Newton's Laws of Motion

Question paper 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Dynamics
Sub Topic	Newton's Laws of Motion
Paper Type	Theory
Booklet	Question paper 2

Time Allowed: **65 minutes**

Score: **/54**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 A helicopter has a cable hanging from it towards the sea below, as shown in Fig. 3.1.

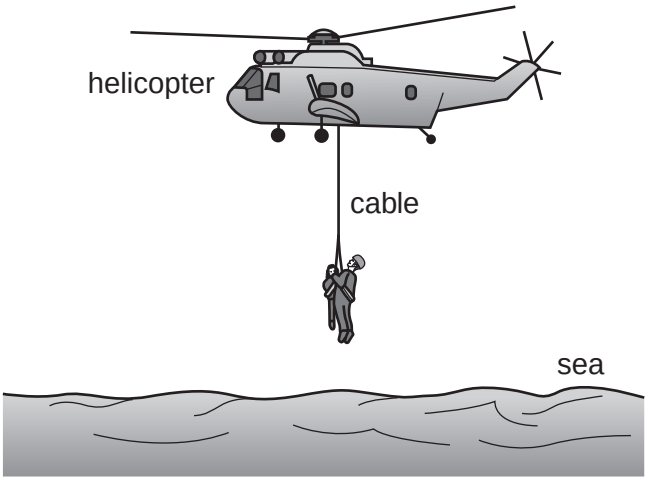

Fig. 3.1

A man of mass 80 kg rescues a child of mass 50.5 kg. The two are attached to the cable and are lifted from the sea to the helicopter. The lifting process consists of an initial uniform acceleration followed by a period of constant velocity and then completed by a final uniform deceleration.

(a) Calculate the combined weight of the man and child.

weight = ... N [1]

(b) Calculate the tension in the cable during

(i) the initial acceleration of 0.570 m s^{-2},

tension = ... N [2]

(ii) the period of constant velocity of 2.00 m s^{-1}.

tension = ... N [1]

(c) During the final deceleration the tension in the cable is 1240 N. Calculate this deceleration.

deceleration = ... $m\,s^{-2}$ [2]

(d) **(i)** Calculate the time over which the man and child are

1. moving with uniform acceleration,

time = ... s [1]

2. moving with uniform deceleration.

time = ... s [1]

(ii) The time over which the man and child are moving with constant velocity is 20 s. On Fig. 3.2, sketch a graph to show the variation with time of the velocity of the man and child for the complete lifting process.

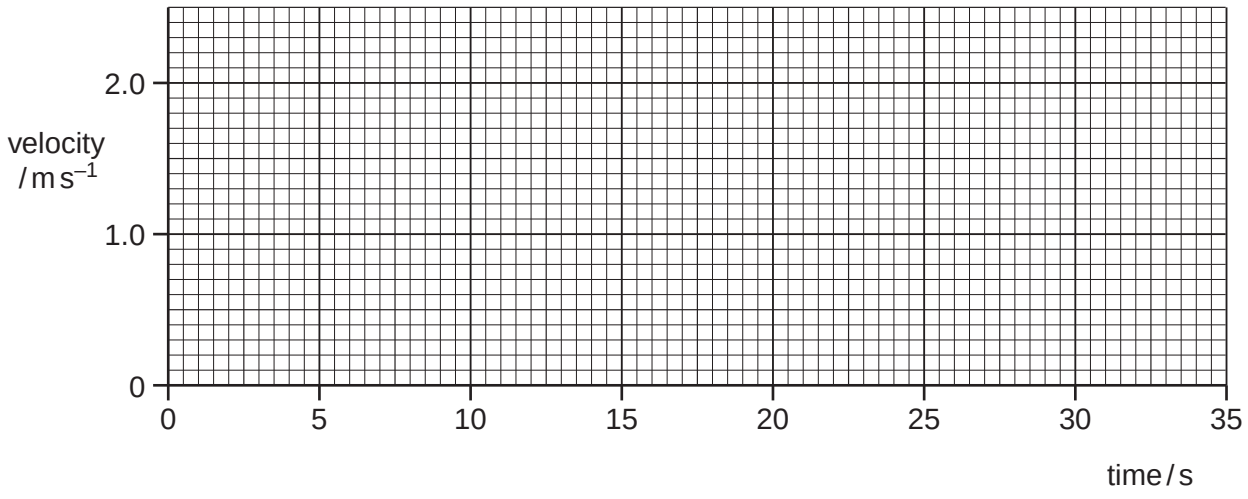

Fig. 3.2

[2]

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

.....

