Answer on Question 70724, Physics, Mechanics, Relativity

Question:

1) A toy car of mass 1 kg moves westwards with a speed of 2 ms^{-1}. It collides head-on with a toy train. The train has a mass of 1.5 kg and is moving at a speed of 1.5 ms^{-1} eastwards. If the car rebounds at 2.05 ms^{-1}, calculate the final velocity of the train.

Solution:

Let's first choose the direction to the east as positive. Then, we can find the final velocity of the train from the Law of Conservation of Momentum:

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f},$$

here, m_1 - is the mass of the toy train; m_2 is the mass of the toy car; v_{1i}, v_{2i} are initial velocities of toy train and car, respectively; v_{1f}, v_{2f} are final velocities of toy train and car, respectively.

Then, we get:

$$m_1 v_{1i} - m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f},$$

$$v_{1f} = \frac{m_1 v_{1i} - m_2 v_{2i} - m_2 v_{2f}}{m_1}$$

$$= \frac{1.5\ kg \cdot 1.5\ ms^{-1} - 1\ kg \cdot 2\ ms^{-1} - 1\ kg \cdot 2.05\ ms^{-1}}{1.5\ kg} =$$

$$= -1.2\ ms^{-1}.$$

The sign minus indicates that after the collision the toy train moves to the west.

Answer:

$v_{1f} = 1.2\ ms^{-1}$, to the west.

2) Consider the collision of two cars. Car 1 is at rest and Car 2 is moving at a speed of 2 ms^{-1} to the left. Both cars each have a mass of 500 kg. The cars collide and stick together. What is the resulting velocity of the cars?

Solution:

We can find the resulting velocity of the cars from the Law of Conservation of Momentum:

$$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_{res},$$

here, m_1, m_2 are the masses of two cars; v_{1i} is the initial velocity of the Car 1(it will be equal to zero, since Car 1 is at rest); v_{2i} is the initial velocity of the Car 2 and v_{res} is the resulting velocity of the cars.

Then, we get:

$$m_2 v_{2i} = (m_1 + m_2) v_{res},$$

$$v_{res} = \frac{m_2 v_{2i}}{m_1 + m_2} = \frac{500\ kg \cdot 2\ ms^{-1}}{500\ kg + 500\ kg} = 1\ ms^{-1}.$$

Answer:

$v_{res} = 1\ ms^{-1}$.