MOMENTUM AND IMPULSE

1. Two particles A and B of mass 2kg and 3kg respectively are moving in a straight line on a smooth table. A has a speed of $3ms^{-1}$ and B has a speed of $1ms^{-1}$. The particles collide and coalesce.

Find the speed of the combined particle if A and B are originally moving

a) in the same direction

[4]

b) in opposite directions.

[3]

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2. Two particles A and B of mass m kg and 2m kg respectively are on a smooth table. A moves with a speed of $4ms^{-1}$ directly towards B, which is at rest. As a result of the collision, A is brought to rest.

Find the speed of B immediately after the collision.

[4]

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3. A gun of mass 6kg fires a bullet of mass 30 grammes horizontally with speed 400 ms^{-1}.

Find the horizontal speed of recoil of the gun.

[6]

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4. Particle A of mass 6kg is moving with speed $5ms^{-1}$. It collides with particle B of mass 4kg which is moving in the same line and same direction with speed $3ms^{-1}$. A is bought to rest by the impact.

a) Find the speed of B after the collision.

[5]

b) After this collision, B goes on with constant speed to collide directly with a particle C of mass 2kg which is at rest. Given that the speeds of B and C after this collision differ by $3ms^{-1}$, find the speed of each.

[5]

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5. A sphere of mass m kg collides directly with a sphere of the same radius and of mass Mkg. Before the collision, both spheres were moving with speed u ms^{-1} in the same line but in opposite directions.The two spheres coalesce in the collision and move in the direction of the original motion of the sphere of mass m.

Given that their speed is $\frac{u}{2}$, find the ratio m:M.

[5]

MOMENTUM AND IMPULSE

6. A particle P of mass 10kg is moving in a straight line under the action of a constant force **F** newtons. At time t = 0, its velocity is $(3\mathbf{i} + 2\mathbf{j})$ ms^{-1} and at time t = 6, its velocity is $(33\mathbf{i} - 22\mathbf{j})$ ms^{-1}.

a) Find **F**.

[4]

The particle P then collides with a stationery identical particle Q. The two coalesce.

b) Find the speed of the combined particle after impact.

[5]

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7. Two particles A and B of masses 3kg and 5kg respectively are joined together by a light inelastic string. Initially the string is slack and both particles are at rest on a smooth horizontal table. B is projected away from A with a speed of $4ms^{-1}$.

Find the common speed of A and B and the impulsive tension when the string becomes taut.

[7]

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8. Charlotte is playing with her Thomas the Tank Engine train set. She pushes the carriage Annabel so that it moves along the track and couples automatically to the engine Thomas. The mass of Annabel is m kg and the mass of Thomas is 3m kg. The speed of Annabel when it collides with Thomas is 0.5 ms^{-1}. Find :

a) the speed at which Thomas and Annabel move along the track

[3]

b) the impulsive force that Annabel exerts on Thomas

[3]

c) the loss of kinetic energy due to the impact.

[5]

d) State a modelling assumption you have made about Thomas and Annabel in your calculations

[1]

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9. A sphere of mass 4kg which has a velocity of $3\mathbf{i} - 2\mathbf{j}$ ms^{-1} collides with a sphere B of the same radius, but mass 7kg, which is moving with velocity $3\mathbf{i} + 2\mathbf{j}$ ms^{-1}. As a result of the collision, A is brought to rest.

a) Find the velocity of B after the impact

[6]

b) State an assumption you have made in your mathematical modelling

[1]

MOMENTUM AND IMPULSE

10. A snooker player hits the stationery cue ball with her cue with an impulsive force of J Ns. The ball moves across the smooth table to hit the green ball directly. As a result of the collision between the cue ball and the green ball, the green ball moves off with a speed of V ms^{-1}.

If both balls are of mass m, find in terms of J, m and V:

a) the speed of the cue ball
i) immediately before

[3]

ii) immediately after it hits the green ball.

[5]

b) Show that the kinetic energy lost as a result of the collision is $Jv - mv^2$.

[7]

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11. Anil is playing with his toy tool set. He is hammering a peg into a hole in a horizontal bench. The peg has a mass of 0.05kg and the hammer a mass of 0.15 kg. The hammer hits the peg directly with a speed of 0.6ms^{-1} and does not rebound, so that the hammer and peg move as one body.

a) Show that the common speed of the peg and hammer immediately after impact is 0.45ms^{-1}.

[5]

b) Find the impulse exerted by the hammer on the peg.

[4]

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12. A rocket comprises an upper section A of mass 10kg and a lower section B of mass 5kg. When the rocket is travelling vertically upwards at a speed of 100ms^{-1} the two sections separate. Section A continues to move upward with a speed of 180ms^{-1} and section B falls downwards with gravity as the only force acting on it.

a) Find the magnitude of the impulse that caused the separation.

[3]

The rocket was 5km above the earth when the separation occurred.

b) Find the time taken for section B to fall to the ground (take g = 10 ms^{-2} and give your answer to the nearest second).

[8]

c) Suggest how your mathematical model could be refined.

[1]
