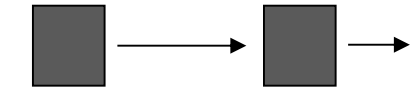
UNIT 4 PRACTICE EXAM
Momentum, Impulse, & Collisions

1. **C** Vehicle #1 has a mass of 500 kg and moves with a velocity of 10 m/s.
Vehicle #2 has a mass of 1000 kg and moves with a velocity of 10 m/s.
A. Vehicle 1's momentum is 2-times greater than Vehicle 2's momentum.
B. Vehicle 1's momentum is 4-times greater than Vehicle 2's momentum.
C. Vehicle 1's momentum is ½ the momentum of Vehicle 2.
D. Vehicle 1's momentum is ¼ the momentum of Vehicle 2.

2. **C** According to the law of conservation of momentum…
A. The total momentum of stationary objects must equal the momentum of the same objects when moving.
B. Moving objects have momentum, stationary objects have zero momentum.
C. The sum of momentums before interactions must equal the sum of momentums after interactions.
D. The total momentum before objects accelerate must equal the total momentum after objects accelerate.

3. **D** See the colliding objects. Two objects are about to have an elastic collision. What will be outcome of velocities after the collision?
A. Object 1 moves at 0 m/s. Object 2 moves at 15.0 m/s.
B. Object 1 moves at -10.0 m/s. Object 2 moves at 5.0 m/s.
C. Object 1 moves at -5 m/s. Object 2 is at 10 m/s.
D. Object 1 moves at 5 m/s. Object 2 moves at 10 m/s.



Object 1
10 kg
10 m/s

Object 2
10 kg
5 m/s

List five important facts about momentum	• Equals mass times velocity • Equation is p=mv • Is a vector • Proportional to mass • Proportional to velocity
What is kinetic energy?	Energy of motion
What is impulse?	A force applied over a length of time
What is the relationship between contact time and force when impulse happens?	The force and contact time are *inversely proportional*. As contact time increases the amount of force decreases and vice versa.

What is the equation to solve for kinetic energy?	$KE = \frac{1}{2}mv^2$	What is the equation to solve for momentum?	$\vec{p} = m\vec{v}$
What is the equation for the impulse-momentum theorem?	$\vec{F} \cdot t = \Delta\vec{p}$ or $\vec{F} = \frac{\Delta\vec{p}}{t}$		
What is an elastic collision?	A perfect collision. Nothing breaks, changes shape, or sticks together during the collision. Momentum **and** kinetic energy are conserved.		
What is an inelastic collision?	An imperfect collision. The objects break, change shape, or stick together during the collision. Momentum is conserved. Kinetic energy is **not** conserved.		
What are the four "rules" for elastic collisions?	In simplified language: 1. Object with more momentum transfers momentum to the object with less momentum during the collision 2. Object with more momentum will slow down after the collision 3. Object with less momentum will speed up after the collision 4. If objects have **equal mass**, they will swap momentum and velocity		
What are the three "rules" for inelastic collisions?	In simplified language: 1. Mass of the combined object is the sum of the mass of the two objects before the collision 2. Velocity of the combined object will be somewhere between the velocities of the two objects before the collision 3. Combined object will travel in the same direction as the object that had more momentum before the collision		
What is the law of conservation of momentum?	When the system is closed, the total momentum of the system will not change. The total momentum of all objects before a collision will equal the total momentum of all objects after the collision.		

Calculations Practice

A man rides his bicycle with a velocity of 8.4 m/s. The mass of the man and his bike together is 104 kg. Calculate momentum. Calculate kinetic energy.	$p = 873.6\ kg \cdot m/s$ $KE = 3669.12\ J$
A man rides his bicycle with a velocity of 7.5 m/s. His momentum is 575 kg·m/s. Calculate his mass.	$m = 76.67\ kg$

A tennis ball moves with an initial velocity of -40 m/s. It is hit by the tennis racket, it changes direction, and it moves with a final velocity of 32 m/s. The mass of the tennis ball was 0.120 kg. The force of impact was 1.92 N.

Calculate initial momentum.	$p_i = -4.8\ kg \cdot m/s$
Calculate final momentum.	$p_f = 3.84\ kg \cdot m/s$
Calculate the impulse	$Impulse = \Delta p = 8.64\ kg \cdot m/s$
Calculate the contact time between the tennis racket and the tennis ball.	$t = 4.5\ s$
Calculate the acceleration of the ball.	$a = 16\ m/s^2$

A car collided with utility pole. The car came to a stop in 0.68 seconds. The mass of the car was 500 kg. The velocity of the car just before impact was 12 m/s.

Calculate initial momentum.	$p_i = 6000$ kg·m/s
Calculate final momentum.	$p_f = 0$ kg·m/s
Calculate the impulse.	Impulse = $\Delta p = -6000$ kg·m/s
Calculate the acceleration of the car when it impacted the pole.	$a = -17.65$ m/s^2
Calculate the force of impact.	$F = -8824$ N