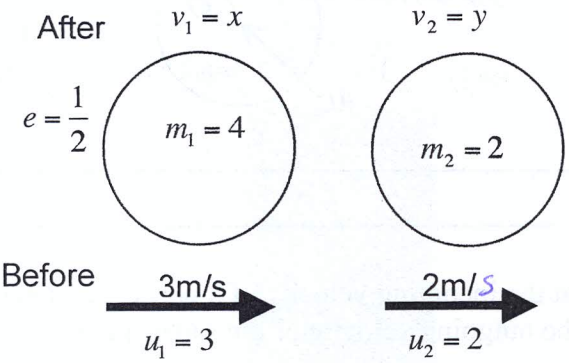
Revision Sheet

Applied Mathematics: Collisions and Impacts

This question is about direct impacts or collisions between a sphere and a barrier (impact) or a sphere and another sphere (collision). At higher level you can also be asked about oblique (at an angle) impacts and collisions.

- *Be able to model the given problem as shown and set up and solve the equations. Separate AFTER and BEFORE information in a table or above and below model.*
- *Be able to find the impulse imparted to each particle and the loss in kinetic energy.*

Modeling



units.
mass = kg
velocity in m/s

Principle of conservation of momentum
If there is no external force in a certain direction, the total momentum of a system in that direction remains unaltered.

$$\text{PCM}: \; m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

Newton's Law of Restitution (NLR) or Newton's Experimental Law (NEL)
If two spheres collide directly, the velocity after impact divided by the velocity before impact is a constant and occurs in the opposite direction.

$$\text{NLR}: \; v_2 - v_1 = -e(u_2 - u_1) \qquad \text{Along the line of centres}$$

$$e = -\left(\frac{\text{relative velocity after collision}}{\text{relative velocity before collision}}\right) \qquad \text{version in log tables}$$

Kinetic Energy
Change (loss) in kinetic energy is total energy after minus total energy before (in Joules).

$$KE = \frac{1}{2}mv^2$$

$$\text{Total kinetic energy before collision} = \frac{1}{2}m_1u_1^{\,2} + \frac{1}{2}m_2u_2^{\,2}$$

$$\text{Total kinetic energy after collision} = \frac{1}{2}m_1v_1^{\,2} + \frac{1}{2}m_2v_2^{\,2}$$

When calculating absolute/total change in KE, just use the component of velocity along the line of centres.
When dividing the absolute change in KE by the original KE of sthe system or body in order to express it as a fraction or percentage, remember to use both components to find the magnitude of the velocity of the original system. If $\vec{v} = v_1\vec{i} + v_2\vec{j}$ then $|\vec{v}| = \sqrt{(v_1)^2 + (v_2)^2}$