Momentum and Impulse

Answer Key

Problem 1: How can a Kungfu master split layers of bricks with the use of a bare hand?

Solution: By applying a great impulse to the bricks in a short amount of time, a tremendous amount of force is then produced, splitting the bricks upon impact.

For numbers 2 and 3: A 400-kg car has a speed of 40 m/s.

Problem 2: Find the speed a 650-kg UV express should have to attain the same momentum the car has.

Solution: To calculate for the momentum, we have the formula $p = mv$. To get the momentum of the car,

$$p_{car} = mv$$

$$p_{car} = (400\ kg)\ (40\ m/s)$$

$$p_{car} = 16000\ kg \cdot m/s$$

In this problem, the momentum of the car should be equal to the momentum of the UV express. To find the needed speed of the UV express,

$$p_{car} = p_{UV} = 16000\ kg \cdot m/s$$

$$p_{UV} = mv$$

$$v = p_{UV}/m$$

$$v = 16000\ kg \cdot m/s\ /\ 650\ kg$$

$$\mathbf{v = 24.6\ m/s}$$

Problem 3: Find the speed a 650-kg UV express should have to attain the same kinetic energy the car has.

Solution: To calculate for the kinetic energy, we have the formula $KE = \frac{1}{2}mv^2$. To get the kinetic energy of the car,

$$KE_{car} = \frac{1}{2}mv^2$$

$KE_{car} = \frac{1}{2}(400\ kg)(40\ m/s)^2$

$KE_{car} = 320000\ J$

In this problem, the kinetic energy of the car should be equal to the kinetic energy of the UV express. To find the needed speed of the UV express,

$KE_{car} = KE_{UV} = 320000\ J$

$KE_{UV} = \frac{1}{2}mv^2$

$$v = \sqrt{\frac{2KE}{m}}$$

$$v = \sqrt{\frac{2\,(320000\ J)}{650\ kg}}$$

v = 31.38 m/s

For numbers 4 and 5: You are driving a 300-kg car at a speed of 45 m/s. You were sleepy and did not notice the stop sign immediately, so, unfortunately, you hit the rear end of another car with a mass of 420 kg. The collision caused both the cars to stick together.

Problem 4: Find the final velocity after collision.

Solution: We are given the following quantities:

$m_1 = 300\ kg$

$v_1 = 45\ m/s$

$m_2 = 420\ kg$

$v_2 = 0\ m/s$ (the car is at rest)

We know that in a perfectly inelastic collision, the momentum is described as

$$m_1v_1 + m_2v_2 = (m_1 + m_2)\ v_f$$

To calculate for the v_f,

$$v_f = (m_1v_1 + m_2v_2)/(m_1 + m_2)$$

Substituting the values, we will get

$$v_f = [(300 \text{ kg}) (45 \text{ m/s}) + (420 \text{ kg}) (0 \text{ m/s})]/(300 \text{ kg} + 420 \text{ kg})$$

$$v_f = 13500 \text{ kg} \cdot \text{m/s} / 720 \text{ kg}$$

$$\mathbf{v_f = 18.75 \text{ m/s}}$$

Problem 5: What is the final momentum of the cars?

Solution: We know that in a perfectly inelastic collision, momentum is conserved. Therefore, the momentum before the collision is equal to the momentum after collision. Calculating for the momentum, we have

$$m_1v_1 + m_2v_2 = (m_1 + m_2) v_f$$

$$(300 \text{ kg}) (45 \text{ m/s}) + (420 \text{ kg}) (0 \text{ m/s}) = (300 \text{ kg} + 420 \text{ kg}) (18.75 \text{ m/s})$$

$$13500 \text{ kg} \cdot \text{m/s} = 13500 \text{ kg} \cdot \text{m/s}$$

Hence, the momentum of the cars is **13500 kg · m/s**.