Paya Lebar Methodist Girls' School (Secondary)
Preliminary Examination 2020
Secondary 4 Express

CANDIDATE NAME		CLASS		CLASS INDEX NUMBER	

CENTRE NUMBER					INDEX NUMBER				

PHYSICS 6091/01

Paper 1 Multiple Choice **31 August 2020**

Additional Materials: Multiple Choice Answer Sheet **1 hour**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Write your name, class and class index number on the separate Answer Sheet in the spaces provided.

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

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 Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this paper.

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

This document consists of 16 printed pages, including this cover page.

1 Max Planck's equation of radiation states that the energy of electromagnetic waves is equal to the product of Planck's constant, *h* and the frequency, *f* of the electromagnetic wave. The equation is $E = hf$. What is the unit of Planck's constant, *h*, expressed as SI base units?

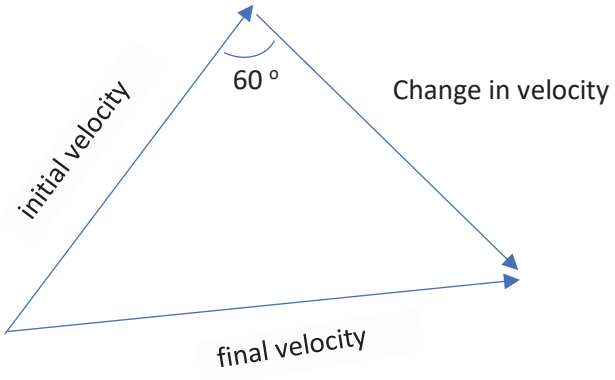
A J / Hz
B m s^2 / kg^3
C kg m^2 / s
D kg m^3 / s^2

2 Which of the following pairs of physical quantities does not have the same unit?

A	friction	electromotive-force
B	work done	thermal energy
C	latent heat	kinetic energy
D	Weight	electric force

3 An object travels with an initial velocity of 7 m/s. It experiences a force that causes it to change its velocity as shown in the diagram below. The force is acting at an angle of 60 ° with respect to the initial velocity of the object. Given that the magnitude of its final velocity is also 7 m/s, calculate the magnitude of change in velocity.

(Diagram is not drawn to scale)



A 3 m/s **B** 5 m/s **C** 6.2 m/s **D** 7 m/s

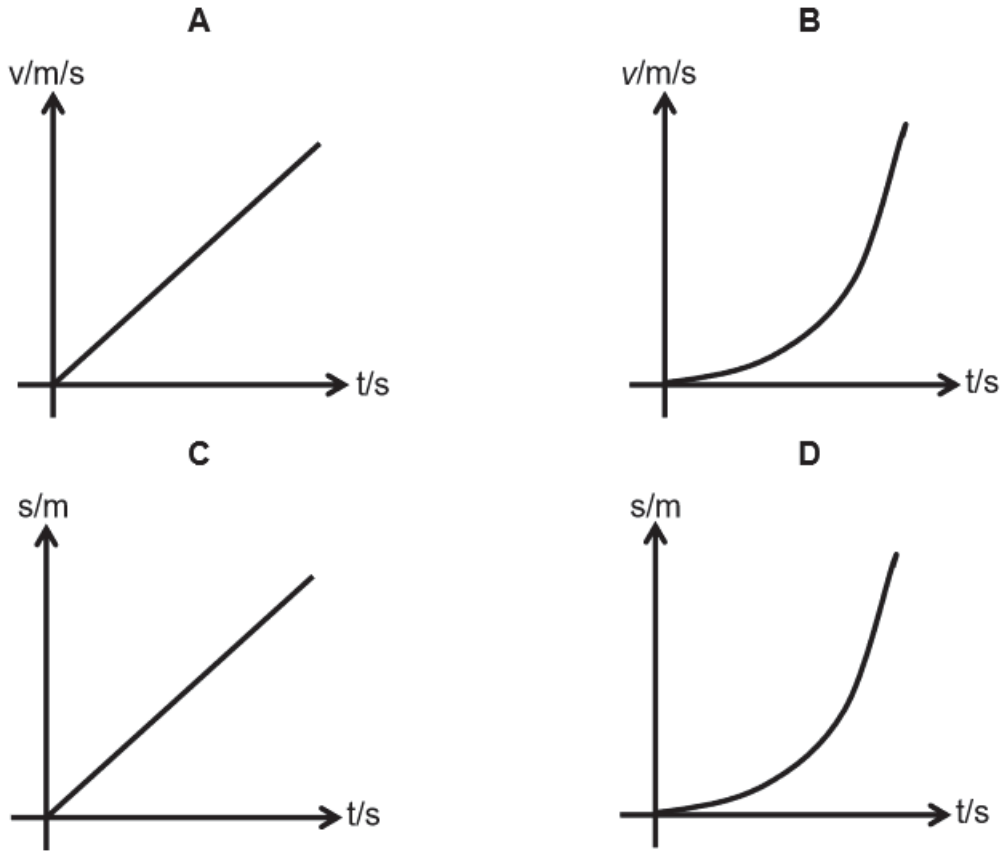
4 A ball is thrown vertically up into the air. Which of the following statements is true when the ball is at its maximum height?

A At maximum height, the speed of the ball is zero and its acceleration is less than the acceleration due to gravity.
B At maximum height, the speed of the ball is zero and its acceleration equals to the acceleration due to gravity.
C At maximum height, the speed of the ball is zero and its acceleration is more than the acceleration due to gravity.
D At maximum height, the speed of the ball is 10 m/s and its acceleration equals to the acceleration due to gravity.

5 At the top of a cliff of height 100 m, a girl throws a rock upwards with a velocity of 15 m/s. How much time later will the rock hit the bottom of the cliff? Ignore the effects of air resistance and take acceleration due to gravity as g = 10 m/s^2.

A 6.2 s **B** 6.8 s **C** 7.5 s **D** 8.2 s

6 An object is released from rest from a height above the ground. If air resistance acts on the object, which graph correctly shows the motion of the object?

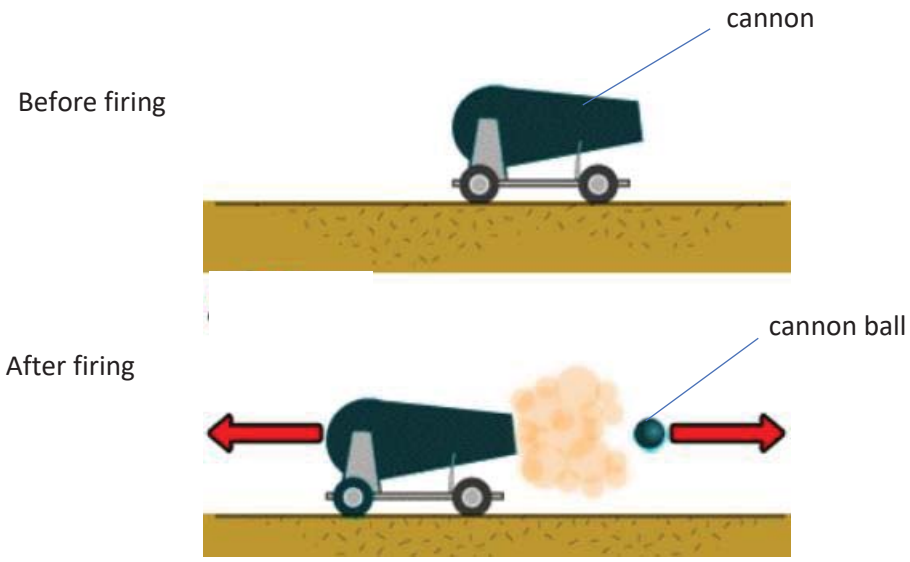


7 When a horizontal force of 8.0 N is applied to a wooden block of mass 5.0 kg on a horizontal surface, the block moves with a constant velocity.

If the force is increased to 15 N, what is the acceleration of the block?

A 0.8 m/s^2 **B** 1.4 m/s^2 **C** 1.6 m/s^2 **D** 3.0 m/s^2

8 A cannon with a mass of 3000 kg (when unloaded) is loaded with a 25 kg cannon ball. Both the cannon and the cannon ball are at rest initially. Immediately after the cannon is fired, the cannon ball accelerates to a speed of 200 m/s in 0.2 s.

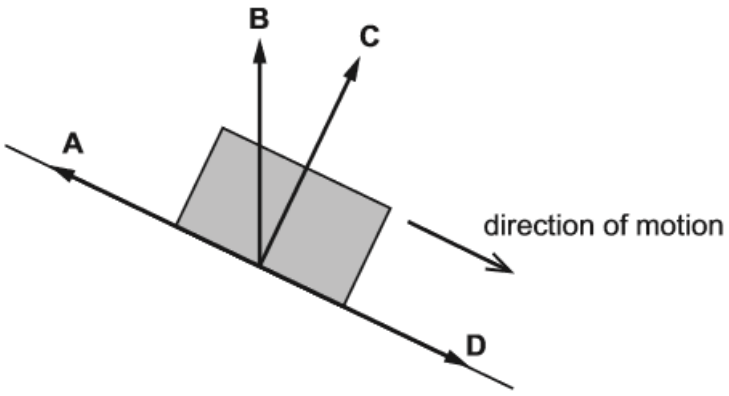


Ignoring contact friction with the ground, calculate the acceleration of the cannon immediately after the cannon is fired.

