1. Nov/2021/Paper_21/No.2

(a) Define *momentum*.

....

.... [1]

(b) Two balls X and Y, of equal diameter but different masses 0.24 kg and 0.12 kg respectively, slide towards each other on a frictionless horizontal surface, as shown in Fig. 2.1.

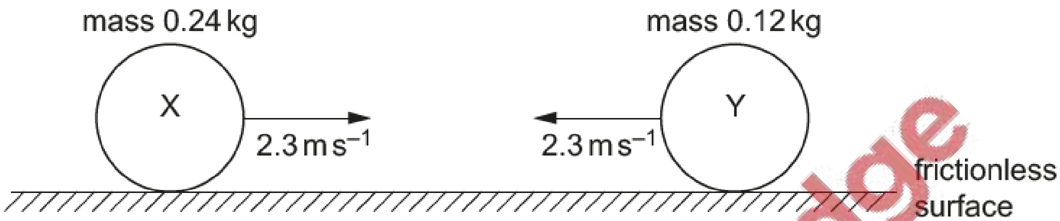

Fig. 2.1

Both balls have initial speed 2.3 m s^{-1} before they collide with each other. Fig. 2.2 shows the variation with time t of the force F_Y exerted on ball Y by ball X during the collision.

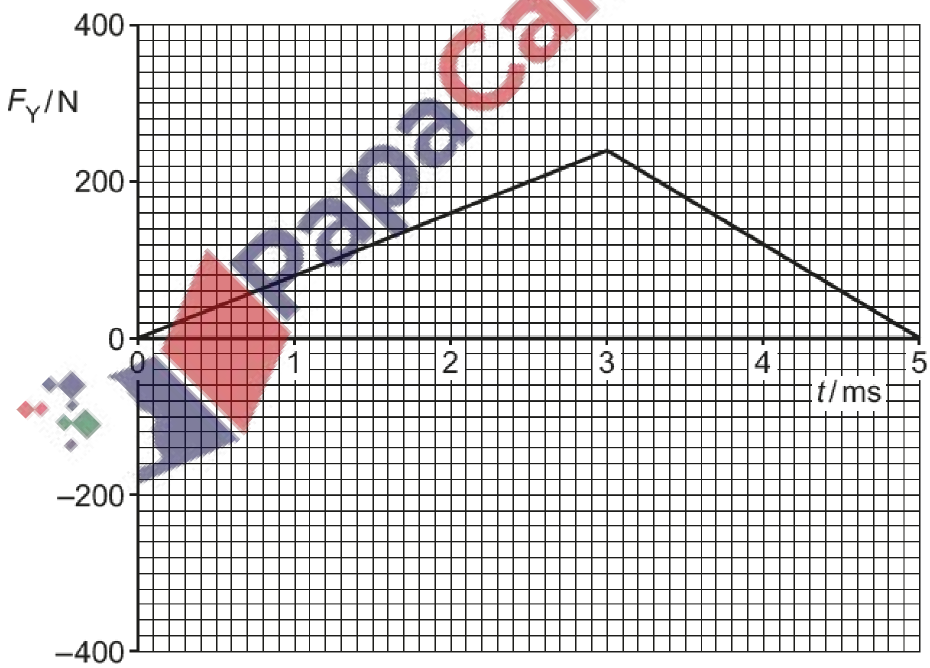

Fig. 2.2

(i) Calculate the kinetic energy of ball X before the collision.

kinetic energy = ... J [3]

(ii) The area enclosed by the lines and the time axis in Fig. 2.2 represents the change in momentum of ball Y during the collision.

Determine the magnitude of the change in momentum of ball Y.

change in momentum = ... N s [2]

(iii) Calculate the magnitude of the velocity of ball Y after the collision.

velocity = ... m s^{-1} [2]

(c) On Fig. 2.3, sketch the variation with time t of the force F_X exerted on ball X by ball Y during the collision in **(b)**.

