

CONCEPT: IMPULSE

- When you push an object with some F over some Δt , you *change* its momentum:

$$\underline{\hspace{1cm}} = \underline{\hspace{1cm}} = \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$$

- This is called an .

Units: [] OR []

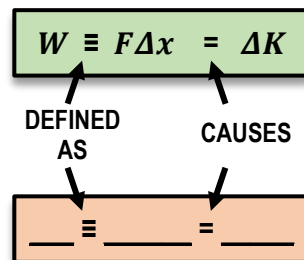
- We obtain this by writing **Newton's 2nd Law** in terms of momentum:

$$F = ma = \underline{\hspace{1cm}} = \underline{\hspace{1cm}} = \underline{\hspace{1cm}}$$

EXAMPLE: You push a 50kg crate initially at rest on a smooth, horizontal surface with a constant 100N force for 8 seconds. Calculate **a)** the impulse that you deliver to the crate and **b)** the crate's speed after 8 seconds.



- Impulse** is similar to **Work**:



PROBLEM: You throw a 100-g ball with 30m/s. If the ball is in your hand for 0.2s during the throw, **a)** calculate the impulse you deliver to it. **b)** Calculate the average Force that you exert on the ball.

- A) $J = 3,000 \text{ kg}\cdot\text{m/s}$, $F_{\text{avg}} = 15,000 \text{ N}$
- B) $J = 3 \text{ kg}\cdot\text{m/s}$, $F_{\text{avg}} = 15 \text{ N}$
- C) $J = 0.2 \text{ kg}\cdot\text{m/s}$, $F_{\text{avg}} = 1 \text{ N}$
- D) $J = 2 \text{ kg}\cdot\text{m/s}$, $F_{\text{avg}} = 10 \text{ N}$

MOMENTUM
$p = mv$
$J = F\Delta t = \Delta p = mv_f - mv_0$

PROBLEM: A 150-g rubber ball is moving at 40m/s to the right, when it hits a wall and bounces back. After the bounce, the ball is moving at 45m/s to the left. **a)** Calculate the impulse delivered to the ball during the bounce. **b)** If the wall exerts an average force of 410N during the bounce, calculate the amount of time the ball is in contact with the wall.

MOMENTUM
$p = mv$
$J = F\Delta t = \Delta p = mv_f - mv_0$

PROBLEM: You catch a 0.6 kg ball initially moving with 10 m/s. Calculate the impulse delivered to the ball during the catch.

MOMENTUM
$p = mv$ $J = F\Delta t = \Delta p = mv_f - mv_0$

PROBLEM: A 1200-kg car moving at 20m/s slams into a wall. The car comes to a stop after compressing 1.0m into the wall.
a) Assuming the acceleration during this collision is constant, how long does this collision last? **b)** Use momentum/impulse to find the magnitude of the average force the wall exerts on the car during the collision.

MOMENTUM

$$p = mv$$

$$J = F\Delta t = \Delta p = mv_f - mv_0$$

UAM Equations

$$(1) v = v_0 + at$$

$$(2) v^2 = v_0^2 + 2a\Delta x$$

$$(3) \Delta x = v_0 t + \frac{1}{2}at^2$$

$$(4) \Delta x = \left(\frac{v+v_0}{2}\right)t$$