Chapter 1 Test – FM1 - Momentum and Impulse – www.m4ths.com

(1) Two spheres A of mass $4kg$ and B of mass $2kg$ are at rest on a smooth horizontal table. A is projected towards B with speed $6ms^{-1}$ and collides with B. After the collision B has speed $8ms^{-1}$.
(a) Find the speed and direction of A after the collision.
(b) Find the magnitude of the impulse A exerts on B.

(2) A particle of mass mkg is travelling on a smooth horizontal table and strikes a vertical wall with speed ums^{-1}. The ball rebounds off the wall with speed $10ms^{-1}$. Given that the impulse the ball receives from the wall is $8Ns$, show that $m < \frac{4}{5}$.

(3) (a) A ball of mass $500g$ is dropped vertically from $1m$ onto a horizontal ground and rebounds to a maximum height of $50cm$. Find the magnitude of the impulse the ball receives from the ground.
(b) The ball then strikes the ground for a second time. Without further calculations, state whether the impulse received by the ball from the ground is the same, greater or smaller when the ball strikes the ground for the second time.

(4) (a) Two spheres of equal size are moving towards each other on a smooth horizontal table. Sphere A has mass mkg and speed ums^{-1} and sphere B has mass $2mkg$ and speed $2ums^{-1}$. After they collide which of the following scenarios can happen?

(i) A has speed ums^{-1} but in the opposite direction to its original travel and B is brought to rest.
(ii) A and B coalesce and continue in the direction that A was originally travelling.
(iii) A and B both come to rest in the collision.
(iv) The direction of A changes and the direction of B remains unchanged but they don't coalesce.

(b) Given that the impulse B exerts on A has magnitude $\frac{3}{2}um\ Ns$, find the speed and direction of the two spheres after the collision giving your answers in terms of u.

(5) Particles P and Q both have mass $1kg$ and are connected by a light inextensible string and are at rest on a smooth horizontal plane. Initially the string connecting the two particles is slack. P is then projected away from Q with speed $10ms^{-1}$.
(a) Show that the speed of P is halved when the string becomes taught.
(b) Find the impulse Q receives when the string becomes taught.

(6) A particle of mass $0.5kg$ has initial velocity $(-2\mathrm{i} + 4\mathrm{j})ms^{-1}$ before receiving an impulse of magnitude $\sqrt{2}Ns$. Given that the impulse makes an angle of 45^o with the vector i, find the possible values of the velocity of the particle after it receives the impulse.

(7) An explosive device is lit. The device explodes into two parts with their masses in the ratio $4:1$. The two parts of the device fire off in opposite horizontal directions. Given that the speed of the of the smaller part is $60ms^{-1}$ greater than the larger part, find the speed of each part of the device after the explosion.

(8) (a) Fred wants to place a small flag post in the ground. He strikes the post with $5kg$ hammer with one blow and the hammer remains in contact with the flag as it enters the ground. The hammer hits the flag with speed $20ms^{-1}$. Given that the mass of the flag is $1kg$, find the speed of the flag enters the ground with. *You can assume the flag and hammer can be modelled as particles*.
(b) Given the ground exerts a constant force of $2458.8N$ on the flag post, find how far the tip of the flag will travel into the ground.

(9) Particle C of mass $4kg$ has velocity $(2\mathrm{i} + 6\mathrm{j})ms^{-1}$ and collides with particle D of mass $2kg$ with velocity $(-3\mathrm{i} + \mathrm{j})ms^{-1}$. After the collision C is travelling parallel to the vector j with speed $1ms^{-1}$. Find the angle the velocity of D makes with the vector i after the collision.