Section A

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

1. A sky-diver jumps from a stationary balloon. His initial downwards acceleration is 10 m/s^2.

Fig. 1.1 shows the directions of the air resistance and the weight of the sky-diver.

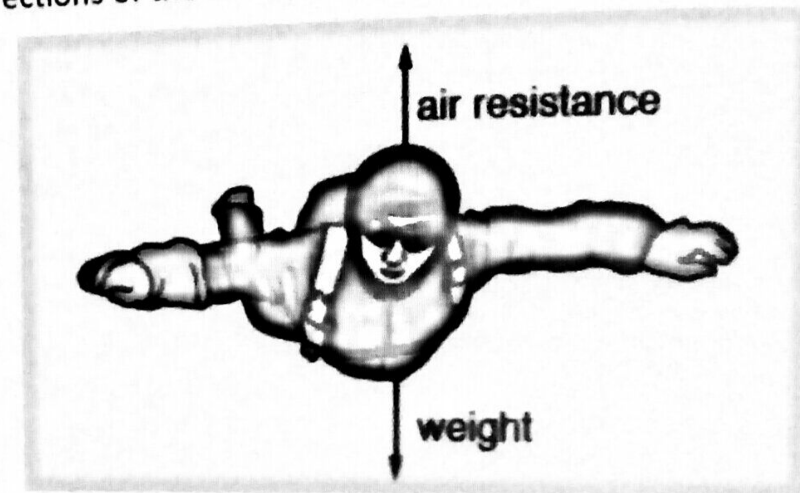

Fig. 1.1

The mass of the sky-diver is 60 kg and his weight is 600 N.

(a) Explain, using ideas about the forces, why his initial downwards acceleration is 10 m/s^2.

....

....

....

....

.... [2]

(b) When the parachute opens, the sky-diver experiences an upward acceleration for a short time.

Explain why.

....

....

....

.... [1]

(c) The total force of air resistance on the sky-diver and open parachute changes with their speed, as shown in Fig. 1.2.

