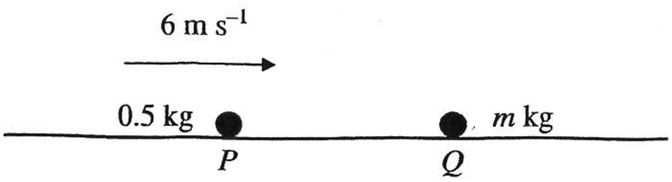
Momentum (Ch 8)

1



Jan '09

A particle P of mass 0.5 kg is travelling with speed $6\,\text{m s}^{-1}$ on a smooth horizontal plane towards a stationary particle Q of mass m kg (see diagram). The particles collide, and immediately after the collision P has speed $0.8\,\text{m s}^{-1}$ and Q has speed $4\,\text{m s}^{-1}$.

(i) Given that both particles are moving in the same direction after the collision, calculate m. **[3]**

(ii) Given instead that the particles are moving in opposite directions after the collision, calculate m. **[3]**

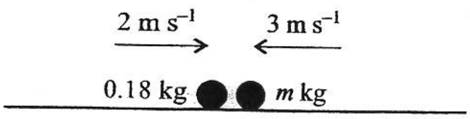
1 Each of two wagons has an unloaded mass of 1200 kg. One of the wagons carries a load of mass m kg and the other wagon is unloaded. The wagons are moving towards each other on the same rails, each with speed $3\,\text{m s}^{-1}$, when they collide. Immediately after the collision the loaded wagon is at rest and the speed of the unloaded wagon is $5\,\text{m s}^{-1}$. Find the value of m. [5]

Jun '06

2 An ice skater of mass 40 kg is moving in a straight line with speed $4\,\text{m s}^{-1}$ when she collides with a skater of mass 60 kg moving in the opposite direction along the same straight line with speed $3\,\text{m s}^{-1}$. After the collision the skaters move together with a common speed in the same straight line. Calculate their common speed, and state their direction of motion. [5]

Jan '08

4



Jun '07

Two particles of masses 0.18 kg and m kg move on a smooth horizontal plane. They are moving towards each other in the same straight line when they collide. Immediately before the impact the speeds of the particles are $2\,\text{m s}^{-1}$ and $3\,\text{m s}^{-1}$ respectively (see diagram).

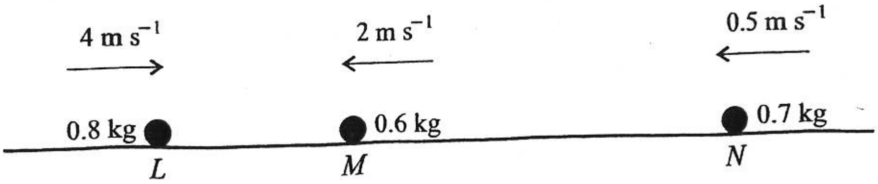
(i) Given that the particles are brought to rest by the impact, find m. [3]

(ii) Given instead that the particles move with equal speeds of $1.5\,\text{m s}^{-1}$ after the impact, find

(a) the value of m, assuming that the particles move in opposite directions after the impact, [3]

(b) the two possible values of m, assuming that the particles coalesce. [4]

4



Jan '07

Three uniform spheres L, M and N have masses 0.8 kg, 0.6 kg and 0.7 kg respectively. The spheres are moving in a straight line on a smooth horizontal table, with M between L and N. The sphere L is moving towards M with speed 4 m s^{-1} and the spheres M and N are moving towards L with speeds 2 m s^{-1} and 0.5 m s^{-1} respectively (see diagram).

(i) L collides with M. As a result of this collision the direction of motion of M is reversed, and its speed remains 2 m s^{-1}. Find the speed of L after the collision. [4]

(ii) M then collides with N.

(a) Find the total momentum of M and N in the direction of M's motion before this collision takes place, and deduce that the direction of motion of N is reversed as a result of this collision. [4]

(b) Given that M is at rest immediately after this collision, find the speed of N immediately after this collision. [2]

5 (i)

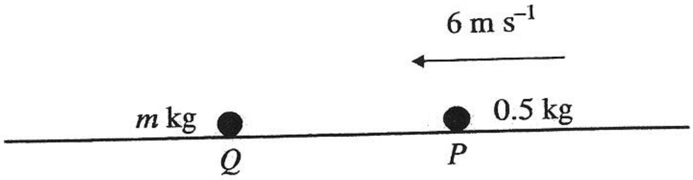


Fig. 1

Jun '09

A particle P of mass 0.5 kg is projected with speed 6 m s^{-1} on a smooth horizontal surface towards a stationary particle Q of mass m kg (see Fig. 1). After the particles collide, P has speed v m s^{-1} in its original direction of motion, and Q has speed 1 m s^{-1} more than P. Show that $v(m + 0.5) = -m + 3$. [3]