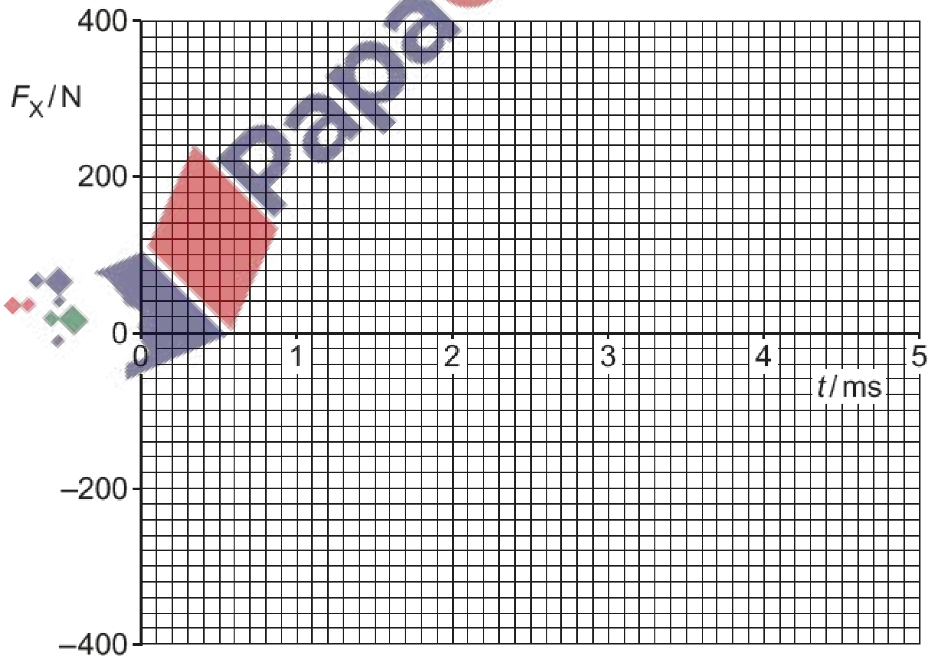

Fig. 2.3

[3]

[Total: 11]

2. Nov/2021/Paper_23/No.3c

(c) The engine of the aircraft in **(b)** stops. The aircraft then glides towards the ground with a constant velocity at an angle θ to the horizontal, as illustrated in Fig. 3.2.

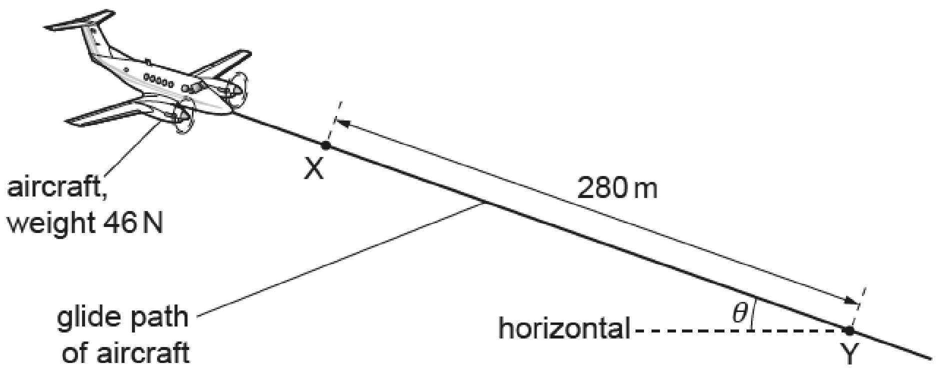

Fig. 3.2 (not to scale)

The aircraft has a weight of 46 N and travels a distance of 280 m from point X to point Y. The change in gravitational potential energy of the aircraft for its movement from X to Y is 6100 J.

Assume that there is now no wind.

(i) Calculate angle θ.

θ = ... ° [3]

(ii) Calculate the magnitude of the force acting on the aircraft due to air resistance.

force = ... N [2]

3. June/2021/Paper_22/No.2

A ball is thrown vertically downwards to the ground, as illustrated in Fig. 2.1.

