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Mathematics 9709/42

Paper 4 Mechanics May/June 2022

Question No (1)

1 Small smooth spheres A and B, of equal radii and of masses 5 kg and 3 kg respectively, lie on a smooth horizontal plane. Initially B is at rest and A is moving towards B with speed $8.5\,\mathrm{m\,s^{-1}}$. The spheres collide and after the collision A continues to move in the same direction but with a quarter of the speed of B.

(a) Find the speed of B after the collision.

(b) Find the loss of kinetic energy of the system due to the collision.

Solution:

(a)

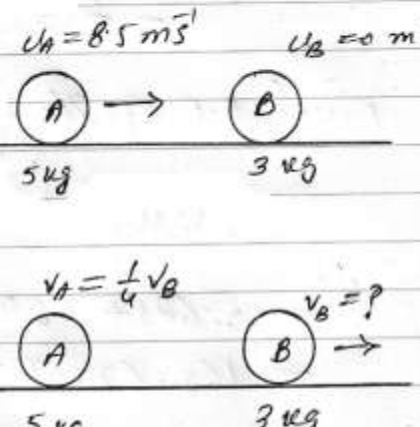
Given data

$m_A = 5$ kg

$m_B = 3$ kg

Before collision, $u_A = 8.5\ ms^{-1}$, $u_B = 0\ ms^{-1}$

After collision $v_A = \frac{1}{4} v_B\ ms^{-1}$, $v_B = ?$



using law of conservation of momentum

$$m_A u_A + m_B u_B = m_A v_A + m_B v_B$$

$$(5)(8.5) + 3(0) = 5\left(\frac{1}{4} v_B\right) + 3 v_B$$

$$42.5 = \frac{5}{4} v_B + 3 v_B$$

$$42.5 = \frac{17}{4} v_B$$

$$v_B = \frac{42.5 \times 4}{17}$$

$$v_B = 10\ ms^{-1}$$

(b) Initial K.E of the system = Initial K.E of A

$= \frac{1}{2}(5)(8.5)^2 = 180.625\ J$

Final K.E of the system = K.E of A + K.E of B

$= \frac{1}{2}(5)\left(\frac{10}{4}\right)^2 + \frac{1}{2}(3)(10)^2$ $\quad \because v_A = \frac{1}{4}v_B$

$= \frac{10}{4} \quad \therefore v_B = 10$

$= 15.625 + 150$

$= 165.625\ J$

Loss of K.E = Initial K.E − Final K.E

$= 180.625 - 165.625$

$\therefore$ Loss of K.E $= 15\ J$