL

O

PRELIMINARY EXAMINATION

PURE PHYSICS **6091/02**

PAPER 2 **24 August 2020**

1 h 45 min

READ THESE INSTRUCTIONS FIRST

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

Section A

Answer **all** questions in the spaces provided.

Section B

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

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

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.

FOR EXAMINER'S USE	
Section A	**/ 50**
Section B	**/ 30**
Total	**/ 80**

Checked by student: _____ Date: _____

Section A (50 marks)

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

1 Fig. 1.1 is the speed-time graph for a rocket from the moment that the fuel starts to burn at time $t = 0$.

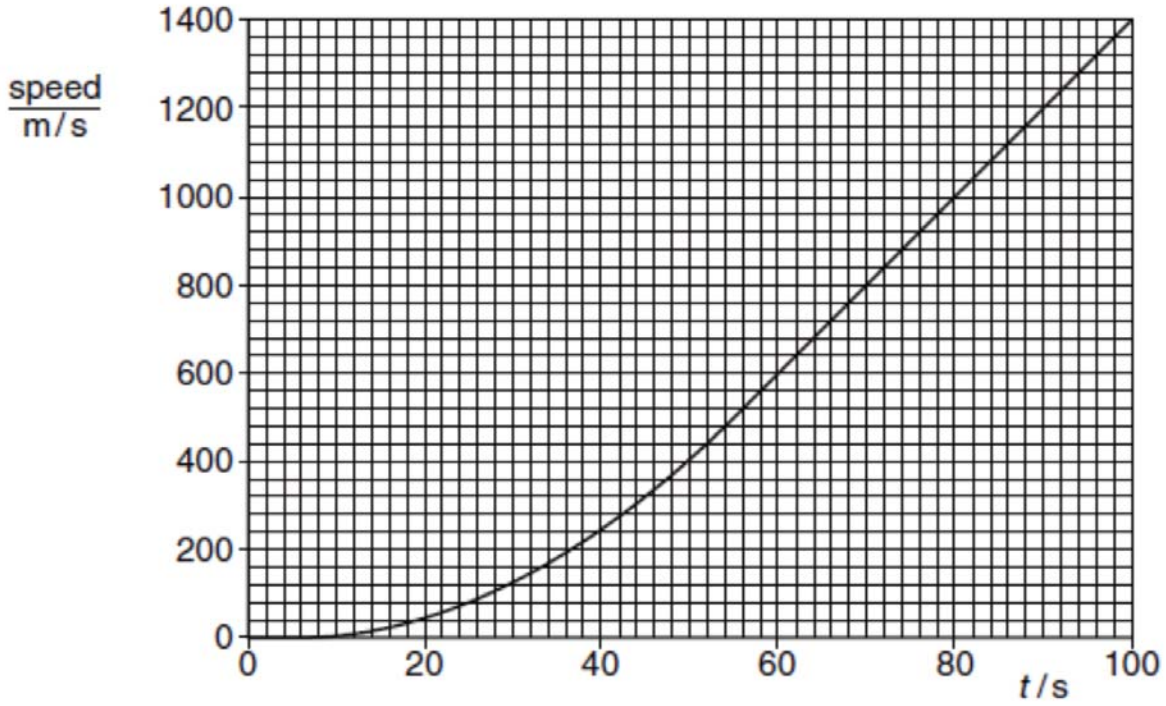


Fig. 1.1

(a) **(i)** State what happens to the acceleration of the rocket between $t = 5$ s and $t = 80$ s.

……[1]

(ii) Calculate the acceleration of the rocket at $t = 80$ s.

acceleration = ……[2]

(iii) The total mass of the rocket at t = 80 s is 1.6×10^6 kg. Calculate the upward force on the rocket at this time, caused by the burning fuel.

upward force = …….[2]

(b) As the rocket burns fuel, it ejects hot gas downwards. Name a pair of action and reaction forces.

……..

……..[1]

2 Fig. 2.1 illustrates the journey of a cyclist from point A to point B. Points A and B are at the same height.

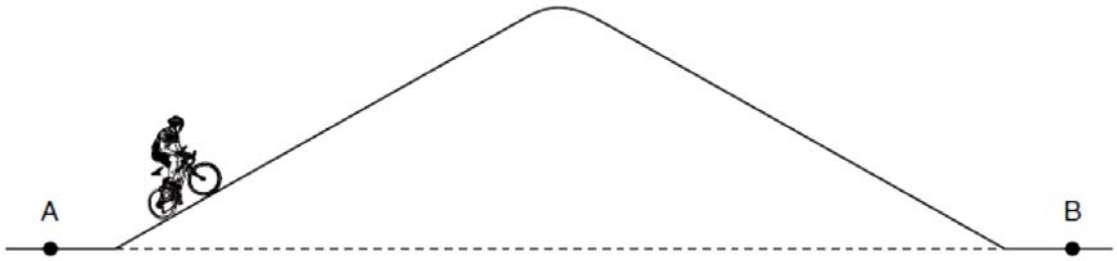


Fig. 2.1

The cyclist starts from rest at A and pedals up and over a hill. Near the bottom of the hill, she starts to brake and comes to rest at B.

(a) Describe the energy changes that take place as she pedals up the hill at constant speed.

……..

……..

……..

……..[2]

(b) Explain how the law of conservation of energy applies to the complete journey from A to B.

……..

……..

……..

……..[2]

(c) At one point in the journey, the gravitational potential energy of the cyclist has increased by 5400 J. The mass of the cyclist is 60 kg.

Calculate the height above A of the cyclist at this point.

height = ……[2]

3 A student conducts an experiment to verify the principle of moments using a set-up shown in Fig. 3.1.

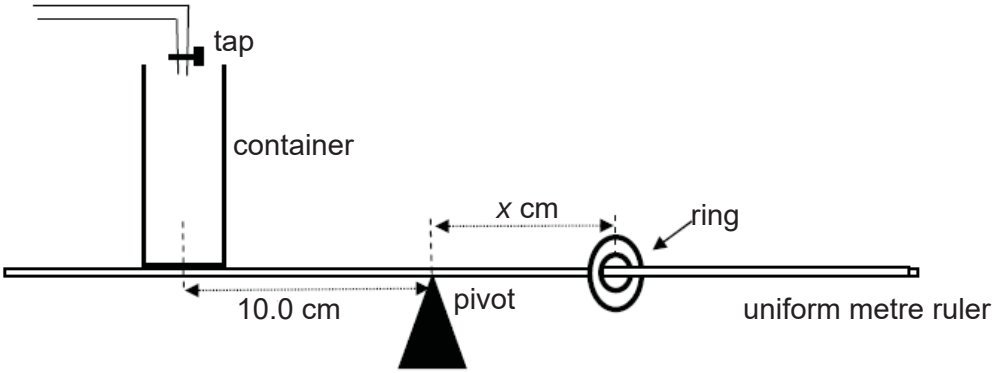


Fig. 3.1

A container of negligible mass is placed on a uniform metre ruler which is pivoted at the 50.0 cm mark. Water of density 1.0 g/cm^3 is released into the container at a constant rate of 50.0 cm^3 per minute. In order to balance the metre ruler, a ring of mass 55 g is hung on the ruler and its position is adjusted accordingly by the student.

(a) Define the moment of a force.

.....

……[1]

(b) Calculate *x* to balance the ruler after the tap is turned on for 3 min.

x = …… [2]

(c) If the force of pivot on the ruler is 3.0 N after the tap is turned on for 3 min, calculate the weight of the ruler.

weight of ruler = ... [2]

4 Fig. 4.1 shows a fully inflated balloon placed inside a sealed and transparent tank. The tank is connected to an oxygen cylinder. Initially, the inside of the tank is kept at atmospheric pressure. When the tap is opened, oxygen is released from the cylinder into the tank. The temperature inside the tank remains constant throughout the experiment.

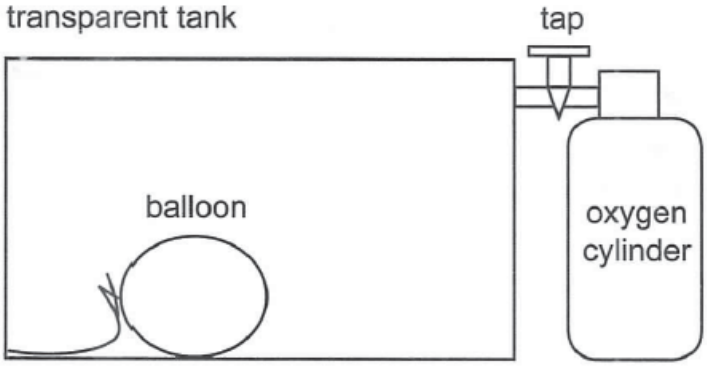


Fig. 4.1

The tap is opened until a noticeable change is observed in the balloon.

(a) State how the volume and pressure inside the balloon will change.

……

……

……[2]

(b) Using kinetic model of matter, describe and explain the changes in pressure and volume observed in the balloon.

