O Level Centre Number/ Index Number	Class	Name

新加坡海星中学

MARIS STELLA HIGH SCHOOL

PRELIMINARY EXAMINATION

SECONDARY FOUR

SCIENCE (PHYSICS, CHEMISTRY) **5086/02**

Paper 2 Physics

22 August 2024

1 hour 15 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A
Answer **all** the questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer **one** question.
Write your answers in the spaces provided on the question paper.

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

For Examiner's Use	
Section A	55
Section B	10
Total	65

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

Section A

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

1 Fig. 1.1 shows a child sitting on a sledge on a snow-covered hill of constant slope.

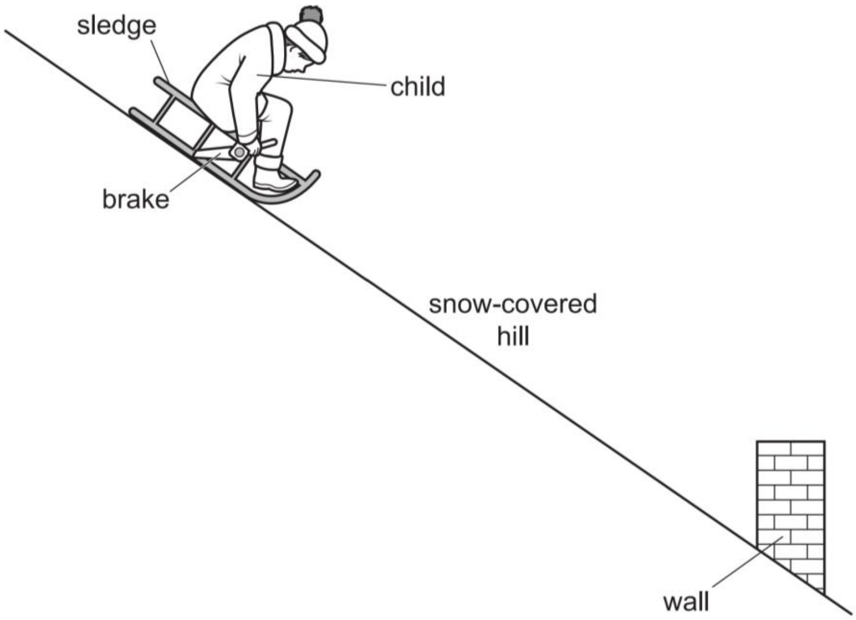


Fig. 1.1 (not to scale)

At time t = 0 s, the child and the sledge begin to move down the hill in a straight line.

When the child sees a wall ahead, he applies the brake.

The child and sledge continue to travel in a straight line until they come to a stop.

(a) Fig. 1.2 shows the child's speed throughout his descent.

Complete the speed-time graph of the child in Fig. 1.2 using the points provided. [2]

