4. Linear Momentum

Starter Quiz · 课前小测

AP Physics C: Mechanics Name: _____ Score: _____

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 at rest throws a 5 kg ball at 8 $\frac{\text{m}}{\text{s}}$. 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 elastic collision

   ☐ an inelastic collision

   ☐ a perfectly inelastic collision

   ☐ all collisions

9. An airbag reduces injury by...

   ☐ reducing the change in momentum

   ☐ increasing the stopping time, which lowers the average force

   ☐ increasing the force

   ☐ removing all momentum instantly

10. Momentum is conserved only when...

    ☐ no forces act at all

    ☐ the net external force is zero

☐ kinetic energy is also conserved

☐ the objects are identical

4. Linear Momentum

Answers · 答案

AP Physics C: Mechanics

1. **20 kg · m/s**

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

2. **20 N · s**

   $J = F\Delta t = 50 \times 0.4 = 20\ \text{N} \cdot \text{s}$.

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. **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.

10. **the net external force is zero**

    An isolated system – zero *net external* force – conserves momentum. Internal forces are fine.