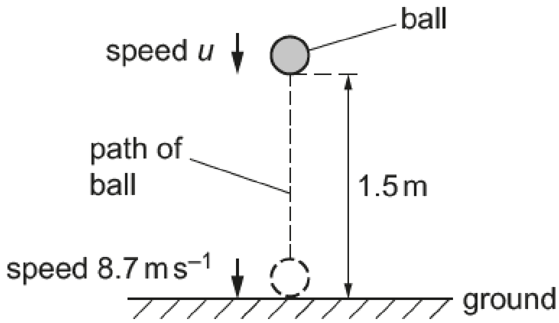

Fig. 2.1

The ball is thrown with speed u from a height of 1.5 m. The ball then hits the ground with speed 8.7 m s^{-1}. Assume that air resistance is negligible.

(a) Calculate speed u.

u = ... m s^{-1} [2]

(b) State how Newton's third law applies to the collision between the ball and the ground.

....

....

....

.... [2]

(c) The ball is in contact with the ground for a time of 0.091 s. The ball rebounds vertically and leaves the ground with speed 5.4 m s^{-1}. The mass of the ball is 0.059 kg.

(i) Calculate the magnitude of the change in momentum of the ball during the collision.

change in momentum = ... N s [2]

(ii) Determine the magnitude of the average resultant force that acts on the ball during the collision.

average resultant force = ... N [1]

(iii) Use your answer in **(c)(ii)** to calculate the magnitude of the average force exerted by the ground on the ball during the collision.

average force = ... N [2]

(d) The ball was thrown downwards at time $t = 0$ and hits the ground at time $t = T$.

On Fig. 2.2, sketch a graph to show the variation of the speed of the ball with time t from $t = 0$ to $t = T$. Numerical values are not required.

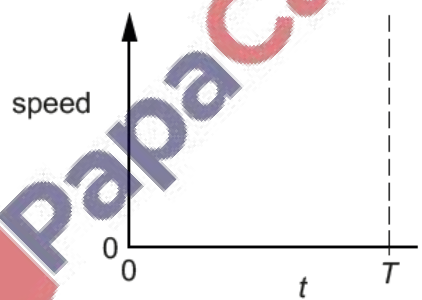

Fig. 2.2

[1]

(e) In practice, air resistance is not negligible.

State and explain the variation, if any, with time t of the gradient of the graph in **(d)** when air resistance is not negligible.

....

....

....

.... [2]

[Total: 12]

4. June/2021/Paper_23/No.2

(a) Define *acceleration*.

....

.... [1]

(b) A stone falls vertically from the top of a cliff. Fig. 2.1 shows the variation with time *t* of the velocity *v* of the stone.