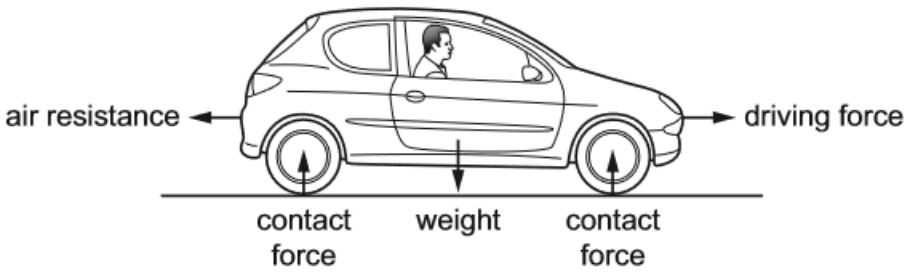
A 1.7 m/s^2 **B** 5.2 m/s^2 **C** 8.3 m/s^2 **D** 1000 m/s^2

9 A box slides down a frictionless slope, as shown.
As the box presses on the surface, the surface pushes back on the box.

In which direction does the surface push back on the box?



10 A car is accelerating along a straight, horizontal road. The diagram shows forces acting on the car.



Which forces are balanced?

A contact forces and air resistance
B contact forces and weight
C driving force and air resistance
D driving force and weight

11 A solid pure copper ball is heated strongly with flame. The copper ball did not melt. Which of the following statement is true?

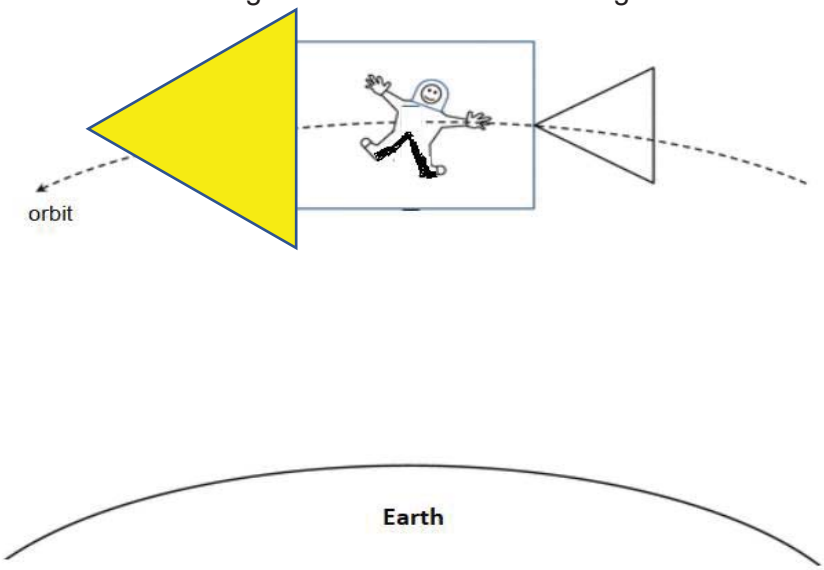
A The density of the copper ball stays the same as it is made of pure copper.
B The weight of the copper ball increases.
C The density of the copper ball decreases.
D The weight of the copper ball decreases as the mass per unit volume of the copper ball decreases.

12 There is no atmosphere on the Moon.
Two metal spheres of identical volume but different masses are at the same height above the ground on the Moon. They are released from rest at the same time.

How do the spheres move after they are released?

A The sphere with the larger mass has a smaller acceleration.
B The sphere with the smaller mass has a smaller acceleration.
C The two spheres hit the ground together.
D The sphere with the larger mass hits the ground first.

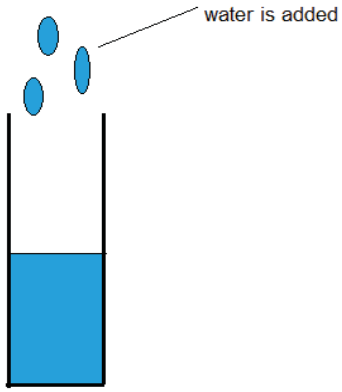
13 An astronaut in a rocket orbits around the Earth due to Earth's gravitational field. The diagram below shows the astronaut floating in the rocket as if he is weightless.



Which of the following statements best explains why the astronaut appears weightless?

A There is no force of gravity acting on the astronaut.
B There is no contact force between astronaut and the floor of the rocket.
C A resultant upward force keeps pulling the astronaut away from the floor in the rocket.
D The muscle mass of the astronaut decreases and he could not feel his weight.

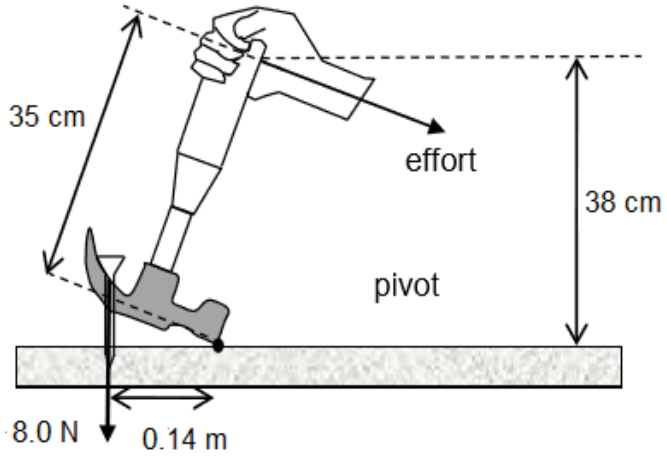
14 The diagram shows a bottle that is initially half-filled with water.



Water is slowly added into the bottle as shown.
What happens to the stability and the centre of the gravity of the bottle (with water) as the bottle is filled with water?

	stability	centre of gravity
A	become more stable	centre of gravity is lowered
B	become less stable	centre of gravity is raised
C	become more stable	centre of gravity is raised
D	become less stable	centre of gravity is lowered

15 A person uses a claw hammer to lift a nail.



What is the minimum effort needed to lift up the nail?

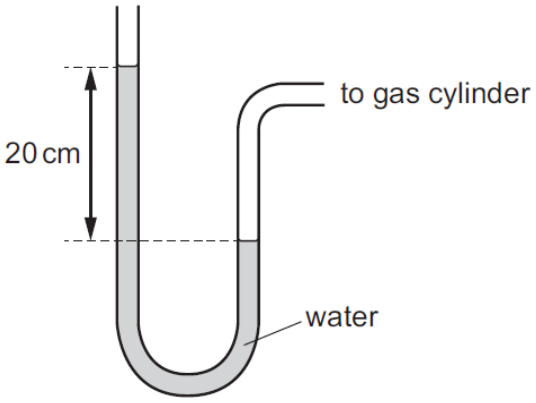
A 0.029 N **B** 0.032 N **C** 2.9 N **D** 3.2 N

16 A garden table weighs 50 N and has a top surface of area 2.0 m^2. It is raining and the rain produces a pressure of 3.0 N/m^2 on the table.

Ignoring the pressure of the atmosphere, what is the force exerted by the table on the ground?

A 44 N **B** 50 N **C** 56 N **D** 66 N

17 The pressure of a gas in a cylinder is measured using a water manometer.



The density of water is 1000 kg/m^3 and the gravitational field strength g is 10 N/kg.
How much greater than the atmospheric pressure is the pressure of the gas in the cylinder?

A 200 Pa **B** 2 000 Pa **C** 20 000 Pa **D** 200 000 Pa

18 A mercury barometer is constructed to measure the atmospheric pressure of Earth at sea level. The atmospheric pressure at sea level is 1.0×10^5 Pa and density of mercury is 13 600 kg/m^3.

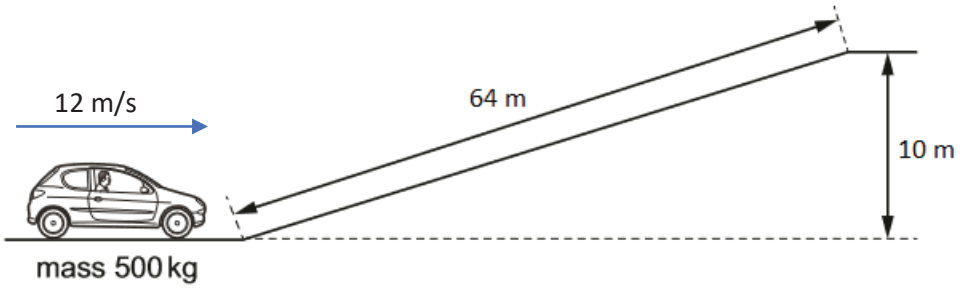
Which of the following is not suitable for use in the construction of this barometer?

A A supply of pure mercury.
B A glass tube having walls 4 mm thick.
C A glass tube sealed at one end.
D A glass tube of 700 mm long.

19 A car of mass M has an engine that can deliver a maximum power of P when travelling along a flat road.
What is the minimum time in which the car takes to accelerate from rest to a speed of 2v on a flat road?

A $\frac{Mv^2}{2P}$ **B** $\frac{Mv^2}{P}$ **C** $\frac{2Mv^2}{P}$ **D** $\frac{4Mv^2}{P}$

20 The diagram shows a small car of mass 500 kg approaching a slope with an initial speed of 12 m/s. It moves up the slope with constant acceleration of 2.0 m/s^2 until it reaches the top of the slope. The car takes 4.0 s to reach the top of the slope.

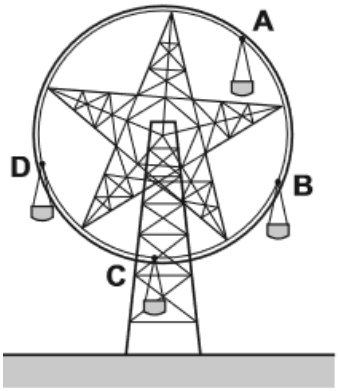


The gravitational field strength g is 10 N / kg.

Ignoring friction, how much work is done by the engine in moving the car up the slope?

A 50 000 J **B** 114 000 J **C** 56 250 J **D** 300 000 J

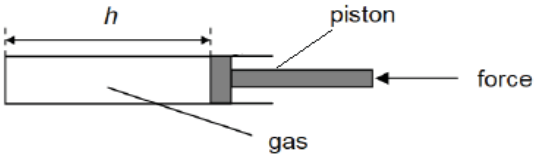
21 The diagram shows a stationary Ferris wheel ride with four chairs of equal mass.
Which chair has the most gravitational potential energy?



