Impulse and Momentum – 2021/20 GCE AS Mechanics Further Mathematics A

1. Nov/2021/Paper_Y533/01/No.3

A particle A of mass 0.5 kg is moving with a speed of $3.15\,\text{ms}^{-1}$ on a smooth horizontal surface when it collides directly with a particle B of mass 0.8 kg which is at rest on the surface. The velocities of A and B immediately after the collision are denoted by $v_A\,\text{ms}^{-1}$ and $v_B\,\text{ms}^{-1}$ respectively. You are given that $v_B = 2v_A$.

(a) Find the values of v_A and v_B. **[3]**

(b) Find the coefficient of restitution between A and B. **[2]**

(c) Explain why the coefficient of restitution is a dimensionless quantity. **[1]**

(d) Calculate the total loss of kinetic energy as a result of the collision. **[3]**

(e) State, giving a reason, whether or not the collision is perfectly elastic. **[1]**

(f) Calculate the impulse that B exerts on A in the collision. **[3]**

2. Nov/2020/Paper_Y533/01/No.2

A particle P of mass 4.5 kg is moving in a straight line on a smooth horizontal surface at a speed of $2.4\,\text{m s}^{-1}$ when it strikes a vertical wall directly. It rebounds at a speed of $1.6\,\text{m s}^{-1}$.

(a) Find the coefficient of restitution between P and the wall. **[1]**

(b) Determine the impulse applied to P by the wall, stating its direction. **[3]**

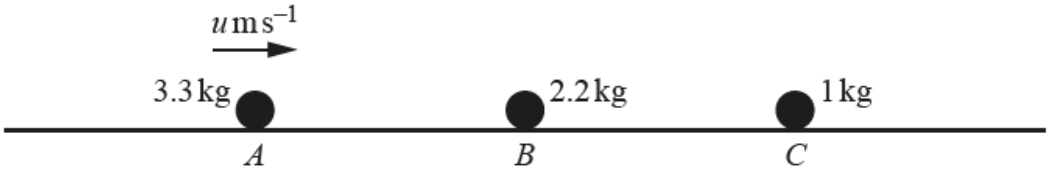
(c) Find the loss of kinetic energy of P as a result of the collision. **[2]**

(d) State, with a reason, whether the collision is perfectly elastic. **[1]**

3. Nov/2020/Paper_Y533/01/No.6

Three particles A, B and C are free to move in the same straight line on a large smooth horizontal surface. Their masses are 3.3 kg, 2.2 kg and 1 kg respectively. The coefficient of restitution in collisions between any two of them is e.

Initially, B and C are at rest and A is moving towards B with speed $u\,\text{m s}^{-1}$ (see diagram). A collides directly with B and B then goes on to collide directly with C.



(a) The velocities of A and B immediately after the first collision are denoted by $v_A\,\text{m s}^{-1}$ and $v_B\,\text{m s}^{-1}$ respectively.

- Show that $v_A = \dfrac{u(3-2e)}{5}$.
- Find an expression for v_B in terms of u and e. **[4]**

(b) Find an expression in terms of u and e for the velocity of B immediately after its collision with C. **[4]**

After the collision between B and C there is a further collision between A and B.

(c) Determine the range of possible values of e. **[4]**