……

……

……

……

……

……

……

……[3]

5 Fig. 5.1 shows a section of a solar heating system which helps to provide hot water for a house.

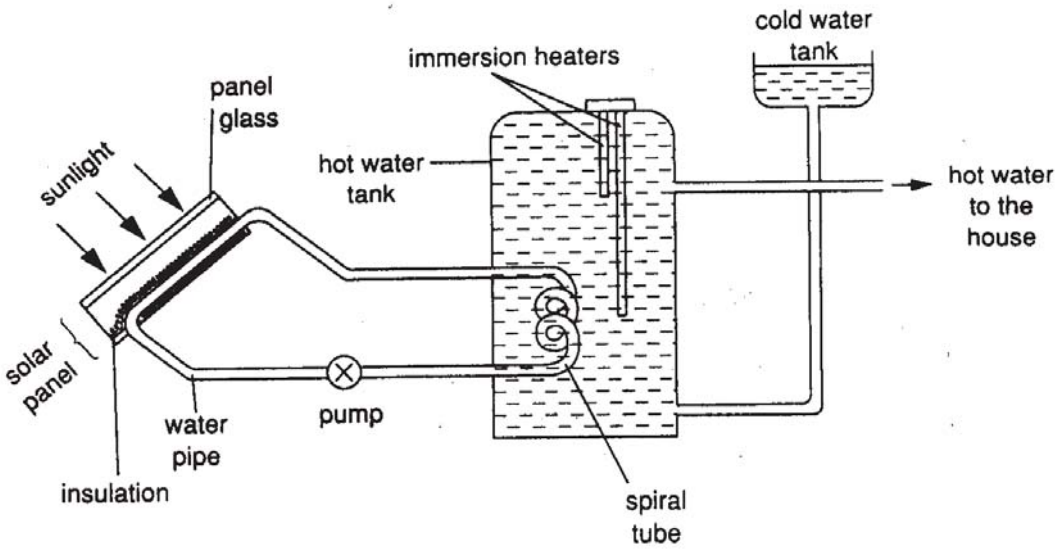


Fig. 5.1

It consists of a solar panel placed outdoor on a roof. Connected to this panel are water pipes. Heat from the Sun warms the water in these pipes which is then pumped to a hot water tank inside the house. Inside the hot water tank, the hot water transfers its heat, becomes cooled and circulates back to the solar panel.

Explain the purpose of the following features:

(a) the solar panel is covered with a sheet of glass,

……..

……[1]

(b) there is an insulation for the water pipe in the solar panel, and

……

……[1]

(c) the water pipe in the hot water tank is spiral and painted black.

……

……

……

……[2]

6 Fig. 6.1 shows circular wavefronts produced at the centre of a circular ripple tank.

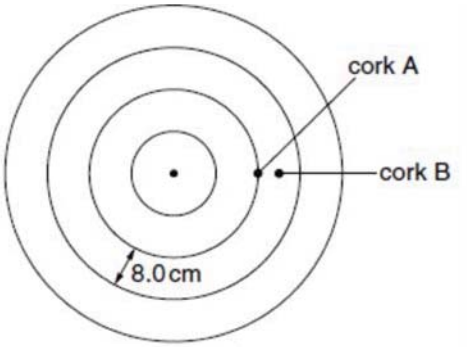


Fig. 6.1

Two corks, A and B, float on the water in the ripple tank. They move up and down on the surface of the water as the wave passes. The wavelength of the wave is 8.0 cm.

Fig. 6.2 shows how the displacement of A varies with time.

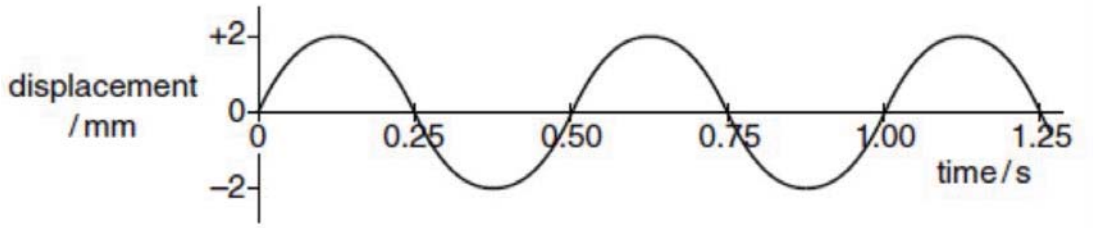


Fig. 6.2

(a) Define what is meant by frequency of the wave.

……..……[1]

(b) **(i)** Use Fig.6.2 to determine the frequency of the wave.

frequency = ……..[1]

(ii) Hence, calculate the speed of the wave.

speed = …….. [2]

(c) The horizontal distance between A and B is half the wavelength of the wave.
On Fig. 6.2, sketch a graph to show how the displacement of B varies with time.
Draw at least 2 complete waves. [1]

7 Fig. 7.1 shows an object **O** placed in front of a converging lens **PQ**. The image of **O** is formed at **I**. A plane mirror is then inserted between the lens **PQ** and the image **I** as shown in the diagram.

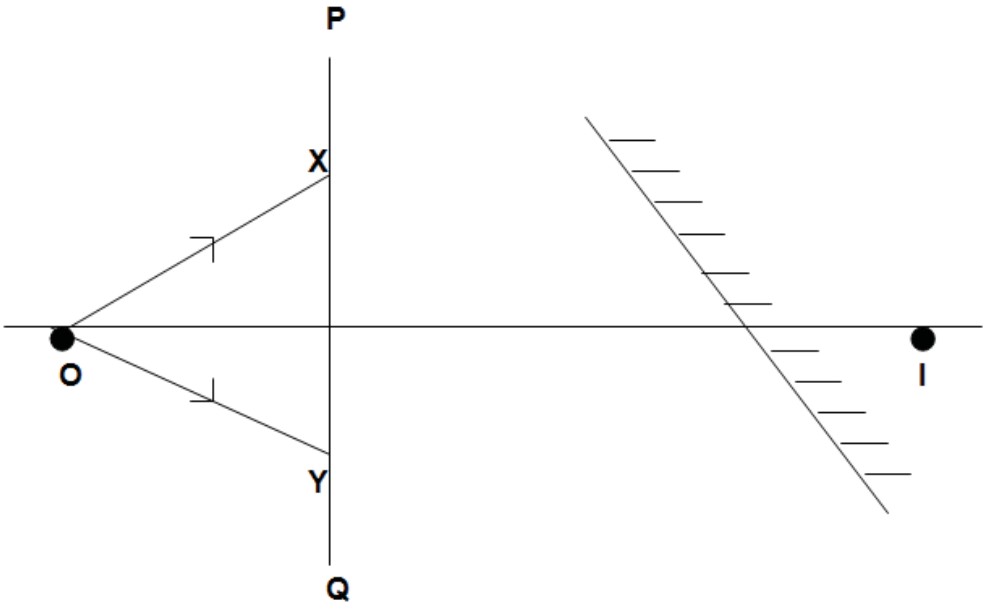


Fig. 7.1

(a) What do you understand by focal length of a lens?

……..……

……..……[1]

(b) **(i)** On Fig. 7.1, complete the ray diagram to show how the two rays **OX** and **OY** are reflected by the mirror after they emerge through **PQ**. [2]

(ii) Using evidence from your diagram in ***(b)(i)*****,** explain whether an image formed will be virtual or real.

……

……

……[2]

8 The base of a storm cloud is negatively charged. Fig. 8.1 shows the cloud above flat ground.

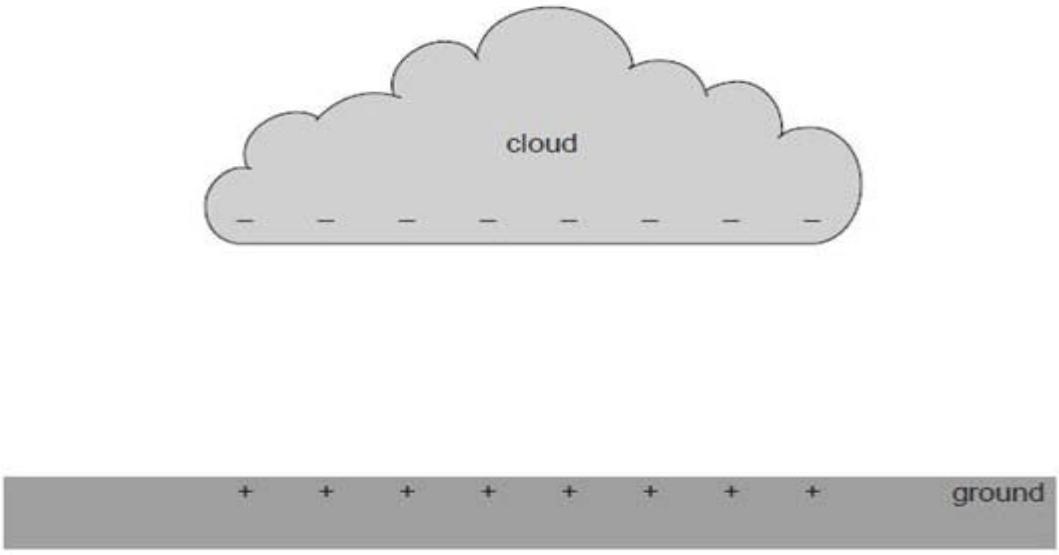


Fig. 8.1

(a) The cloud causes the ground beneath it to become positively charged. Explain, in terms of the particles involved, how the ground becomes positively charged.

……

……

……

……[2]

(b) In the space between the negative charge on the cloud and the positive charge on the ground, there is an electric field.

(i) State what is meant by an *electric field*.