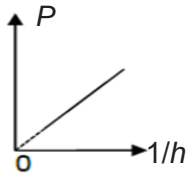
22 What happens to the molecules in a solid when the solid melts?

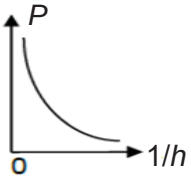
A The kinetic energy of the molecules increases and spacing between molecules increases.
B The potential energy of the molecules remain unchanged and the spacing between molecules decreases.
C The kinetic energy of the molecules remain unchanged but spacing between molecules increases.
D The potential energy of the molecules decreases and the spacing between molecules decreases.

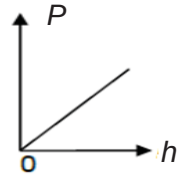
23 A column of gas is slowly compressed by a force on the piston, as shown in the diagram below.

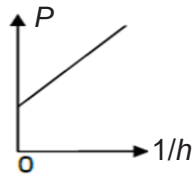


Which of the following graphs correctly shows the relation between the gas pressure *P* and the length of the gas column *h* if the temperature of the gas remains constant?

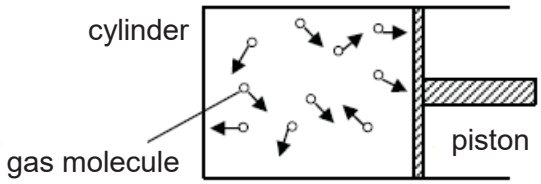
A


B


C


D


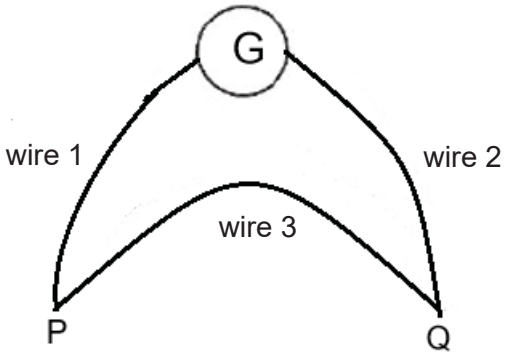
24 Gas inside a cylinder is heated slowly to a high temperature. The volume of cylinder remains constant.



How do the average distance between molecules and the pressure exerted against the inner walls of the cylinder compare with their initial values at a lower temperature?

	Average distance between molecules	Pressure exerted against the inner walls of cylinder
A	Same	Greater
B	Greater	Same
C	Greater	Reduced
D	Reduced	Greater

25 The diagram shows a thermocouple connected to a galvanometer. Two ends of the wires are placed in junction P and Q respectively. However, the galvanometer does not show any deflection.



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

A Wire 1 and wire 2 are made of the same material.
B Wire 1 and wire 3 are made of the same material.
C Both junctions P and Q have same temperature.
D The galvanometer is not sensitive enough to detect the current.

26 A resistance thermometer is used to measure the temperature of a water bath.

	Resistance / Ω
Pure melting ice	200
Thermometer junction in 50 °C water	350

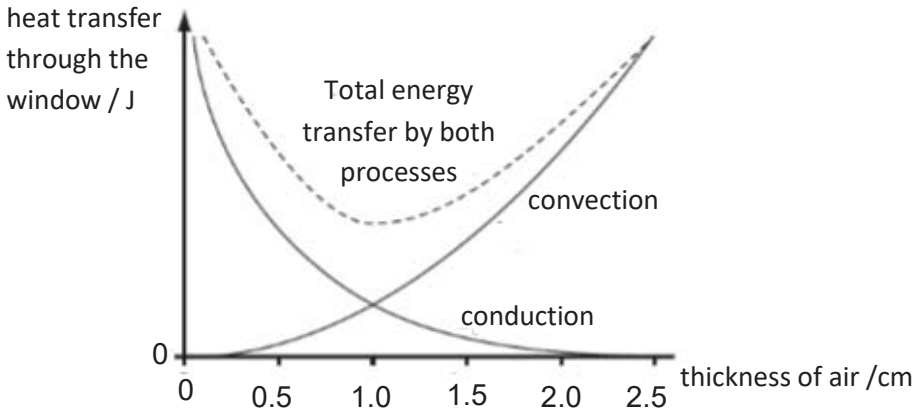
What is the resistance of the thermometer when its junction is placed in steam above boiling water at standard atmospheric pressure?

A 400 Ω **B** 500 Ω **C** 550 Ω **D** 700 Ω

27 Which quantity must be the same for two bodies in thermal equilibrium?

A Total internal energy of particles in the two bodies are the same.
B Total kinetic energy of particles in the two bodies are the same.
C Temperature of the two bodies are the same.
D State of matter of the two bodies must be the same.

28 A double-glazed window has two sheets of glass separated by a layer of air. Thermal energy is transferred through conduction and convection through the layer of air.
The amount of heat transfer due to conduction and convection varies with the thickness of the layer of air, as shown in the graph below.



Which thickness of air produces the smallest thermal energy transfer, and why?

A 0.0, because there is little thermal energy transfer by convection.
B 1.0 cm, because the total thermal energy transfer is least
C 1.5 cm, because the thermal energy transfer by conduction is less significant than that by convection.
D 2.5 cm, because there is little thermal energy transfer by conduction.

29 A piece of aluminium of mass 1.0 kg at 800 °C is placed into **m** kg of water at 25 °C until it reaches thermal equilibrium.

specific heat capacity of aluminum	900 J kg^{-1} $°C^{-1}$
specific heat capacity of water	4200 J kg^{-1} $°C^{-1}$
specific latent heat of vaporisation of water	2.27 x 10^6 J kg^{-1}

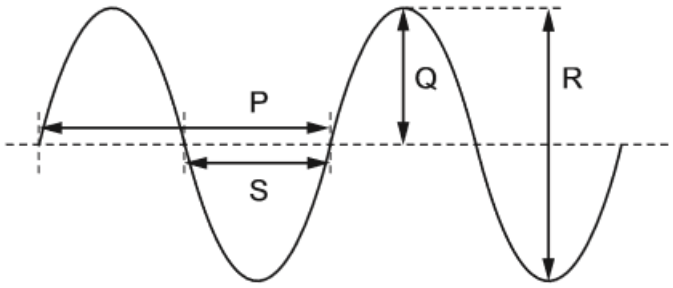
What is the value **m** if only 200 g of water is boiled off?

A 0.20 kg **B** 0.56 kg **C** 0.76 kg **D** 1.0 kg

30 Which of the following statements about the process of evaporation is incorrect?

A Evaporation can bring about cooling effect.
B Rate of evaporation increases as humidity in the air decreases.
C Rate of evaporation of liquids has a relationship with their boiling points.
D Evaporation occurs at any state.

31 The diagram shows the surface of water as a wave passes across a ripple tank.



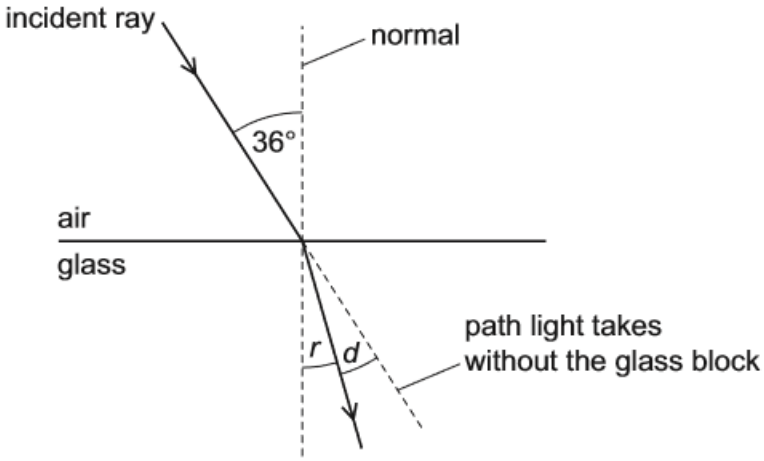
Which lengths represent the amplitude and the wavelength of the wave?

	amplitude	wavelength
A	R	S
B	Q	P
C	P	Q
D	Q	S

32 X- Ray has a typical wavelength that is comparable to the diameter of a typical atom. What is the order of magnitude of the frequency of X-Ray in vacuum?

A 10^{15} Hz **B** 10^{18} Hz **C** 10^{20} Hz **D** 10^{22} Hz

33 A ray of light is incident on the surface of a glass block. The diagram is not drawn to scale. The refractive index of the glass is 1.5.

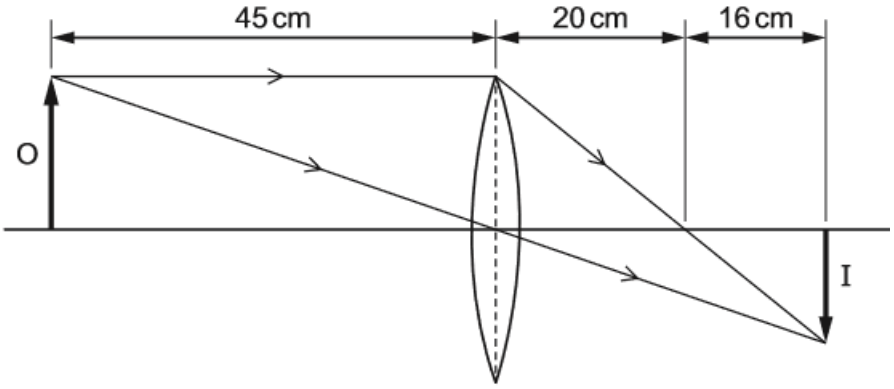


The angle of refraction is r. The angle between the refracted ray and the path the light takes without the glass block is d.