.....

.....[2]

(b) A uniform rectangular sheet of card of weight *W* is suspended from a wooden rod. The card is held to one side, as shown in Fig. 3.1.

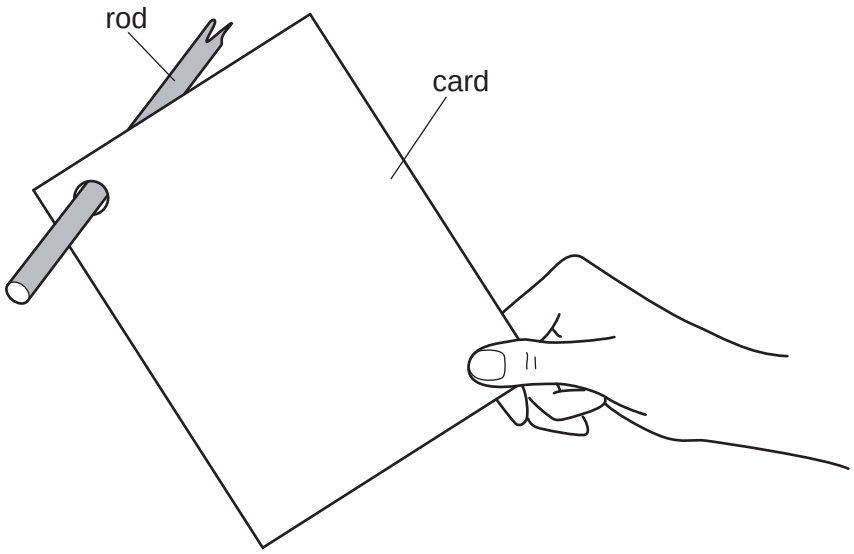

Fig. 3.1

On Fig. 3.1,

(i) mark, and label with the letter C, the position of the centre of gravity of the card, [1]

(ii) mark with an arrow labelled *W* the weight of the card. [1]

(c) The card in **(b)** is released. The card swings on the rod and eventually comes to rest.

(i) List the two forces, other than its weight and air resistance, that act on the card during the time that it is swinging. State where the forces act.

1. .....

.....

2. .....

.....

[3]

(ii) By reference to the completed diagram of Fig. 3.1, state the position in which the card comes to rest.
Explain why the card comes to rest in this position.

.....

.....

.....[2]

3 **(a)** **(i)** Define *force*.

.....

.....[1]

(ii) State Newton's third law of motion.

.....

.....

.....

.....[3]

(b) Two spheres approach one another along a line joining their centres, as illustrated in Fig. 3.1.

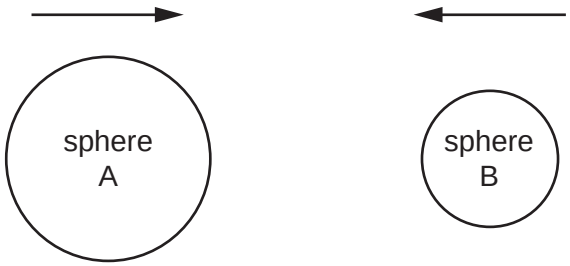

Fig. 3.1

When they collide, the average force acting on sphere A is F_A and the average force acting on sphere B is F_B.

The forces act for time t_A on sphere A and time t_B on sphere B.

(i) State the relationship between

1. F_A and F_B,

.....[1]

2. t_A and t_B.

.....[1]

(ii) Use your answers in **(i)** to show that the change in momentum of sphere A is equal in magnitude and opposite in direction to the change in momentum of sphere B.

.....

.....[1]

(c) For the spheres in **(b)**, the variation with time of the momentum of sphere A before, during and after the collision with sphere B is shown in Fig. 3.2.

