

Answer on Question 64727, Physics, Other

Question:

Car A with a mass of 2000 kg moves at 72 km/h and car B of mass 1250 kg travels at 60 km/h . Both approach each other and car A collides with car B. The cars then remain stuck together after collision. Find their velocity after the collision. Determine if kinetic energy is lost.

Solution:

a) Let's first convert the velocity of the cars from km/h to m/s :

$$v_A = 72 \frac{\text{km}}{\text{h}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 20 \frac{\text{m}}{\text{s}},$$

$$v_B = 60 \frac{\text{km}}{\text{h}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 16.6 \frac{\text{m}}{\text{s}}.$$

Let's assume, that the car A moves in positive x -direction and the car B moves towards car A. Then, we can find their velocity after the collision from the law of conservation of momentum:

$$m_A v_A - m_B v_B = (m_A + m_B) v_f,$$

here, m_A, m_B are the masses of the cars A and B, respectively; v_A, v_B are the velocities of the cars A and B before the collision, v_f is the final velocity of the cars after the collision.

Then, we get:

$$v_f = \frac{m_A v_A - m_B v_B}{(m_A + m_B)} = \frac{2000 \text{ kg} \cdot 20 \frac{\text{m}}{\text{s}} - 1250 \text{ kg} \cdot 16.6 \frac{\text{m}}{\text{s}}}{2000 \text{ kg} + 1250 \text{ kg}} = 5.92 \frac{\text{m}}{\text{s}}.$$

b) Let's first calculate the initial kinetic energy of the cars A and B:

$$KE_A = \frac{1}{2} m_A v_A^2 = \frac{1}{2} \cdot 2000 \text{ kg} \cdot \left(20 \frac{\text{m}}{\text{s}}\right)^2 = 400000 \text{ J},$$

$$KE_B = \frac{1}{2} m_B v_B^2 = \frac{1}{2} \cdot 1250 \text{ kg} \cdot \left(16.6 \frac{\text{m}}{\text{s}}\right)^2 = 206670 \text{ J}.$$

Then, we can calculate the kinetic energy of the cars after the collision:

$$\begin{aligned} KE_{\text{collision}} &= \frac{1}{2} (m_A + m_B) v_f^2 = \frac{1}{2} \cdot (2000 \text{ kg} + 1250 \text{ kg}) \cdot \left(5.92 \frac{\text{m}}{\text{s}}\right)^2 = \\ &= 56950.4 \text{ J}. \end{aligned}$$

Finally, we can determine whether the kinetic energy is lost:

$$\begin{aligned} KE_{\text{loss}} &= KE_{\text{collision}} - (KE_A + KE_B) = 56950.4 \text{ J} - (400000 \text{ J} + 206670 \text{ J}) = \\ &= -549719.6 \text{ J}. \end{aligned}$$

Sign minus means that we have the loss in kinetic energy.

Answer:

a) $v_f = 5.92 \frac{\text{m}}{\text{s}}$.

b) $KE_{\text{loss}} = 549719.6 \text{ J}$.

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