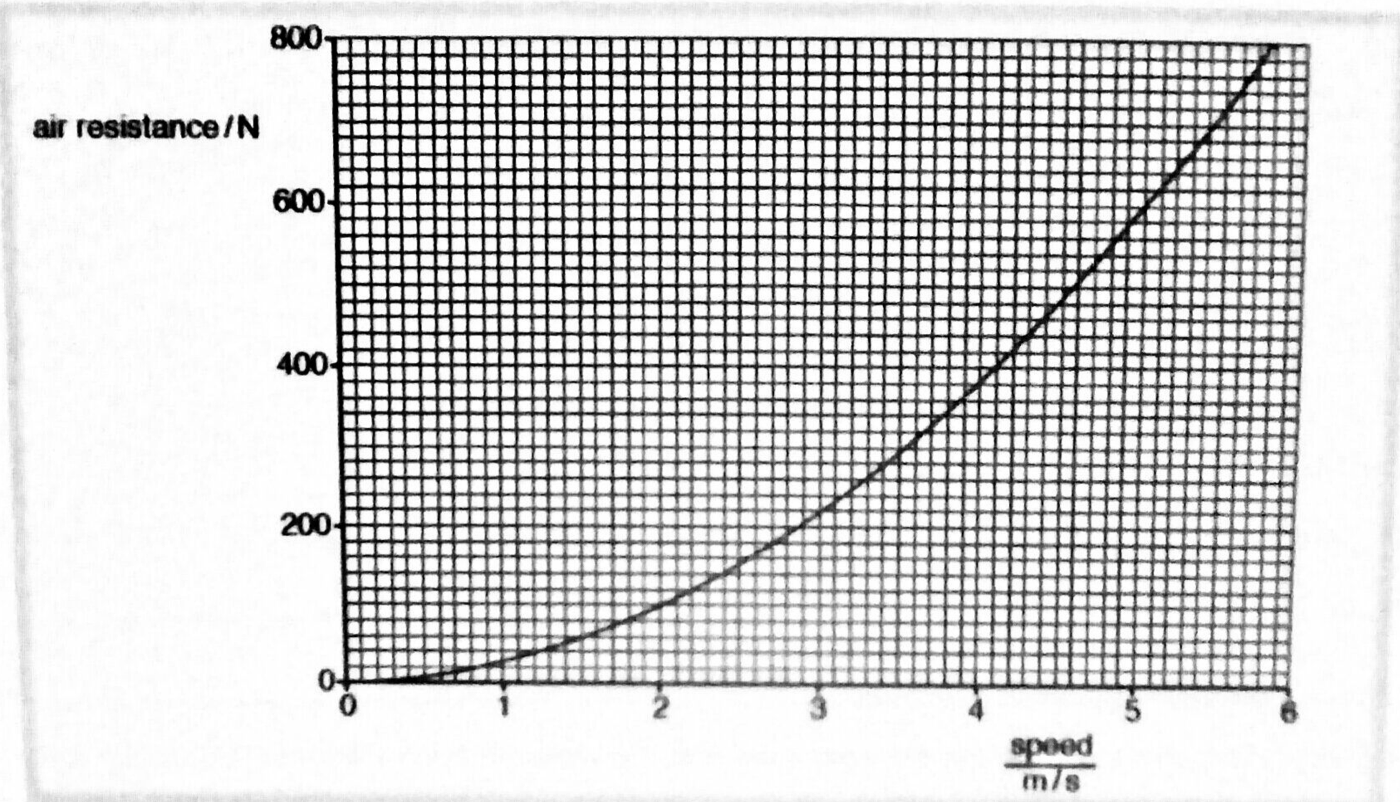

Fig. 1.2

After the parachute opens, the sky-diver slows down to a terminal velocity.

The weight of the sky-diver is 600 N.

(i) Using Fig. 1.2, determine the terminal velocity of the sky-diver.

terminal velocity = ... [1]

(ii) Calculate the resultant force on the sky-diver when his speed is 5.5 m /s.

resultant force = ... [1]

2. Two small tugboats are pulling a large ship in a harbour. Fig. 2.1 represents the view from above and shows the directions of the forces on the ship.

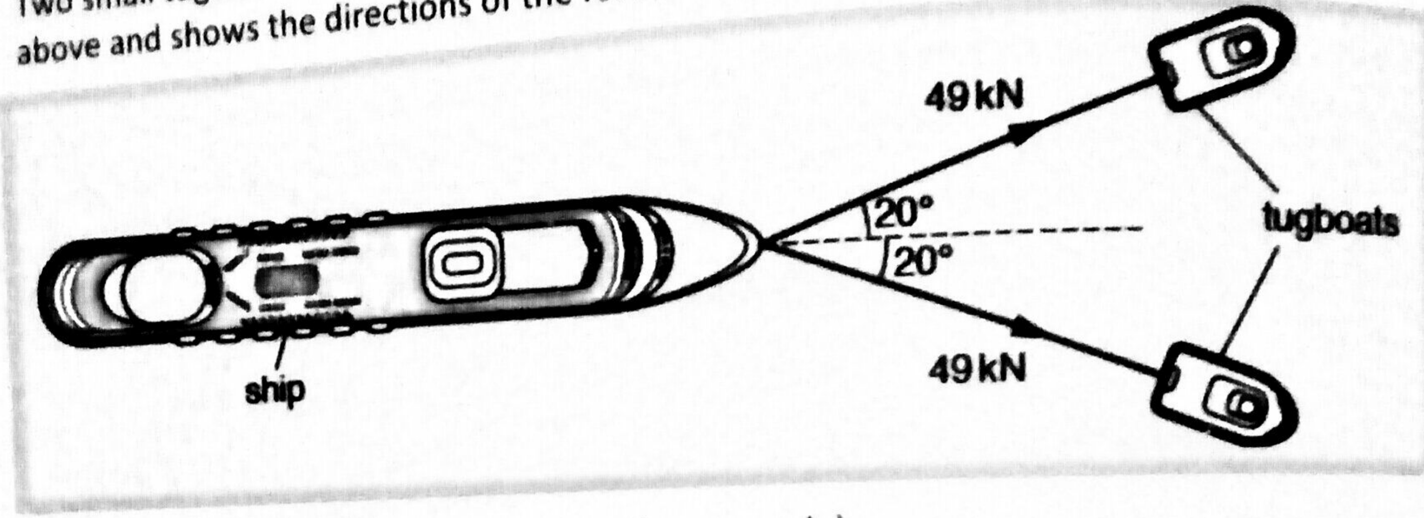

Fig.2.1(not to scale)

Each of the tugboats is exerting a force of 49 kN on the ship.

(a) Determine by a graphical method the resultant of these two forces and state the scale used.

scale ....

resultant = ... [3]

(b) The engines of the ship are not operating and the water in the harbour is stationary. The ship is moving in a straight line in the direction of the total force exerted by the tugboats. It is travelling at a constant speed. Explain, in terms of the forces acting, why the ship is moving in a straight line at constant speed.

....

....

....

.... [2]

3. A student hangs various masses from the end of a spring and determines the extension produced.

Fig. 3.1 shows the spring hanging vertically on its own and with an unknown mass X at one end.