What are r and d ?

	r / °	d / °
A	23	13
B	22	14
C	26	10
D	24	12

34 In the diagram, a convex lens forms an image I of an object O. The diagram is not drawn to scale.



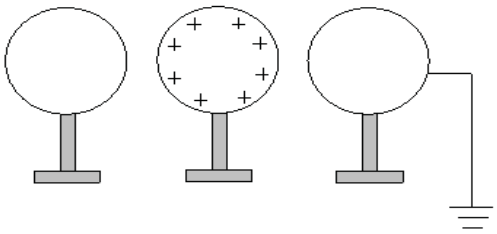
At what distance should the object O be placed with respect to the optical centre of the lens such that the image form is real and same size as the object?

A 20 cm **B** 36 cm **C** 40 cm **D** 42 cm

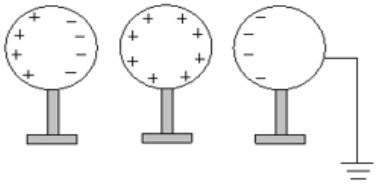
35 Which property of a sound wave increases as the pitch of the sound increases?

A loudness **B** speed **C** wavelength **D** frequency

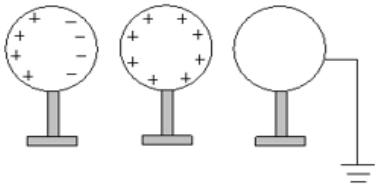
36 The figure below shows a positively charged metal sphere which is placed between two uncharged metal spheres, one of which is grounded to the earth.



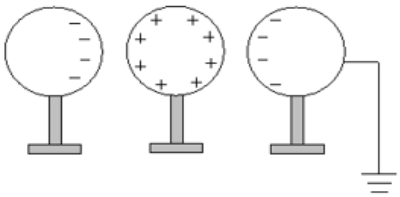
Which of the diagrams correctly shows how the charges are distributed on the spheres?



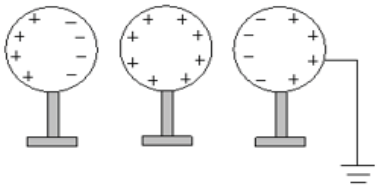
A



B



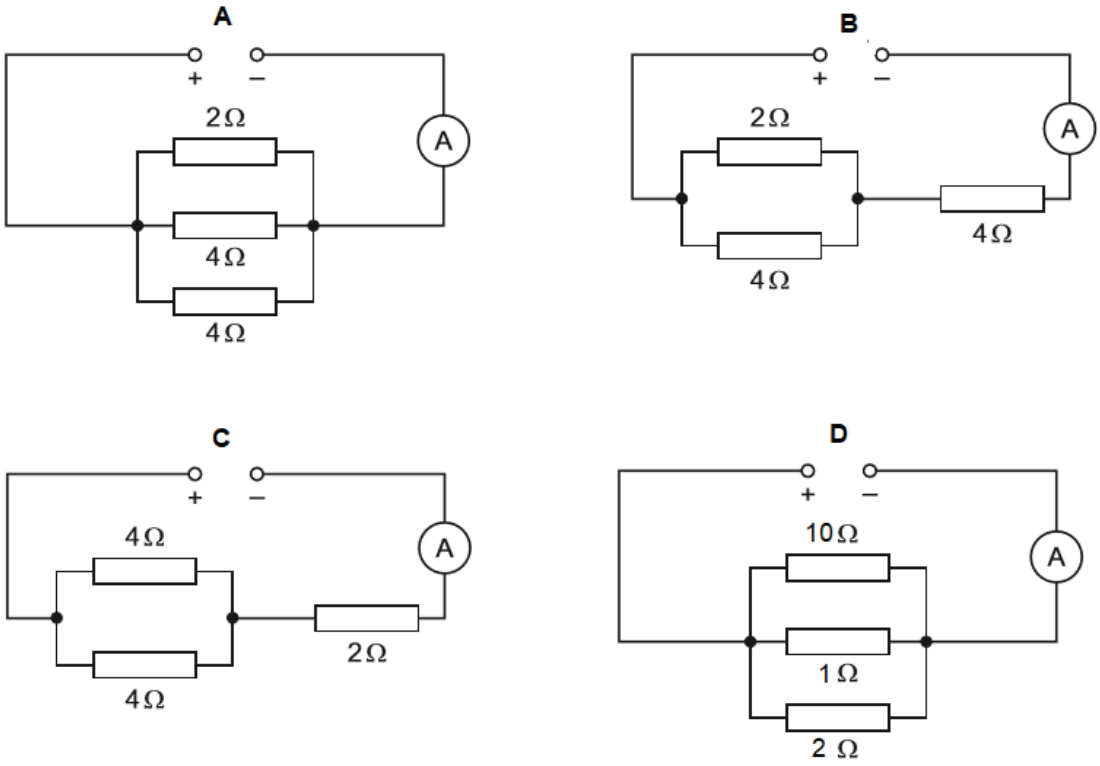
C



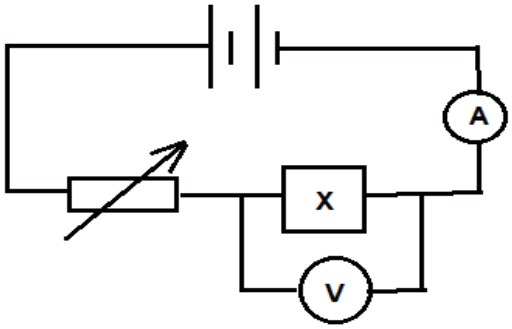
D

37 An ammeter is connected to three resistors and a power supply.

Which arrangement of resistors gives the greatest ammeter reading?



38 In the circuit below, X is an unknown component. The rheostat is varied to obtain 3 different readings of current and voltage of X respectively.



If X is a filament lamp, which of the following readings for current is possible for the corresponding values in voltages?

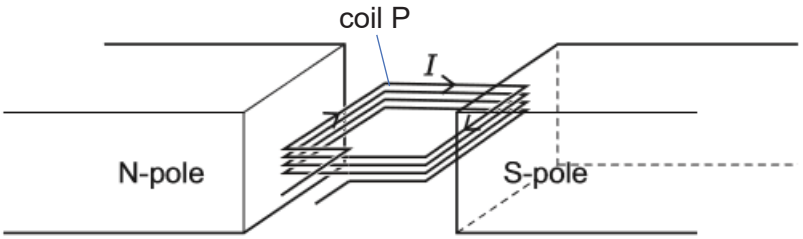
voltage	1.0 V	2.0 V	3.0 V
A	0.5 A	1.0 A	1.5 A
B	0.5 A	0.5 A	0.5A
C	0.5 A	0.7 A	0.8 A
D	0.5 A	1.0 A	3.5 A

39 A lamp is connected to a mains plug.

Where are the switch and the fuse connected so that the lamp is safe to use?

	switch	fuse
A	live wire	live wire
B	live wire	neutral wire
C	neutral wire	live wire
D	neutral wire	neutral wire

40 A coil P of *n* turns is made from a length *L* of wire. This coil carries a current ***I*** when between two magnetic poles.



A similar coil Q of 2*n* turns is made from a length 2*L* of identical wire. It also carries the same amount of current ***I*** when it is between the two magnetic poles.

Which coil, P or Q, has the greater resistance and which coil experiences a greater turning effect?

	greater resistance	greater turning effect
A	P	P
B	P	Q
C	Q	P
D	Q	Q

END OF PAPER

Paya Lebar Methodist Girls' School (Secondary)
Preliminary Examination 2020
Secondary 4 Express

CANDIDATE NAME		CLASS		CLASS INDEX NUMBER	

CENTRE NUMBER					INDEX NUMBER				

PHYSICS 6091/02

Paper 2 **21 August 2020**

Candidates answer on the Question Paper.

No additional materials are required. **1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, centre number and index number.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.

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

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

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	
11	/10
12	/10
13 E / O	/10
Total	/80

This paper consists of 20 printed pages, including this cover page.

SECTION A (50 marks)

Answer **all** questions in this section.
Write your answers in the spaces provided.

1 Fig. 1.1 shows the velocity-time graph of a space rocket launched on the surface of a planet. The space rocket starts its engine from rest and rises vertically from the surface of the planet. After several seconds, the engine is switched off.

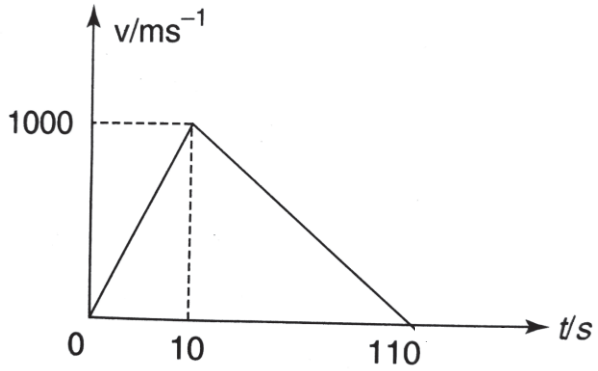


Fig. 1.1

(a) Calculate the maximum height reached by the space rocket.

maximum height = _____ [1]

(b) Calculate the acceleration due to gravity on the planet.

acceleration due to gravity = _____ [1]

(c) Describe the motion of the space rocket from 0 second to 110 seconds.

_____

_____

_____

_____ [2]

2 Fig. 2.1 shows a pendulum suspended by a string that is blown with a wind of a force of 30 N to the right. The mass of the pendulum ball is 2 kg.

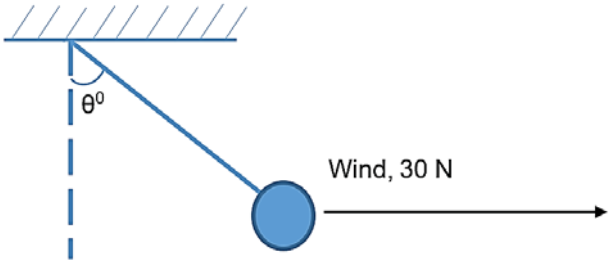


Fig. 2.1

(a) The pendulum is in equilibrium. State the conditions for the pendulum to be in equilibrium.