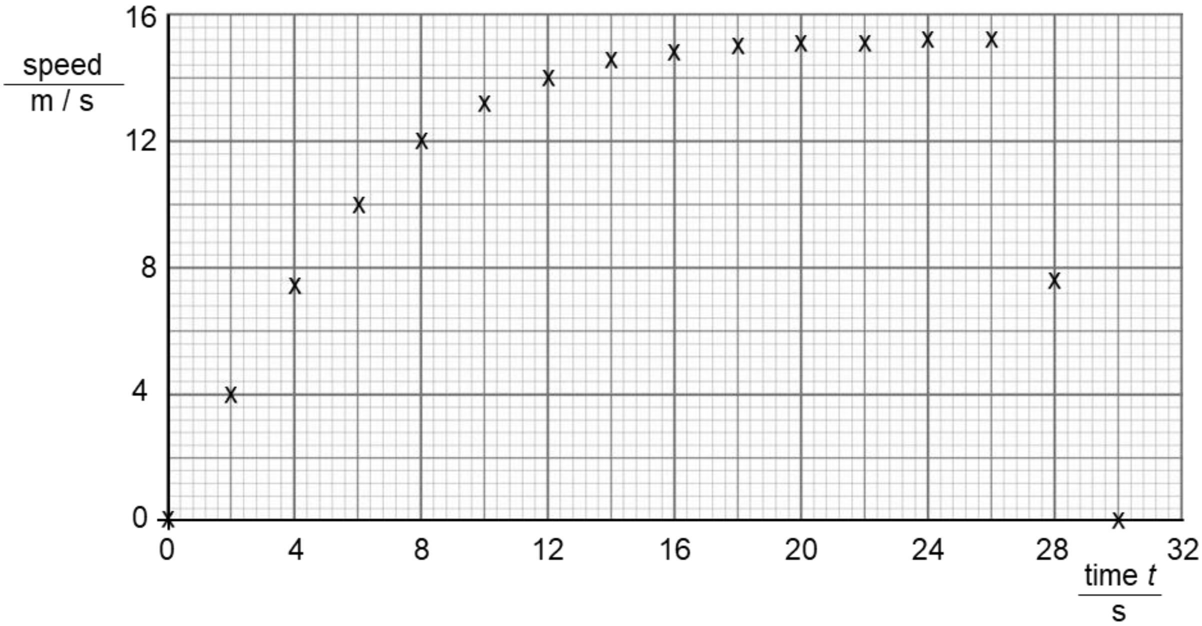


Fig. 1.2

(b) At t = 26 s, the front of the sledge is 35 m from the wall and the child and sledge begin to decelerate. The mass of the child is 46 kg and the mass of the sledge is 9.0 kg.

(i) Calculate the energy in the child's kinetic store at t = 26 s.

energy in kinetic store = ... J [2]

(ii) Determine the size of the child's deceleration.

deceleration = ... m/s^2 [2]

(iii) Calculate the resultant force on the child and the sledge as they decelerate.

resultant force = ... N [2]

(iv) State the energy transfer that is taking place as the child and sledge decelerate.

....

....

.... [2]

[Total: 10]

2 A student sets up the following apparatus in Fig. 2.1 to measure the density of an unknown liquid A. The liquids do not mix.

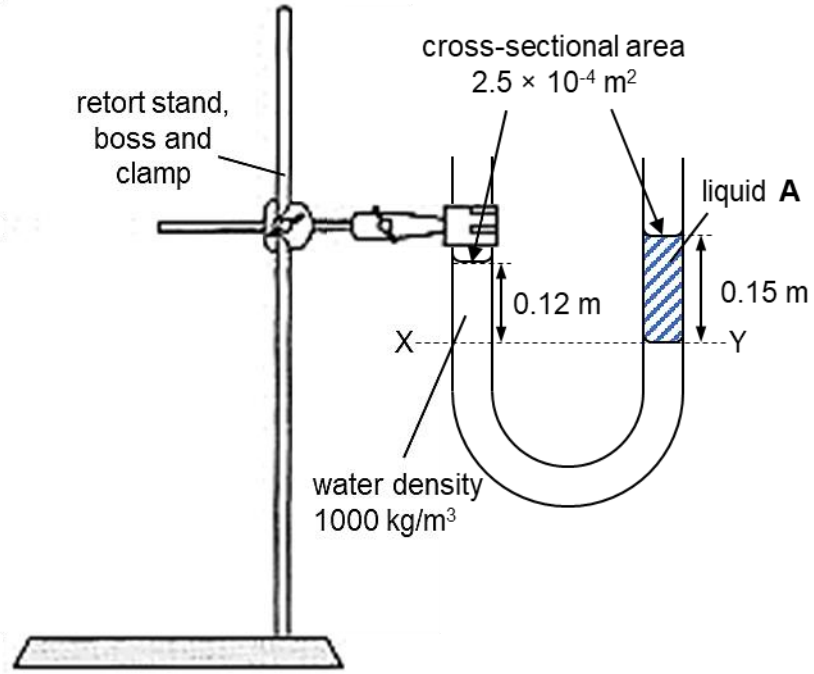


Fig. 2.1

XY is the horizontal line at the same height as the junction between liquid A and water.

The cross-sectional area of the U-tube is 2.5×10^{-4} m^2, the density of water is 1000 kg/m^3 and the gravitational field strength is 10 N/kg.

