ST JOSEPH'S INSTITUTION
END-OF-YEAR EXAMINATION 2020
(YEAR 3)

CANDIDATE NAME									
CLASS						INDEX NUMBER			

PHYSICS **6091/02**

Paper 2 **5 OCTOBER 2020**

Additional Materials: Nil **1 hour 40 minutes (08:00 – 09:40)**

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on the cover page of this Question Paper and all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A and B
Answer **all** questions on the Question paper.

Candidates are reminded that **all** quantitative answers should include appropriate units.
Candidates are advised to show formulae and 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.

Section A							
1	2	3	4	5	6	7	8
Section B							
9	10	11					

For Examiner's Use	
Sect. A	/ 40
Sect. B	/ 30
Total	/ 70

Section A (40 marks)

Answer all questions in this section.

1 In a practical session, a student is required to measure the thickness of a piece of graph paper.

Fig. 1.1 shows the reading of the micrometer used to measure 100 pieces of graph papers.

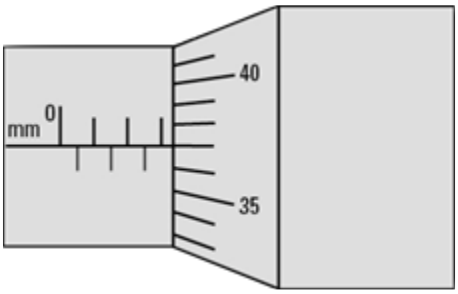


Fig. 1.1

(a) Determine the thickness of one piece of graph paper in metre and in standard form.

thickness = …….. [2]

(b) The term GSM (grams per square meter) is a measure of the mass of various types of paper from a sample sheet cut to one square meter. The heavier the paper, the higher the GSM.

The student bought a piece of A1 size cardboard rated at 400 GSM as shown in Fig. 1.2.

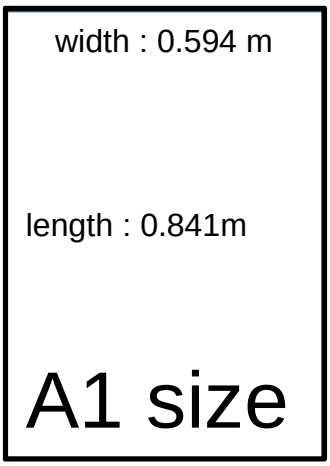


Fig. 1.2

(i) Calculate the volume of the cardboard in m^3, given that it has a thickness of 0.22 mm.

volume = …….. [2]

(ii) Using the GSM of the paper, calculate the mass, and hence the density of the A1 sized cardboard in kg/m^3.

density = …….. [2]

2 In a bungee jump, a fixed rubber cord is fastened to the jumper's ankles to stop his fall. Fig. 2.1 shows how the velocity of the bungee jumper changes during the first 6.0 s after he made the jump off a cliff.

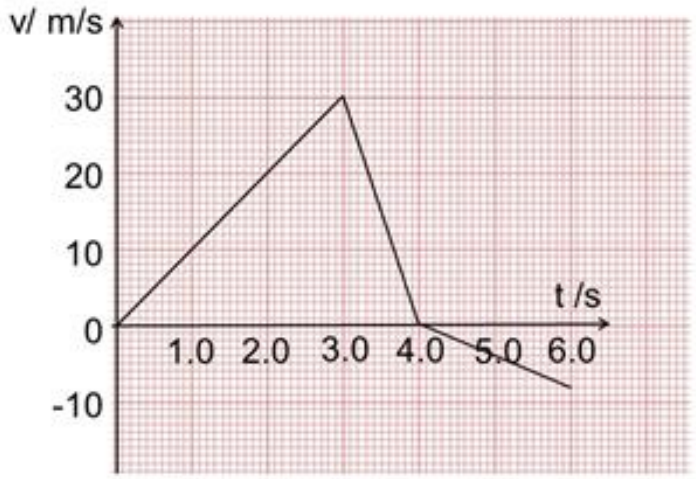


Fig. 2.1

(a) Calculate the acceleration of the jumper between t = 1.0 and 3.0 s.

acceleration = …….. [1]

(b) Describe how the motion of the jumper changes between t = 3.0 s and 6.0 s.