_____

_____ [1]

(b) Using a scale diagram, determine the tension of the string and the angle θ°.

tension = _____ [2]

θ° = _____ [1]

(c) A student claims that the tension in the string acting on the pendulum is 20 N when the wind is not blowing because the tension and the weight of the pendulum are action-reaction pair. Do you agree with him? Explain your answer.

_____

_____

_____

_____ [2]

[Turn Over

3 Pure gold is usually mixed with copper to form a harder alloy that can be used to make jewellery. Eran bought a gold chain from his best friend, Chai, who claimed that it is rated 21 karats (with 87.5% pure gold). He doubted Chai's claim as the gold chain looked cheap. He went to the school's science laboratory to measure the mass and volume of the chain and obtained 78 g and 5.0 cm^3 respectively.

(a) Suggest an apparatus in the school's science laboratory that can be used to measure the mass accurately.

_____ [1]

(b) Given that the densities of pure gold and pure copper are 19.3 g cm^{-3} and 8.92 g cm^{-3} respectively, calculate the percentage, by mass, of pure gold in the gold chain. Assume the volume and mass of gold and copper remain unchanged during mixing.

percentage = _____ [3]

4 Fig. 4.1 shows a non-uniform plank **XY** 2.50 m long and weighing 900 N. Spring balances A and B are attached to the plank at a distance of 0.40 m from each end, as shown.

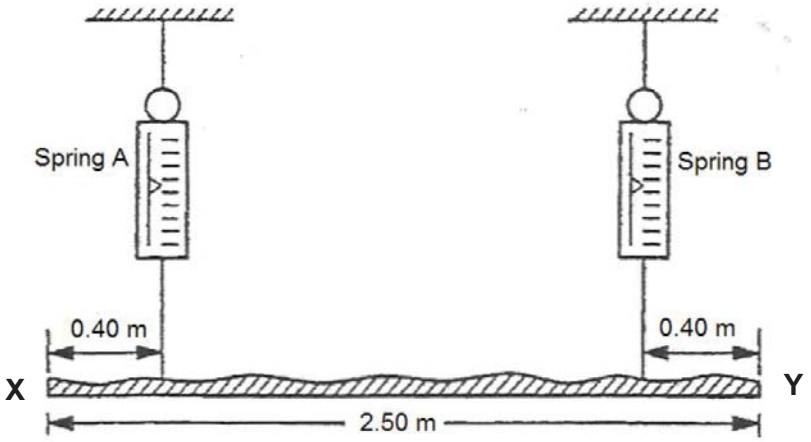


Fig. 4.1

When the plank is horizontal, spring balance B records 580 N.

(a) Define moment of a force.

_____

_____ [1]

(b) Determine the reading on spring balance A.

reading on spring balance A = _____ [1]

(c) Calculate the distance of the centre of gravity from the **X** end of the plank.

distance of the centre of gravity from the **X** end of the plank = _____ [2]

[Turn Over

5 Two barometers are set up as shown in Fig 5.1 below using identical tubes of uniform cross-sectional area, at sea level.

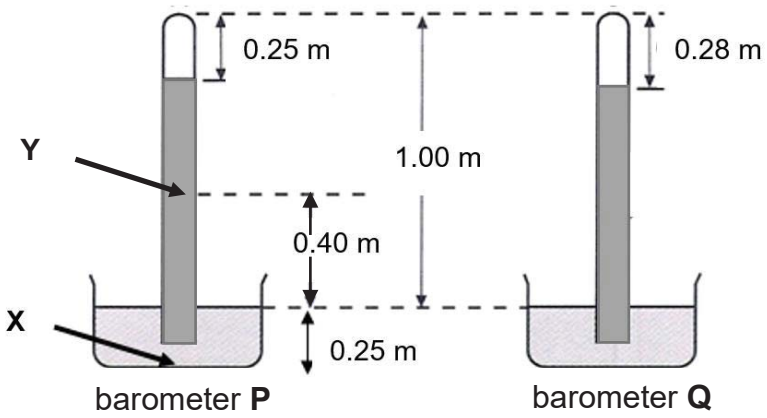


Fig. 5.1

(a) Indicate clearly, in the mercury column for barometer **Q**, with the letter **Z**, the point that has the same pressure as the atmosphere. [1]

(b) Suggest a possible reason why barometer **Q** has a shorter mercury column compared to barometer **P**.

_____

_____ [1]

(c) Calculate the difference in pressure between point **X** and point **Y** in kPa.
(density of mercury = 13 600 kg m^{-3})

difference in pressure = _____ [2]

(d) Suggest a reason for using mercury instead of water in the tubes.

_____

_____ [1]

6 Fig. 6.1 shows the structure of a solar heating system to heat up water in a household.

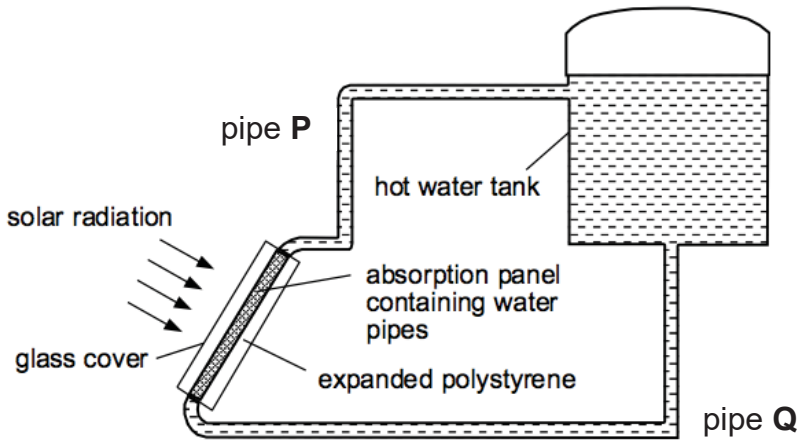


Fig. 6.1

(a) State the process(es) by which heat is transferred from the sun to the water in the pipe through the absorption panel.

_____ [1]

(b) Name the pipe (**P** or **Q**) through which the heated water flows into the water tank. Explain your answer.

_____

_____

_____

_____ [2]

(c) On a hot day, the amount of solar energy falling on the panel is 120 W/m^2. If the total area of the panel is 6 m^2 and only 15% of the energy is absorbed by water, calculate the energy absorbed by the water in 6 hours.

energy = _____ [2]

(d) Suggest an improvement on the panel for better solar energy absorption.

_____ [1]

[Turn Over

7 Fig. 7.1 shows a partially inflated balloon placed in a bell jar. The attached vacuum pump is turned on for several minutes. The volume of the balloon increases.

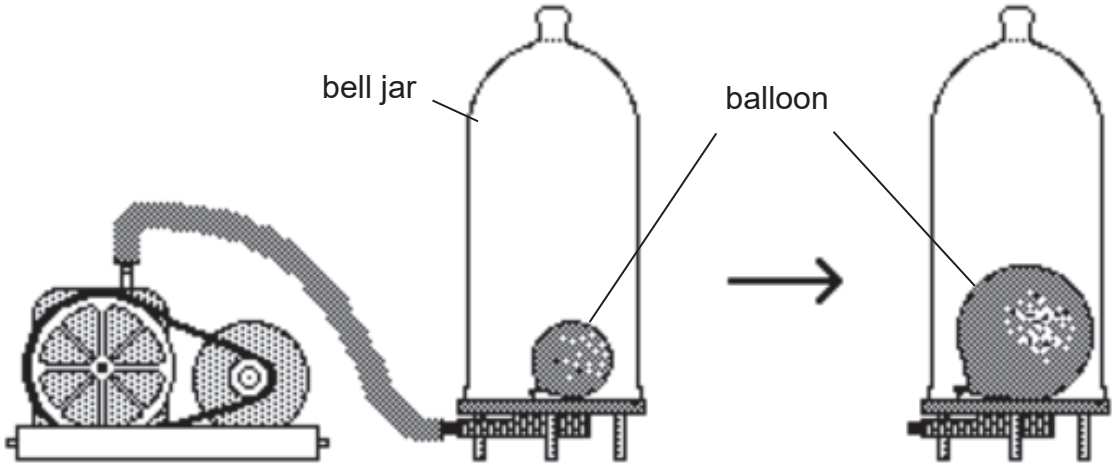


Fig. 7.1

(a) Explain, using the kinetic theory of matter, why the balloon has indefinite shape.

_____

_____

_____

_____ [2]

(b) Before the vacuum pump is turned on, the pressure of the air inside the bell jar is 101 kPa and the balloon contains 80 cm^3 of air. After the pump is turned on, the pressure of the air inside the bell jar is now 45 kPa.

Calculate the volume of air inside the balloon.

volume = _____ [2]

[Turn Over

8 Fig. 8.1 shows a narrow laser beam directed towards a point **A** on a vertical wall. A semi-circular glass block **G** is placed symmetrically across the path of the beam.