(a) Calculate

(i) the mass of water above line XY.

mass of water above XY = ... kg [2]

(ii) the pressure due to the water above line XY.

pressure = ... N/m^2 [2]

(b) The pressure due to liquid A above line XY is the same as the pressure due to water above line XY.

Calculate the density of liquid A.

density of liquid **A** = ... kg/m^3 [2]

(c) The set up has a risk of toppling over. Suggest how the set up can be modified to increase its stability.

....

.... [1]

[Total: 7]

3 A student invents a machine to measure the force of the wind.

A large piece of light-weight material is used as a wind-catcher and is attached to the top of a mast.

An instrument **A** is used to measure the turning force and is attached to the bottom of the mast.

Instrument **B** (not shown in figure) is used to measure the heights of the wind-catcher to the pivot and instrument **A** to pivot respectively.

The mast is free to rotate about a pivot as shown in Fig. 3.1

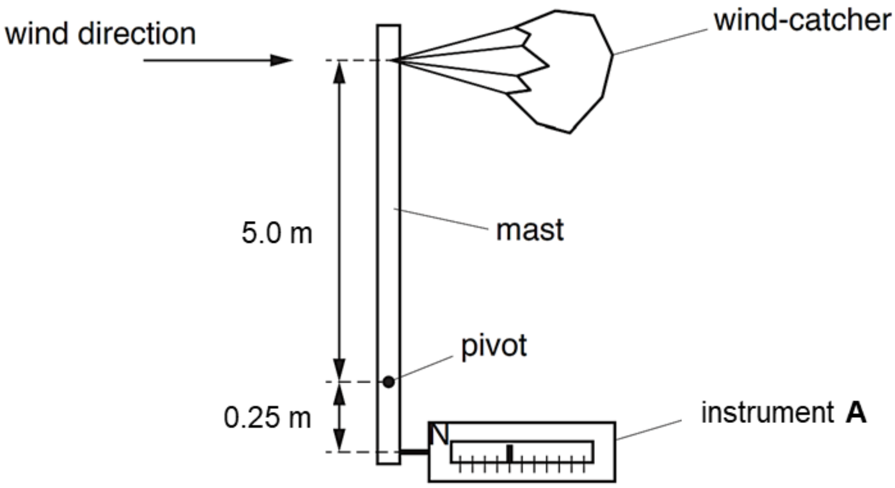


Fig. 3.1 (not to scale)

(a) Suggest the instruments **A** and **B** used in the machine.

(i) instrument **A** .... [1]

(ii) instrument **B** .... [1]

(b) Instrument **A** is attached 0.25 m from the pivot.

On a windy day, the reading on instrument **A** is 52.0 N when the mast is vertical.

(i) State the *principle of moments*.

....

....

.... [2]

(ii) The wind-catcher is attached 5.0 m from the pivot.

Calculate the force from the wind when the mast is vertical.

force from the wind = ... N [2]

[Total: 6]

4 Fig. 4.1 shows the structure of a water cooler that is used to supply cold water to the workers in a hot office.

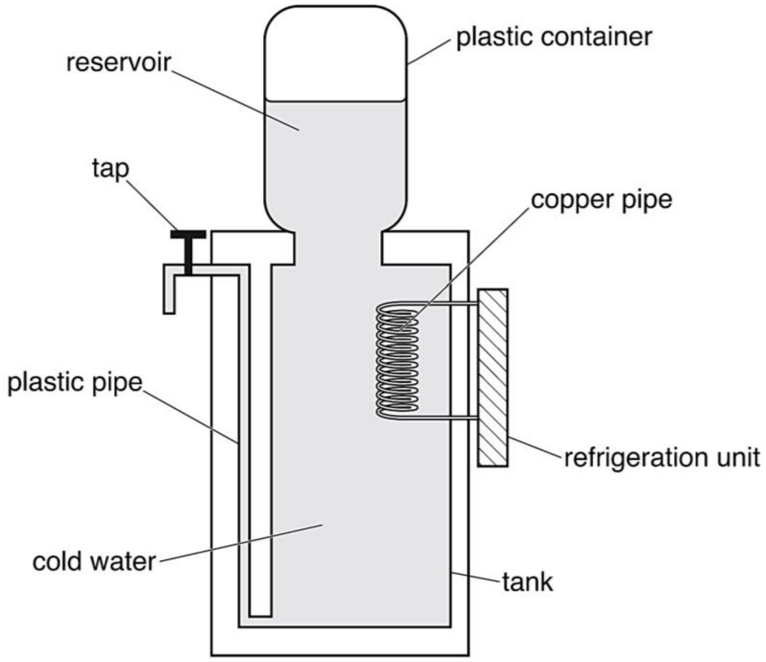


Fig. 4.1

When the tap is opened, water at room temperature from the reservoir flows down into the tank. Cold water from the tank flows through the plastic pipe and out of the tap.