(ii)

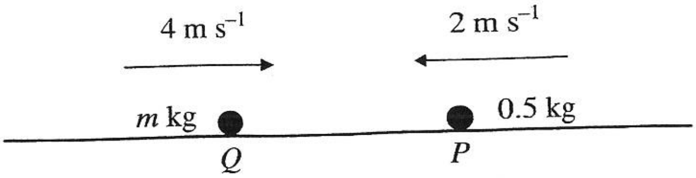


Fig. 2

Q and P are now projected towards each other with speeds 4 m s^{-1} and 2 m s^{-1} respectively (see Fig. 2). Immediately after the collision the speed of Q is v m s^{-1} with its direction of motion unchanged and P has speed 1 m s^{-1} more than Q. Find another relationship between m and v in the form $v(m + 0.5) = am + b$, where a and b are constants. [4]

(iii) By solving these two simultaneous equations show that $m = 0.9$, and hence find v. [4]

5 A railway wagon A of mass 2400 kg and moving with speed 5 m s^{-1} collides with railway wagon B which has mass 3600 kg and is moving towards A with speed 3 m s^{-1}. Immediately after the collision the speeds of A and B are equal.

Jun '08

(i) Given that the two wagons are moving in the same direction after the collision, find their common speed. State which wagon has changed its direction of motion. [5]

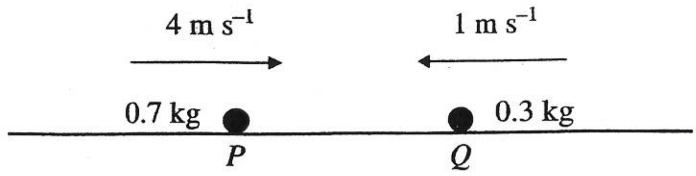
(ii) Given instead that A and B are moving with equal speeds in opposite directions after the collision, calculate

(a) the speed of the wagons,

(b) the change in the momentum of A as a result of the collision.

[5]

7



Jan '09

Two particles P and Q have masses 0.7 kg and 0.3 kg respectively. P and Q are simultaneously projected towards each other in the same straight line on a horizontal surface with initial speeds of 4 m s^{-1} and 1 m s^{-1} respectively (see diagram). Before P and Q collide the only horizontal force acting on each particle is friction and each particle decelerates at 0.4 m s^{-2}. The particles coalesce when they collide.

(i) Given that P and Q collide 2 s after projection, calculate the speed of each particle immediately before the collision, and the speed of the combined particle immediately after the collision. **[6]**

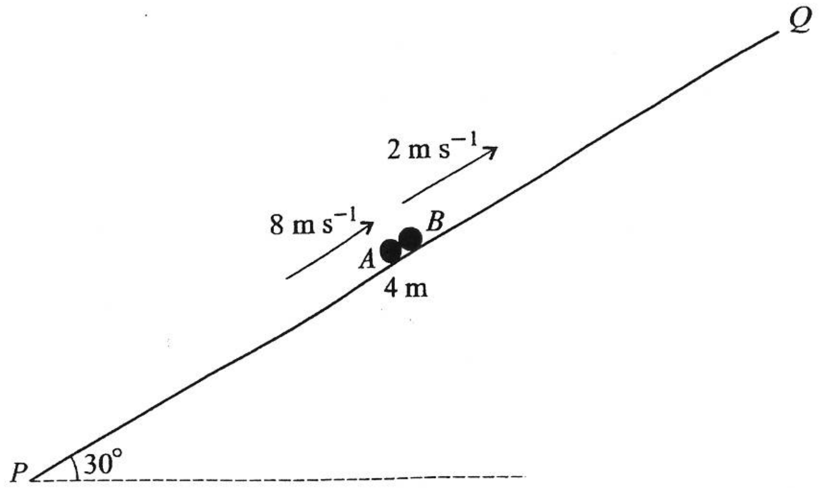
(ii) Given instead that P and Q collide 3 s after projection,

(a) sketch on a single diagram the (t, v) graphs for the two particles in the interval $0 \leqslant t < 3$, **[3]**

(b) calculate the distance between the two particles at the instant when they are projected. **[6]**

7

Jan '06



PQ is a line of greatest slope, of length 4 m, on a smooth plane inclined at 30° to the horizontal. Particles A and B, of masses 0.15 kg and 0.5 kg respectively, move along PQ with A below B. The particles are both moving upwards, A with speed 8 m s^{-1} and B with speed 2 m s^{-1}, when they collide at the mid-point of PQ (see diagram). Particle A is instantaneously at rest immediately after the collision.

(i) Show that B does not reach Q in the subsequent motion. [8]

(ii) Find the time interval between the instant of A's arrival at P and the instant of B's arrival at P. [6]