Bronze

Question 1

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)

Question 2

A particle P of mass m is moving in a straight line on a smooth horizontal table. Another particle Q of mass km is at rest on the table. The particle P collides directly with Q. The direction of motion of P is reversed by the collision. After the collision, the speed of P is v and the speed of Q is $3v$. The coefficient of restitution between P and Q is $\frac{1}{2}$.

(a) Find, in terms of v only, the speed of P before the collision.

(3)

(b) Find the value of k.

(3)

After being struck by P, the particle Q collides directly with a particle R of mass $11m$ which is at rest on the table. After this second collision, Q and R have the same speed and are moving in opposite directions. Show that

(c) the coefficient of restitution between Q and R is $\frac{3}{4}$,

(4)

(d) there will be a further collision between P and Q.

(2)
(Total 12 marks)

Silver

Question 1

Two smooth spheres of equal radius, A and B, of mass 3 kg and m kg respectively, are moving in the same direction, along a straight line on a smooth horizontal plane.

The spheres collide and the magnitude of impulse exerted on B by A is 15 Ns.

Before the collision, the respective speeds of A and B are 8 ms^{-1} and 2 ms^{-1}.

After the collision B is moving with speed 2 ms^{-1} **relative** to A.

Determine the value of m and the speed of B, after the collision. **(7)**

Question 2

A small ball A of mass $3m$ is moving with speed u in a straight line on a smooth horizontal table. The ball collides directly with another small ball B of mass m moving with speed u towards A along the same straight line. The coefficient of restitution between A and B is $\frac{1}{2}$. The balls have the same radius and can be modelled as particles.

(a) Find

(i) the speed of A immediately after the collision,

(ii) the speed of B immediately after the collision.

(7)

After the collision B hits a smooth vertical wall which is perpendicular to the direction of motion of B. The coefficient of restitution between B and the wall is $\frac{2}{5}$.

(b) Find the speed of B immediately after hitting the wall.

(2)

The first collision between A and B occurred at a distance 4a from the wall. The balls collide again T seconds after the first collision.

(c) Show that $T = \frac{112a}{15u}$.

(6)
(Total 15 marks)

Gold

Question 1

Three small smooth spheres A, B and C, are resting on a straight line, and in that order, on a horizontal surface.

The respective masses of A, B and C, are m, $3m$ and $7m$.

A is project towards B with speed u and a direct collision takes place.

The coefficient of restitution between A and B is 0.5.

The coefficient of restitution between B and C is e.

If there is a second collision between A and B, find the range of possible values of e.

(14)

Question 2

A smooth sphere P of mass m is moving with speed u on a smooth horizontal plane. It collides directly with a smooth sphere Q of mass $4m$ which is initially at rest. The spheres are modelled as particles and the coefficient of restitution between P and Q is e, where $e > 0.25$.

a) Show that the **speed** of P after the collision is $\frac{1}{5}u(4e-1)$ and find a similar expression for the speed of Q. **(7)**

Three smooth spheres A, B and C lie in a straight line in that order on the same smooth horizontal plane. The masses of A and C are $4m$ each, while the mass of B is m. The three spheres are modelled as particles and the coefficient of restitution between any of these spheres is 0.75.

The spheres are initially at rest when B is projected towards C with speed u.

b) Show that after B and C collide, there will be another collision between A and B, and no more collisions between the spheres thereafter. **(9)**