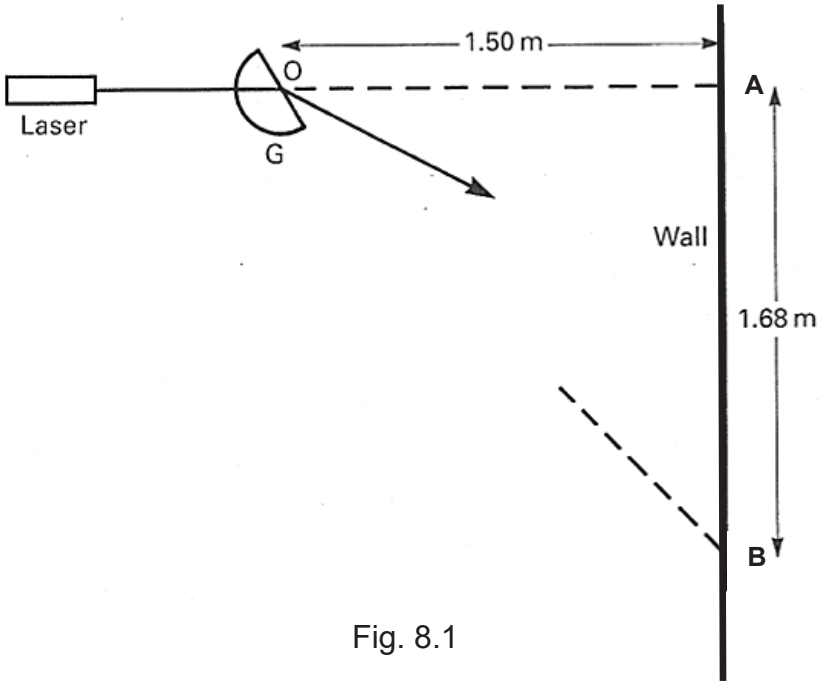


Fig. 8.1

The glass block is rotated about the centre, **O**, and the bright spot where the beam strikes the wall moves down from **A** to **B** and then disappears.

(a) Draw the initial orientation of glass block **G** when the laser is able to strike the wall at **A**, in the diagram below.

[1]

(b) State and explain the direction of rotation (clockwise or anticlockwise) of the glass block **G** in order to obtain the bright spot that moves down from **A** to **B**.

_____

_____

_____ [1]

(c) Explain the disappearance of the bright spot after **B**.

_____

_____

_____ [1]

[Turn Over

(d) Calculate the refractive index of the glass block **G**.

refractive index = _____ [3]

(e) Explain whether **AB** would be longer or shorter if the glass block used is of a lower refractive index.

_____

_____

_____

_____ [2]

9 Stars that are being formed emit infra-red radiation. Some of this radiation is received by a telescope that orbits the earth. Microwave signals from the telescope are sent to the Earth surface, as shown in Fig. 9.1.

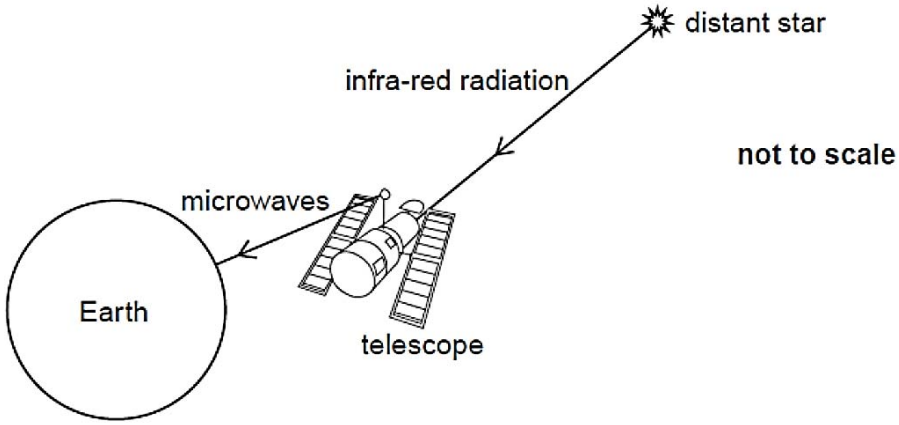


Fig. 9.1

(a) Infra-red and microwave radiation are both part of the electromagnetic spectrum. State one other similarity and one difference between infra-red and microwave radiation.

one similarity : _____

_____

one difference : _____

_____ [2]

(b) The telescope is 1200 km above Earth's surface. Calculate the time for a microwave signal from the telescope to reach the Earth's surface.

time = _____ [1]

(c) Eran claims that he can see Infra-red radiation with his naked eyes, just like Tom Cruise in the movie "Mission Impossible". Do you agree with him? Explain your answer.

_____

_____ [1]

[Turn Over

10 Fig. 10.1 shows a negatively charged metal sphere held with an insulating handle. When the sphere is brought near the metal plate, the sensitive galvanometer indicates a momentary deflection.

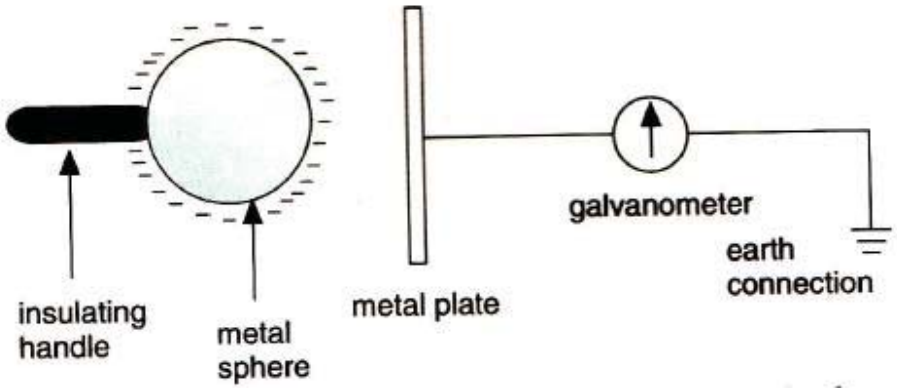


Fig. 10.1

(a) Draw on the diagram, the charge distribution on the metal plate. [1]

(b) Explain why the galvanometer indicates a momentary deflection.

_____

_____

_____

_____ [2]

(c) State and explain whether there is a deflection in the galvanometer if the metal sphere is held by a person's hand.

_____

_____ [1]

(d) Suggest a change in the above setup such that a deflection in the galvanometer in the opposite direction is produced.

_____

_____ [1]

SECTION B (30 marks)

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

11 Fig. 11.1 shows the arrangement used to measure the temperature rise of a piece of lead struck by an air-gun lead pellet.

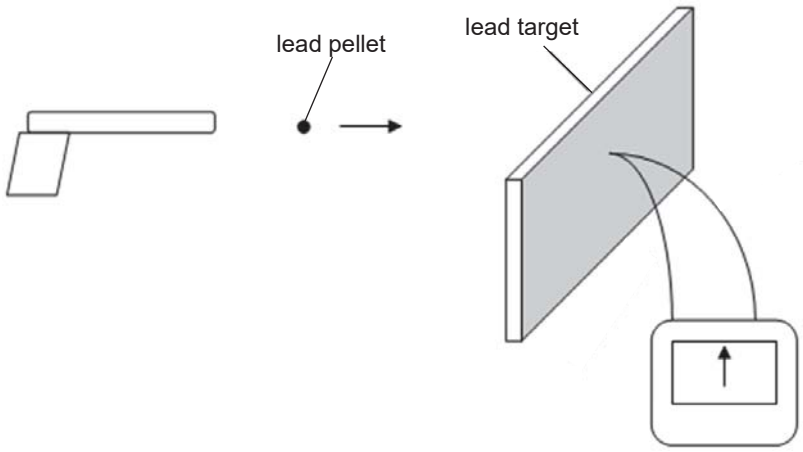


Fig. 11.1

The thermometer consists of a thermocouple whose junction is embedded in the lead. When the temperature of the junction is raised, a deflection is observed on the galvanometer. After the lead pellet is fired into the lead target, the results and data are given below.

Mass of lead target = 39.5 g
Mass of lead pellet = 0.5 g
Deflection on galvanometer = 8 divisions
Specific heat capacity of lead = 130 J / (kg ℃)
Galvanometer sensitivity = 10 divisions / ℃

(a) Write down the thermometric property of the thermometer and state an assumption on using this property with respect to temperature measurements.

thermometric property : _____

assumption : _____

_____ [2]

(b) Explain what is meant by specific heat capacity of lead is 130 J / (kg °C).

_____

_____ [1]

[Turn Over

(c) **(i)** Determine the temperature rise of the lead target.

temperature rise = _____ [1]

(ii) Hence, calculate the thermal energy gained by the lead target.

thermal energy = _____ [2]

(d) The lead target with the lead pellet embedded, is then detached from the thermometer and immersed into icy water with 20 g of ice and 100 g of water at 25.0 °C. The initial temperature of the lead target and the lead pellet is 40.0 °C.

The specific heat capacity of water is 4200 J / (kg °C).
The specific latent heat of fusion of ice is 3.4×10^5 J / kg.

(i) Assuming all the ice melted in the process, calculate the final temperature of the lead target with the pellet embedded.

final temperature = _____ [3]

(ii) State an assumption you made in the above calculation.

_____

_____ [1]

12 Two students are studying the Physics topics on light and sound waves.

(a) State a similarity between light and sound waves.

_____

_____ [1]

(b) Illustrate by drawing the directions of motions of particles **X**, **Y** and **Z** in Fig. 12.1 and Fig. 12.2 below and explain the differences between light and sound waves. The directions of the waves travelled are as indicated by the arrow.

Light

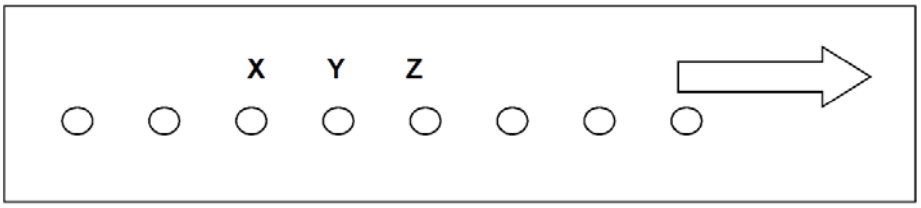


Fig. 12.1

Explanation : _____

_____

Sound

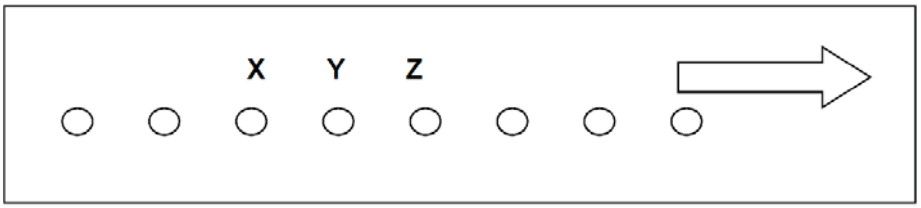


Fig. 12.2

Explanation : _____

_____ [4]

(b) One of the student, using a stopwatch, records a 4.0 seconds delay between seeing a flash of lightning and hearing the sound of the thunder.
Calculate the distance between him and the lightning.
(Take the velocity of sound in air to be 330 ms^{-1}.)

distance = _____ [2]

[Turn Over

(c) The other student, standing beside the first student, hears the softer echo of the thunder reflected from a nearby tall building, another 3.0 seconds later.