……...

……...

……...

……..…[2]

(c) Determine the displacement of the jumper at t = 6.0 s, from where he jumped off.

displacement = …….. [2]

(d) Calculate the average speed of the jumper for the duration of 6.0 s.

average speed = …….. [2]

(e) Explain why the average speed of the jumper is higher than his average velocity.

……...

……...

……..[1]

3 A physicist brought a mercury manometer with him to check the air pressure in an aircraft's cabin when he was taking a flight.

Fig. 3.1 shows the manometer. The left limb is connected to a gas container while the right limb is exposed to the cabin air. The gas pressure in the container is 40.0 cmHg. The density of mercury is 13 600 kg/m^3. The gravitational field strength g = 10 N/kg.

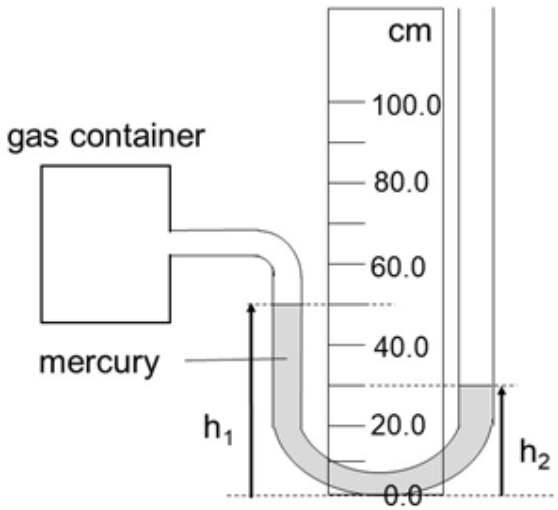


Fig. 3.1

(a) Express the gas pressure in the container in Pa.

pressure = …….. [1]

(b) Determine the air pressure in the cabin in cmHg.

pressure = …….. [1]

(c) The air pressure in the cabin suddenly dropped during the flight. State and explain how h_1 and h_2 changed.

……...

……...

……..…[2]

(d) When the aircraft is flying at an altitude of 12 000 m, the atmospheric pressure outside the aircraft decreases significantly to 20 000 Pa. To create a safe and comfortable environment for the passengers, the cabin is pressurised and the air pressure in the cabin is kept at 80 000 Pa.

(i) Explain why atmospheric pressure decreases at higher altitude.

……...

……...

……..[1]

(ii) The area of one panel of the window in the cabin is 875 cm^2, determine the force exerted by the air inside the cabin on the window.

force = …….. [2]

4 Fig. 4.1 shows a toy car of mass 1.0 kg that is moving towards the edge of a ramp.

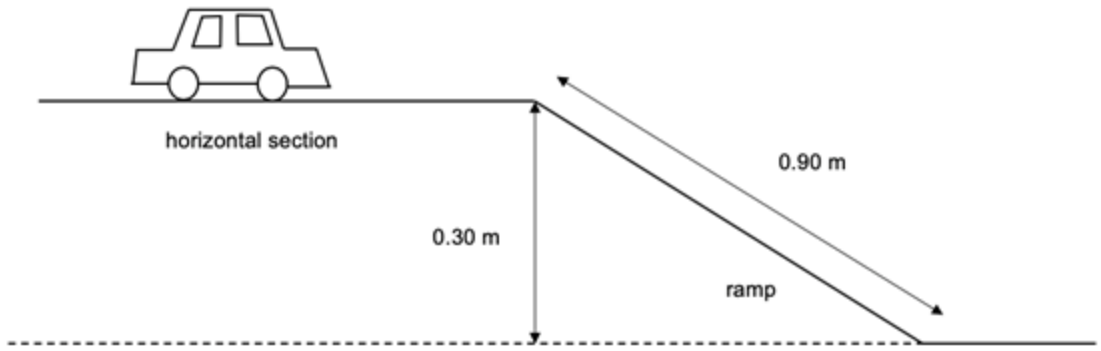


Fig. 4.1

At the end of the horizontal section of the track, the car accelerates down the rough surface of the ramp of length 0.90 m, achieving a speed of 2.5 m/s at the end of the ramp.

