Name _____

Impulse & Momentum (p. 229 – 235)

I. Impulse & Momentum

1. Derive impulse and momentum using Newton's 2nd Law of Motion.

1. Substitute $\Delta v/\Delta t$ for acceleration.

   $F = ma = m\left(\frac{\Delta v}{\Delta t}\right)$

2. Multiply both sides by Δt.

   $F\Delta t = m\Delta v$

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Firing a gun

Car Accidents

Force of bat on baseball over a short time

$F\Delta t = \Delta p$

2. Define the term impulse. ← (change in momentum)

Impulse – ($F\Delta t$) – the product of the average force on an object and the time interval over which it acts.

3. What units are used to measure impulse? Newtons • seconds = kg·m/s

4. Define the term momentum.

Momentum – product of an object's mass and object's velocity

5. Write out the formula used to determine momentum.

$p = mv$ Momentum = (mass)(velocity)

Momentum Examples:
- Bullets – Cars in Motion
- Trains
- Avalanche

6. What units are used to measure momentum? kg • m/s = N • s

7. Define the term impulse-momentum theorem.

Impulse-Momentum Theorem – impulse of an object is equal to the object's final momentum minus the object's initial momentum

8. Write out the formula used to determine the impulse-momentum theorem.

$F\Delta t = p_f - p_i$

9. Momentum is a vector, but impulse is ~~not~~ a vector.

Circle One : True (False)

Velocity = vector $p = mv$

Force = vector $p = F\Delta t$

II. Using The Impulse-Momentum Theorem

1. Fill in the following equations relating to the impulse-momentum theorem.

1. $m\Delta v = mv_f - mv_i = F\Delta t$

2. $mv_f = p_f$; $mv_i = p_i$

3. $F\Delta t = m\Delta v = p_f - p_i$

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III. Using The Impulse-Momentum Theorem

1. **A large change in momentum occurs when there is a large change in impulse.**

   Circle One : (True) False

2. **What are two ways that a large impulse can be generated?**

   Boxing → 1. Large force acting over a short period of time

   Pushing a lawnmower → 2. Small force acting over a longer period of time

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3. **Using the term impulse, explain how a car airbag reduces injuries.** (Impulse decreased)

   1) Reduces force by increasing the time interval for impact

   2) Exerts a force over a larger area (air bag)

IV. Angular Momentum

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1. **Define the term angular momentum.**

   Angular Momentum – product of an object's moment of inertia and angular velocity

$I = mr^2$

$\omega = \frac{\Delta\theta}{\Delta t}$

2. **Derive the equation for angular momentum using Newton's Law for Rotational Motion.**

   1. Substitute $\Delta\omega/\Delta t$ for α.

      $\tau = I\alpha = I\,\Delta\omega/\Delta t$

   2. Multiply both sides by Δt.

      $(\tau = I\Delta\omega/\Delta t) = \tau\,\Delta t = I\,\Delta\omega$

   3. Write out the formula used to determine angular momentum.

      $L = I\,\omega$ (Angular Momentum = (Moment of Inertia)(Angular Velocity))

$\alpha = \frac{\Delta\omega}{\Delta t}$

↓ radius = ↑ angular velocity

3. **What units are used to measure angular momentum?** $kg \cdot m^2/s$

4. **Define the term angular impulse-angular momentum theorem.**

   Angular Impulse-Angular Momentum Theorem – angular impulse on an object is equal to the object's final angular momentum minus the object's initial angular momentum

Assuming a constant linear velocity

$\omega = \frac{v}{r}$

5. **Write out the formula to determine the angular impulse-angular momentum theorem.**

   $\tau\Delta t = L_f - L_i$

6. **A decrease in the moment of inertia of a body causes an increase in angular velocity.**

   Circle One : (True) False (Mass is constant, but the way the is distributed about the axis of rotation changes)

7. **List three examples of how angular momentum can be conserved.**

   Tetherball →

   1. Ice-Skater (p. 235) 2. Diver (p. 234) 3. Planetary Orbit (↓ distance between planet + Sun = ↑ angular velocity)