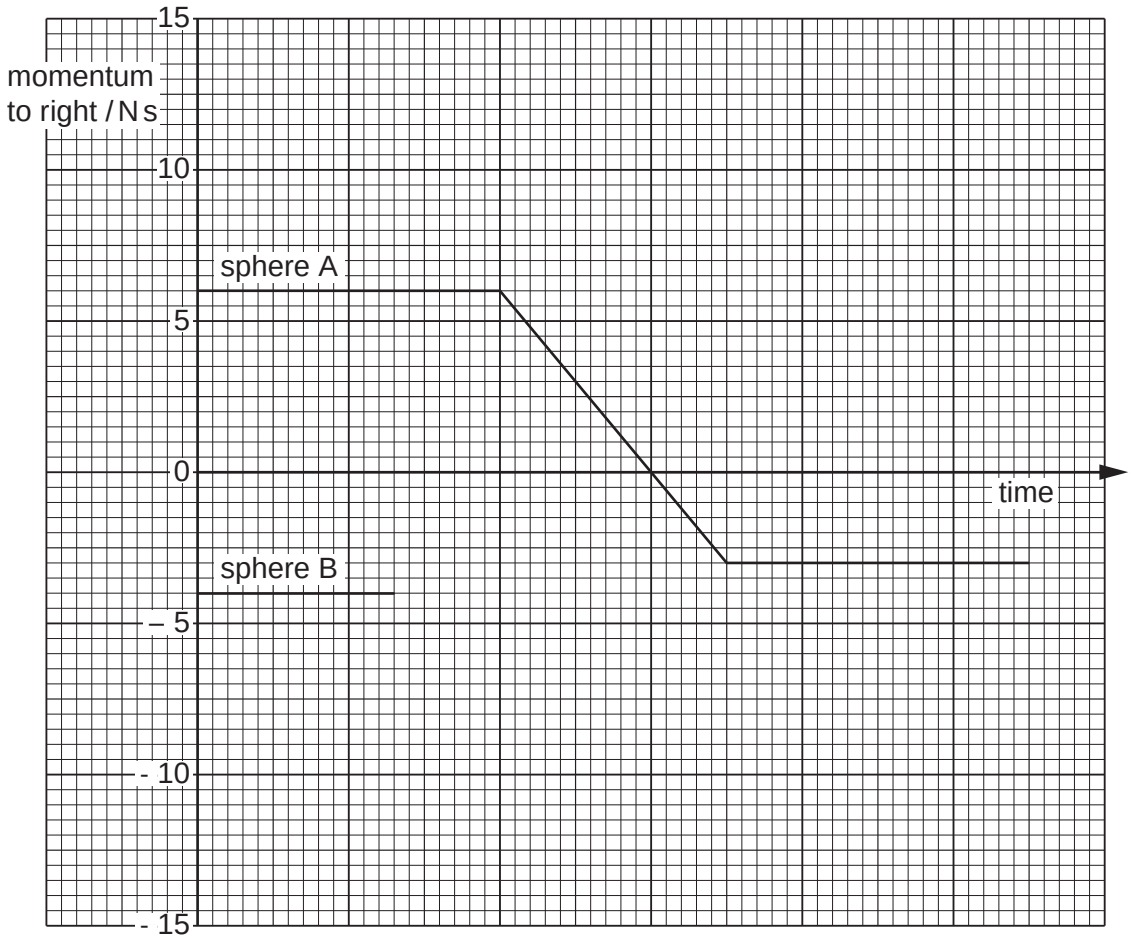

Fig. 3.2

The momentum of sphere B before the collision is also shown on Fig. 3.2.

Complete Fig. 3.2 to show the variation with time of the momentum of sphere B during and after the collision with sphere A. [3]

4 A sky-diver jumps from a high-altitude balloon.

(a) Explain briefly why the acceleration of the sky-diver

(i) decreases with time,

.....

.....

..... [2]

(ii) is 9.8 m s^{-2} at the start of the jump.

.....

..... [1]

(b) The variation with time *t* of the vertical speed *v* of the sky-diver is shown in Fig. 2.1.

