Q- Two railroad cars moving on same track towards each other. One of mass 10000 kg with speed 0.3 m/s and the other of mass 15000 kg with speed of 0.1 m/s.

(a) What is the magnitude of their common velocity after they couple together?

(b) How much kinetic energy is lost during collision?

Solution:

a) m_1 = 10000 kg; u_1 = 0.3 m/s; m_2 = 15000 kg; u_2 = - 0.1 m/s;

As after collision the cars couple together, they move with a common velocity v.
As there is no external force on the system in horizontal direction, according to law of conservation of linear momentum we have

Momentum of the system after collision = momentum before collision

Or $(m_1 + m_2)*v = m_1u_1 + m_2u_2$

Gives $v = \frac{m_1u_1 + m_2u_2}{m_1 + m_2} = \frac{10000*0.3 + 15000*(-0.1)}{10000+15000} = \frac{1500}{25000} = 0.06$ m/s

Hence their common velocity after collision will be **0.06 m/s** along the direction of the motion of first car before collision.

(b) The loss in kinetic energy = initial kinetic energy of the system – final kinetic energy

Or $\Delta KE = \frac{1}{2} m_1u_1^2 + \frac{1}{2} m_2u_2^2 - \frac{1}{2}(m_1 + m_2)v^2$

Or $\Delta KE = \frac{1}{2} * 10000 * 0.3^2 + \frac{1}{2} * 15000 * 0.1^2 - \frac{1}{2}(10000 + 15000)0.06^2$

Or $\Delta KE = 450 + 75 - 45 = 480\ J$

Hence the loss in the kinetic energy during collision will be **480 J.**