Answer on Question #42035 – Physics - Mechanics | Kinematics | Dynamics

14. Two clay balls are moving toward each other along a common straight line. The one on the left has mass 3 kg and velocity 4 m/s. The one on the left has mass 2 kg and velocity 9 m/s. The balls collide and form a single ball of mass 5 kg and keep moving. Some kinetic energy is lost as heat in this process. Calculate this lost energy.

Solution:

$m_1 = 3\ \text{kg} - \text{mass of the first ball;}$

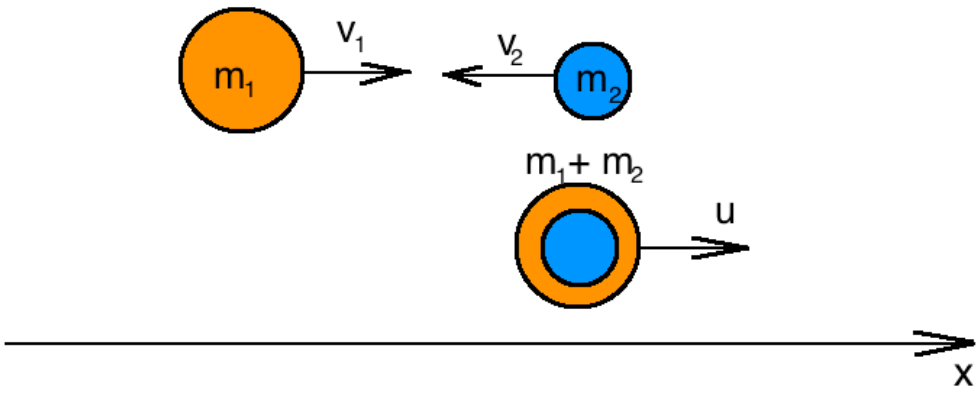
$v_1 = 4\frac{m}{s} - \text{initial velocity of the first ball;}$

$m_2 = 2\ \text{kg} - \text{mass of the second ball;}$

$v_2 = 9\frac{m}{s} - \text{initial velocity of the second ball;}$

$u - \text{velocity of the balls after collision}$

$E_{heat} - \text{lost kinetic energy as heat;}$



Law of momentum conservation along X-axis:

$$m_1v_1 - m_2v_2 = (m_1 + m_2)u$$

$$u = \frac{m_1v_1 - m_2v_2}{m_1 + m_2} \quad (1)$$

Law of energy conservation:

$$E_{initial} = E_{final}$$

$$KE_1 + KE_2 = KE_{1+2} + E_{heat}$$

$$\frac{m_1v_1^2}{2} + \frac{m_2v_2^2}{2} = \frac{(m_1 + m_2)u^2}{2} + E_{heat}$$

$$E_{heat} = \frac{m_1v_1^2 + m_2v_2^2}{2} - \frac{(m_1 + m_2)u^2}{2} \quad (2)$$

$(1)\text{in}(2)$:

$$E_{heat} = \frac{m_1v_1^2 + m_2v_2^2}{2} - \frac{(m_1 + m_2)}{2}\frac{(m_1v_1 - m_2v_2)^2}{(m_1 + m_2)^2} =$$

$$= \frac{(m_1v_1^2 + m_2v_2^2)(m_1 + m_2) - (m_1v_1 - m_2v_2)^2}{2} =$$

$$= \frac{\left(3\text{kg} \cdot \left(4\frac{\text{m}}{\text{s}}\right)^2 + 2\text{kg} \cdot \left(9\frac{\text{m}}{\text{s}}\right)^2\right)(3\text{kg} + 2\text{kg}) - \left(3\text{kg} \cdot 4\frac{\text{m}}{\text{s}} - 2\text{kg} \cdot 9\frac{\text{m}}{\text{s}}\right)^2}{2} = 507\text{J}$$

Answer: lost energy is equal to 507J.