Dynamics

Nov 02

3 A ball falls from rest onto a flat horizontal surface. Fig. 3.1 shows the variation with time *t* of the velocity *v* of the ball as it approaches and rebounds from the surface.

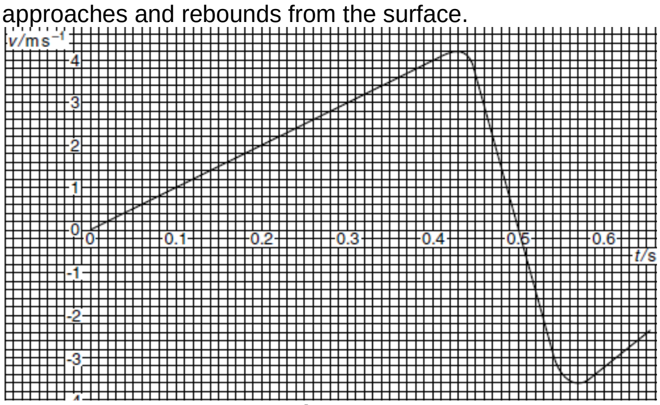

Fig. 3.1

Use data from Fig. 3.1 to determine

(a) the distance travelled by the ball during the first 0.40 s,

distance = …………………………………… m [2]

(b) the change in momentum of the ball, of mass 45 g, during contact of the ball with the surface,

change = ………………………………….. Ns [4]

(c) the average force acting on the ball during contact with the surface. force = ………………… N [2]

Nov 03

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

(b) Slate two situations where a body of constant mass may experience a change in its apparent weight. [2]

May 04

4 A ball has mass *m*. It is dropped onto a horizontal plate as shown in Fig. 4.1.

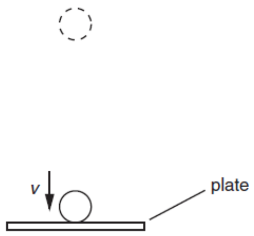

Fig. 4.1

Just as the ball makes contact with the plate, it has velocity *v*, momentum *p* and kinetic energy E_k.

(a) (i) Write down an expression for momentum *p* in terms of *m* and *v*.

(ii) Hence show that the kinetic energy is given by the expression $E_k = p^2/2m$

(b) Just before impact with the plate, the ball of mass 35 g has speed $4.5 ms^{-1}$. It bounces from the plate so that its speed immediately after losing contact with the plate is $3.5 ms^{-1}$. The ball is in contact with the plate for 0.14 s. Calculate, for the time that the ball is in contact with the plate,

(i) the average force, in addition to the weight of the ball, that the plate exerts on the ball,

magnitude of force = ... N direction of force = ...[4]

(ii) the loss in kinetic energy of the ball. loss = ... J [2]

(c) State and explain whether linear momentum is conserved during the bounce. [3]

Nov 04

3 A girl stands at the top of a cliff and throws a ball vertically upwards with a speed of $12 ms^{-1}$, as illustrated in Fig. 3.1.

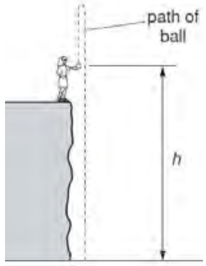

Fig. 3.1

At the time that the girl throws the ball, her hand is a height *h* above the horizontal ground at the base of the cliff.

The variation with time *t* of the speed *v* of the ball is shown in Fig. 3.2.

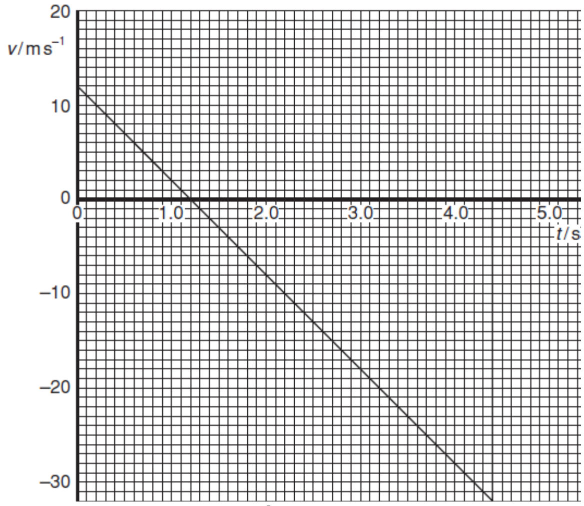

Fig. 3.2

Speeds in the upward direction are shown as being positive. Speeds in the downward direction are negative.

