

FM1 – Mechanics Chapter 4

Exam Questions: Coefficient of Restitution

Q1.

A particle P of mass $3m$ is moving with speed $2u$ in a straight line on a smooth horizontal plane. The particle P collides directly with a particle Q of mass $4m$ moving on the plane with speed u in the opposite direction to P .

The coefficient of restitution between P and Q is e .

Find in terms of e and u , the speed of Q immediately after the collision.

(Total 6 marks)

Q2.

A particle A of mass m is moving with speed u on a smooth horizontal floor when it collides directly with another particle B , of mass $3m$, which is at rest on the floor.

The coefficient of restitution between the particles is e .

The direction of motion of A is reversed by the collision.

Find, in terms of e and u ,

- (i) the speed of A immediately after the collision,
- (ii) the speed of B immediately after the collision.

(Total 7 marks)

Q3.

Two particles, P , of mass $2m$, and Q , of mass m , are moving along the same straight line on a smooth horizontal plane.

They are moving in opposite directions towards each other and collide. Immediately before the collision the speed of P is $2u$ and the speed of Q is u .

The coefficient of restitution between the particles is e , where $e < 1$.

Find, in terms of u and e ,

- (i) the speed of P immediately after the collision,
- (ii) the speed of Q immediately after the collision.

(Total 7 marks)

Q4.

Three particles P , Q and R lie at rest in a straight line on a smooth horizontal table with Q between P and R .

The particles P , Q and R have masses $2m$, $3m$ and $4m$ respectively.

Particle P is projected towards Q with speed u and collides directly with it.

The coefficient of restitution between each pair of particles is e .

(a) Show that the speed of Q immediately after the collision with P is $\frac{2}{5}(1 + e)u$.

(6)

After the collision between P and Q there is a direct collision between Q and R .

Given that $e = \frac{3}{4}$, find

(b)(i) the speed of Q after this collision,

(ii) the speed of R after this collision.

(6)

Immediately after the collision between Q and R , the rate of increase of the distance between P and R is V .

(c) Find V in terms of u .

(3)

(Total 15 marks)

Q5.

A particle P of mass m is moving in a straight line on a smooth horizontal surface with speed $4u$.

The particle P collides directly with a particle Q of mass $3m$ which is at rest on the surface.

The coefficient of restitution between P and Q is e .

The direction of motion of P is reversed by the collision.

Show that $e > \frac{1}{3}$.

(Total 8 marks)

Q6.

Two particles, P and Q , have masses m and em respectively.

The particles are moving on a smooth horizontal plane in the same direction along the same straight line when they collide directly.

The coefficient of restitution between P and Q is e , where $0 < e < 1$

Immediately before the collision the speed of P is u and the speed of Q is eu .

(a) Show that the speed of Q immediately after the collision is u .

(6)

(b) Show that the direction of motion of P is unchanged by the collision.

(3)

The magnitude of the impulse on Q in the collision is $\frac{2}{9}mu$

(c) Find the possible values of e .

(4)

(Total for question = 13 marks)