Question 1:

A tennis ball of mass 0.1 kg is hit by a racquet. Immediately before being hit, the ball has velocity $30\mathbf{i}$ ms^{-1}. The racquet exerts an impulse of $(-2\mathbf{i} - 4\mathbf{j})$ N s on the ball. By modelling the ball as a particle, find the velocity of the ball immediately after being hit.

[4]

Question 2:

Two particles A and B, of mass $5m$ kg and $2m$ kg respectively, are moving in opposite directions along the same straight horizontal line. The particles collide directly. Immediately before the collision, the speeds of A and B are 3 ms^{-1} and 4 ms^{-1} respectively. The direction of motion of A is unchanged by the collision. Immediately after the collision, the speed of A is 0.8 ms^{-1}.

(a) Find the speed of B immediately after the collision.

[3]

In the collision, the magnitude of the impulse exerted on A by B is 3.3 Ns.

(b) Find the value of m.

[3]

Question 3:

Particle P has mass 3 kg and particle Q has mass 2 kg. The particles are moving in opposite directions on a smooth horizontal plane when they collide directly. Immediately before the collision, P has speed 3 ms^{-1} and Q has speed 2 ms^{-1}. Immediately after the collision, both particles move in the same direction and the difference in their speeds is 1 ms^{-1}.

(a) Find the speed of each particle after the collision.

[5]

(b) Find the magnitude of the impulse exerted on P by Q.

[3]

Question 4:

Two particles A and B are moving on a smooth horizontal plane. The mass of A is km, where $2 < k < 3$, and the mass of B is m. The particles are moving along the same straight line, but in opposite directions, and they collide directly. Immediately before they collide the speed of A is $2u$ and the speed of B is $4u$. As a result of the collision the speed of A is halved and its direction of motion is reversed.

(a) Find, in terms of k and u, the speed of B immediately after the collision.

[3]

(b) State whether the direction of motion of B changes as a result of the collision, explaining your answer.

[3]

(c) Given that $k = \frac{7}{3}$, find, in terms of m and u, the magnitude of the impulse that A exerts on B in the collision.

[3]

Question 5:

A ball of mass 0.5 kg is moving with velocity $(10\mathbf{i} + 24\mathbf{j})$ ms^{-1} when it is struck by a bat. Immediately after the impact the ball is moving with velocity $20\mathbf{i}$ ms^{-1}.

(a) Find the magnitude of the impulse of the bat on the ball.

[4]

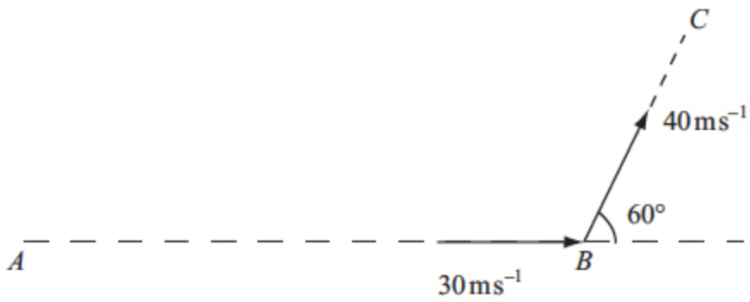
(b) Find the size of the angle between the vector $\mathbf{i}$ and the impulse exerted by the bat on the ball.

[2]

(c) Find the kinetic energy lost by the ball in the impact.

[3]

Question 6:



The points A, B and C lie in a horizontal plane. A batsman strikes a ball of mass 0.25 kg. Immediately before being struck, the ball is moving along the horizontal line AB with speed 30 ms^{-1}. Immediately after being struck, the ball moves along the horizontal line BC with speed 40 ms^{-1}. The line BC makes an angle of 60° with the original direction of motion AB.

(a) Find the magnitude of the impulse given to the ball.

[4]

(b) Find the size of the angle that the direction of this impulse makes with the original direction of motion AB.

[4]

Numerical Answers:

(1) $(10\mathbf{i} - 40\mathbf{j})$ ms^{-1}

(2) (a) 1.5 ms^{-1}
    (b) $m = 0.3$

(3) (a) $v_P = 0.6$ ms^{-1} and $v_Q = 1.6$ ms^{-1}
    (b) 7.2 Ns

(4) (a) $u(3k - 4)$
    (b) Direction of motion is reversed
    (c) $7mu$

(5) (a) 13 Ns
    (b) 67.4°
    (c) 69 J

(6) (a) 9.01 Ns
    (b) 106°