……

……[1]

(ii) On Fig. 8.1, draw the electric field between the cloud and ground. [1]

9 Four resistors and a rheostat are connected as shown in Fig. 9.1. Each resistor has a resistance of **R.**

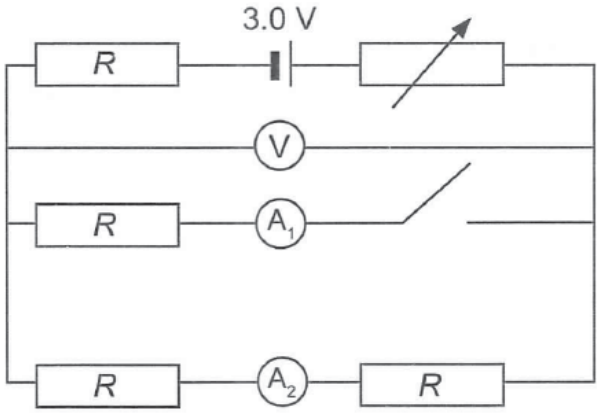


Fig. 9.1

Both the ammeters and the voltmeter used are ideal.

(a) When the switch is open and the rheostat is set to 1.0 Ω, the voltmeter reads 1.50 V. Calculate value of R.

R = …… [3]

(b) The rheostat is now set to a different resistance value so that when the switch is closed, ammeter A_1 reading is 0.36 A and ammeter A_2 reading is 0.18 A. Calculate the new resistance of the rheostat.

new resistance = …..…… [3]

10 Fig.10.1 shows the structure of a circuit-breaker that uses an electromagnet. The circuit-breaker operates when the current is 10 A.

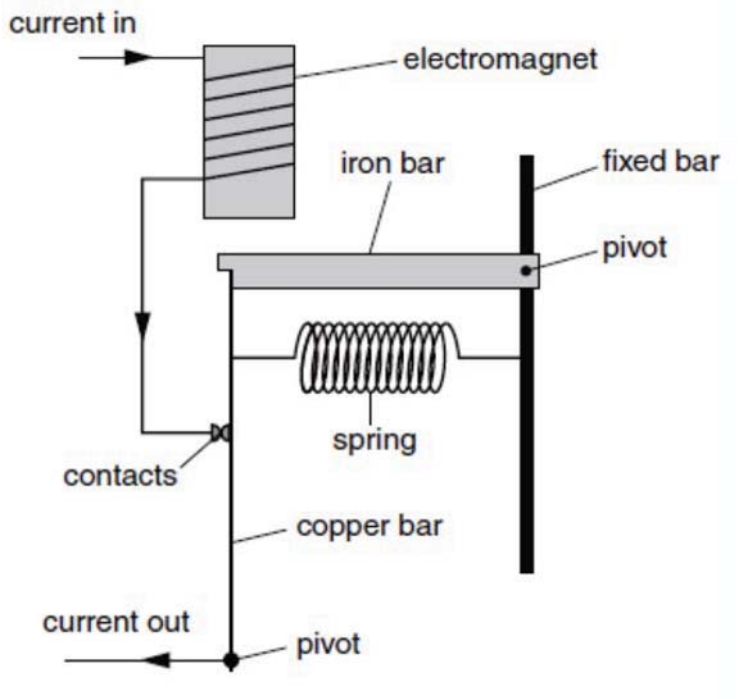


Fig. 10.1

(a) When the current is greater than 10 A, the circuit-breaker stops the current. Explain what happens in the circuit-breaker when this occurs.

……

……

……

……

……

……[3]

(b) State how the electromagnet can be altered so that the circuit-breaker stops the current at less than 10 A.

……

……[1]

Section B (30 marks)

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

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

11 **(a)** In an experiment to measure the specific heat capacity of water, an electric heater heats water in a glass beaker. The temperature of the water is measured at regular intervals of time. Fig. 11.1 shows how the temperature varies with time t.

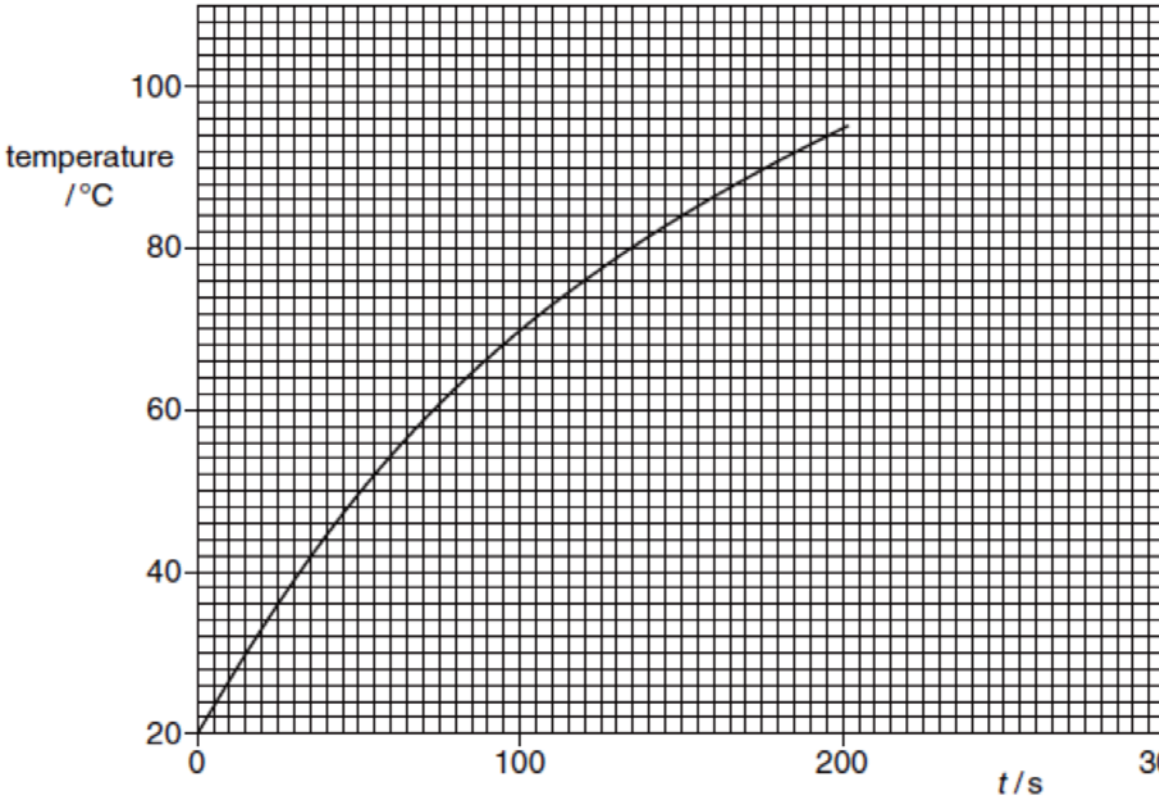


Fig. 11.1

(i) Use Fig. 11.1 to determine the change in temperature between

t = 0 and t = 100 s, change = ……..

t = 100 s and t = 200 s. change = …….. [1]

(ii) Explain why the values in **(i)** are different.

……..

……..

……..

……[2]

(b)

The experiment in **(a)** is repeated using 72 g of water. The heater supplies 7400 J of thermal energy to the water and the temperature rise of the water is 23 °C. Calculate the specific heat capacity of water.

specific heat capacity = …… [2]

(c) **(i)** A bullet of mass 72 g is fired from a gun at a speed of 450 m/s. Calculate the kinetic energy of the bullet.

kinetic energy = …… [2]

(ii) The amount of internal energy gained by the water and the amount of kinetic energy gained by the bullet are approximately equal.

Describe the change in the motion of the molecules of the water and of the molecules of the bullet caused by this addition of energy.

Water : ……...

……..

……..

……..…[2]

Bullet: ……..

……..

……..……[1]

12 A racing car of mass 500 kg, including the driver but not fuel, decelerates from a speed of 50.0 m s^{-1} to 30.0 m s^{-1} when approaching a bend. While the brakes are applied, the driver steps on the clutch to disengage the engine transmission to the wheels. A constant resultant retarding force of 7000 N thus acts on the vehicle.

(a) Given that the capacity of the fuel tank of the racing car is 0.178 m^3 and the density of the fuel used is 720 kg m^{-3}, calculate the mass of the fuel needed to fill up the fuel tank.

mass = ……[2]

(b) Calculate the total weight of the racing car when it is travelling with a full tank.

total weight = ……[2]

(c) Assuming that the racing car approaches the bend with a full tank and assuming that the change in the mass of the fuel is negligible during the deceleration, calculate the time taken for the deceleration.

time = ……..[3]

(d) Calculate the work done by the retarding force to decelerate the car from 50.0 m s^{-1} to 30.0 m s^{-1}.

work done = ……[3]

13 EITHER

Part of the mains electrical circuit in a house is shown in the figure 13.1. Two lamps L_1 and L_2, each rated at 90 W, 240 V, are connected to the wire A through fuse X. An electric kettle, rated at 2.1 kW, 240 V is also connected to the wire A through fuse Y. Fuse Z protects the whole circuit. The electric kettle has a metal case that is connected to wire C. The mains supply voltage is 240 V and the maximum current of fuses X, Y and Z are 3 A, 9 A and 10 A respectively.

