Single Mechanics – Impulse

The *Impulse-Momentum Equation* states

$$Ft = mv - mu.$$

Notice the right hand side is the *change in momentum*. The left hand side is called *impulse*. Its units are Newton seconds (Ns) which are equivalent to kgms^{-1}.

Questions often ask for, or give you, the magnitude of the impulse exerted on a particle. The best way to approach problems where this is the case is to define the positive direction in the same direction as the impulse. That way the magnitude of the impulse *is* the impulse.

1. A particle P of mass 3 kg is travelling at a speed of 4 ms^{-1}. A force is exerted on P and it now travels at 7 ms^{-1} in the same direction. Calculate the magnitude of the impulse exerted on P.

   9 Ns

2. A particle P of mass 3 kg is travelling at a speed of 4 ms^{-1}. A force is exerted on P and it now travels at 7 ms^{-1} in the opposite direction. Calculate the magnitude of the impulse exerted on P.

   33 Ns

3. A particle P of mass 7 kg is thrown at a wall. P strikes the wall with speed 8 ms^{-1}. It bounces off the wall with speed 6 ms^{-1}. Find the magnitude of the impulse exerted on P by the wall.

   98 Ns

4. A particle P of mass 2 kg is thrown at a wall. P strikes the wall with speed 20 ms^{-1}. The magnitude of the impulse on P from the wall is 66 Ns. Find the speed with which P bounces off the wall.

   13 ms^{-1}

5. Two particles (A and B) are headed towards each other on a smooth table top. A has mass 10 kg and is travelling at 4 ms^{-1}. B has mass 4 kg and is travelling at 6 ms^{-1}. In the collision the speed of A becomes 1 ms^{-1} with its direction of travel unchanged.

   (a) Find the magnitude of the impulse exerted on A by B. 30 Ns

   (b) Find the speed and direction of B after the collision. $\frac{3}{2}$ ms^{-1} in opposite direction

6. Two particles (P and Q) are headed towards each other on a smooth table top. P has mass 4 kg and is travelling at 6 ms^{-1}. Q has mass 6 kg and is travelling at 5 ms^{-1}. In the collision, the magnitude of the impulse exerted on P by Q is 36 Ns.

   (a) Find the speed and direction of P after the collision. 3 ms^{-1} in opposite direction

   (b) Find the speed and direction of Q after the collision. 1 ms^{-1} in opposite direction

7. Two particles of equal mass m kg are projected at each other. One has speed u ms^{-1} and one has speed ku ms^{-1}, where $k > 1$ is a constant. In the collision the two particles coalesce.

   (a) Find an expression for the speed of the combined particle after the collision. $\frac{u(k-1)}{2}$

   (b) Find an expression for the magnitude of the impulse of one particle on the other. $\frac{mu(k+1)}{2}$