(i) Calculate the distance between him and the building.
(Take the velocity of sound in air to be 330 ms^{-1}.)

distance = _____ [2]

(ii) On Fig. 12.3, draw the waveform of the echo, given the waveform of the original sound of thunder.

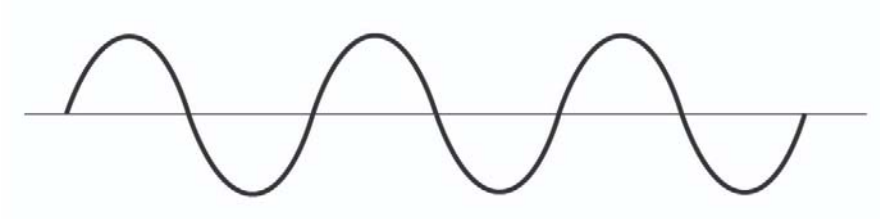


Fig. 12.3 [1]

Either

13E Fig. 13E.1 shows a circuit with a transistor switch used to control the temperature in a room. The transistor switch acts like a switch, when switched on, will activate the relay to turn on the heater in the room. The transistor switch is switched ON when the voltage across the thermistor, V_b, is higher or equal to 2.5 V.

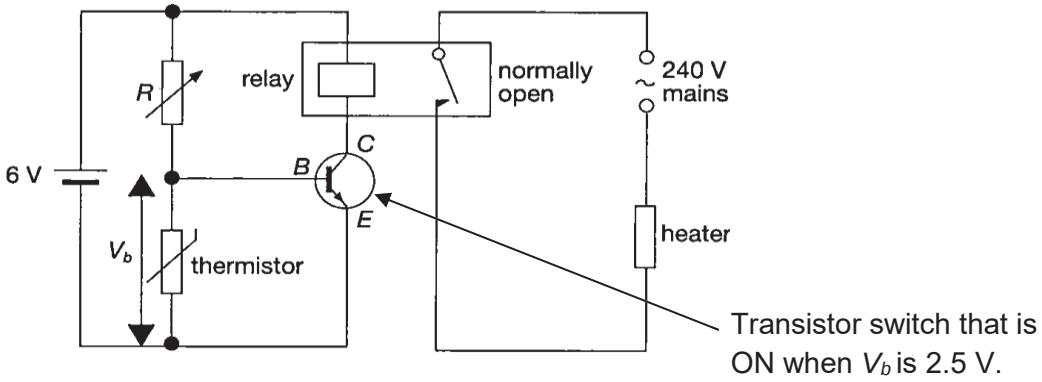


Fig. 13E.1

The relationship between the resistance of the thermistor and the temperature of the surroundings is shown in Fig. 13E.2.

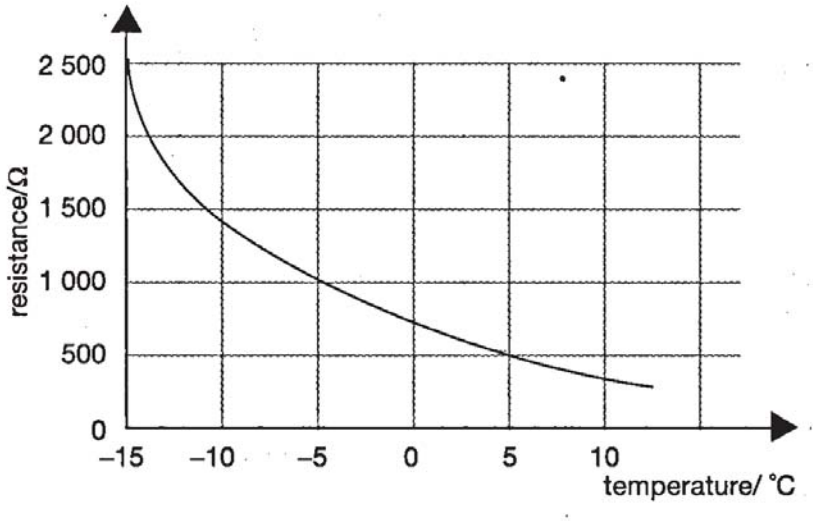


Fig. 13E.2

(a) State what is meant by *resistance*. Write down the SI unit of resistance.

_____ [1]

(b) Describe and explain how the voltage across the thermistor, V_b, changes as the temperature of the surrounding decreases.

_____

_____ [2]

[Turn Over

(c) Calculate the voltage across the rheostat, *R*, when the transistor switch just switched on.

voltage = _____ [2]

(d) During a day in winter, the temperature of the surrounding drops below 5 °C.

(i) From Fig. 13E.2, determine the resistance of the thermistor at 5 °C.

resistance = _____ [1]

(ii) Calculate the maximum resistance of the rheostat, *R*, so that the transistor switch can switch ON when the temperature drops below 5 °C.

maximum resistance = _____ [2]

(iii) Calculate the current flowing through the rheostat, *R*, when the temperature drops below 5 °C.

current = _____ [2]

Or

13O (a) Fig. 13O.1 shows the heating element in a heater labelled 240 V, 3 kW.

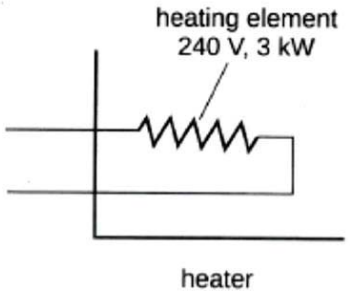


Fig. 13O.1

(i) Explain the label “240 V, 3 kW” on the heating element.

_____

_____ [1]

(ii) Calculate the resistance of the heating element.

resistance = _____ [2]

(iii) The connecting wires of the heating element have a large cross-sectional area.
Explain how this feature helps the connecting wires to remain relatively cool even when the heater has been turned on for a period of time.

_____

_____

_____

_____ [2]

[Turn Over

(b) Fig. 13O.2 shows a light aluminium rod AB resting between the poles of a U-shaped magnet, with S pole vertically above rod AB and N pole vertically below rod AB. A current is passed through the rod from the two brass strips connected to a power supply.

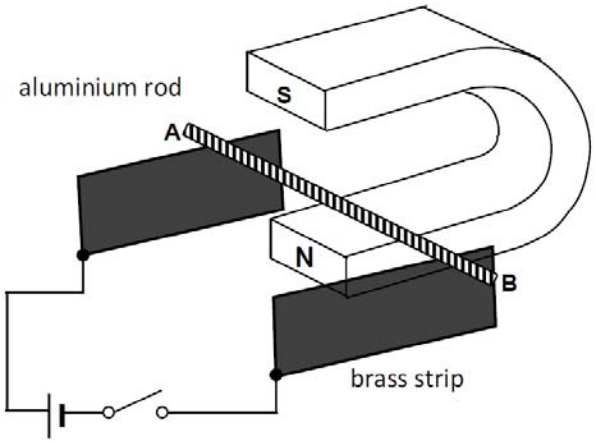


Fig. 13O.2

(i) State and explain which way the rod moves when the switch is closed.

_____

_____

_____

_____ [2]

(ii) State the effect on the movement of the rod when

1. the current is reversed;

_____

_____ [1]

2. the current is decreased;

_____

_____ [1]

3. the magnet is rotated 90° anticlockwise to form an inverted U, with S pole on the left of rod AB and N pole on the right of rod AB.

_____

_____ [1]

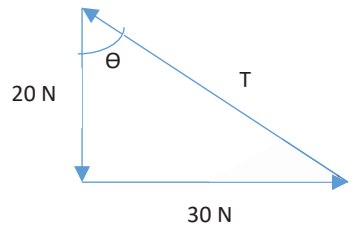
END OF PAPER

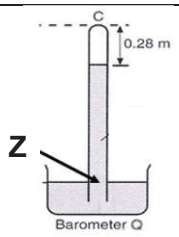
ANSWER

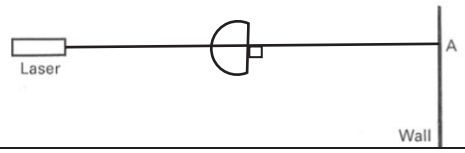
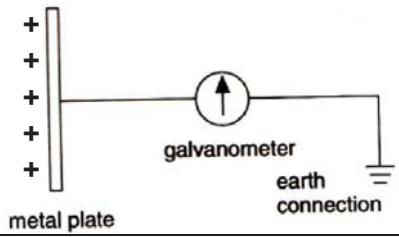
1	2	3	4	5	6	7	8	9	10
C	A	D	B	A	D	B	C	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	C	B	B	D	C	B	D	C	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	C	A	A	A	B	C	B	B	D
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	B	A	C	D	A	D	C	A	D