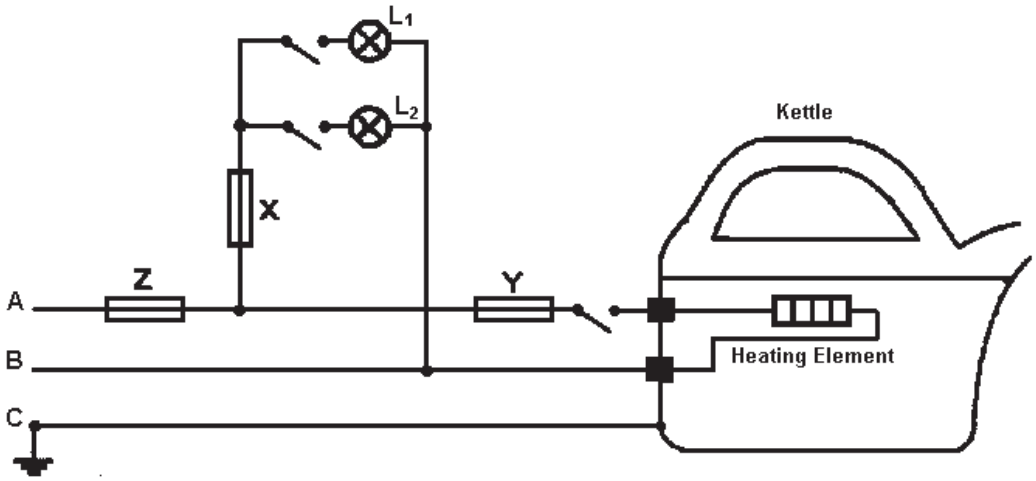


Figure 13.1

(a) State and explain the purpose of each wire A, B and C.

……

……

……

……

……

……

……[3]

(b) Calculate the total current drawn from the mains when the electric kettle and both the lamps are switched on.

total current = …… [3]

(c) State and explain whether fuse X, fuse Y and fuse Z will blow if the owner decides to add another six more identical lamps to light up the house?

……

……

……

……

……

……

……[3]

(d) Give a reason why the heating element is inappropriately positioned.

……

……[1]

13 OR

A company claims that their product, which is an ultrasound mosquito repeller, can be used to repel mosquitoes. This repeller is an electronic appliance which has a power rating of 3.0 W and is used on a 230 V supply. The ultrasound produced by the repeller is between 28kHz to 80 kHz and this range repels female mosquitoes.

(a) Explain if the ultrasound can be heard by humans.

.....

..... [1]

(b) Describe how the repeller propagates the ultrasound and how this ultrasound travels through air.

.....

.....

.....

..... [2]

(c) The repeller is placed X metres from a wall and a mosquito hovers in the air a distance away from the repeller as shown in Fig. 13.2.

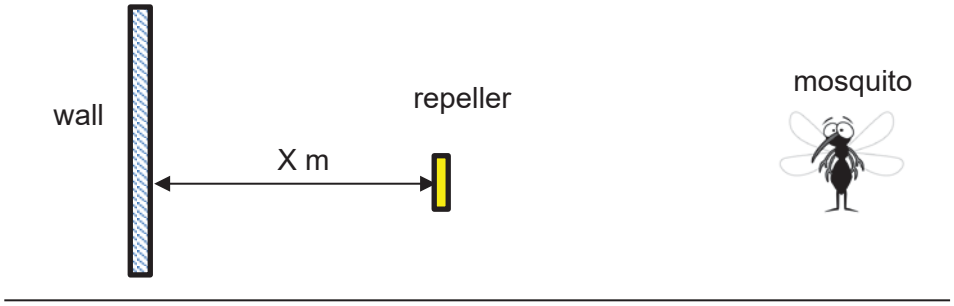


Fig. 13.2

If the ultrasound from the repeller hits the hovering mosquito twice with a time lapse of 0.10 s, calculate X. (Assume the speed of ultrasound in air is 330 m/s)

X = ……..…… [2]

(d) State and explain the effect on the following when the repeller's frequency increases from 28 kHz to 80 kHz?

Pitch : …..…….....

……[1]

Speed : ...…….....

……[1]

(e) The sound wave from the repeller travels from left to right through air. Fig. 13.3 is a **scaled diagram** that shows the actual positions of the air particles at a particular instance. Before the sound wave arrives, the particles are all spaced equally apart on the vertical lines shown. At the instance shown, particles X and Y are passing through the original undisturbed position.

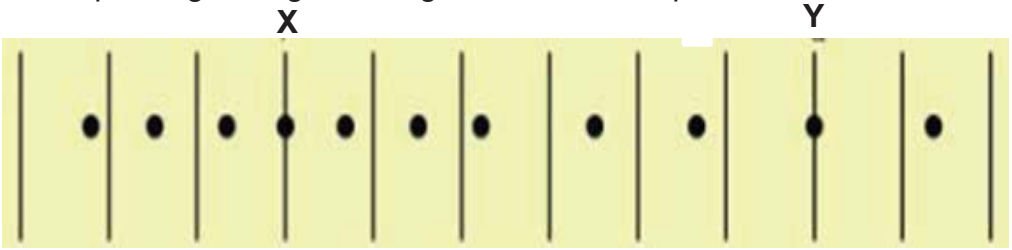


Fig. 13.3

(i) For the instance shown in Fig. 13.3, sketch the displacement-distance graph of all the particles in the axes below. Label particles **X** and **Y** in your graph.

[2]

(ii) Indicate on the graph above the points where the pressure is the highest with a letter **A** and the point where the pressure is the lowest with the letter **B**. [1]

-- END OF PAPER –

NGEE ANN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2020
SECONDARY 4 EXPRESS
PHYSICS 6091
PAPER 1

MARK SCHEME

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

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

Name: …….. Index no: ……..... Class: ……

NGEE ANN SECONDARY SCHOOL

0

PRELIMINARY EXAMINATION

PURE PHYSICS **6091/02**

PAPER 2 **24 August 2020**

1 h 45 min

MARK SCHEME

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

Section A (50 marks)

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

1 Fig. 1.1 is the speed-time graph for a rocket from the moment that the fuel starts to burn at time $t = 0$.

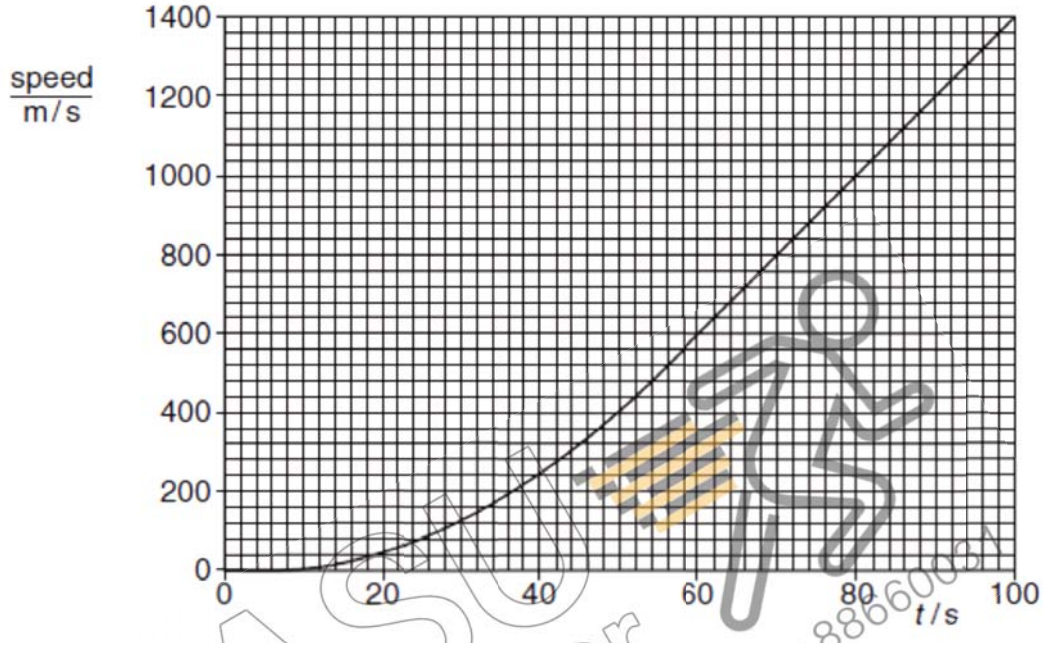


Fig. 1.1

(a) **(i)** State what happens to the acceleration of the rocket between $t = 5$ s and $t = 80$ s.

*It **increases** and **eventually reaches a constant value**. [1]*

(ii) Calculate the acceleration of the rocket at $t = 80$ s.

Acceleration** = **gradient of speed-time graph
= (1400 – 400) / (100 – 50) [1]
= 20 m/s^2 [1]

(iii) The total mass of the rocket at $t = 80$ s is 1.6×10^6 kg. Calculate the upward force on the rocket at this time, caused by the burning fuel.

Net force = ma = 1.6 x 10^6 x 20
= 3.2 x 10^7 N [1]

Upward force = 3.2 x 10^7 + (1.6 x 10^6 x 10)
= 4.8 x 10^7 N [1]

(b) As the rocket burns fuel, it ejects hot gas downwards. Name a pair of action and reaction force.

