STEP/Collisions: Exercises - Overview (11/6/23)

Q1

Two particles of the same mass are travelling directly towards each other, on a smooth surface. Particle A has a speed which is θ times that of particle B (where $\theta > 0$). The coefficient of restitution between A and B is e.

(i) Find the condition on θ that must apply in order for A to change direction on impact. Also give the condition on e.

(ii) Describe the motion of the particles after they have collided, in the case where $e = 0$.

(iii) Describe the motion of the particles after they have collided, in the case where $e = 1$.

(iv) In the case where $e = \frac{1}{3}$, describe the motion of the particles after they have collided, for the various possible values of θ.

Q2

For two balls colliding directly on a smooth surface, show that kinetic energy is conserved when $e = 1$.

Q3

Particle A of mass m_A is travelling with speed u on a smooth surface and collides with particle B of mass m_B, which is at rest. If the coefficient of restitution between the particles is e, find a condition involving e, m_A & m_B for A to reverse its direction after the collision.

Q4

Particles A and B have the same mass and are travelling on a smooth surface, along the same line and in the same direction, with the speed of A being λ times that of B, where $\lambda > 1$, so that A and B collide. Show that the direction of A is never reversed.

Q5

Ball A of mass m, travelling with speed u on a smooth surface, collides directly with ball B of mass km, which is at rest. The coefficient of restitution between the two balls is e.

(i) With $k = 1$, what condition must apply to e for ball A to be at rest after the collision?

(ii) For a given k, what condition must apply to e for ball A to reverse its direction after the collision?

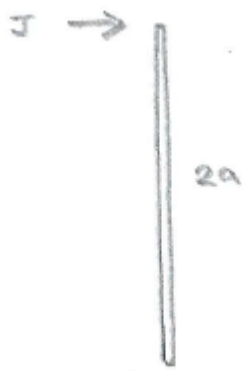
Q6

Ball A of mass m, travelling with speed u on a smooth surface, collides directly with ball B of mass km, which is at rest. The coefficient of restitution between the two balls is e.

Show that the loss of kinetic energy is greatest when $e = 0$.

Q7

An impulse J is applied to one end of a thin, uniform rod of length $2a$ and mass m, as shown below. Describe the resulting motion.



Q8

A snooker ball is hit towards a cushion, with speed v, in such a way that it hits each of the four sides of the table. The coefficient of restitution between the ball and the cushions is e. Investigate the speed and direction of the ball.

Q9

Two balls, A & B, collide directly on a smooth surface. Ball A has mass m, and travels towards ball B, whilst ball B has mass km, and travels away from ball A. Show that the reduction in speed of ball A, after the collision, is equal to k times the increase in speed of ball B.

Q10

Two balls, A & B, collide directly on a smooth surface. Investigate the circumstances in which the loss of kinetic energy is maximised.