Cold liquid from the refrigeration unit is pumped through the copper pipe and thermal energy passes through the copper to this liquid.

(a) State the method of heat transfer through the copper pipe and suggest why copper is a suitable material for the pipe.

....

....

.... [2]

(b) Water in the plastic container remains at room temperature.

Explain why the refrigeration unit is positioned near the top of the tank.

....

....

....

....

.... [2]

(c) Describe the motion of the molecules in a liquid as temperature of the liquid decreases.

....

....

.... [2]

[Total: 6]

5 The apparatus shown in Fig. 5.1 is used to find the speed of sound in air.

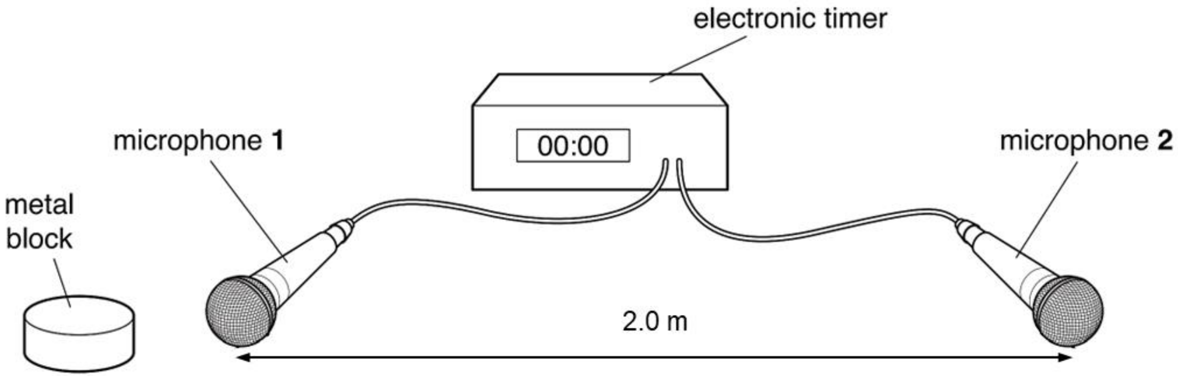


Fig. 5.1

Two microphones 2.0 m apart are connected to an electronic timer.

The metal block is hit with a hammer to produce a short ‘pulse’ of sound containing different frequencies and wavelengths.

Microphone **1** detects the pulse of sound and starts the electronic timer.

Microphone **2** detects the pulse of sound and stops the timer.

The electronic timer measured 5.88 ms.

(a) **(i)** Calculate the speed of sound in air using the following equation:

$$speed = \frac{distance}{time}$$

speed of sound in air = ... m/s [1]

(ii) One of the waves produced has a frequency of 485 Hz.

Calculate the wavelength of this wave.

wavelength = ... m [2]

(iii) All the waves within this pulse of sound reach microphone **2** in the same amount of time.

Explain why.

....

.... [1]

(b) The set up is modified such that a block of metal 2.0 m wide is placed between the two microphones and both microphones are touching each end of the metal block. The experiment is then repeated.

Explain if the timer would have a reading greater than or smaller than what was measured in Fig. 5.1.

....

.... [1]

[Total: 5]

6 Fig. 6.1 shows an image from a popular online video.

A teacher is shown rubbing a bunch of plastic strings with a fur cloth. He then does the same to a hollow plastic pipe. When he throws the bunch of plastic strings in the air, the bunch of plastic strings spread out and levitate above the plastic pipe.

