Name: KEY

Physics – Conservation of Momentum: Collisions Practice

Tips:

- Total momentum before = Total momentum after ($p_{Ai} + p_{Bi} = p_{Af} + p_{Bf}$)
- Momentum is a vector; be sure you give each term the correct sign
- If the two objects stick together, they have the same final velocity

1) Two freight cars, each with a mass of 3.0 x 10^5 kg, collide. One was initially moving to the right at 2.2 m/s; the other was at rest. They stick together. What is their final velocity (magnitude and direction)?

MOMENTUM BEFORE = MOMENTUM AFTER

$$(3.0\times10^5\,kg)(+2.2\,m/s) + \emptyset = (3\times10^5\,kg + 3\times10^5\,kg)\vec{v}$$

$$\boxed{+1.1\,m/s = \vec{v}}$$

2) A 0.105-kg hockey puck moving at +24 m/s is caught and held by a 75-kg goalie initially at rest. If the surface is frictionless, what is the velocity of the goalie and puck after the collision?

$$\vec{p}_{puck_i} + \emptyset = \vec{p}_{goalie+puck\ f}$$

$$(0.105\,kg)(+24\,m/s) = (75\,kg + 0.105\,kg)\vec{v}$$

$$\boxed{+0.0336\,m/s = \vec{v}}$$

3) A 35.0-g (0.035 kg) bullet strikes a 5.00-kg stationary wooden block sitting on a frictionless surface. The bullet embeds itself in the block. The block and bullet slide off together at +8.6 m/s. What was the original velocity of the bullet?

$$p_{bullet_i} + \emptyset = p_{bullet+block\ f}$$

$$(0.035\,kg)(\vec{v}_i) = (5.035\,kg)(+8.6\,m/s)$$

$$\boxed{\vec{v}_i = 1240\,m/s}$$

4) Glider A (m = 0.355 kg) moves along a frictionless air track with a velocity of +0.095 m/s. It collides with glider B (m = 0.710 kg), which has a velocity of +0.045 m/s. After the collision glider A is moving at +0.035 m/s. What is the velocity of glider B after the collision?

$$\vec{P}_{A_i} + \vec{P}_{B_i} = \vec{P}_{A_f} + \vec{P}_{B_f}$$

$$(0.355\ kg)(+0.095\ m/s) + (0.710\ kg)(+0.045\ m/s) = (0.355\ kg)(+0.035\ m/s) + (0.710\ kg)\vec{v}$$

$$\boxed{+0.075\ m/s = \vec{v}}$$

5) A 0.50-kg ball (A) traveling at +6.0 m/s collides head-on with a 1.00-kg ball (B) moving at –12.0 m/s. The 0.50-kg ball bounces backwards at –14 m/s after the collision. What is the velocity of the second ball after the collision?

$$\vec{P}_{A_i} + \vec{P}_{B_i} = \vec{P}_{A_f} + \vec{P}_{B_f}$$

$$(0.50\ kg)(+6.0\ m/s) + (1.00\ kg)(-12.0\ m/s) = (0.50\ kg)(-14\ m/s) + (1.00\ kg)\vec{v}$$

$$\boxed{-2\ m/s = \vec{v}}$$

6) A 5.00-g (0.005 kg) bullet is fired with a velocity of +100 m/s toward a 10.0-kg stationary block resting on a horizontal surface. The coefficient of kinetic friction between the block and surface is 0.24.

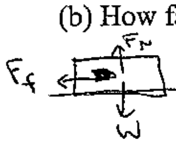
(a) If the bullet embeds itself in the block, determine the velocity of the bullet/block after the collision.

$$\vec{P}_{BULLET_i} + \emptyset = \vec{P}_{BULLET+BLOCK_f}$$

$$(0.005\ kg)(+100\ m/s) = (10.005\ kg)\vec{v}_f$$

$$\boxed{+0.0500\ m/s = \vec{v}_f}$$

(b) How far does the block slide on the horizontal surface before coming to rest?



