1. A 4 kg cart moves at 5 $\frac{\text{m}}{\text{s}}$. What is its momentum (in kg · m/s)?

   _____ kg · m/s

2. A force of 50 N acts for 0.4 s. What impulse does it deliver (in N · s)?

   _____ N · s

3. A 50 kg skater and a 5 kg ball start at rest on frictionless ice. The skater throws the ball horizontally at 8 $\frac{\text{m}}{\text{s}}$ relative to the ground. Find the skater\'s recoil speed (in m/s).

   _____ m/s

4. A 3 kg cart at 4 $\frac{\text{m}}{\text{s}}$ sticks to a stationary 1 kg cart. Their common speed afterward (in m/s)?

   _____ m/s

5. Two objects moving toward each other can have a total momentum of zero.

   ☐ True ☐ False

6. An impulse of 12 N · s acts on a 3 kg cart at rest. Its final speed (in m/s)?

   _____ m/s

7. An internal explosion inside a floating system changes the system's total momentum.

   ☐ True ☐ False

8. In which collision is kinetic energy conserved?

   ☐ an inelastic collision

   ☐ all collisions

   ☐ a perfectly inelastic collision

   ☐ an elastic collision

9. Momentum is a _____ quantity, pointing the same way as the velocity.

   _____

10. An airbag reduces injury by...

    ☐ removing all momentum instantly

    ☐ reducing the change in momentum

    ☐ increasing the stopping time, which lowers the average force

    ☐ increasing the force

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1. **20 kg · m/s**

   $p = mv = 4 \times 5 = 20$ $\frac{\text{kg·m}}{\text{s}}$.

2. **20 N · s**

   $J = F\Delta t = 50 \times 0.4 = 20$ N · s.

3. **0.8 m/s**

   $0 = 5(8) + 50v$, so $v = -40/50 = -0.8$ $\frac{\text{m}}{\text{s}}$ – the skater recoils at 0.8 $\frac{\text{m}}{\text{s}}$.

4. **3 m/s**

   $3(4) = (3+1)v_f$, so $v_f = 12/4 = 3$ $\frac{\text{m}}{\text{s}}$.

5. **True**

   Momentum is a vector – opposite directions carry opposite signs, which can cancel to zero.

6. **4 m/s**

   $J = \Delta p = m\Delta v$, so $\Delta v = 12/3 = 4$ $\frac{\text{m}}{\text{s}}$ from rest.

7. **False**

   Explosion forces are internal (third-law pairs), so the total momentum is unchanged.

8. **an elastic collision**

   Only an elastic collision conserves kinetic energy. Momentum, though, is conserved in all of them.

9. **vector**

   $\vec{p} = m\vec{v}$ is a vector – it has both size and direction.

10. **increasing the stopping time, which lowers the average force**

    The momentum change is fixed; the airbag stretches the time, so the average force $F = \Delta p/\Delta t$ drops.