(a) State the feature of Fig. 3.2 that shows that the acceleration is constant. [1]

(b) Use Fig. 3.2 to determine the time at which the ball

(i) reaches maximum height, time = ……………. s

(ii) hits the ground at the base of the cliff.

time = ………………. s [2]

(c) Determine the maximum height above the base of the cliff to which the ball rises. height = ………………… m [3]

(d) The ball has mass 250 g. Calculate the magnitude of the change in momentum of the ball between the time that it leaves the girl's hand to time *t* = 4.0s.

change = …………….. Ns [3]

(e) (i) State the principle of conservation of momentum. [2]

(ii) Comment on your answer to **(d)** by reference to this principle. [3]

May 05

3 A bullet of mass 2.0 g is fired horizontally into a block of wood of mass 600 g. The block is suspended from strings so that it is free to move in a vertical plane.

The bullet buries itself in the block. The block and bullet rise together through a vertical distance of 8.6 cm, as shown in Fig. 3.1.

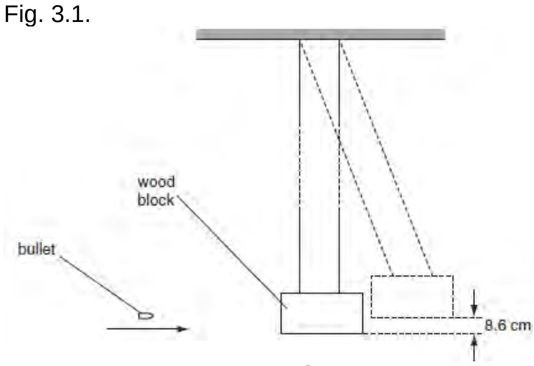

Fig. 3.1

(a) (i) Calculate the change in gravitational potential energy of the block and bullet. change = ... J [2]

(ii) Show that the initial speed of the block and the bullet, after they began to move off together, was $1.3 ms^{-1}$. [1]

(b) Using the information in **(a)(ii)** and the principle of conservation of momentum, determine the speed of the bullet before the impact with the block. speed = ... ms^{-1} [2]

(c) (i) Calculate the kinetic energy of the bullet just before impact. kinetic energy = ... J [2]

(ii) State and explain what can be deduced from your answers to **(c)(i)** and **(a)(i)** about the type of collision between the bullet and the block.[2]

Nov 05

4 A trolley of mass 930 g is held on a horizontal surface by means of two springs, as shown in Fig. 4.1.

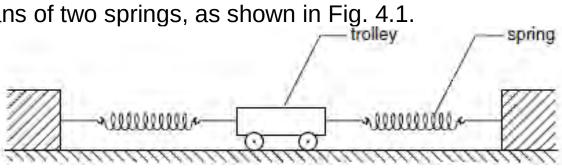

Fig. 4.1

The variation with time *t* of the speed *v* of the trolley for the first 0.60 s of its motion is shown in Fig. 4.2.

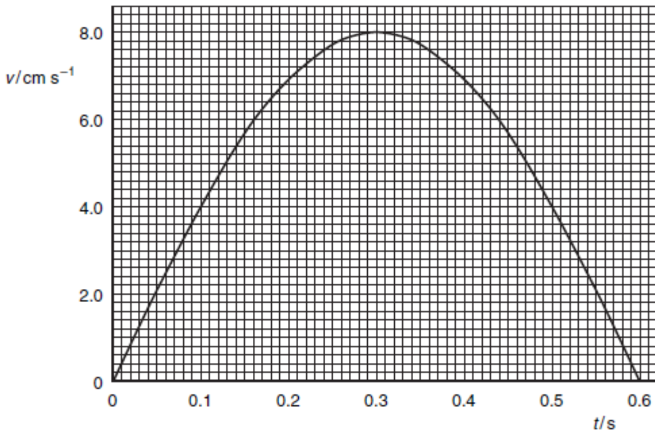

Fig. 4.2

(a) Use Fig. 4.2 to determine

(i) the initial acceleration of the trolley,

acceleration = ……………………….. m s^{-2} [2]

(ii) the distance moved during the first 0.60 s of its motion.

distance = …………………………… m [3]

(b) (i) Use your answer to **(a)(i)** to determine the resultant force acting on the trolley at time $t = 0$.

force = ……………………………. N [2]

(ii) Describe qualitatively the variation with time of the resultant force acting on the trolley during the first 0.60 s of its motion. [3]

Nov 06

3 Francium-208 is radioactive and emits α-particles with a kinetic energy of 1.07×10^{-12} J to form nuclei of astatine, as illustrated in Fig. 3.1.