The upward force on the rocket by the gas

The downward force acting on the hot gas by the rocket. ***[1]***

2 Fig. 2.1 illustrates the journey of a cyclist from point A to point B. Points A and B are at the same height.

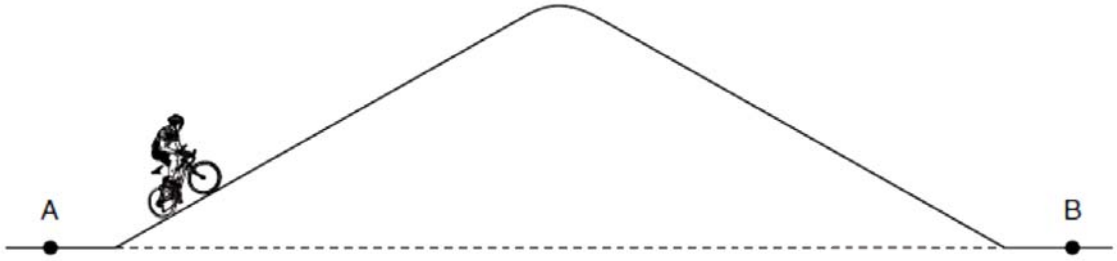


Fig. 2.1

The cyclist starts from rest at A and pedals up and over a hill. Near the bottom of the hill, she starts to brake and comes to rest at B.

(a) Describe the energy changes that take place as she pedals up the hill at constant speed.

***Chemical potential energy** in the cyclist is **converted to gravitational potential energy** as she pedals **up the hill**. [1]*

*Some of it is also **converted to thermal energy/heat** due to **friction** on the road. [1]*
(if KE is mentioned, an idea of no net gain in KE must be conveyed)

(b) Explain how the law of conservation of energy applies to the complete journey from A to B.

*From A to B, **all the chemical potential energy** used by the cyclist is **converted to thermal energy / heat**. [1]*

*Since the **total energy remains constant from A to B**, the law of conservation of energy applies to this journey. [1]*

(c) At one point in the journey, the gravitational potential energy of the cyclist has increased by 5400 J. The mass of the cyclist is 60 kg.

Calculate the height above A of the cyclist at this point.

Using GPE = mgh,
5400 = 60 x 10 x h [1]
h = 9.0 m [1]

3 A student conducts an experiment to verify the principle of moments using a set-up shown in Fig. 3.1.

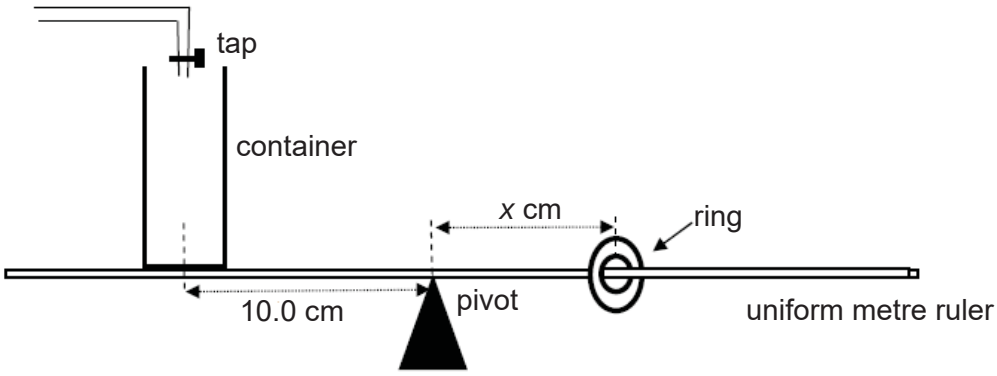


Fig. 3.1

A container of negligible mass is placed on a uniform metre ruler which is pivoted at the 50.0 cm mark. Water of density 1.0 g/cm^3 is released into the container at a constant rate of 50.0 cm^3 per minute. In order to balance the metre ruler, a ring of mass 55 g is hung on the ruler and its position is adjusted accordingly by the student.

(a) Define the moment of a force.

The product between a force and the perpendicular distance from line of action of force and pivot [1]

(b) Calculate *x* to balance the ruler after the tap is turned on for 3 min.

mass of water after 3 min = 1.0 × (50 × 3) = 150 g [1]

$$150 \times 10 = 55 \times x$$
$$x = 27.3 \text{ cm } [1]$$

(c) If the force of pivot on the ruler is 3.0 N after the tap is turned on for 3 min, calculate the weight of the ruler.

Total upward force = total downward force
3 = weight + (0.150 + 0.055) × 10 [1]
weight = 0.95 N [1]

4 Fig. 4.1 shows a fully inflated balloon placed inside a sealed and transparent tank. The tank is connected to an oxygen cylinder. Initially, the inside of the tank is kept at atmospheric pressure. When the tap is opened, oxygen is released from the cylinder into the tank. The temperature inside the tank remains constant throughout the experiment.

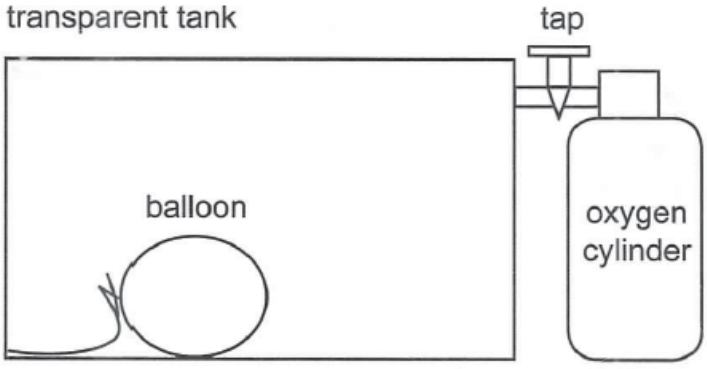


Fig. 4.1

The tap is now opened until a noticeable change is observed in the balloon.

(a) State how the volume and pressure inside the balloon will change.

Volume of balloon decreases [1]
and pressure in balloon increases. [1]

(b) Using kinetic model of matter, describe and explain the changes in pressure and volume observed in the balloon.

As pressure outside balloon is greater than the pressure inside the balloon, there is a net force which causes the balloon to decrease in volume. [1]

There is a greater number of gaseous molecules per unit volume and frequency of collisions of molecules with the inner wall of the balloon increases. [1]

This results in an increase in average force exerted by the gas molecules per unit area which leads to an increase in pressure inside the balloon. [1]

5 Fig. 5.1 shows a section of a solar heating system which helps to provide hot water for a house.

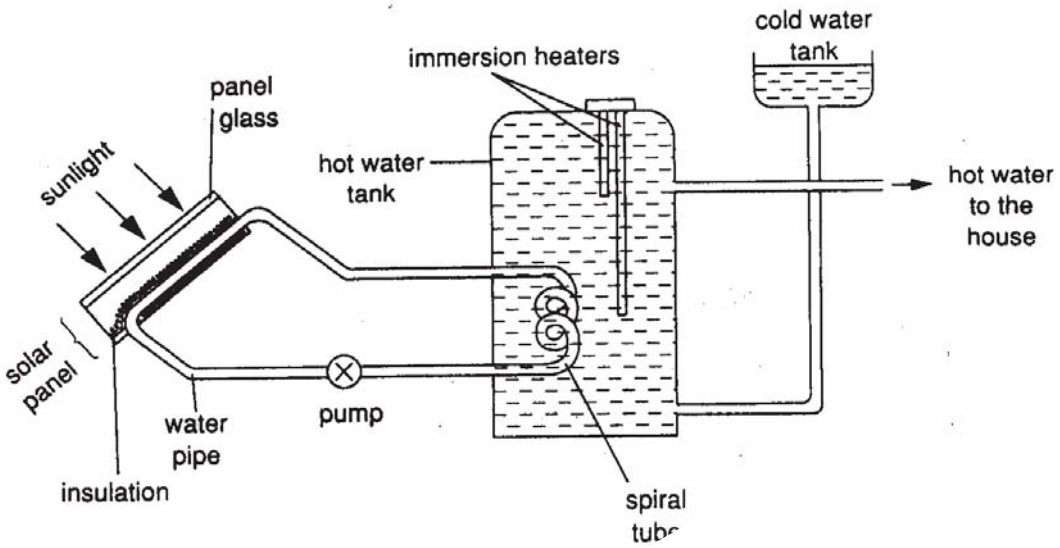


Fig. 5.1

It consists of a solar panel placed outdoor on a roof. Connected to this panel are water pipes. Heat from the Sun warms the water in these pipes which is then pumped to a hot water tank inside the house. Inside the hot water tank, the hot water transfers its heat, becomes cooled and circulates back to the solar panel.

Explain the purpose of the following features:

(a) the solar panel is covered with a sheet of glass,

Glass allows infrared rays into solar panel and trap the heat [1]

(b) there is an insulation for the water pipe in the solar panel, and

It reduces heat loss from the water in the pipe by conduction to the solar panel when the Sun is not shinning. [1]

(c) the water pipe in the hot water tank is spiral and painted black.