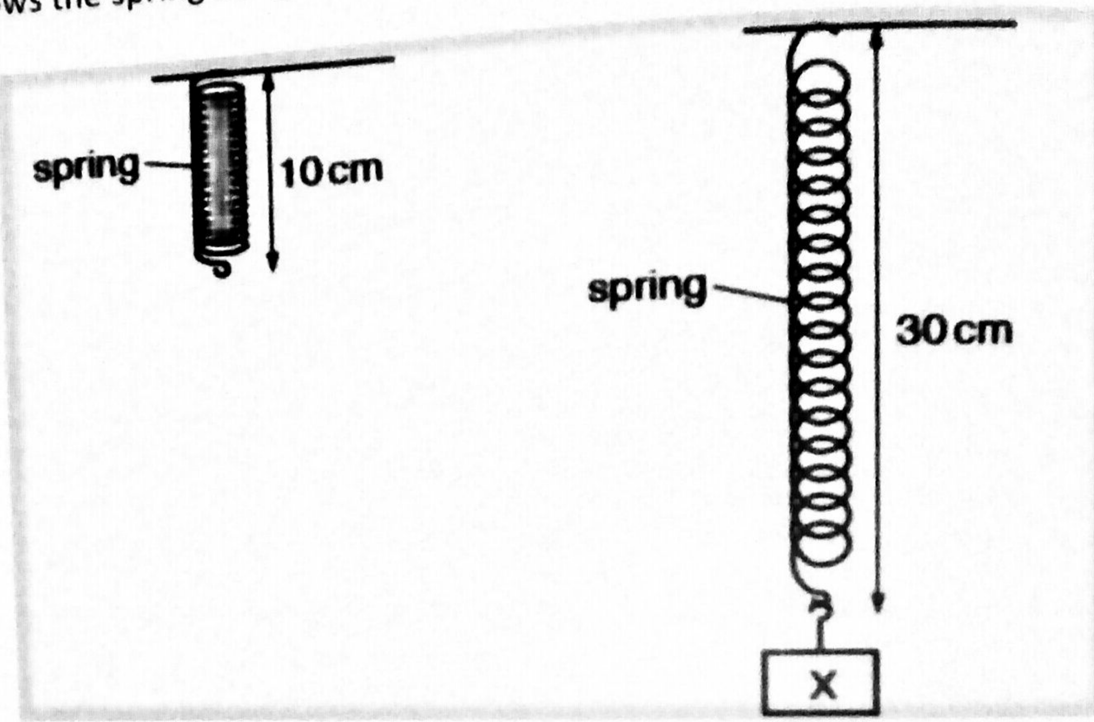

Fig. 3.1 (not to scale)

(a) The student plots a graph of the extension of the spring against the mass hanging on the spring. Fig. 3.2 shows the student's graph.

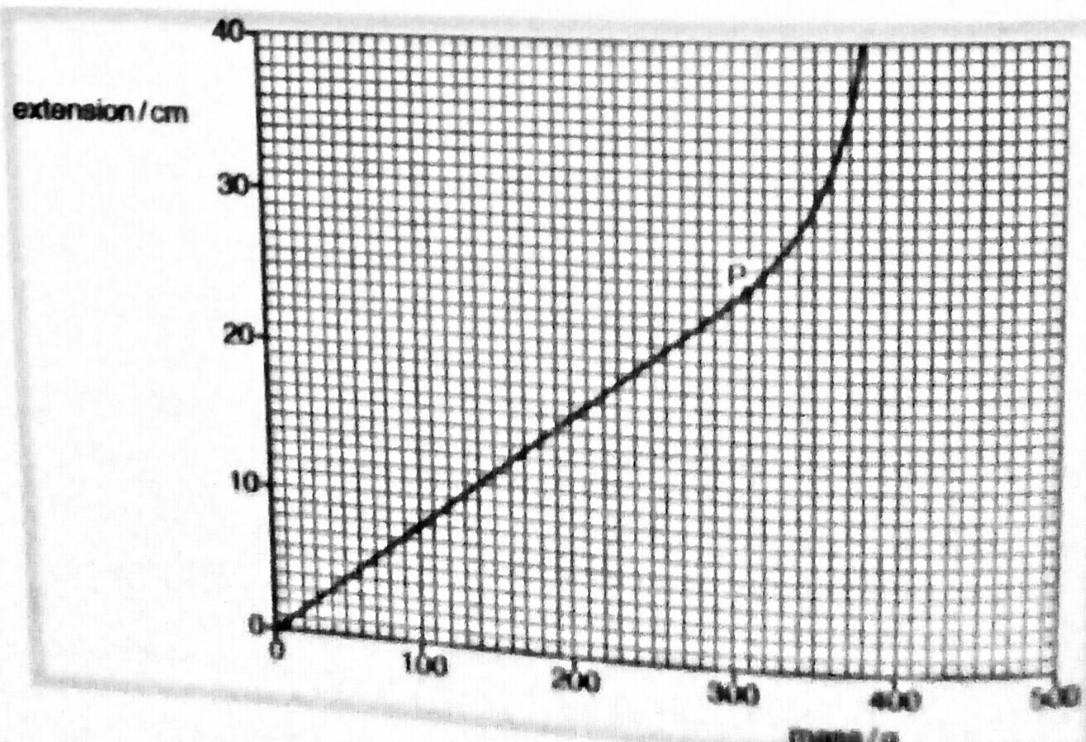

Fig. 3.2

(i) At point P on the graph, the line begins to curve.