① $\Sigma F = F_f = \mu_k F_N = \mu_k \cdot W = 23.5\ N$

② $a = \frac{\Sigma F}{m} = \frac{23.5\ N}{10.005\ kg} = 2.35\ m/s^2$

← → +

$V_0 = +0.05\ m/s$
$V = \emptyset$
$a = -2.35\ m/s^2$
$x = ?$

③ $v^2 = v_0^2 + 2ax$

$\boxed{5.32 \times 10^{-4}\ m = x}$

-OR-

$KE_i = \frac{1}{2}mv^2 = 0.0125\ J$

$KE_f = \emptyset$

$W_{FRICTION} = \Delta KE = -0.0125\ J$

$-0.0125\ J = (F_f \cos\theta)s$

$\frac{-0.0125\ J}{(23.5\ N \cos 180°)} = s = \boxed{5.32 \times 10^{-4}\ m}$

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Physics – Conservation of Momentum: Explosions Practice

Tips:
- Total momentum before = Total momentum after $(p_{Ai} + p_{Bi} = p_{Af} + p_{Bf})$
- Momentum is a vector; be sure you give each term the correct sign
- In explosions, if the two objects start together at rest, the total momentum before equals zero; therefore, the final momentum of one must be equal and opposite to the final momentum of the other

1) A 50-kg woman stands on a 10-kg cart, both initially at rest. She jumps off the front of the cart, achieving a velocity of +7.0 m/s. What is the velocity of the cart after the woman jumps off?

MOMENTUM BEFORE = MOMENTUM AFTER

$$\emptyset = \vec{p}_{WOMEN} + \vec{p}_{CART}$$

$$\emptyset = (50\,kg)(+7\,m/s) + (10\,kg)\vec{v}_{CART}$$

$$-35\,m/s = \vec{v}_{CART}$$

2) Two students on roller skates stand face-to-face and push off of each other. One student has a mass of 90 kg; the other has a mass of 60 kg. The more massive student has a velocity of –2.5 m/s after they push off. Determine the velocity of the less massive student.

$$\emptyset = \vec{p}_1 + \vec{p}_2$$

$$= (90\,kg)(-2.5\,m/s) + (60\,kg)\vec{v}$$

$$+3.75\,m/s = \vec{v}$$

3) A 7.5 x 10^4-kg space probe sits motionless in space (far from any star or planet). It fires its rocket, propelling 1500 kg of fuel at a speed of 3200 m/s into space. What is the speed of the probe after firing the rocket?

$$\emptyset = \vec{p}_{PROBE} + \vec{p}_{FUEL}$$

$$= (7.5\times10^4\,kg)(\vec{v}_{PROBE}) + (1500\,kg)(3200\,m/s)$$

$$-64\,m/s = \vec{v}_{PROBE}$$

(NEGATIVE IMPLIES THE PROBE IS TRAVELING IN THE OPPOSITE DIR. OF THE EXPELLED FUEL)

4) A 75-kg student stands motionless on a frozen lake (frictionless surface) carrying nothing but his 2.5-kg Physics book. He throws the book east with a velocity of 18 m/s. What is the magnitude and direction of the student's velocity after throwing the book?

W ← − + → E

$$\emptyset = \vec{P}_{STUDENT} + \vec{P}_{BOOK}$$

$$= (75\,kg)v + (2.5\,kg)(+18\,m/s)$$

$$-0.6\,m/s = v$$

0.6 m/s WEST

5) A two-stage rocket moves in space at a constant velocity of +4900 m/s. The two stages are then separated by a small explosive charge placed between them. Immediately after the explosion the velocity of the 1200-kg upper stage is +5700 m/s. What is the velocity of the 2400-kg lower stage after the explosion?

$$\vec{P}_i = \vec{P}_{UPPER\,f} + \vec{P}_{LOWER\,f}$$

$$(3600\,kg)(+4900\,m/s) = (1200\,kg)(+5700\,m/s) + (2400\,kg)\vec{v}$$

$+4500\,m/s = \vec{v}$