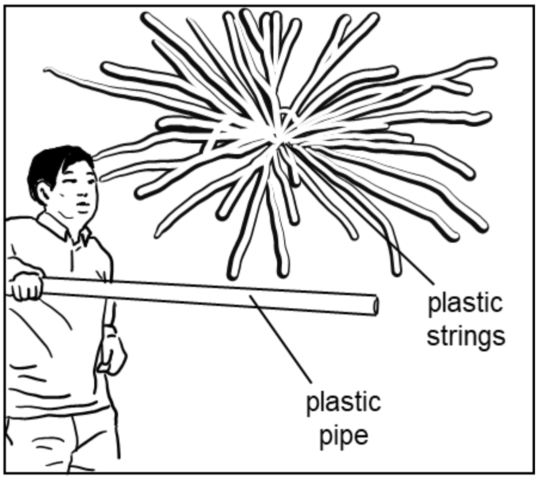


Fig. 6.1

(a) Fur has a tendency to be charged positively.

Complete the sentences to explain how fur and plastic get electrically charged. [2]

You may use words from the following list to answer the above. You may use each word once, more than once or not at all.

gained positive charges	gained neutrons	gained negative charges
lost positive charges	lost neutrons	lost negative charges

The fur ………………………………………………………….. to become positively charged.

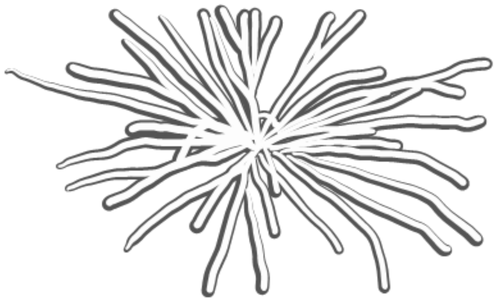
The plastic ……………………………………………………….. to become negatively charged.

(b) **(i)** Mass of the strings is 15 g and the gravitational field strength is 10 N/kg.

Calculate the weight of the bunch of strings.

weight of strings = ... N [2]

(ii) Draw the forces acting on the bunch of plastic strings.



[1]

[Total: 5]

7 Table 7.1 shows the composition of four neutral atoms and one atom that has been ionised.

These five particles are labelled P, Q, R, S and T.

Table 7.1

	P	Q	R	S	T
number of protons	17	19	18	19	20
number of neutrons	20	20	24	23	21
number of electrons	17	18	18	19	20

(a) The charge on an electron is -1.6×10^{-19} C.

State which of P, Q, R, S and T is the ionised atom and what is its charge.

.... [1]

(b) State which pair of particles are isotopes of the same element.

.... [1]

(c) **(i)** Fill in the blanks below with the correct atom P, Q, R, S or T. [1]

Atom ……… is a radioactive isotope that undergoes beta decay to produce ……… when its neutron is transformed into a proton and a fast-moving electron is ejected from the radioactive nucleus.

(ii) The half-life of this radioactive decay is 33 years.

A radioactive sample contains a large number of atoms that decay in this way. Determine the fraction of this number of radioactive atoms remaining after 99 years.

fraction of remaining radioactive atoms = ... [2]

(iii) β-particles are used in industrial processes to measure thickness of materials such as paper.

Explain why β-particles instead of α-particles or γ-particles are used in this application.

....

.... [1]

[Total: 6]

8 Fig. 8.1 shows a circuit including three resistors and two open switches S_1 and S_2.

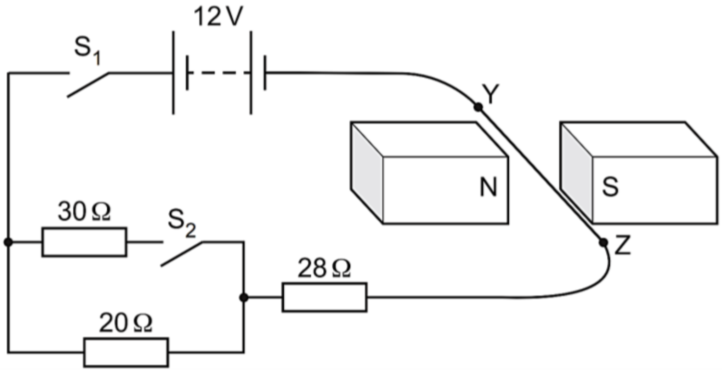


Fig. 8.1

The power supply in an electric circuit is a battery of electromotive force (e.m.f.) of 12 V.