State the name of point P.

(ii) Using Fig. 3.1 and Fig. 3.2, determine the mass X.

mass = ... [1]

(iii) The gravitational field strength *g* is 10 N / kg.

Calculate the weight of X.

weight = ... [1]

(b) An identical spring is used with the original spring, as shown in Fig. 3.3.

Together they support the mass X.

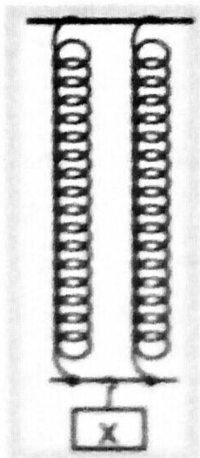

Fig. 3.3 (not to scale)

State and explain how the extension in Fig. 3.3 compares with the extension in Fig. 3.1.

....

....

....

.... [2]

4. Fig. 4.1 shows a thin sheet of plastic. A student tries to measure the thickness of the sheet with a ruler, but the sheet is too thin to measure accurately.

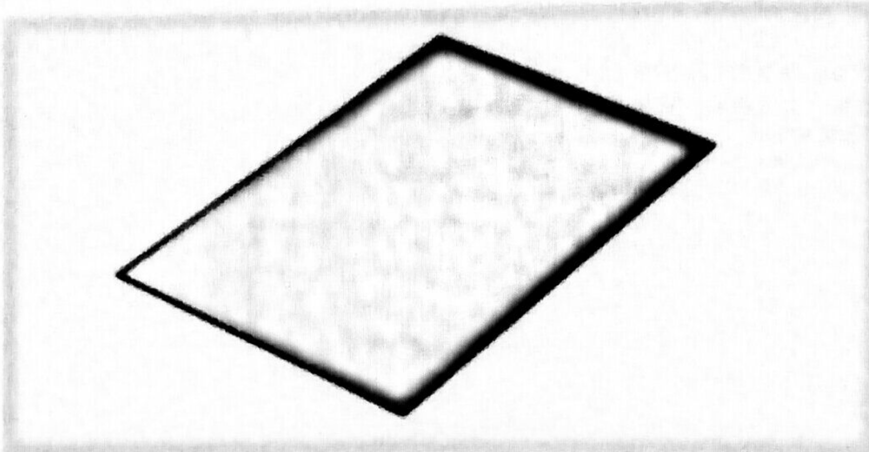

Fig. 4.1 (not to scale)

The student measures the mass of the sheet and obtains the value 0.12 g.

(a)

(i) State what is meant by *mass*.

....

.... [1]

(ii) The student is told that the density of the plastic is 0.91 g / cm^3.

Calculate the volume of the plastic sheet.

volume = ... [2]

(iii) The student measures the length and width of the sheet. The readings obtained are:

length of sheet = 3.0 cm

width of sheet = 2.0 cm

Calculate the thickness of the sheet.

thickness = ... [2]

(b) State a measuring instrument that can be used to measure the thickness of the sheet accurately.

.... [1]

5. Fig. 5.1 shows a student sitting on a chair. Fig. 5.2 shows the same student with his chair tilted backwards slightly.

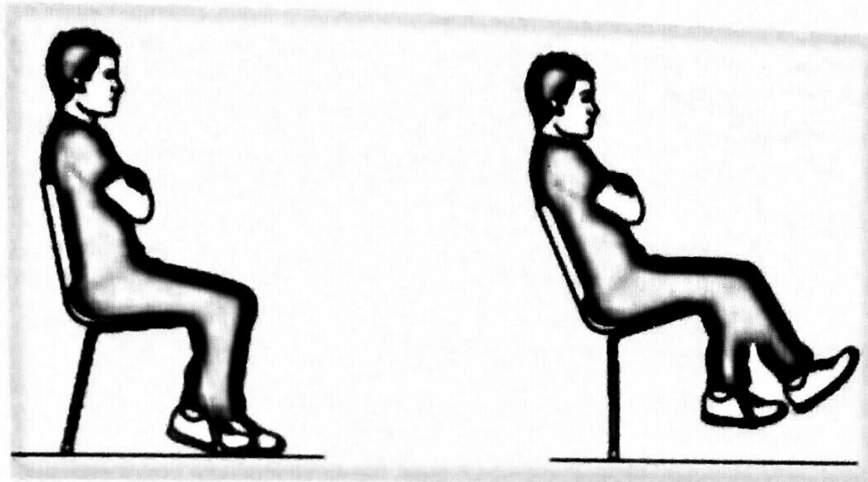

Fig. 5.1 Fig. 5.2

(a) State and explain how the pressure of the chair on the floor differs in the two positions.

....

....

....

....