Spiral increase surface area to allow more heat to be transferred to water by conduction / radiation. [1]

Black is a good emitter of infra-red radiation. These increase rate of radiation to water / enable water to be heated up quickly. [1]

6 Fig. 6.1 shows circular wavefronts produced at the centre of a circular ripple tank.

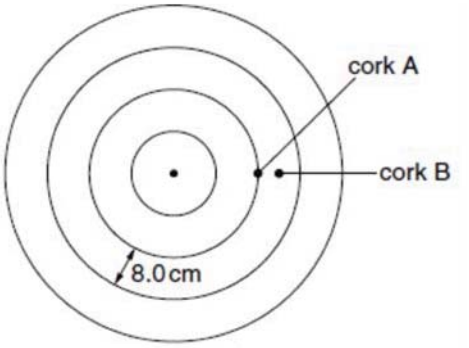
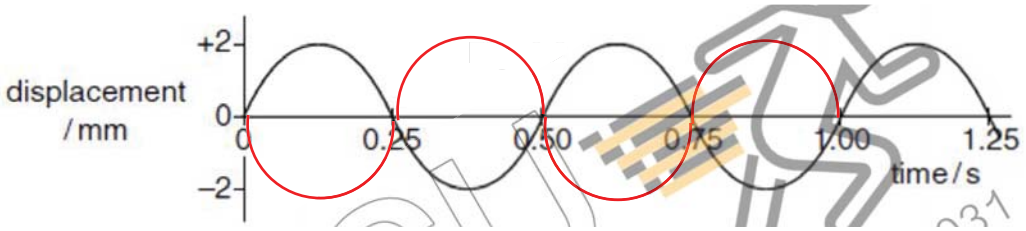


Fig. 6.1

Two corks, A and B, float on the water in the ripple tank. They move up and down on the surface of the water as the wave passes. The wavelength of the wave is 8.0 cm.

Fig. 6.2 shows how the displacement of A varies with time.



(a) Define what is meant by frequency of the wave.

Number of complete waves in one second. [1]

(b) **(i)** Use Fig.6.2 to determine the frequency of the wave.

f = 1/ T = 1 / 0.50 = 2.0 Hz [1]

(ii) Hence, calculate the speed of the wave.

v = fλ = 2.0 x 8.0 [1]
= 16 cm/s or 0.16 m/s [1

(c) The horizontal distance between A and B is half the wavelength of the wave.
On Fig. 6.2, sketch a graph to show how the displacement of B varies with time. Draw at least 2 complete waves.

[1] for 2 correct and complete waves drawn

7 Fig. 7.1 shows an object **O** placed in front of a converging lens **PQ**. The image of **O** is formed at **I**. A plane mirror is then inserted between the lens **PQ** and the image **I** as shown in the diagram.

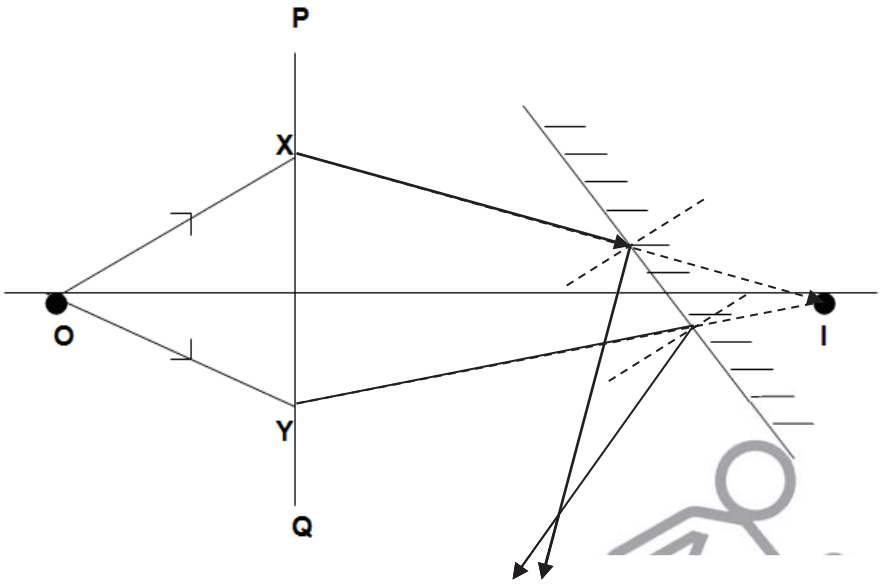


Fig. 7.1

(a) What do you understand by focal length of a lens?

The distance between the optical centre and the focal point [1]

(b) **(i)** On Fig. 7.1, complete the ray diagram to show how the two rays **OX** and **OY** are reflected by the mirror after they emerge through **PQ**.

Normal drawn and 1st correct reflected ray [1]
Normal drawn and 2nd correct reflected ray [1]
-1 if no arrow

(ii) Using evidence from your diagram in *(b)(i)*, explain whether an image formed will be virtual or real.

The image formed will be real [1] as the rays converge at a point [1]

8 The base of a storm cloud is negatively charged. Fig. 8.1 shows the cloud above flat ground.

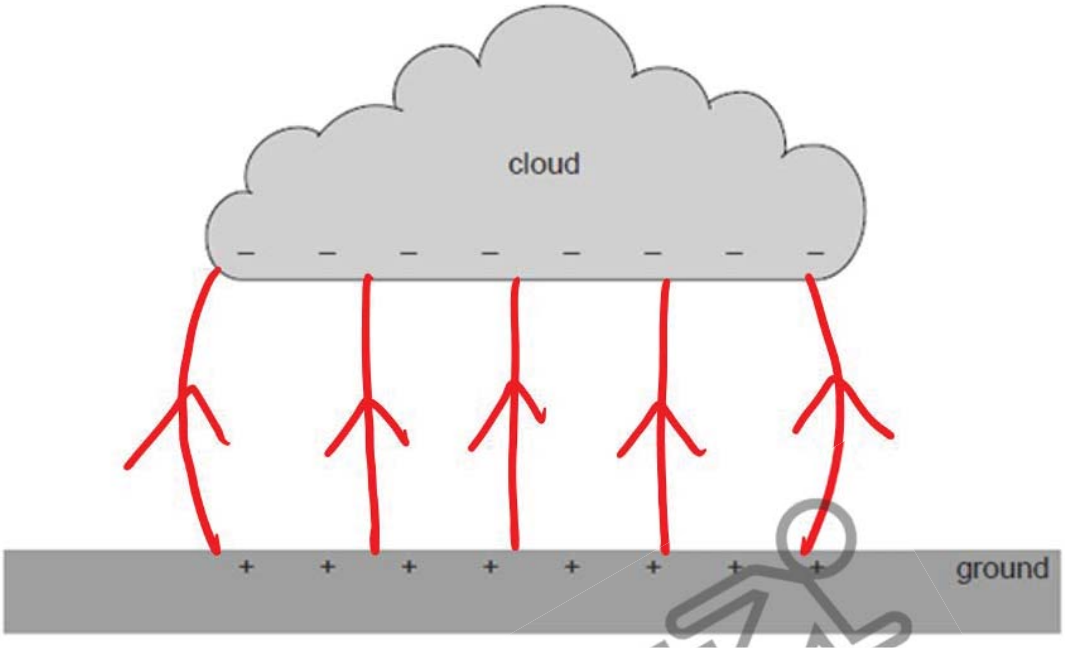


Fig. 8.1

(a) The cloud causes the ground beneath it to become positively charged.
Explain, in terms of the particles involved, how the ground becomes positively charged.

Electrons on the ground are repelled by the negatively-charged cloud, [1] as like charges repel. [1] This causes the ground to be positively charged.

(b) In the space between the negative charge on the cloud and the positive charge on the ground, there is an electric field.

(i) State what is meant by an *electric field*.

Region where electric charges experience an electrical force [1]

(ii) On Fig. 8.1, draw the electric field between the cloud and ground.

[1] for correct electric field drawn. [1]

9 Four resistors and a rheostat are connected as shown in Fig. 9.1. Each resistor has a resistance of **R.**

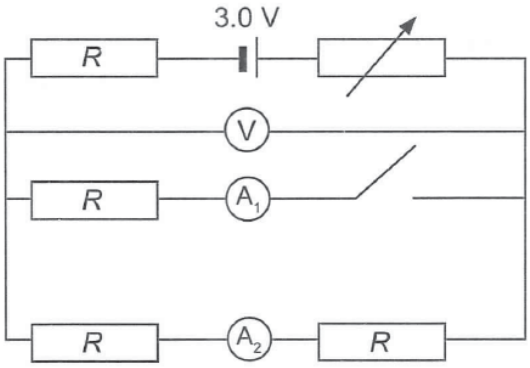


Fig. 9.1

Both the ammeters and the voltmeter used are ideal.

(a) When the switch is open and the rheostat is set to 1.0 Ω, the voltmeter reads 1.50 V. Calculate value of R.

$$V_R = \frac{1.50}{2} = 0.75V$$

$V_{\text{variable resistor}} = 3.0 - (0.75 \times 3) = 0.75$ **[1]**

$$I = \frac{V}{R} = \frac{0.75}{1.0} = 0.75A$$ **[1]**

$$R = \frac{V}{I} = \frac{0.75}{0.75} = 1.0\Omega$$ **[1]**

(b) The rheostat is now set to a different resistance value so that when the switch is closed, ammeter A_1 reading is 0.36 A and ammeter A_2 reading is 0.18 A. Calculate the new resistance of the rheostat.

