Answer on Question #52296, Physics, Other

1. Two carts, one twice the mass of the other, experience the same force for the same time. What is their difference in momentum? What is their difference in kinetic energy?

Solution:

If a force F is applied to a particle for a time interval t, the momentum of the particle changes by an amount

$$p = Ft$$

Change of momentum is independent of body mass.

Thus, *their difference in momentum* is equal **zero**.

The kinetic energy of first cart is

$$K_1 = \frac{p^2}{2m_1} = \frac{p^2}{2 * 2m} = \frac{p^2}{4m}$$

The kinetic energy of second cart is

$$K_2 = \frac{p^2}{2m_2} = \frac{p^2}{2m}$$

Thus, *their difference in kinetic energy* is

$$K_2 - K_1 = \frac{p^2}{2m} - \frac{p^2}{4m} = \frac{p^2}{4m} = \frac{F^2t^2}{4m}$$

2. A 12 g bullet is fired horizontally into a 96 g wooden block initially at rest on a horizontal surface. After impact, the block slides 7.5 m before coming to rest. If the coefficient of kinetic friction between block and surface is 0.60, what was the speed of the bullet immediately before impact?

Solution:

The equation that denotes the conservation of momentum is:

$$m_1 v_i = (m_1 + m_2) v_f$$
$$12 v_i = (12 + 96)\, v_f$$

The equation of motion after impact is

$$(m_1 + m_2) a = F_{friction}$$
$$(m_1 + m_2) a = \mu (m_1 + m_2) g$$

The acceleration is

$$a = \frac{v_f^2}{2d} = \mu g$$

Thus,

$$v_f = \sqrt{2 d \mu g} = \sqrt{2 * 7.5 * 0.60 * 9.8} = 9.39 \frac{\text{m}}{\text{s}}$$

The initial speed is

$$v_i = \frac{(m_1 + m_2) v_f}{m_1} = \frac{(12 + 96) * 9.39}{12} = 84.5 \text{ m/s}$$

Answer: 84.5 m/s

3. A ball bounces upward from the ground with a speed of 14 m/s and hits a wall with a speed of 12 m/s. How high above the ground does the ball hit the wall?

Ignore air resistance.

Solution:

The kinetic equation is

$$h = \frac{v_2^2 - v_1^2}{-2g}$$

Thus,

$$h = \frac{12^2 - 14^2}{-2 * 9.8} = 2.65 \text{ m}$$

Answer: 2.65 m