.... [2]

(b) The chair and student fall over if the chair is tilted backwards more than in Fig. 5.2.

Explain why.

....

....

....

....

.... [2]

6. Gas is trapped in a syringe by a piston. Fig. 6.1 shows that the narrow end of the syringe is sealed.

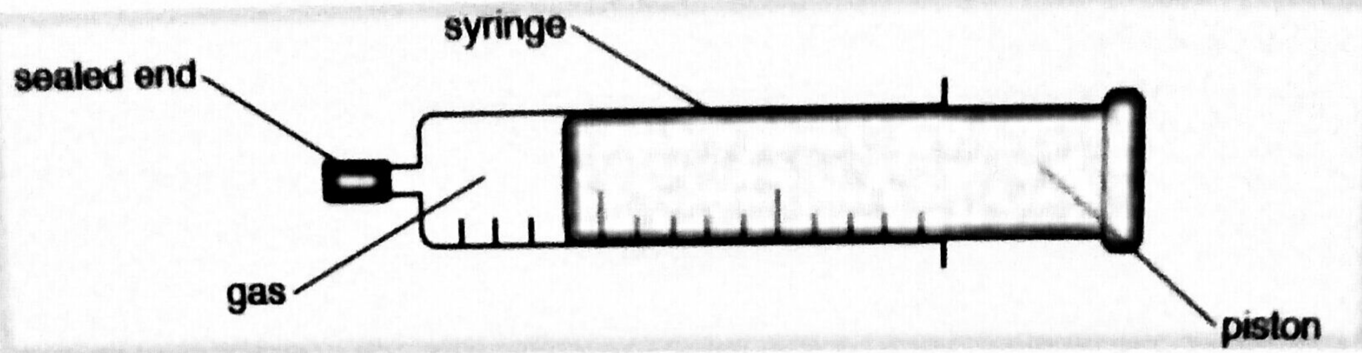

Fig. 6.1

When the gas is at a pressure of 1.1×10^5Pa, it occupies a volume of 40 cm^3.

(a) Explain, in terms of the molecules, how the gas exerts a pressure on the inside of the syringe.

....

....

....

....

.... [2]

(b) The piston is slowly pulled to the right until the volume occupied by the gas is 110 cm^3. The temperature of the gas does not change.

Calculate the new pressure of the gas.

Pressure = ... [2]

7. Fig. 7.1 shows apparatus used to investigate the turning effect of a force.

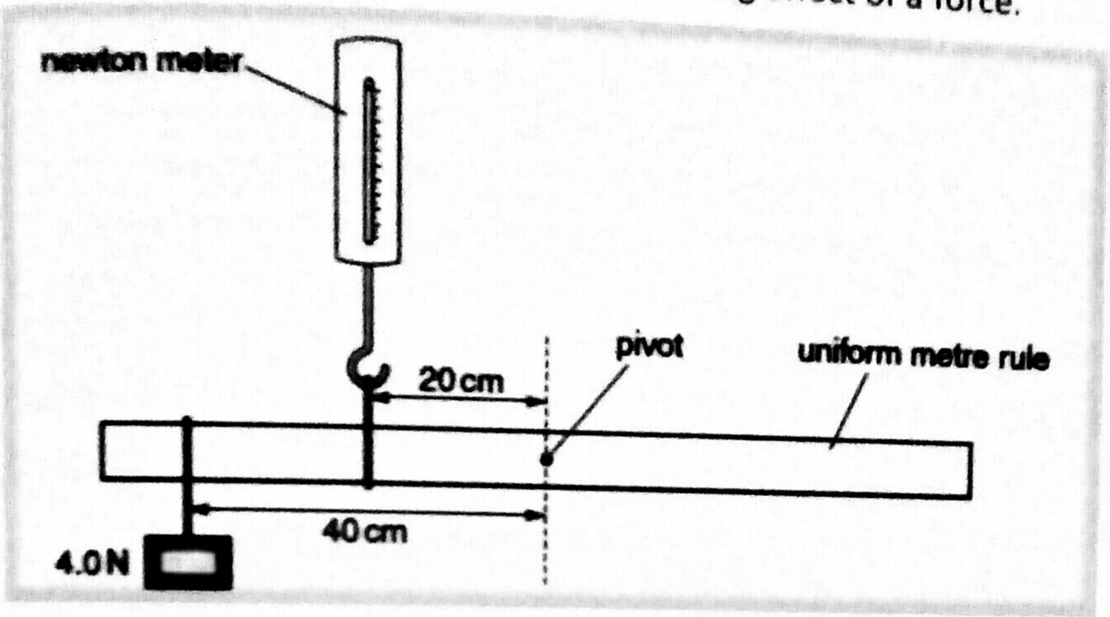

Fig. 7.1

The uniform metre rule is freely pivoted at its centre.

The newton meter is 20 cm from the pivot and a 4.0 N weight is 40 cm from the pivot.