ANSWER

Section A

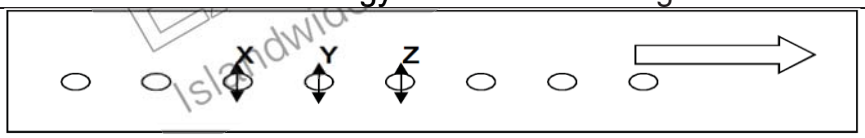
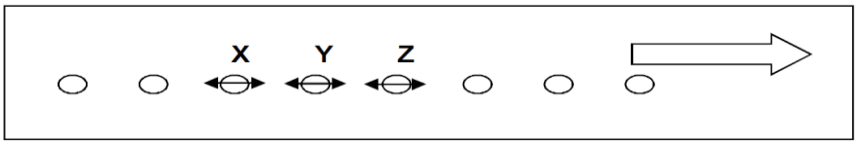
Qns	Answer	Marks
1a	Maximum height = area under the v-t graph = ½ x 110 x 1000 = 55000 m **or** 55km	B1
b	Acceleration due to gravity on planet = (v-u) / t = (0-1000) / (110-10) = -10.0 m/s^2 **or** 10.0 m/s^2	B1
c	From 0-10 s, rocket **moves upwards** from **rest to 1000 m/s** with **constant acceleration**. From 10-110 s, rocket **moves upwards** from **1000 m/s to 0 m/s** with **constant deceleration**.	B1 B1
		Q1: 4 marks
2a	An object is in equilibrium if there is **no resultant force** acting on it and there is **no resultant moment** acting on it.	B1
b	 Scale: 1cm: 10 N By measurement, $T = 36.1N$ (accept 34.0 – 38.0 N) $\theta = 56.3°$ (accept 53.5 – 59.0°)	B1 – correct diagram with arrows & scale B1 – to 1 d.p. B1 – to 1 d.p.
c	Disagree. Tension and the weight of the pendulum are **not** action-reaction pair since they are two different types of forces acting on the same object.	B1 (Provided reason correct) B1
		Q2: 6 marks
3a	Electronic balance	B1
b	Let m_g be the mass of gold, m_c be the mass of copper, V_g be the volume of gold and V_c be the volume of copper. $m_g + m_c = 78$ $m_c = 78 - m_g$ --- eqn 1 $V_g + V_c = 5.0$ $(m_g/19.3) + (m_c/8.92) = 5.0$ --- eqn 2 Sub eqn 1 into eqn 2 and solve for mg: $m_g = 62.102 = 62.1$ g percentage purity = 62.102/78 x 100% = 79.6%	M1 M1 A1
		Q3: 4 marks

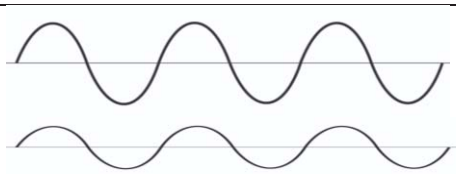
4a	It is the product of the force and the perpendicular distance from the line of action of the force to the pivot.	B1 (o.e)
b	Reading on spring balance A = 900 – 580 = 320 N	 B1
c	Let *d* m be the distance from spring A to the CG of the plank. Taking moment about spring A, at equilibrium, Clockwise moment = anti clockwise moment 900 x *d* = 580 x 1.7 d = 1.0956 m Distance of the centre of gravity from X = 1.0956 + 0.4 = 1.50 m	 M1 A1
		Q4: 4 marks
5a		 B1
b	There could be gas trapped in the space above the mercury column in barometer **Q**.	 B1
c	Difference in Pressure = (0.40 + 0.25) x 13 600 x 10 = 88.4 kPa **Or** Difference in Pressure = Pressure at X – Pressure at Y = 1.00 x 13600 x 10 – (1.00 – 0.40 – 0.25) x 13600 x 10 = 88.4 kPa	M1 A1
d	Mercury is denser compared to water. As such, lesser height of liquid column is required.	 B1
		Q5: 5 marks
6a	Radiation and conduction.	B1
b	Pipe P. As the water at the absorption panel is heated, it expands and become less dense. Hence, it rises towards pipe P and flows into the water tank. The cold water which is more dense will flow down pipe Q to the absorption panel to replace the heated water, thereby giving rise to a convection current.	 B1 B1
c	Rate at which energy is absorbed by the panel = 120 × 6 × 0.15 = 108 W Energy absorbed by water = 108 × 6 × 60 × 60 = 2.33 MJ	 M1 A1
d	Paint the surface of the absorption panel black.	B1
		Q6: 6 marks

7a	The balloon contains air particles with **very weak forces of attraction** between the air particles**.** Thus, the air particles can **move freely** and this **allows their arrangement to change** and take the shape of its container**.**	B1 B1
b	$P_1V_1 = P_2V_2$ $101 \times 80 = 45 \times V_2$ $V_2 = 180\ \text{cm}^3$	 M1 A1
		Q7: 4 marks
8a		 B1
b	Anticlockwise. As the glass block rotates in the anticlockwise direction, the angle of incidence increases and the **refracted ray bends further away from the normal** (or the angle of refraction increases), causing the bright spot to move down from **A** to **B**.	 B1
c	The angle of incidence in the glass block at **O** exceeds the critical angle and the laser beam undergoes total internal reflection.	 B1
d	When the spot is at B, $\tan\theta = \frac{1.68}{1.50}$ $\theta = 48.2°$ Critical angle = (180° − 90°) − 48.2° = 41.8° $\eta = \frac{1}{\sin 41.8°} = 1.50$	 M1 M1 A1
e	A lower refractive index will result in a **larger critical angle**. This will result in **longer** length of **AB**.	B1 B1
		Q8: 8 marks
9a	Both are transverse waves Both can travel in vacuum at 3x10^8 m/s Both do not require a medium Infrared has a higher frequency than microwaves. Microwave has a longer wavelength than infrared.	 B1 (any 1 of the 3) B1 (any 1 of the 2)
b	Speed of EM wave = 3 00000000 m/s Time = Distance / speed = 1200000 / 300000000 = 0.004 s	
c	Disagree as infrared light radiation falls outside the visual spectrum.	 B1
		Q9: 4 marks
10a		 B1

b	Free electrons in the metal plate are repelled by the negatively charged sphere and flow through the galvanometer to the earth. Such flow of electrons to the earth (until all the excess electrons flow to the earth) produce a current causing a momentary deflection in the galvanometer.	B1 B1
c	There is **no** deflection in the galvanometer if the metal sphere is held by a person's hand. The sphere will be discharged, as excess electrons will flow from the body to the earth, and become neutral.	B1
d	A positively charged metal sphere should be used.	B1
		Q10: 5 marks

Section B

11a	Property: Electrical voltage or electromotive force (e.m.f.) Assumption: The e.m.f. varies linearly with temperature.	B1 B1
b	The amount of energy that is needed to raise the temperature of 1 kg of lead by 1 °C is 130 J.	B1
ci	Temperature rise = 8/10 = 0.8 °C	B1
ii	$Q = mc\Delta\theta$ $= 39.5/1000 \times 130 \times 0.8$ $= 4.11$ J	M1 A1
di	Let x °C be the final temperature of the lead target. Heat lost by lead target with pellet & water = Heat gain by ice $(mc\Delta\theta)_{lead} + (mc\Delta\theta)_{water} = (ml_f)_{ice} + (mc\Delta\theta)_{ice}$ $\frac{39.5+0.5}{1000} \times 130 \times (40.0 - x) + \frac{100}{1000} \times 4200 \times (25.0 - x) = \frac{20}{1000} \times 3.4 \times 10^5 + \frac{20}{1000} \times 4200 \times (x - 0)$ $x = 7.67$ °C	M1 (for correct sub of any $mc\Delta\theta$ or ml_f) M1 A1
ii	No thermal lost to the surrounding/container of icy water.	B1
12a	Both waves transfer energy without transferring the medium.	B1
b	 Explanation: Light is a **transverse wave** and the particles **vibrate perpendicularly** to the wave motion.  Explanation: Sound is a **longitudinal wave** and the particles **vibrate parallel** to the wave motion.	B1 (must draw all 3 particles) B1 B1 (must draw all 3 particles) B1
c	Let d m be the distance between the student and the lightning. $\frac{d}{330} - \frac{d}{3\times10^8} = 4.0$ **or** $\frac{d}{330} \approx 4.0$ $d = 1320$ The distance between the student and the lightning is 1320 m.	M1 A1

di	Let *f* m be the distance between the student and the building. $\frac{2f}{330} = 3.0$ $f = 495$ The distance between the student and the lightning is 495 m.	 M1 A1
ii		B1 (waveform with smaller amplitude but same frequency)
13E		
a	Resistance is the ratio of the potential difference across a component to the current flowing through it. SI unit is ohm (Ω).	 B1
b	As the temperature of the surrounding decreases, the resistance of the thermistor increases. Since the voltage across the thermistor is proportional to its resistance, the voltage increases.	 B1 B1
c	Voltage across R = 6 – 2.5 = 3.5 V	M1 A1
di	500 Ω	B1
ii	$V_b = (R_t / R_t + R_R) V$ $2.5 = (500 / 500 + R_R) 6$ $R_R = 700\ \Omega$ Max resistance of R = 700 Ω	 M1 A1
iii	I = V/R = 2.5/500 = 0.005 A	 M1 A1
13O		
ai	It means that when an operating voltage of 240 V is applied across the heating element, it (converts electrical energy to thermal energy at a rate of 3000 W) **or** (operates with a power of 3000 W).	 B1
ii	$P = V^2 / R$ $R = V^2 / P$ $= 240^2 / 3000$ = 19.2 Ω	 M1 A1
iii	A larger cross-sectional area means that the wire has a lower resistance. Hence, the heat produced ($E = I^2Rt$) will be much lower and hence it remains relatively cooler.	 B1 B1
bi	Rod moves out of the magnet / to the left / out of paper. Current flows from A to B / magnetic field from N to S and using Fleming's Left Hand Rule, the direction of the force on the rod is out of the magnet / to the left / out of paper.	B1 B1
ii	1. The rod moves into the curved part of magnet / to the right / in the opposite direction. 2. The rod moves out of the magnet at a slower rate / moves lesser outwards. 3. The rod remains stationary.	B1 B1 B1