YZ is a straight, horizontal section of conducting wire that lies between two magnets.

S_1 is now closed and a current flows through YZ.

(a) **(i)** State what is meant by the term *current.*

....

.... [1]

(ii) Calculate the current in YZ.

current = ... A [2]

(iii) YZ experiences a force.

Draw the force acting on YZ in Fig. 8.1 and explain why YZ experiences a force.

....

....

....

.... [3]

(b) Switch S_2 in the circuit in Fig. 8.1 is now also closed.

(i) Calculate the total resistance of the circuit.

resistance = ... Ω [2]

(ii) Explain what happens to the force on YZ as switch S_2 is closed.

....

....

.... [2]

[Total: 10]

Section B

Answer **one** question from this section.

9 When measuring refractive index of materials, refractometers most often use the sodium D-line, which is a bright yellow light that corresponds to 589 nm in vacuum.

(a) Calculate the frequency of sodium D-line. The speed of light in vacuum is 3.0×10^8 m/s.

frequency = ... [2]

(b) Fig. 9.1 shows a ray of sodium D-line light entering a rectangular glass block at point A. The refractive index of the glass block is 1.5.

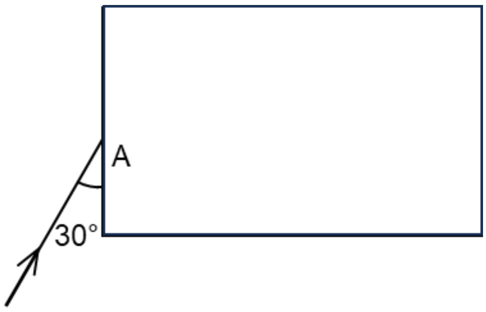


Fig. 9.1

(i) Calculate the angle of refraction at point A.

angle of refraction = ... [2]

(ii) Draw the refracted ray until the light ray strikes the top surface of the glass block in Fig. 9.1. [1]

(iii) Calculate the speed of yellow light in the glass block.

speed of light in glass = ... [2]

(c) A small, brightly illuminated display is located at the back of a projector. The projector lens produces an inverted and magnified image of the display on a white classroom wall.

Fig. 9.2 is a scaled diagram showing the position and size of both the display and the image on the wall. **R** is a point on the display.