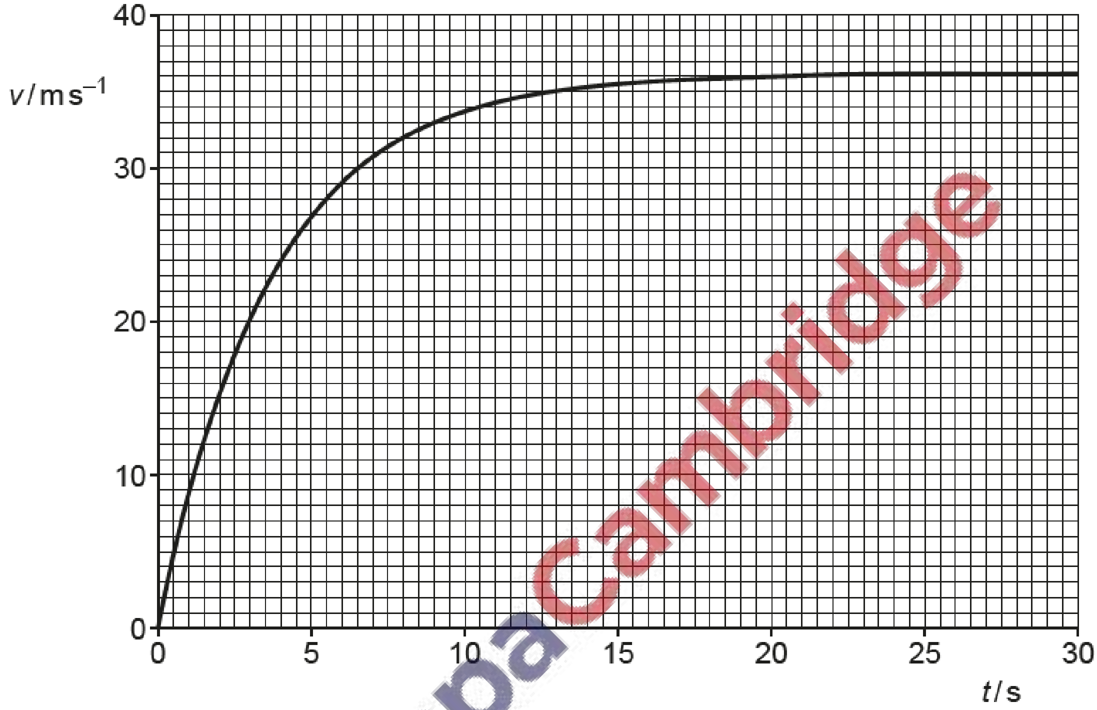

Fig. 2.1

(i) Explain, with reference to forces acting on the stone, the shape of the curve in Fig. 2.1.

....

....

....

....

.... [3]

(ii) Use Fig. 2.1 to determine the speed of the stone when the resultant force on it is zero.

speed = ... $m\,s^{-1}$ [1]

(iii) Use Fig. 2.1 to calculate the approximate height through which the stone falls between $t = 0$ and $t = 30$ s.

height = ... m [3]

(iv) On Fig. 2.2, sketch the variation with t of the acceleration a of the stone between $t = 0$ and $t = 30$ s.

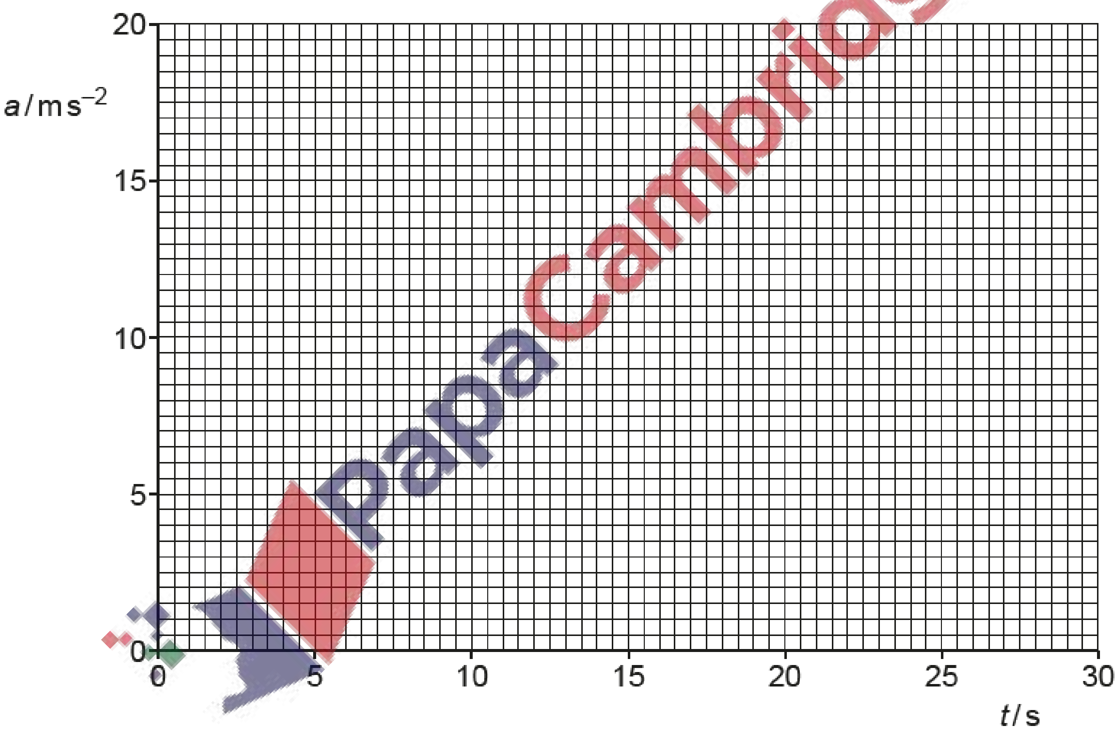

Fig. 2.2

[3]

[Total: 11]