The effect of air resistance is negligible.

(a) Explain how the principle of conservation of energy is applied as the toy car moves down the ramp.

……...

……...

……...

……...

……..…[2]

(b) **(i)** Calculate the change in gravitational potential energy of the toy car as it moves down the ramp. The gravitational field strength g = 10 N/kg.

energy = …….. [1]

(ii) Given that the average frictional force between the toy car and the ramp is 0.11 N, determine the speed of the toy car at the top of the ramp.

speed = …….. [2]

(c) The initial speed of the toy car is now doubled.

Explain why this does not result in an increase in the speed of the toy car at the bottom of the ramp to 5.0 m/s.

……...

……...

……..…[1]

5 An aluminum can with an opening on the top contains a small amount of water that is heated until the water boils.

(a) Explain why the air particles in the aluminium can exert pressure onto the wall of the can.

……...

……...

……...

……..…[2]

(b) Explain why the heated aluminium can finally crumples when it is completely immersed in cold water, immediately after being heated.

……...

……...

……...

……..…[2]

6 Fig. 6.1 shows the structure of a water cooler that is used to supply cold water.

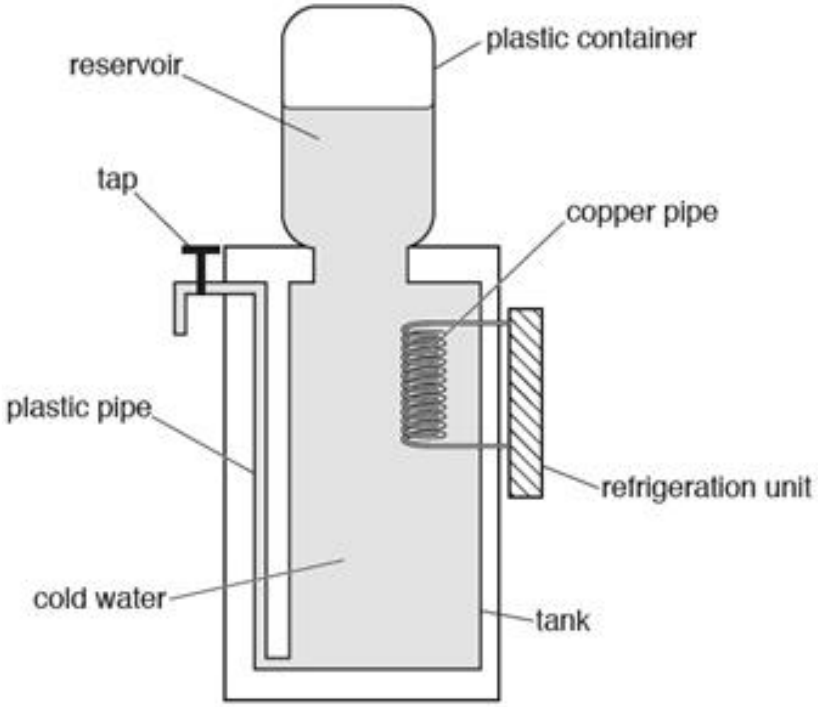


Fig. 6.1

Water in the tank is being cooled before being dispensed through the tap.

A cold liquid from the refrigeration unit is pumped through the copper pipe and thermal energy from the water is transferred through the copper pipe to this liquid.

(a) Explain, in terms of particles, how thermal energy is transferred through the copper pipe.

……...

……...

……..[2]

(b) The water surrounding the copper pipe is cooled. Explain how this helps to decrease the temperature of the water in the tank.

……...

……...

……..[2]

7 A student calibrates a thermometer by determining its thermometric property, which is gas pressure, at ice point and steam point of pure water.

When the thermometer is placed in melting ice and steam separately, the gas pressure is 10 kPa and 90 kPa respectively.

(a) State what is meant by thermometric property.

