FM1 – Mechanics Chapter 4
Exam Questions: Loss of Kinetic Energy

Q1.

Two identical particles, *A* and *B*, lie at rest in a straight line on a smooth horizontal.

The mass of each particle is *m*.

Particle *A* is projected towards *B* with speed *u* and collides directly with *B*.

The coefficient of restitution between each pair of particles is $\frac{2}{3}$.

(a) Find, in terms of *u*,

(i) the speed of *A* after this collision,

(ii) the speed of *B* after this collision.

(7)

(b) Show that the kinetic energy lost in this collision is $\frac{5}{36}mu^2$

(4)

(Total 11 marks)

Q2.

A particle P of mass $2m$ is moving with speed $2u$ in a straight line on a smooth horizontal plane.

A particle Q of mass $3m$ is moving with speed u in the same direction as P.

The particles collide directly. The coefficient of restitution between P and Q is $\frac{1}{2}$.

(a) Show that the speed of Q immediately after the collision is $\frac{8}{5}u$.

(5)

(b) Find the total kinetic energy lost in the collision.

(5)

(Total 10 marks)

Q3.

A particle A of mass $4m$ is moving with speed $3u$ in a straight line on a smooth horizontal table.

The particle A collides directly with a particle B of mass $3m$ moving with speed $2u$ in the same direction as A.

The coefficient of restitution between A and B is e.

Immediately after the collision the speed of B is $4eu$.

(a) Show that $e = \frac{3}{4}$.

(5)

(b) Find the total kinetic energy lost in the collision.

(4)

(Total 9 marks)

Q4.

A particle P of mass $2m$ is moving in a straight line with speed $3u$ on a smooth horizontal table.

A second particle Q of mass $3m$ is moving in the opposite direction to P along the same straight line with speed u.

The particle P collides directly with Q.

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

The coefficient of restitution between P and Q is e.

(a) Given that the speed of Q immediately after the collision is $\frac{1}{5}(8e + 3)$, find the range of possible values of e.

(4)

The total kinetic energy of the particles before the collision is T.

The total kinetic energy of the particles after the collision is kT. Given that $e = \frac{1}{2}$

(b) find the value of k.

(4)

(Total 8 marks)

Q5.

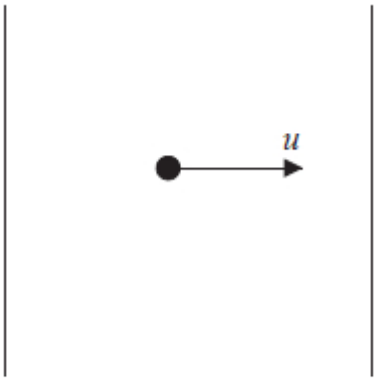

Figure 2

A particle of mass em is at rest on a smooth horizontal plane between two smooth fixed parallel vertical walls, as shown in the plan view in Figure 2.

The particle is projected along the plane with speed u towards one of the walls and strikes the wall at right angles.

The coefficient of restitution between the particle and each wall is e and air resistance is modelled as being negligible.

Using the model,

(a) find, in terms of m, u and e, an expression for the total loss in the kinetic energy of the particle as a result of the first two impacts.

(3)

Given that e can vary such that $0 < e < 1$ and using the model,

(b) find the value of e for which the total loss in the kinetic energy of the particle as a result of the first two impacts is a maximum,

(4)

(c) describe the subsequent motion of the particle.

(2)

(Total for question = 9 marks)

Q6.

Two particles, A and B, are moving in opposite directions along the same straight line on a smooth horizontal surface when they collide directly.

Particle A has mass $5m$ and particle B has mass $3m$.

The coefficient of restitution between A and B is e, where $e > 0$

Immediately **after** the collision the speed of A is v and the speed of B is $2v$.

Given that A and B are moving in the same direction after the collision,

(a) find the set of possible values of e.

(8)

Given also that the kinetic energy of A immediately after the collision is 16% of the kinetic energy of A immediately before the collision,

(b) find the value of e,

(3)

(Total for question = 14 marks)