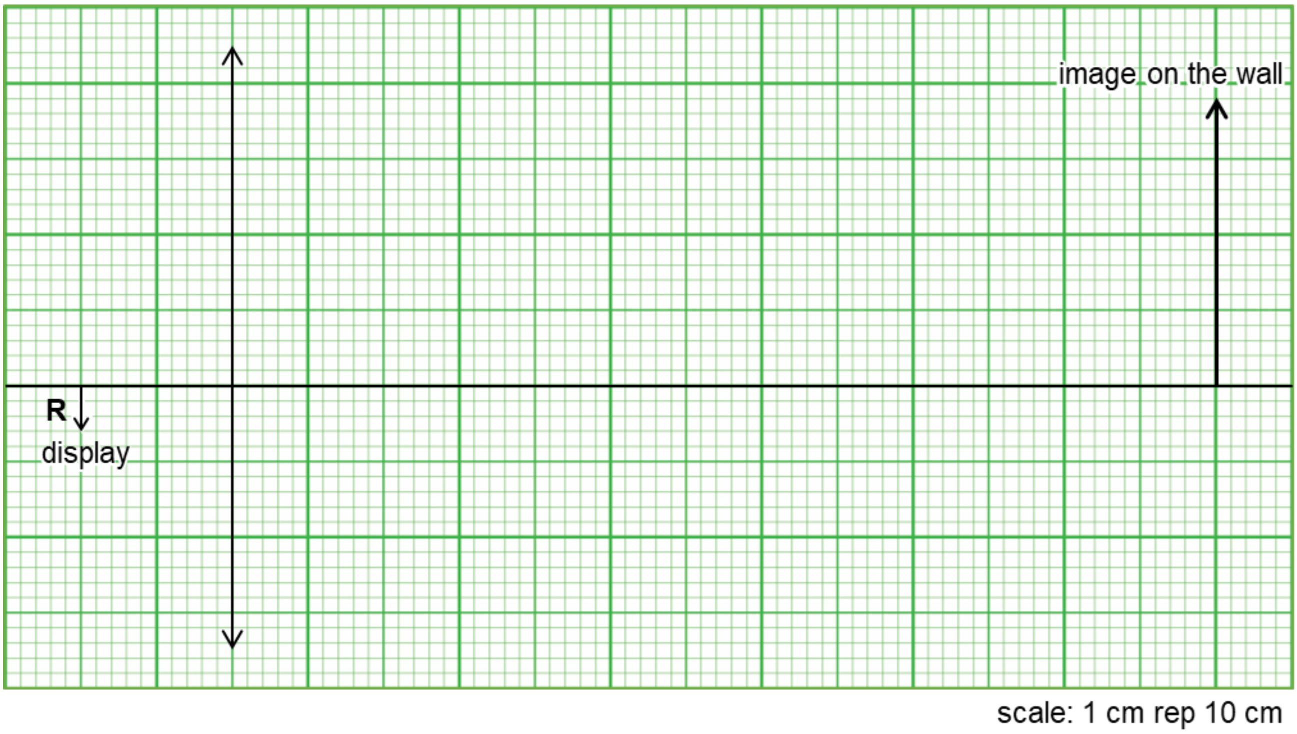


Fig. 9.2

(i) In Fig. 9.2, complete the ray diagram to determine the focal length of the lens.

focal length = ... [2]

(ii) The refractive index of glass increases when visible light of a higher frequency is used.

State what happens to the focal length of the lens when violet light of 380 nm is used.

....

.... [1]

[Total: 10]

10 **(a)** Fig. 10.1 shows the rating label at the bottom of an electric kettle which is connected to a 240 V mains supply.

Fig. 10.1

(i) Calculate the maximum current flowing through the electric kettle when it is connected to 240 V mains supply.

current = ... [2]

(ii) Suggest a suitable fuse rating for the electric kettle.

fuse rating = ... [1]

(iii) The kettle is used at maximum power for 10 minutes everyday. Calculate the cost of using this kettle for 30 days if each kWh of electrical energy costs 29.89 cents.

cost = ... [2]

(b) Fig. 10.2 shows the wiring of an electrical lamp. The lamp has a metal case and a switch. There are three wires X, Y and Z in the mains cable connected to the plug shown in Fig. 10.3.

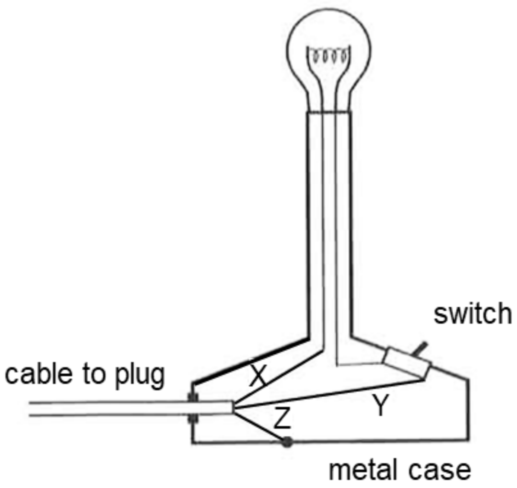


Fig. 10.2

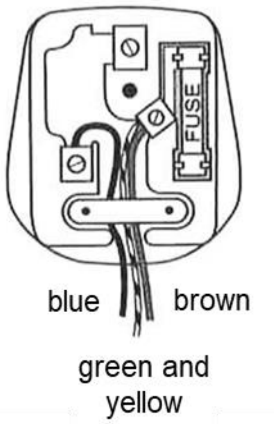


Fig. 10.3

(i) Match the wires X, Y and Z to the corresponding type of wire found in a plug. [3]

wire X ●	● earth
wire Y ●	● live
wire Z ●	● neutral

(ii) The plug of the lamp is wired wrongly. Explain the danger of using the plug wired this way.

....

....

.... [2]

END OF PAPER