……...

……..…[1]

(b) The thermometer is placed in a glass of warm water and the gas pressure of the thermometer is 30 kPa. Calculate the temperature of the warm water.

temperature = …….. [2]

8 A small lamp L hangs by a cable from the ceiling of a room. A white screen, AB is placed on the floor vertically below the lamp. A plane mirror M is placed above the lamp as shown in Fig. 8.1. The diagram is drawn to scale.

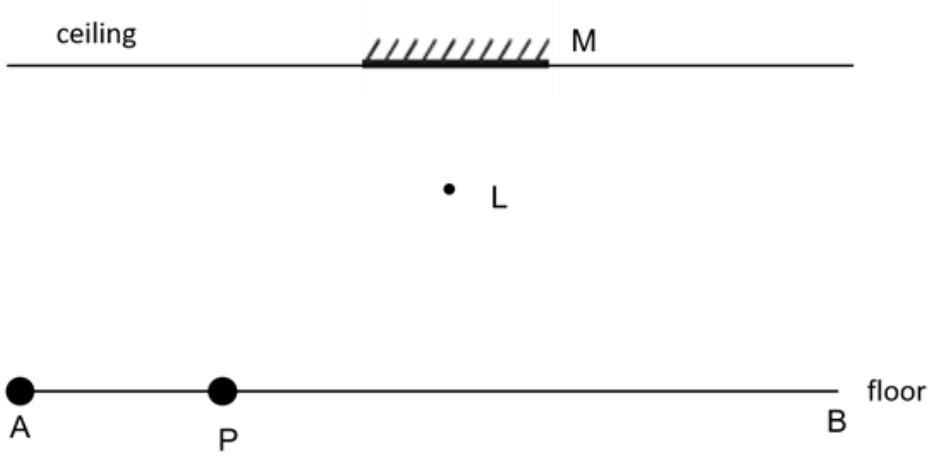


Fig. 8.1

With the aid of a light ray on Fig. 8.1, explain why the region on the screen around P appears brighter as compared to the region on the screen around A. You may draw on the diagram, if you wish.

……

……[2]

Section B (30 marks)

Answer all questions in this section.

9 A motorboat of mass 1 200 kg has a maximum driving force of 800 N.

(a) At one instant when the motorboat is powered with the maximum driving force, its acceleration is 0.50 m/s^2.

(i) Determine the total resistive force acting on the motorboat.

resistive force = …….. [2]

(ii) Explain, using ideas about forces, why the velocity of the motorboat increases at a decreasing rate even though the motorboat is powered with maximum driving force.

……...

……...

……...

……[2]

(b) Fig. 9.1 shows the motorboat used to parasail a man attached to a canopy wing. The man has a mass of 100 kg and he moves at a constant speed of 1.0 m/s. The angle of the rope that ties the man to the motorboat is 30° to the horizontal.

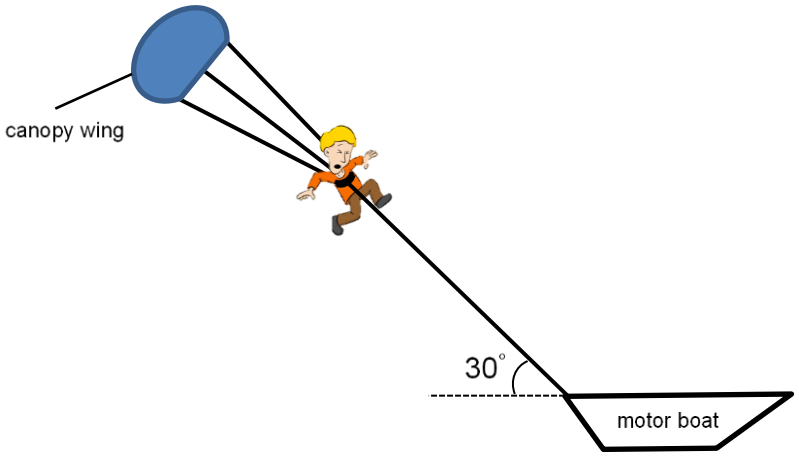


Fig. 9.1

At one instance, the rope exerts a force of 1 500 N on the boat.