$I_T = 0.36 + 0.18 = 0.54$ A

1/R = 1/1 + ½ = 3/2
R = 2/3 = 0.667 Ω **[1]**

$$R_E = \frac{V_T}{I_T} = \frac{3.0}{0.54} = 5.56\Omega$$ **[1]**

$5.56 - 1 - 0.667 = 3.89\Omega$ **[1]**

10 Fig.10.1 shows the structure of a circuit-breaker that uses an electromagnet. The circuit-breaker operates when the current is 10 A.

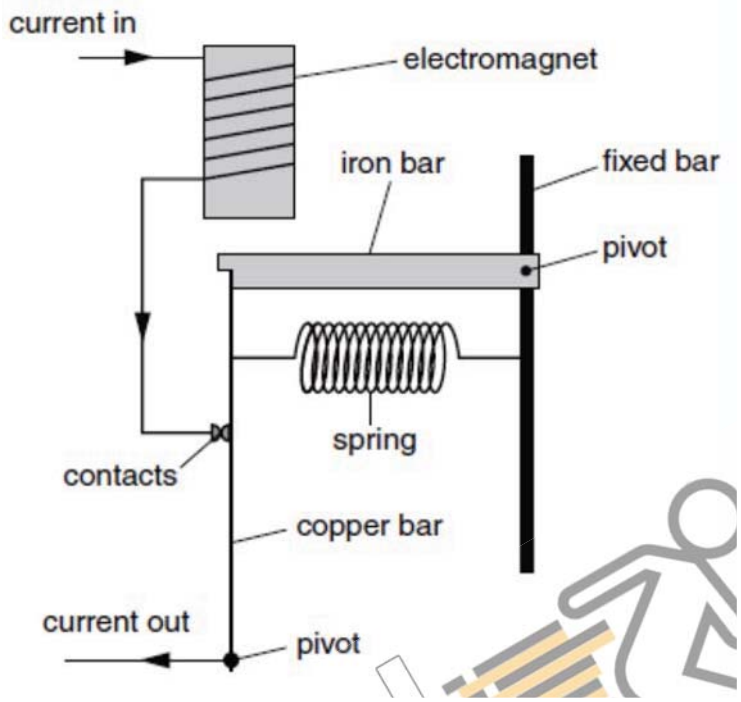


Fig. 10.1

(a) When the current is greater than 10 A, the circuit-breaker stops the current. Explain what happens in the circuit-breaker when this occurs.

When the current is greater than 10 A, the electromagnet becomes ***strongly magnetised*** *and* ***attracts the iron bar upwards****. [1]*
The ***spring contracts*** *and* ***pulls the copper bar****, breaking the contacts. [1] The* ***circuit*** *is now* ***open*** *and the* ***current stops flowing****. [1]*

(b) State how the electromagnet can be altered so that the circuit-breaker stops the current at less than 10 A.

Increase the number of turns *in the coil. [1]*

(This will increase the attractive force acting on the iron bar when the current is less 10 A.)

(accept other answers involving force on the iron bar)

Section B (30 marks)

Answer **all** questions in this section in the spaces provided.
Answer **only one** of the two alternative questions in **Question 13**.

11 **(a)** In an experiment to measure the specific heat capacity of water, an electric heater heats water in a glass beaker. The temperature of the water is measured at regular intervals of time. Fig. 11.1 shows how the temperature varies with time t.

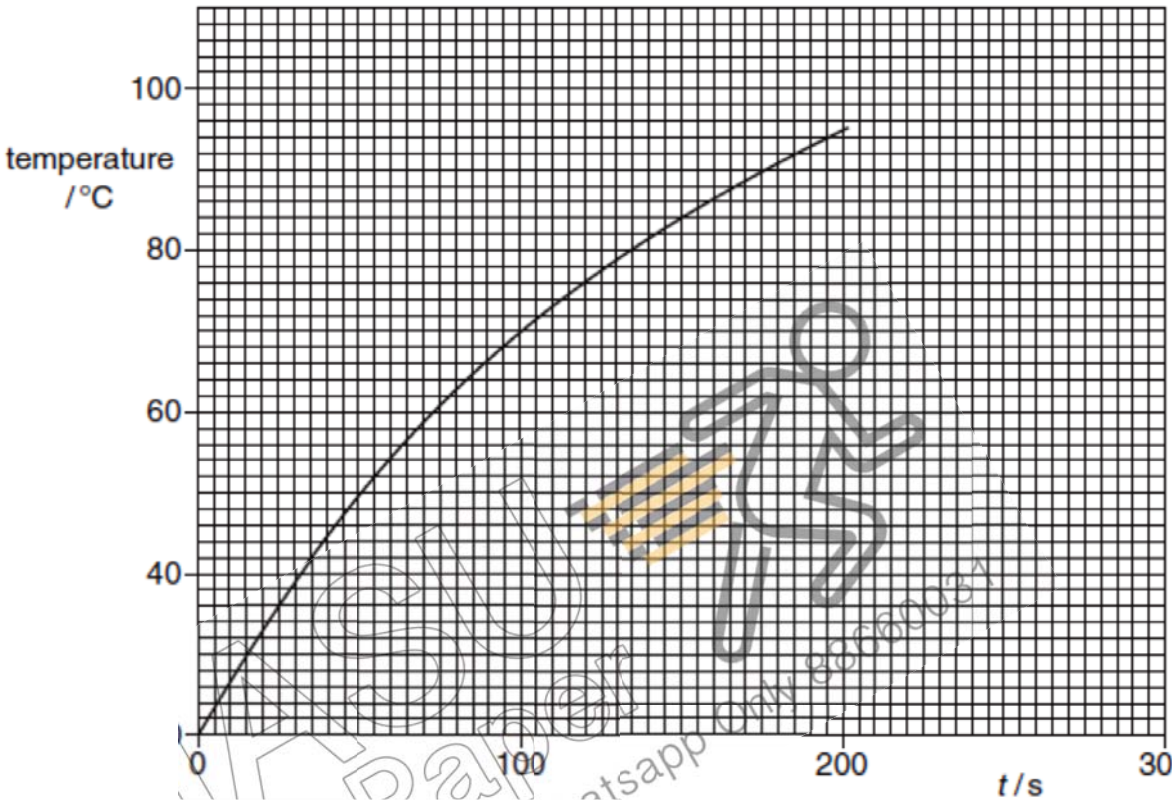


Fig. 11.1

(i) Use Fig. 11.1 to determine the change in temperature between

t = 0 and t = 100 s, change = ***50 °C***

t = 100 s and t = 200 s. change = ***25 °C [both for 1 mark]***

(ii) Explain why the values in **(i)** are different.

At higher temperature, the rate of temperature change decreases due to higher rate of evaporation [1]. More energy is used to overcome the intermolecular bonds then to increase the temperature of water [1]

(b) The experiment in **(a)** is repeated using 72 g of water. The heater supplies 7400 J of thermal energy to the water and the temperature rise of the water is 23 °C. Calculate the specific heat capacity of water.

Q = mcΔθ
c = 7400 / (72 x 23) [1]

= ***4.47 J / (g °C) or 4470 J / (kg °C) [1]***

(c) **(i)** A bullet of mass 72 g is fired from a gun at a speed of 450 m/s. Calculate the kinetic energy of the bullet.

KE = ½ mv²
= ½ x 0.072 x 450² [1]
= 7290 J [1]

(ii) The amount of internal energy gained by the water and the amount of kinetic energy gained by the bullet are approximately equal.

Describe the change in the motion of the molecules of the water and of the molecules of the bullet caused by this addition of energy.

water:
The water molecules move faster. [1] However, the motion is still random as the molecules slide over each other in the liquid.[1]

bullet:

All the molecules of the bullet move/vibrate faster about their fixed positions. [1]

12 A racing car of mass 500 kg, including the driver but not fuel, decelerates from a speed of 50.0 m s^{-1} to 30.0 m s^{-1} when approaching a bend. While the brakes are applied, the driver steps on the clutch to disengage the engine transmission to the wheels. A constant resultant retarding force of 7000 N thus acts on the vehicle.

(a) Given that the capacity of the fuel tank of the racing car is 0.178 m^3 and the density of the fuel used is 720 kg m^{-3}, calculate the mass of the fuel needed to fill up the fuel tank.

Mass = density x volume = 720 x 0.178 [1]
= 128.16 kg = 128 kg (3 sf) [1]

(b) Calculate the total weight of the racing car when it is travelling with a full tank.

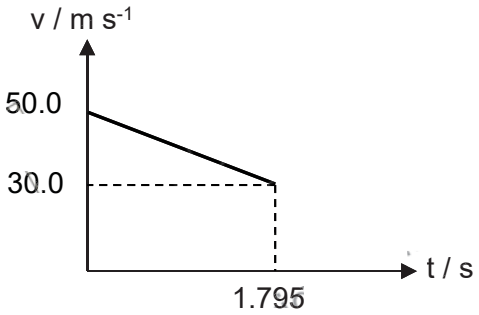
Total weight = m x g = (500 + 128.16) × 10 [1]
= 6281.6 N = 6280 N (3 sf) [1]

(c) Assuming that the racing car approaches the bend with a full tank and that the change in the mass of the fuel is negligible during the deceleration, calculate the time taken for the deceleration.

Deceleration experienced by the car = $\frac{F}{m} = \frac{7000}{628.16} \approx 11.14\,\text{m s}^{-2}$ **[1]**

$a = \frac{v-u}{t} \rightarrow t = \frac{v-u}{a} = \frac{30.0-50.0}{-11.14} \approx 1.795 \approx 1.80\,\text{s}$ (3 s.f) **[2]**

(d) Calculate the work done by the retarding force to decelerate the car from 50.0 m s^{-1} to 30.0 m s^{-1}. (Leave your answer to 3 s.f.)



