PRACTICE EXERCISES

Formula: $\vec{p} = m\vec{v}$ $\quad \vec{p}_{\text{sys(after)}} = \vec{p}_{\text{sys(before)}}$ $\quad m_1\vec{v}_1 + m_2\vec{v}_2 = m_1\vec{v}_1' + m_2\vec{v}_2'$

Note: Angles (directions) are expressed first in terms of north, east, etc., and also in terms of the rectangular coordinate system.

1. A 30.0 kg object moving to the right at a velocity of 1.00 m/s collides with a 20.0 kg object moving to the left at a velocity of 5.00 m/s. If the 20.0 kg object continues to move left at a velocity of 1.25 m/s, what is the velocity of the 30.0 kg object?

before: 30 kg, 1 m/s → ; 20 kg, 5 m/s ←
after: 30 kg, V = ? ; 20 kg, 1.25 m/s ←

$mV + mV = mV + mV$

$30(+1) + 20(-5) = 30(V) + 20(-1.25)$

$V = -1.5$ m/s

$= 1.5$ m/s [W] ✓

2. A 4.50×10^3 kg railway car is moving east at a velocity of 5.0 m/s on a level frictionless track when it collides with a stationary 6.50×10^3 kg railway car. If the two cars lock together upon collision, how fast are they moving after collision?

before: 4500 kg, 5 m/s → ; 6,500 kg, 0 m/s
after: 11 000 kg, V = ?

$(4500)(5) + 0 = 11\,000\,V$

$V = 2.1$ m/s [E] ✓

3. A 925 kg car moving at a velocity of 18.0 m/s right collides with a stationary truck of unknown mass. The two vehicles lock together as a result of the collision and move off at a velocity of 6.50 m/s. What was the mass of the truck?

before: 925 kg, 18 m/s → ; m, 0 m/s
after: 925 + m, 6.5 m/s →

$(925)(18) + 0 = (925 + m)(6.5)$

$m = 1636.5$

$= 1.64 \times 10^3$ kg ✓

4. A 50.0 g bullet strikes a 7.00 kg stationary wooden block. If the bullet becomes embedded in the block, and the block with the embedded bullet moves forward at a velocity of 5.00 m/s, what was the initial velocity of the bullet?

0.05 kg, V_b → ; 7 kg, 0 m/s
after: 7.05 kg, 5 m/s →

$0.05\,V_b + 0 = 7.05(5)$

$V_b = 705$ m/s ✓

5. A 40.0 g object moving with a velocity of 9.00 m/s to the right collides with a 55.0 g object moving with a velocity of 6.00 m/s left. If the two objects stick together upon collision, what is the velocity of the combined masses after collision?

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0.04 kg, 9 m/s → ; 0.055 kg, 6 m/s ←
after: 0.095 kg, V = ?

$(0.04)(9) + (0.055)(-6) = 0.095\,V$

$V = 0.316$ m/s [right] ✓

6. A 76 kg student, standing at rest on a frictionless horizontal surface, throws a 0.20 kg object horizontally with a velocity of 22 m/s left. What was the initial velocity of the student upon release of the object?

before: 76.2 kg, 0 m/s | after: 76 kg, V | 0.2 kg ← 22 m/s

$0 = 76V + 0.2(-22)$

$V = 0.058 \text{ m/s}$ [right] ✓

7. A 25 kg projectile is fired horizontally from a 1.1×10^3 kg launcher. If the horizontal velocity of the projectile is 325 m/s east, what is the recoil velocity of the launcher?

25 kg + 1.1×10^3 kg, 0 | 25 → 325 m/s | 1.1×10^3 kg, V = ?

$0 = 25(325) + 1.1 \times 10^3 V$

$V = -7.4$ m/s

$= 7.4 \frac{m}{s}$ [W] ✓

8. A rail vehicle with a rocket engine is being tested on a smooth horizontal track. Starting from rest, the engine is fired for a short period of time releasing 4.5×10^2 kg of gases. It is estimated that the average velocity of the gases is 1.4×10^3 m/s right, and that the maximum velocity of the vehicle is 45 m/s left. What is the mass of this vehicle?

m + gas, 0 | m ← 45 m/s | gas: 4.5×10^2 kg → 1.4×10^3 m/s

$0 = m(-45) + 4.5 \times 10^2 (1.4 \times 10^3)$

$m = 1.4 \times 10^4$ kg ✓

9. A 7.0 kg object at rest explodes into two parts. If part A has a mass of 2.0 kg and a velocity of 10.0 m/s right, what is the velocity of part B?

7 kg, 0 m/s | A 2 kg, 10 m/s → | B 5 kg, ← V = ?

$0 = 2(10) + 5(V)$

$V = -4 \text{ m/s} = 4 \text{ m/s}$ [left] ✓

10. A 1.02×10^4 kg truck moving at a velocity of 15 m/s north collides head on with a 1.02×10^3 kg car moving at a velocity of 25 m/s south. If they stick together upon impact, what is the velocity of the combined masses?

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1.02×10^4 kg, 15 m/s ↑ | 1.02×10^3 kg, ↓ 25 m/s | $1.02 \times 10^4 + 1.02 \times 10^3$ kg, V = ?

$1.02 \times 10^4 (15) + 1.02 \times 10^3 (-25) = (1.02 \times 10^4 + 1.02 \times 10^3) V$

$V = 11 \text{ m/s}$ [North] ✓

11. A 225 g ball moves with a velocity of 30.0 cm/s to the right. This ball collides with a 125 g ball moving in the same direction at a velocity of 10.0 cm/s. After the collision, the velocity of the 125 g ball is 24.0 cm/s to the right.

a) What is the velocity of the 225 g ball after the collision?

before 0.225 kg, .3 m/s → ; 0.125 kg, → .10 m/s | after .225, V=? ; 0.125, → 0.24 m/s

$(0.225)(0.3) + (0.125)(0.1) = 0.225V + (0.125)(0.24)$

$V = 0.222 \text{ m/s} = 22.2 \text{ cm/s [right]}$ ✓

b) Is this an elastic or inelastic collision? Provide mathematical evidence for your answer.

Check $E_{k\,before} \stackrel{?}{=} E_{k\,after}$

$\frac{1}{2}(0.225)(0.3)^2 + \frac{1}{2}(0.125)(0.1)^2 \stackrel{?}{=} \frac{1}{2}(0.225)(0.222)^2 + \frac{1}{2}(0.125)(0.24)^2$

$0.01075 \text{ J} \neq 0.00916$ energy lost so inelastic ✓

12. A 10.0 g object is moving with a velocity of 20.0 cm/s to the right when it collides with a stationary 30.0 g object. After collision, the 10.0 g object is moving left at a velocity of 6.00 cm/s.

a) What is the velocity of the 30.0 g object after the collision?

leave as g + cm

10g, 20 cm/s → ; 30g, 0 cm/s | after 10g, ← 6 cm/s ; 30g, V=?

$10(20) + 0 = (10)(6) + 30(V)$

$V = 8.\overline{6} = 8.67 \text{ cm/s [right]}$ ✓

b) Is this an elastic or inelastic collision? Provide mathematical evidence for your answer.

$\frac{1}{2}(10)(20)^2 + \frac{1}{2}(30)(0)^2 \stackrel{?}{=} \frac{1}{2}(10)(6)^2 + \frac{1}{2}(30)(8.\overline{6})^2$

$2000 \neq 1306.\overline{6}$

energy lost ∴ inelastic ✓

c) What happened to the kinetic energy that was lost?

friction / heat ✓

sound