(i) State and explain the force the rope exerts on the man.

……...

……[1]

(ii) If the 100 kg man continues to move at a constant speed of 1.0 m/s, determine the magnitude of the force the canopy wing exerts on the man.

Include a labelled vector diagram in your answer, by using a scale of 1 cm : 200 N. Ignore the effects of air resistance on the man.

force = …… [3]

(iii) If the rope snaps, determine the immediate acceleration of the man and state the direction that the man will move.

acceleration = …….. [1]

direction = …….. [1]

10 **(a)** Fig. 10.1 shows a cardboard lamina suspended from a wooden rod at pivot P. The cardboard has a weight of W, and it is held to one side.

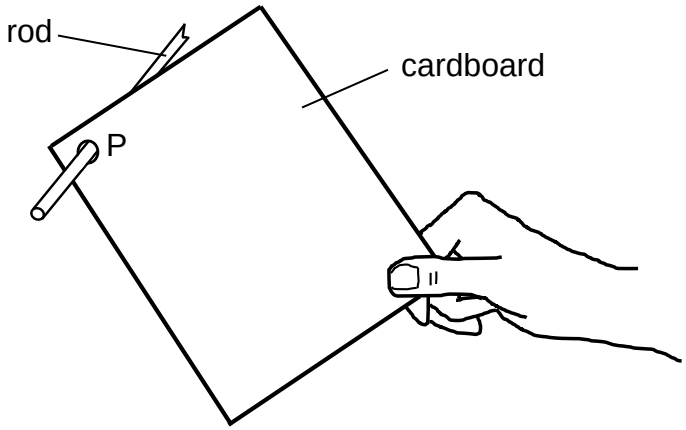


Fig. 10.1

(i) State what is meant by the *centre of gravity* of a body.

……...

……..……[1]

(ii) The cardboard is released. It swings on the rod and eventually comes to rest.

State the position at which the cardboard will rest and explain why it comes to rest at this position.

……..

……..

……..

……..…[2]

(b) The uniform wooden rod is removed from the cardboard, and it is now held by two strings, A and B, as shown in Fig. 10.2.

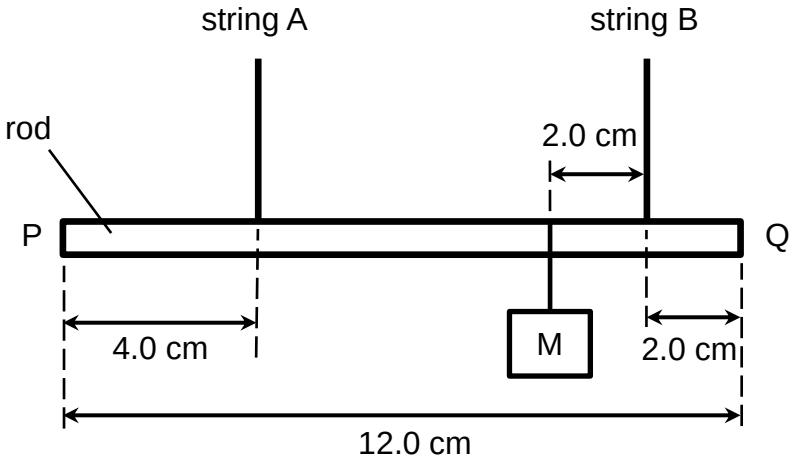


Fig. 10.2

The rod is 12.0 cm long. String A is positioned 4.0 cm from P, while string B is positioned 2.0 cm from Q. An object M with a weight of 1.3 N is hung 2.0 cm from string B.