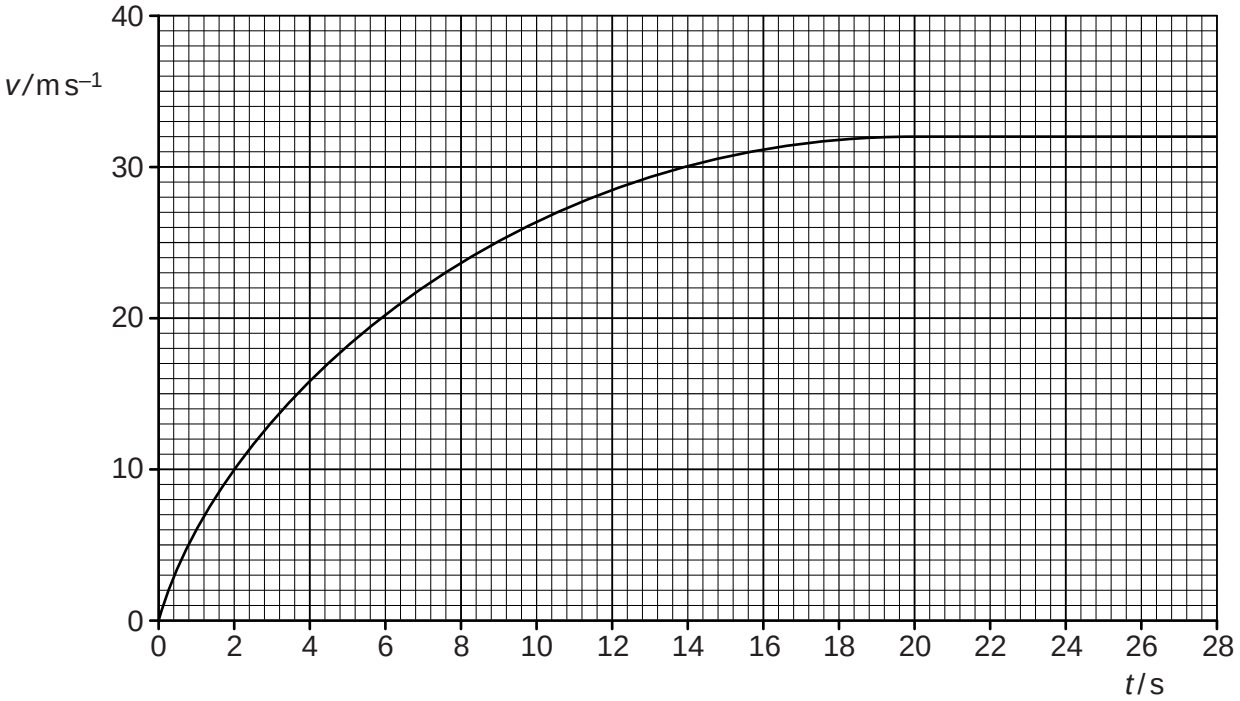

Fig. 2.1

Use Fig. 2.1 to determine the magnitude of the acceleration of the sky-diver at time $t = 6.0\,s$.

acceleration = ... $m\,s^{-2}$ [3]

(c) The sky-diver and his equipment have a total mass of 90 kg.

(i) Calculate, for the sky-diver and his equipment,

1. the total weight,

weight = ... N [1]

2. the accelerating force at time $t = 6.0\,s$.

force = ... N [1]

(ii) Use your answers in **(i)** to determine the total resistive force acting on the sky-diver at time $t = 6.0\,s$.

force = ... N [1]

5 **(a)** Explain what is meant by the *centre of gravity* of a body.

.....

.....

..... [2]

(b) An irregularly-shaped piece of cardboard is hung freely from one point near its edge, as shown in Fig. 2.1.