The metre rule is in equilibrium.

(a) State the principle of moments for a body in equilibrium.

....

....

.... [1]

(b) Calculate the reading on the newton meter.

reading = ... [2]

(c) The weight of the metre rule is 1.2 N.

Calculate the size of the force exerted on the metre rule by the pivot.

8. Fig.8.1 shows a metal coffee cup on a metal warming plate.

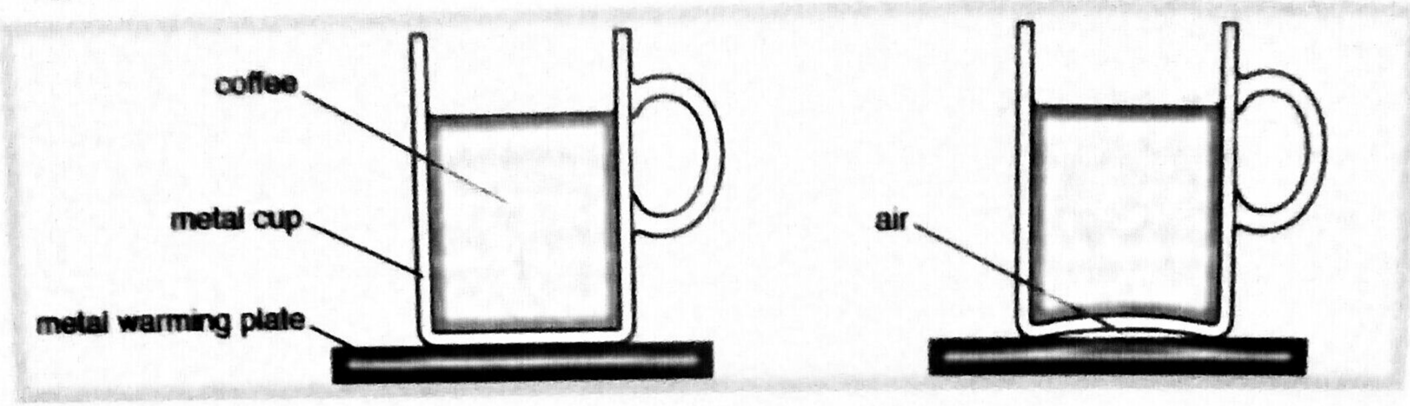

Fig.8.1 Fig.8.2

There is a small electrical heater inside the warming plate that keeps the plate hotter than the coffee.

(a) Describe how heat is transferred through the metal and then to all of the liquid in the cup.

....

....

....

....

....

.... [3]

(b) A cup of a different shape is placed on the same heater, as shown in Fig. 8.2. The two cups are made of the same metal and contain the same amount of coffee.

Explain why the coffee in the cup in Fig. 8.2 is not kept as warm as the coffee in the cup in Fig. 8.1.

....

.... [1]

(c) The outside surface of the cup can be either black or white and can be either dull or shiny.

Underline which colour **and** which type of surface is best to keep the coffee warm. [1]

black white dull shiny

Section B

Answer any **one** question from this section.

9. Fig. 9.1 shows a satellite in orbit around the Earth.

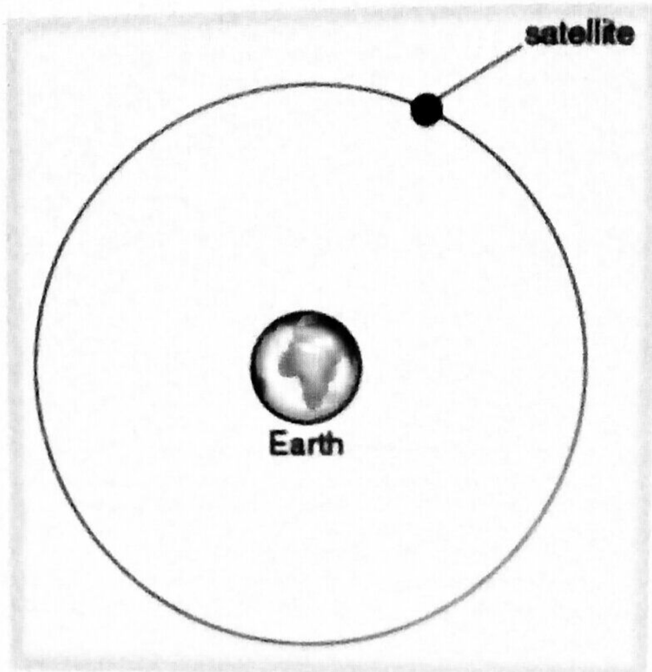

Fig. 9.1 (not to scale)

(a) The satellite travels at a constant speed in a circular orbit.

(i) Underline the quantities in the list below that are scalars. [2]

Acceleration **force** **mass** **speed** **velocity**

(ii) The velocity of the satellite changes, but its speed is constant.

