Name _____

Conservation Of Momentum (p. 236 – 245)

I. Two-Particle Collisions

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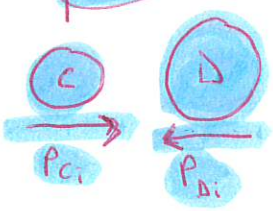

1. **According to Newton's 3rd Law of Motion, forces exerted on each other are equal in magnitude and opposite in direction.**

2. **The impulse forces of two particles colliding are equal and similar in direction.**

   opposite

   Circle One : True (False)

   Ball C: $p_{Cf} - p_{Ci} = F_{D on C}\,\Delta t$
   Ball D: $p_{Df} - p_{Di} = F_{C on D}\,\Delta t$

3. **In a collision between two particles, momentum is conserved.**

   Circle One : (True) False

   Trains Cars Connecting

   $p_i = p_f$ → $mv_i = mv_f$

   Shopping Carts

II. Momentum In A Closed, Isolated System

1. **Define the term closed system.**

   Enviro-Sci Project

   Closed System – a system in which mass is not gained or lost

2. **What are two conditions necessary to create a system that conserves momentum?**

   1. No mass is gained or lost
   2. Forces involved are internal forces (No external forces)

3. **Define the term isolated system.**

   Isolated System – system in which the net external force on a closed system equals zero

4. **No system on Earth can be considered absolutely isolated.**

   Circle One : (True) False

   * Always some interactions between system + surroundings
   ↳ often small → can be ignored

5. **What are two outcomes that occur as objects collide?**

   1. Stick Together 2. Come Apart

6. **Define the term law of conservation of momentum.**

   Law Of Conservation Of Momentum – momentum of any closed, isolated system does not change

III. Recoil

Before: $p_{Ci} + p_{Di} = p_{Cf} + p_{Df}$
After: $0 = p_{Cf} + p_{Df}$
$p_{Cf} = -p_{Df}$
$m_C v_{Cf} = -m_D v_{Df}$

Smooth surface, no external forces

1. **If the total momentum before a push is zero, what must the momentum be after the push?**

   - Zero → (momentum must be conserved)

2. **What is recoil (with regards to momentum)?**

   - Backwards motion of a push (Newton's 3rd Law)

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Guns

Skates

Outer Space

Name _____

IV. Propulsion In Space

1. **How do traditional rocket engines and ion engines allow for velocity changes in space?**

Traditional = "Chemical reaction taking place in a combustion chamber are released at high speeds for a few minutes

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Ion = Small force of xenon atoms expelled are released over days, weeks or months (Produces a large impulse + large momentum)

V. Two-Dimensional Collisions

1. **What is the difference between inelastic collisions and elastic collisions and what formulas are used to determine outcomes of the collisions?** (Not in the book.)

Ex - Collide + Stick - Car Crash

1. Inelastic Collision – collision in which momentum is conserved but not kinetic energy

Formula = $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$

2. Elastic Collision – collisions in which momentum and kinetic energy are conserved

Ex - Billiard Balls - Rebounding Collision

Formula = $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$

$\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$

2. **How are the overall displacements of a collision determined?**

(1) Find resultant magnitude using x and y components.

(2) Find angle using $\tan^{-1}$

VI. Conservation Of Angular Momentum

Wheel + Chair DEMO

1. **Define the law of conservation of angular momentum.**

Law Of Conservation Of Angular Momentum – if no net external torque acts on an object, then its angular momentum does not change (initial angular momentum = final angular momentum)

2. **Write out the formulas used to determine angular velocity using the law of conservation of angular momentum.**

$L = I\omega$

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Ice Skater

$L_i = L_f$

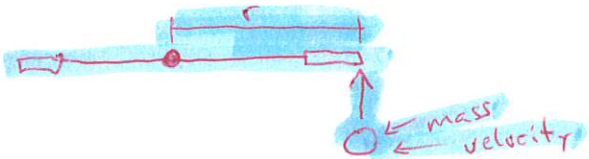
$I_i \omega_i = I_f \omega_f$ (Moment of inertia; Angular velocity)

↓ Moment of Inertia (radius) (EQUALS) ↑ Angular Velocity

3. **Write out the formula used to determine angular momentum of a moving object at the outermost perpendicular point from an axis of rotation.**

$L = mvr$ (linear)

Assuming constant linear velocity



Name _____

VII. Tops & Gyroscopes

Toy Top p 244

1. **Define the term precession.**

Precession – change in the orientation of the rotation axis of a rotating body

2. **Explain why Earth's rotational axis takes 26,000 years to go through one precession cycle.**

- the Sun exerts a torque on Earth which creates a "wobble" that is slowly worked out

Gyroscopic Precession - axis of a spinning object "wobbles" when torque is applied

3. **Define the term gyroscope.**

Gyroscope – device used for measuring or maintaining orientation in which a spinning wheel or disk has an axle that is free to take on any orientation

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4. **List three uses of gyroscopes.**

1. Airplanes 2. Submarines 3. Spacecraft

(keep an unchanging reference direction)

5. **Explain how a thrown football exhibits the gyroscope effect.**

Spiral = spin direction in direction of spin axis of rotation

Wobble = spin direction is slightly off

Lacks conservation of momentum

Conservation of Momentum

Spin football horizontally to vertical position