# Collisions and explosions

1. A ball of mass 0.4 kg moving at 0.10 ms^{-1} collides with a wall as shown in the diagram. The collision is perfectly elastic.
Calculate:
(a) the speed of the ball after collision
(b) the velocity of the ball parallel to the wall after the collision
(c) the velocity of the ball at right angles to the wall after the collision
(d) the change of momentum of the ball parallel to the wall
(e) the change of momentum of the ball at right angles to the wall
(f) the force of the wall on the ball if the ball was in contact with the wall for 0.02 s during the collision
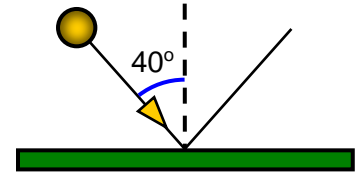
2. A car accelerates steadily from rest under the action of a constant accelerating force.
Draw a graph to show:
(a) how the momentum of the car varies with time
(b) how the kinetic energy of the car varies with time
(Ignore any effects due to air resistance).

3. A ball mass 2 kg moving left to right at 1.5 ms^{-1} collides with a ball of mass 3 kg moving from right to left at 0.2 ms^{-1}. After the collision the 2 kg ball moves from left to right at 1 ms^{-1}.
Calculate:
(a) the change of momentum of the 2 kg ball
(b) the momentum of the 3 kg ball after the collision
(c) the velocity of the 3 kg ball after the collision
(d) the loss of kinetic energy of the 3 kg ball

4. A ball mass 4 kg moving left to right at 3 ms^{-1} collides with a ball of mass 2 kg moving from right to left at 0.8 ms^{-1}. After the collision the 4kg mass moves left to right at 2.8 ms^{-1}.
If the collision is perfectly elastic calculate:
(a) the change of momentum of the 4 kg ball
(b) the momentum of the 2 kg ball after the collision
(c) the velocity of the 2 kg ball after the collision
(d) the loss of kinetic energy of the 4 kg ball

5. A high-energy proton moves in a bubble chamber in a plane at right angles to a uniform magnetic field. No other forces act on the particle.
(a) what is the shape of the track of the proton
(b) how does the kinetic energy of the proton vary along its track
(c) how does the linear momentum of the proton vary along its track

6. A shell explodes and breaks up into two parts, one of mass m moving at a speed v and the other of mass M moving at a speed V.
How is the speed of mass m related to the speed of mass M?

7. A 1 kg ball of plasticene moving at 4 ms^{-1} collides with another ball of mass 2 kg initially at rest. They stick together and move off.
Calculate:
(a) the total momentum of the system before the collision
(b) the velocity of the combined balls after impact
(c) the kinetic energy converted to other forms

8. In the fission of a uranium 235 nucleus a neutron collides with the nucleus causing it to break up. The particles formed are two smaller nuclei and three neutrons. Is the linear momentum of the system conserved during the collision? Explain your answer.

9. A rocket ejects 2 kg of exhaust gases at a velocity of 500 ms^{-1}. If the rocket has a mass of 400 kg estimate the increase in the velocity of the rocket during the first second after ignition.

10. A radium 226 nucleus decays by the emission of an alpha particle into a radon 222 nucleus. If the velocity of the alpha particle is 2x10^6 ms^{-1} what is the recoil velocity of the nucleus?