1. State what is meant by *velocity*. ....

....

.... [1]

2. Explain why the velocity changes. ....

....

.... [1]

(iii) Explain what makes this satellite move in an orbit that is circular.

....

....

....

....

.... [2]

(b) The satellite is placed into orbit by a rocket. Fig. 9.2 shows the rocket as it takes off.

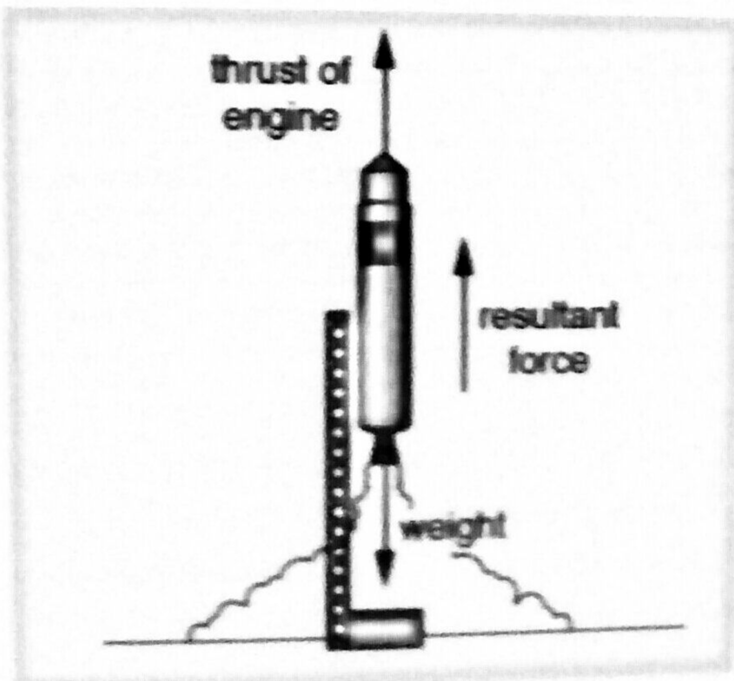

Fig. 9.2

The rocket and fuel have a total mass of 40 000 kg and a total weight of 400 000 N. The resultant force acting upwards on the rocket is 50 000 N.

(i) Calculate the thrust produced by the rocket engine.

thrust = ... [1]

(ii) Calculate the acceleration of the rocket.

accelerator = ... [2]

(c) In the first four minutes after take-off, the acceleration of the rocket is uniform.

(i) State what is meant by a *uniform acceleration*.

....

....

....

.... [2]

(ii) Fig. 9.3 describes the motion of the rocket in the first 12 minutes.

time/minutes	motion of the rocket
0 to 4	uniform acceleration
4 to 6	increasing acceleration
6 to 10	decreasing acceleration
10 to 12	constant speed

Fig. 9.3

On Fig. 9.4, sketch the speed-time graph of the rocket for the first 12 minutes.

You do not need to give values for the speed.

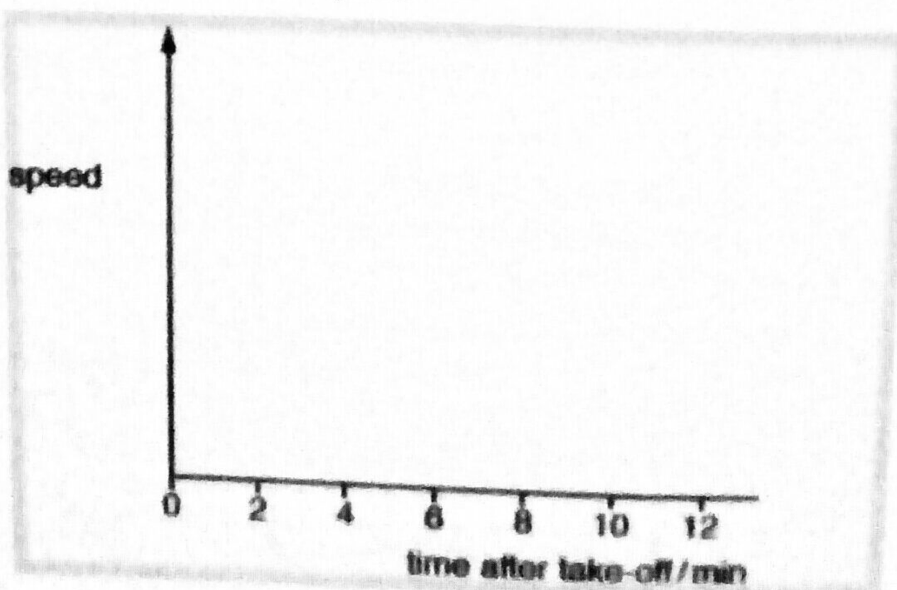

Fig. 9.4

[3]

(iii) State how the speed-time graph in **(ii)** can be used to find the distance travelled by the rocket.