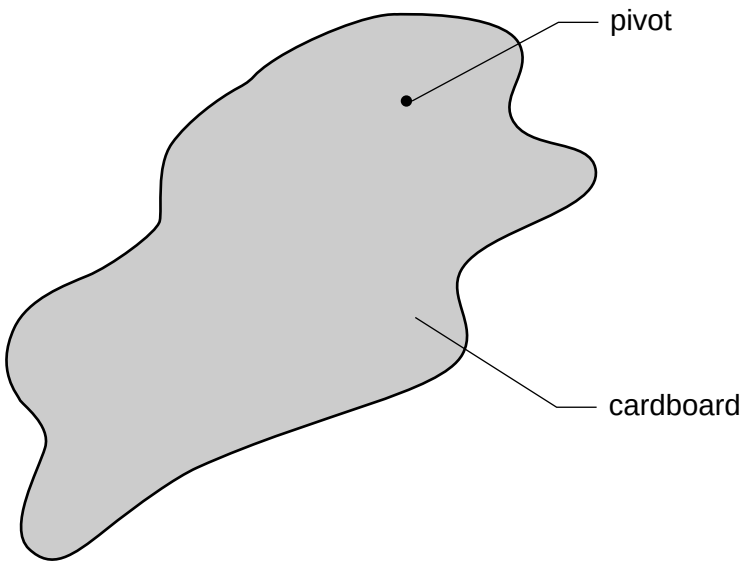

Fig. 2.1

Explain why the cardboard will come to rest with its centre of gravity vertically below the pivot. You may draw on Fig. 2.1 if you wish.

.....

.....

..... [2]

6 A stone on a string is made to travel along a horizontal circular path, as shown in Fig. 3.1.

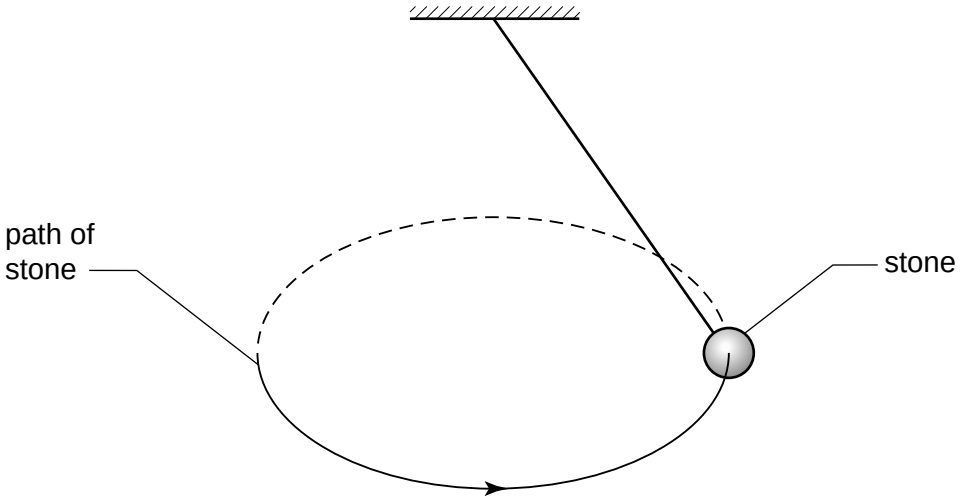

Fig. 3.1

The stone has a constant speed.

(a) Define *acceleration*.

.....

..... [1]

(b) Use your definition to explain whether the stone is accelerating.

.....

.....

..... [2]

(c) The stone has a weight of 5.0 N. When the string makes an angle of 35° to the vertical, the tension in the string is 6.1 N, as illustrated in Fig. 3.2.

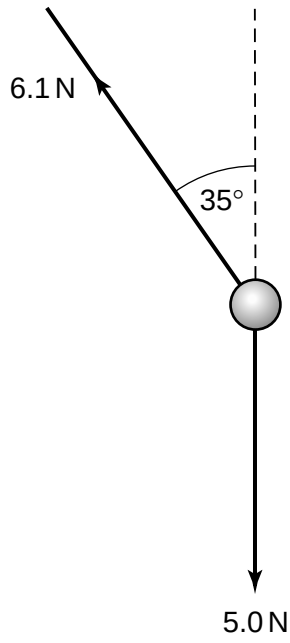

Fig. 3.2

Determine the resultant force acting on the stone in the position shown.

magnitude of force = ... N

direction of force..... [4]

7 **(a)** Distinguish between the mass of a body and its weight.

mass .....

.....

weight .....

..... [3]

(b) State two situations where a body of constant mass may experience a change in its apparent weight.

1. .....

.....

2. .....

..... [2]