(i) In Fig. 10.3, draw arrows to indicate the forces acting on the rod: Tension of string A (T_A), tension of string B (T_B), weight of rod (W), and the weight of M.
[1]

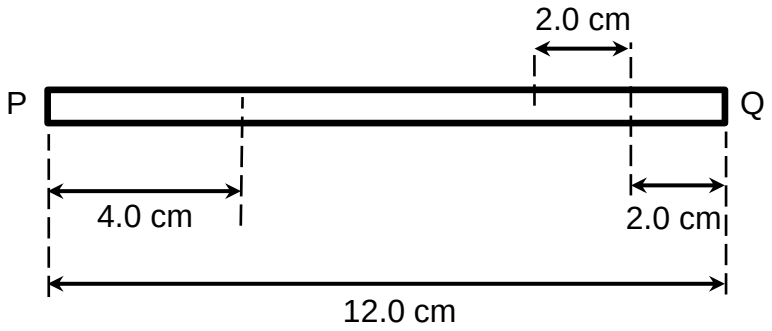


Fig. 10.3

(ii) The tension in string B is 1.0 N. By taking moments about string A, find the weight of the rod.

weight = …….. [2]

(iii) Hence, find the mass of the rod.

mass = …….. [1]

(iv) Find the tension in string A.

tension = …….. [1]

(v) State and explain the direction that object M has to move towards in order to make the tensions in strings A and B equal.

……..

……..

……..…[2]

11 **(a)** Fig. 11.1 shows a ray of light in air incident on the vertical side of a rectangular glass block. The angle of incidence is 60°.

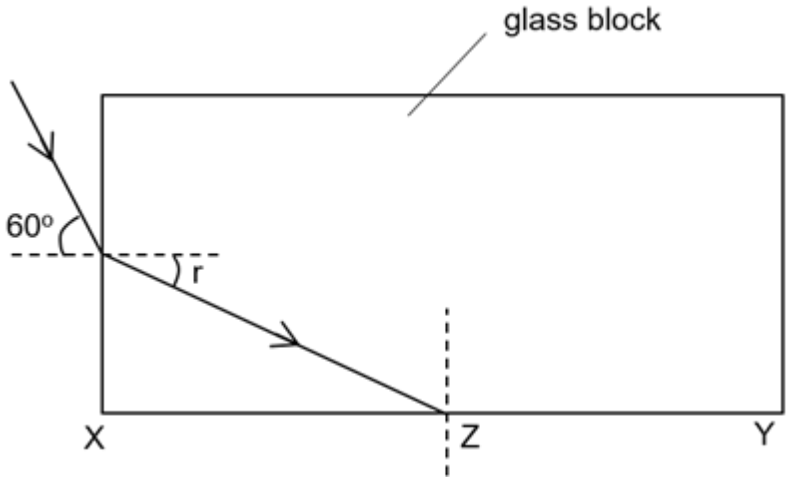


Fig. 11.1

The refractive index of the glass is 1.6. The light travels in the glass and incident on the side XY.

(i) Explain what is meant by “the refractive index of the glass is 1.6”.

……...

……..[1]

(ii) Calculate angle r.

r = …….. [1]

(iii) **1** Calculate the critical angle for light travelling in the glass block.

critical angle = …….. [1]

2 Hence explain what happens to the ray of light when it is incident at point Z.

……...

…….[1]

3 On Fig. 11.1, draw the path of the light ray after it is incident at Z until it emerges into air again. [1]

(iv) The glass block is now immersed in water which has a refractive index of 1.3.

Without carrying out any calculation, explain the change in the angle r if the angle of incidence remains at 60°.

……...

……..[1]

(b) Fig. 11.2 shows a thin converging lens forming a real image I of a point object O.

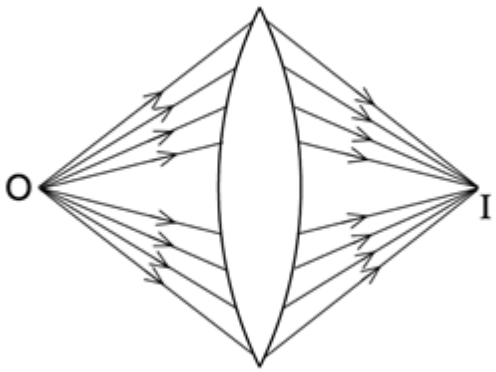


Fig. 11.2

(i) Explain why light rays incident on the edges of the lens bend more compared to the light rays incident near the centre of the lens.