....

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....

....

.... [2]

10. Fig. 10.1 shows a conveyor belt carrying suitcases into an aeroplane.

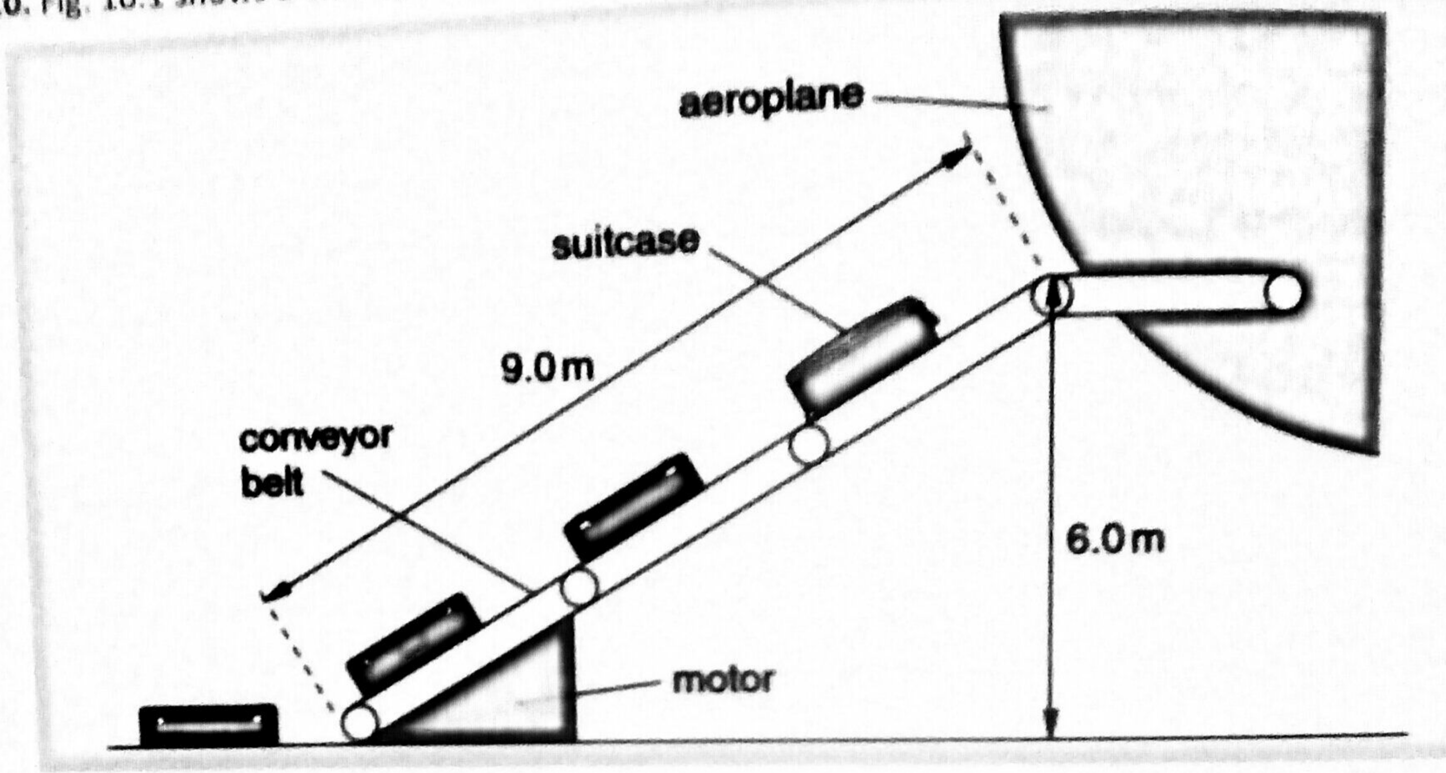

Fig.10.1 (not to scale)

An electric motor drives the conveyor belt.

(a) A suitcase of mass 20 kg is lifted from the ground into the aeroplane.

(i) Explain what is meant by *mass* and by *weight*.

....

....

....

.... [2]

(ii) The gravitational field strength g is 10 N / kg.

Calculate the increase in the gravitational potential energy of the suitcase.

increase in potential energy = ... [2]

(iii) The suitcase takes 12 s to travel 9.0 m along the conveyor belt.

Calculate the kinetic energy of the suitcase.

kinetic energy = ... [3]

(iv) Define kinetic energy and potential energy.

....

....

.... [2]

....

(v)

1. State the principle of the conservation of energy.

....

....

....

.... [2]

2. Explain how this principle applies to the lifting of the suitcases into the aeroplane.

....

....

.... [1]

(b) Some of the electrical energy for the motor comes from renewable energy sources.

(i) Explain what is meant by a *renewable energy source*.

....

....

.... [1]

(ii) State two renewable energy sources.

1. ....

2. .... [2]