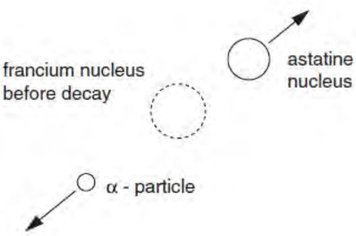

Fig. 3.1

(a) State the nature of an α-particle. [1]

(b) Show that the initial speed of an α-particle after the decay of a francium nucleus is approximately $1.8 \times 10^{7} ms^{-1}$. [2]

(c) (i) State the principle of conservation of linear momentum. [2]

(ii) The Francium-208 nucleus is stationary before the decay. Estimate the speed of the astatine nucleus immediately after the decay. speed = ………………… ms^{-1} [3]

(d) Close examination of the decay of the francium nucleus indicates that the astatine nucleus and the α-particle are not ejected exactly in opposite directions.
Suggest an explanation for this observation. [2]

May 08

2. (b) Given that the strain energy stored in the spring is 0.49J for a compression of 3.5 cm. [2]

(b) Two trolleys, of masses 800 g and 2400 g, are free to move on a horizontal table. The spring in **(a)** is placed between the trolleys and the trolleys are tied together using thread so that the compression of the spring is 3.5 cm, as shown in Fig. 2.3.

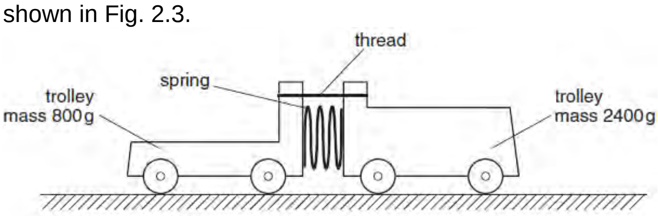

Fig. 2.3

Initially, the trolleys are not moving.
The thread is then cut and the trolleys move apart.

(i) Deduce that the ratio

$$\frac{\text{speed of trolley of mass 800 g}}{\text{speed of trolley of mass 2400 g}}$$

is equal to 3.0. [2]

(ii) Use the answers in **(a)(ii)** and **(b)(i)** to calculate the speed of the trolley of mass 800 g. speed = ... m s^{-1} [3]

May 09

2 A ball B of mass 1.2 kg travelling at constant velocity collides head-on with a stationary ball S of mass 3.6 kg, as shown in Fig. 2.1.

Fig. 2.1

Frictional forces are negligible. The variation with time *t* of the velocity *v* of ball B before, during and after colliding with ball S is shown in Fig. 2.2.

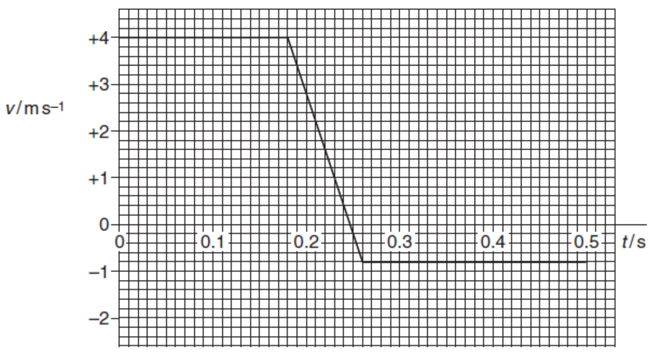

Fig. 2.2

(a) State the significance of positive and negative values for *v* in Fig. 2.2. [1]

(b) Use Fig. 2.2 to determine, for ball B during the collision with ball S,

(i) the change in momentum of ball B,

change in momentum = ... N s [3]

(ii) the magnitude of the force acting on ball B.

force = ... N [3]

(c) Calculate the speed of ball S after the collision.

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

(d) Using your answer in **(c)** and information from Fig. 2.2, deduce quantitatively whether the collision is elastic or inelastic. [2]