

FM1 – Mechanics Chapter 1

Exam Questions: Momentum and Impulse (Vectors Questions)

Q1.

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

(4)
(Total 4 marks)

Q2.

A particle P of mass 2 kg is moving with velocity $(\mathbf{i} - 4\mathbf{j}) \text{ m s}^{-1}$ when it receives an impulse of $(3\mathbf{i} + 6\mathbf{j}) \text{ N s}$. Find the speed of P immediately after the impulse is applied.

(5)

(Total 5 marks)

Q3.

A particle of mass 0.25 kg is moving with velocity $(3\mathbf{i} + 7\mathbf{j}) \text{ m s}^{-1}$ when it receives the impulse $(5\mathbf{i} - 3\mathbf{j}) \text{ N s}$. Find the speed of the particle immediately after the impulse.

(5)

(Total 5 marks)

Q4.

A particle of mass 0.6kg is moving with constant velocity $(c\mathbf{i} + 2c\mathbf{j})\text{ms}^{-1}$, where c is a positive constant. The particle receives an impulse of magnitude $2\sqrt{10}$ N s.

Immediately after receiving the impulse the particle has velocity $(2c\mathbf{i} - c\mathbf{j})\text{ms}^{-1}$.

Find the value of c .

(6)

(Total for question = 6 marks)

Q5.

A particle P of mass 0.5 kg is moving with velocity $4\mathbf{j} \text{ m s}^{-1}$ when it receives an impulse $\mathbf{I} \text{ N s}$. Immediately after P receives the impulse, the velocity of P is $(2\mathbf{i} + 3\mathbf{j}) \text{ m s}^{-1}$.

Find

(a) the magnitude of $\mathbf{I}$,

(4)

(b) the angle between $\mathbf{I}$ and $\mathbf{j}$.

(2)

(Total for question = 6 marks)

Q6.

A ball of mass 0.4 kg is moving in a horizontal plane when it is struck by a bat. The bat exerts an impulse $(-5\mathbf{i} + 3\mathbf{j})$ N s on the ball. Immediately after receiving the impulse the ball has velocity $(12\mathbf{i} + 15\mathbf{j})$ m s⁻¹.

Find

(a) the speed of the ball immediately before the impact,

(4)

(b) the size of the angle through which the direction of motion of the ball is deflected by the impact.

(3)

(Total 7 marks)

Q7.

A particle P of mass 0.5 kg is moving with velocity $(4\mathbf{i} + 3\mathbf{j}) \text{ m s}^{-1}$ when it receives an impulse $\mathbf{J} \text{ N s}$. Immediately after receiving the impulse, P is moving with velocity $(-\mathbf{i} + 6\mathbf{j}) \text{ m s}^{-1}$.

(a) Find the magnitude of $\mathbf{J}$.

(4)

The angle between the direction of the impulse and the direction of motion of P immediately before receiving the impulse is α°

(b) Find the value of α

(3)

(Total for question = 7 marks)

Q8.

A particle P has mass 0.5 kg . It is moving in the xy plane with velocity $8\mathbf{i} \text{ m s}^{-1}$ when it receives an impulse $\lambda(-\mathbf{i} + \mathbf{j}) \text{ N s}$, where λ is a positive constant.

The angle between the direction of motion of P immediately before receiving the impulse and the direction of motion of P immediately after receiving the impulse is θ°

Immediately after receiving the impulse, P is moving with speed $4\sqrt{10} \text{ m s}^{-1}$

Find (i) the value of λ
(ii) the value of θ

(8)

(Total for question = 8 marks)

Q9.

A ball of mass 0.5 kg is moving with velocity $12\mathbf{i} \text{ m s}^{-1}$ when it is struck by a bat. The impulse received by the ball is $(-4\mathbf{i} + 7\mathbf{j}) \text{ N s}$. By modelling the ball as a particle, find

(a) the speed of the ball immediately after the impact,

(4)

(b) the angle, in degrees, between the velocity of the ball immediately after the impact and the vector $\mathbf{i}$,

(2)

(Total 6 marks)