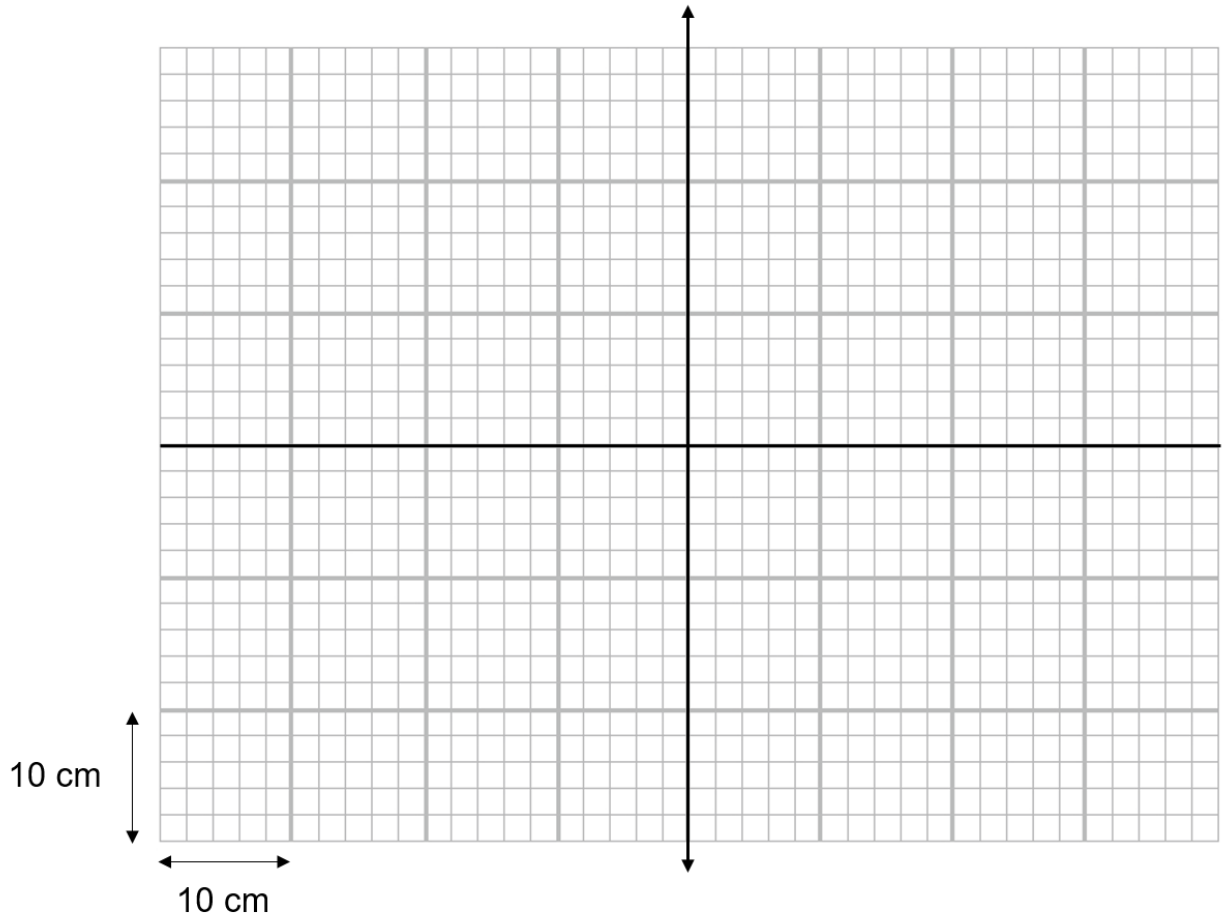
……...

……...

……..[1]

(ii) The converging lens has a focal length of 12.0 cm. It is used to form a real image of an object of height 10.0 cm.

1 Construct a ray diagram that would produce a real image of an object whose height is magnified two times. The principal axis and the lens have been provided in the grid below. [2]



2 State the image distance.

…… [1]

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