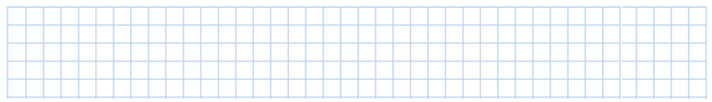
**IMPULSE**

DO NOW: CHANGE IN MOMENTUM

***Directions:*** *Use your knowledge of the laws of motion to answer the question below*

1. An 80kg baseball player runs to catch a fly ball near the back wall. Before he hits the wall his velocity is 4.5m/s. When he hits the wall he stops moving. What is his change in momentum?





1. What is the difference between *momentum* and *change in momentum*?

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GUIDED LECTURE: CALCULATING CHANGE IN MOMENTUM

***Directions:*** *As you listen to the lecture, complete the notes section below.*

In the two baseball clips, why does one player get hurt and the other one does not?

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CORE IDEA 2:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Why does “cushioning” protect objects in a collision?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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In the two shots, what is different that allows Karim more change in momentum?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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CORE IDEA 3:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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A car crash will hurt less if I reduce my velocity, or\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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I will throw a baseball farther if I use more force, or\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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EXPLORE: COMPARING CHANGE IN MOMENTUM TO FORCE AND TIME

***Directions:*** *With your neighbor, complete both tables in the page below. Use the space beneath each table to show work.*

**Situation 1:** In lab, a 2-kg cart traveling with an initial velocity of 4 m/s is brought to a stop with two different types of cushion. Use this information to find the net force acting on each cart.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mass (kg) | Initial Velocity (m/s) | Final Velocity (m/s) | Stopping Time (s) | Acceleration (m/s/s) | Net Force (N) |
| 2 kg | 4 m/s |  | 0.25 s |  |  |
| 2 kg | 4 m/s |  | 0.50 s |  |  |

**Situation 2:** In lab, a 2-kg cart traveling is at rest. A 40-N force is applied for different amounts of time, causing it to change velocity. Use this information to find the final velocity of each cart:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mass (kg) | Initial Velocity (m/s) | Net Force (N) | Pushing Time (s) | Acceleration (m/s/s) | Final Velocity (m/s) |
| 2 kg | 0 m/s |  | 0.25 s |  |  |
| 2 kg | 0 m/s |  | 0.50 s |  |  |

**Situation 1:** In lab, a 2-kg cart traveling with an initial velocity of 4 m/s is brought to a stop with two different types of cushion. Use this information to find the net force acting on each cart.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mass (kg) | Initial Velocity (m/s) | Final Velocity (m/s) | Stopping Time (s) | Acceleration (m/s/s) | Net Force (N) |
| 2 kg | 4 m/s | 0m/s | 0.25 s | -16 m/s/s | -32 m/s |
| 2 kg | 4 m/s | 0m/s | 0.50 s | -8 m/s/s | -16 m/s |

|  |  |  |
| --- | --- | --- |
| Stopping Time (s) | **Change in Momentum**  mass(vf – vi) (kg\*m/s) | **Net Force\*time**  (N\*s) |
| .25 s |  |  |
| .5 s |  |  |

**Situation 2:** In lab, a 2-kg cart traveling is at rest. A 40-N force is applied for different amounts of time, causing it to change velocity. Use this information to find the final velocity of each cart:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mass (kg) | Initial Velocity (m/s) | Net Force (N) | Pushing Time (s) | Acceleration (m/s/s) | Final Velocity (m/s) |
| 2 kg | 0 m/s | 40 N | 0.25 s | 20 m/s/s | 5 m/s |
| 2 kg | 0 m/s | 40 N | 0.50 s | 20 m/s/s | 10 m/s |

|  |  |  |
| --- | --- | --- |
| Pushing Time (s) | **Change in Momentum**  mass(vf – vi) (kg\*m/s) | **Net Force\*time**  (N\*s) |
| .25 s |  |  |
| .5 s |  |  |

What do you notice about the relationship between an object’s Δ momentum and net force\*time?\_\_\_\_\_\_\_\_

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CORE IDEA 4:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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PRACTICE: CHANGE IN MOMENTUM AND IMPULSE

***Independent Practice Round 1:*** *Silently and independently complete the following problems. Use your notes and the sample problems from guided practice. Be ready to share and explain your answers.*

1. A 500-kg bumper car traveling East at 3 m/s collides with another bumper car, causing the first one to come to a stop in 0.75 s. What was the force acting on the first bumper car during the collision?
2. A soccer player kicks a 6N soccer ball with a net force of 150 N for 0.4 s. What is the soccer ball’s change in momentum?

***Independent Practice Round 2:*** *Silently and independently complete the following problems. Use your notes and the sample problems from guided practice. Be ready to share and explain your answers.*

1. A student applies a 25-N force to a 30-kg desk that’s initially at rest. After some time, the desk is traveling at 5 m/s. For how much time did the student push the desk?
2. You’re riding in a taxi when all of a sudden it gets rear-ended by the car behind it. If the taxi’s change in momentum is 25000 kg\*m/s, what impulse does it experience?
3. A cannon fires a cannon ball. After the 0.01s explosion, the 4,000-kg cannon is traveling backward with a velocity of 1.25 m/s. What was the force acting on the cannon?
4. What is the change in velocity of a 0.5 kg football that is thrown with a force of 375 N for 0.02s?

EXIT SLIP: CALCULATING CHANGE IN MOMENTUM

***Directions:*** *Answer the questions below to the best of your ability.*

1. A 2000-kg car experiences a net force of 500N for 5 seconds while accelerating from a stoplight. What is the car’s change in momentum?
   1. -10,000 kg\*m/s
   2. -2.500 kg\*m/s
   3. +4 kg\*m/s
   4. +2,500 kg\*m/s
   5. +10,000 kg\*m/s
2. What force is needed to stop a 1200 kg car that is initially traveling 22 m/s in 20.0 s?

PREPWORK 8.06: CHANGE IN MOMENTUM AND IMPULSE

***Directions:*** *Independently complete the following problems. Use your notes and the sample problems from guided practice.*

1. How long must you applied 450 N of force on an object to obtain an impulse of 337.5 N\*s?
2. A 0.2 kg egg is dropped from a height of 5m and hits the ground at 10 m/s. If the egg comes to a stop in 0.12 seconds, what amount of net force does the egg experience?
3. Which object below will have a greater change in momentum?

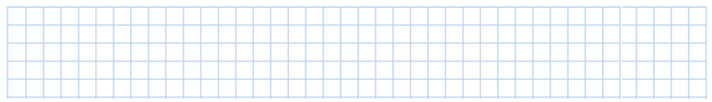
**Case A Case B**

1. As a stoplight turns green, Randy Raptor punches the gas in his 1500 kg SUV. As the engine turns the wheels, the ground exerts 7000 N of net force on the vehicle. If Randy keeps the gas pressed for 9 seconds, what is the car’s change in velocity?

**Situation:** You’re riding in a taxi when all of a sudden it gets rear-ended by the car behind it. During a car crash, your body goes from the car’s original velocity to a stop in a really short period of time. Your change in momentum is 5,000 kg\*m/s.

1. If you are wearing a seatbelt, you come to a stop in 0.4 seconds. If you aren’t wearing a seatbelt, you hit the windshield and come to a stop in 0.1 seconds. In which situation do you get hurt less? Diagram, show work, and explain.

Diagram:



Work:

Explain:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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