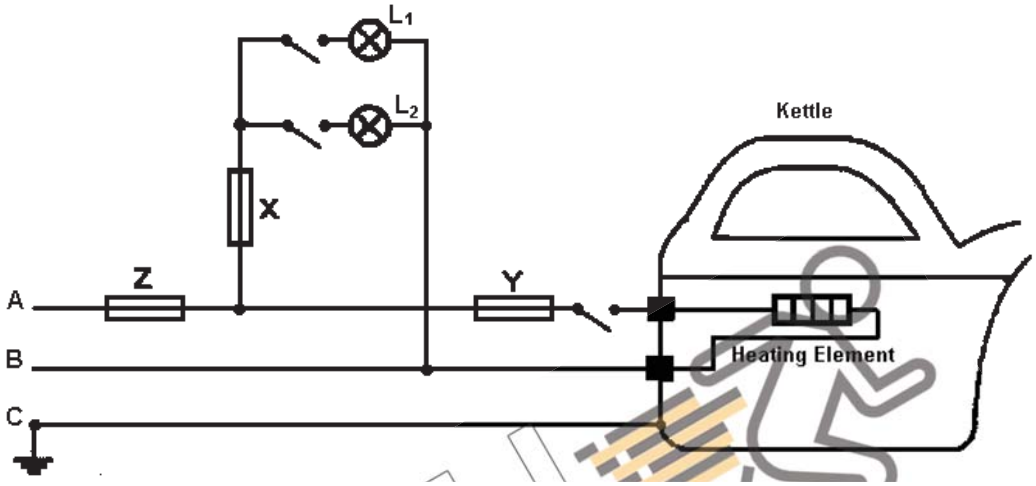
Distance travelled
= area under graph

$\frac{1}{2}(50.0+30.0)(1.795) = 71.8$ ***m [1]***

W.d = F x s
= 7000 × 71.8
= 502600 J [1]
= 503 000 J (3 s.f.) [1]

14 EITHER

Part of the mains electrical circuit in a house is shown in the diagram. Two lamps L_1 and L_2, each rated at 90 W, 240 V, are connected to the wire A through fuse X. An electric kettle, rated at 2.1 kW, 240 V is also connected to the wire A through fuse Y. Fuse Z protects the whole circuit. The electric kettle has a metal case that is connected to wire C. The mains supply voltage is 240 V and the maximum current of fuses X, Y and Z are 3 A, 9 A and 10 A respectively.



(e) State and explain the purpose of each wire A, B and C.

Wire A is a Live wire. It carries current from the mains to the kettle [1]

Wire B is a Neutral wire. It carries current from the kettle back to the mains [1]

Wire C is an Earth wire. It is a low resistance wire tied to the ***metal casing of the kettle. Should the metal casing accidentally becomes live, a large current will flow through the Earth wire*** *and blow the circuit fuse, hence protecting the user from an electric shock* ***[1]***

(f) Calculate the total current drawn from the mains when the electric kettle and both the lamps are switched on.

Let current drawn by one lamp, $I_1 = \frac{P}{V} = \frac{90\ W}{240\ V}$ ***= 0.375 A [1]***

Let current drawn by electric kettle, $I_2 = \frac{P}{V} = \frac{2100\ W}{240\ V}$ ***= 8.75 A [1]***

Total current drawn, I = (0.375 A x 2) + 8.75 A= ***9.5 A*** ***[1]***

(g) State and explain whether fuse X, fuse Y and fuse Z will blow if the owner decides to add another six more identical lamps to light up the house?

Fuse X will blow since current drawn by 8 lamps is 3 A and fuse is rated at exactly 3A [1].

Fuse Y will not blow since current drawn by electric kettle is still 8.75 A and is less than the fuse rating of 9A [1].

Fuse Z will blow because total current drawn is 11.75 A but it is rated at 10 A only [1]

(h) Give a reason why the heating element is inappropriately positioned.
Convection currents cannot be set up since the heating element is located at the top of the water.[1]

13 OR

A company claims that their product, which is an ultrasound mosquito repeller, can be used to repel mosquitoes. This repeller is an electronic appliance which has a power rating of 3.0 W and is used on a 230 V supply. The ultrasound produced by the repeller is between 28 kHz to 80 kHz and this range repels female mosquitoes.

(a) Explain if the ultrasound can be heard by humans.

No. Audible range for human is between 20 to 20kHz. [1]

(b) Describe how the repeller propagates the ultrasound and how this ultrasound travels through air.

*The repeller **vibrates** and air molecules **push and pull/collide** on the neighbouring molecules **parallel to the direction of wave travel**. [1]*
*This sets up regions of **compressions** and **rarefactions** of longitudinal ultrasound waves and longitudinal waves are formed [1]*

(c) The repeller is placed X metres from a wall and a mosquito hovers in the air a distance away from the repeller as shown in Fig. 13.2.

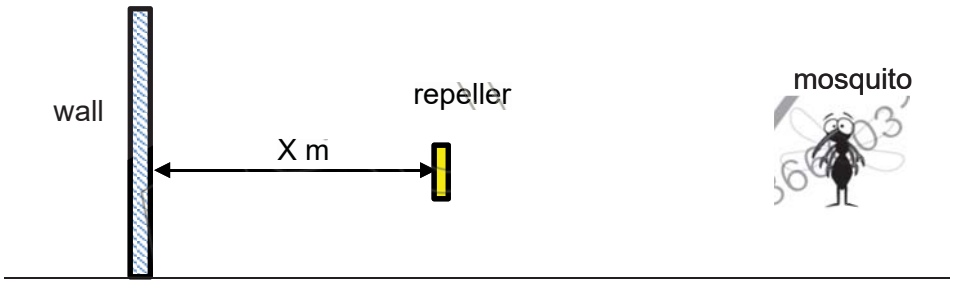


Fig. 13.2

If the ultrasound from the repeller hits the hovering mosquito twice with a time lapse of 0.10 s, calculate X. (Assume the speed of ultrasound in air is 330 m/s)

$t_2 - t_1 = 0.10$ → (d+X) / 330 – (d-X) / 330 = 0.10 [1]
→ d + X – d + X = 0.10
→ 2 X = 33
→ X = 16.5 m [1]

(d) State and explain the effect on the following when the repeller's frequency increases from 28 kHz to 80 kHz?

Pitch : The pitch increases as frequency increases. [1]

Speed : The speed remains the same as it is affected only by the medium and medium remains unchanged [1]

(e) The sound wave from the repeller travels from left to right through air. Fig. 13.3 is a scaled diagram that shows the actual positions of the air particles at a particular instance. Before the sound wave arrives, the particles are all spaced equally apart on

the vertical lines shown. At the instance shown, particles X and Y are passing through the original undisturbed position.

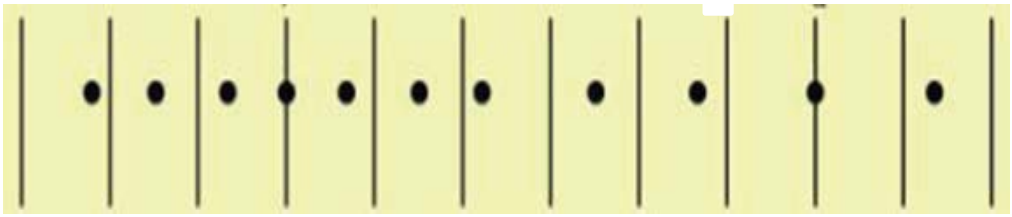
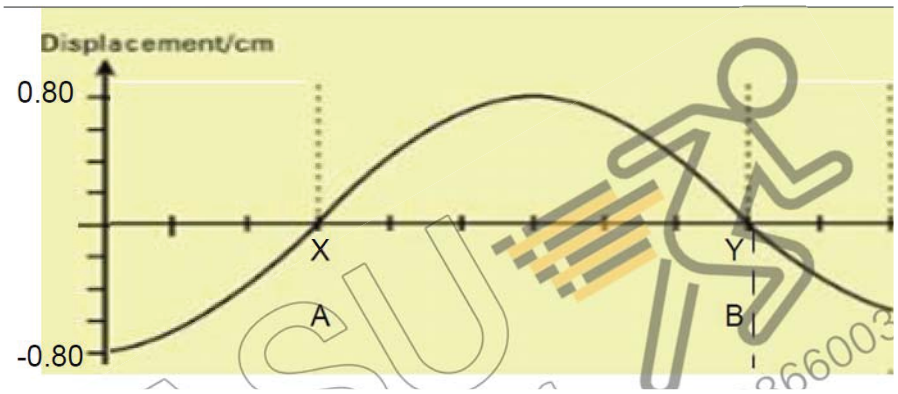


Fig. 13.3

(ii) For the instance shown in Fig. 13.3, sketch the displacement-distance graph of all the particles in the axes below. Label particles **X** and **Y** in your graph.



Shape [1] , value & label [1] : accept 0.80cm or 0.90cm

(ii) Indicate on the graph above the points where the pressure is the highest with a letter **A** and the point where the pressure is the lowest with the letter **B**.

Both A and B correctly labelled [1]

-- END OF PAPER --