There is a term in physics for an object's "bashing power":

MOMENTUM

Momentum: $\vec{p} = m\vec{v}$ $(kg \cdot m/s)$ OR $(slug\ ft/s)$

Why "p"?

Don't want to confuse "m" for momenutm with "m" for mass.

In Newton's time, **impetus** was the quality of an object that was moving independent of an observed force.

Impetus -- from Latin -- in + **P**etere (to go, to seek)

Also, from Greek origins:

Petestrai (to fly)
Pipein (to fall)
Pteron (wing)

Why is the concept of momentum helpful?

$$\Sigma F = ma$$

$$\text{But } a = \frac{v - v_0}{\Delta t}$$

So

$$\boxed{\Sigma F = \frac{\Delta P}{\Delta t}}$$

Newton's 2nd Law as he thought about it -- in terms of **momentum**

$\Sigma F = \frac{\Delta p}{\Delta t}$ So What? Why is this form important?

1. Cases of changing mass can be considered.

2. Momentum is conserved ($p_o = p_f$) when the sum of all forces acting on an object/system is zero.

WHEN $\Sigma F = 0$

$m_1 v_1 + m_2 v_2 \ldots = m_1 v_1' + m_2 v_2' \ldots$

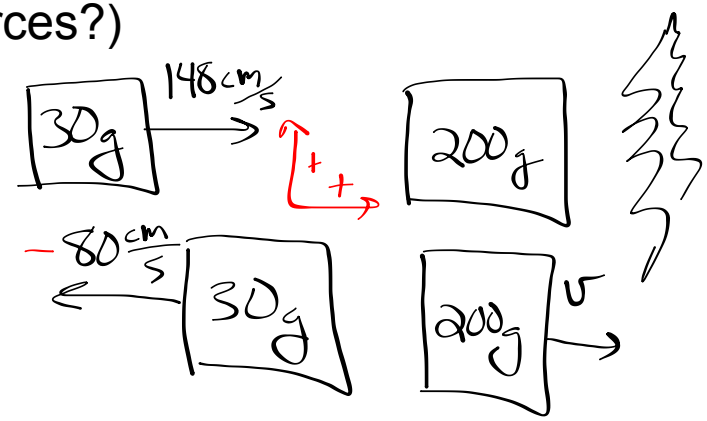
INITIAL MOMENTUM OF THE SYSTEM

FINAL MOMENTUM OF THE SYSTEM

v_1' = FINAL VELOCITY OF OBJECT #1

v_2' = " " " " #2

EXAMPLE #1: A 30-g object gliding at 148 cm/sec across a frictionless surface strikes a 200-g object that is motionless. If the 1st object bounces off the 2nd object so that it is travelling at 80 cm/sec in the opposite direction of its original motion, what is the new velocity of the 2nd object? (Are there external forces?)



1. Draw picture
2. Frame of ref.
3. ID variables (conversions/components)
4. Substitute/solve
5. Interpret

$m_1 = 30\ g$

$m_2 = 200\ g$

$v_1 = 148\ \frac{cm}{s}$

$v_2 = 0$

$v_1' = -80\ \frac{cm}{s}$

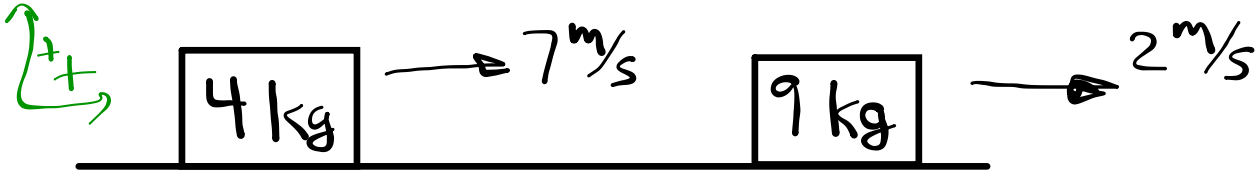
$v_2' = v_2'$

$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

$(30)(148) + (200)(0) = (30)(-80) + 200v_2'$

$v_2' = 34.2\ \frac{cm}{s}$

EXAMPLE 2: These two objects collide and stick together, what is their final speed? (Are there external forces?)



$v_1' = v_2' = v'$

$m_1 = 4\ kg$
$m_2 = 9\ kg$
$v_1 = 7\ m/s$
$v_2 = 2\ m/s$
$v' = ?$

$(4)(7) + 2(9) = 4v' + 9v'$

$\frac{4 \cdot 7 + 2 \cdot 9}{13} = v'$

$v' = 3.5\ m/s$

EXAMPLE #3: The person and ship are initially motionless. If the person jumps off horizontally at 5 m/s to the right. What will the ship do? (Are there external forces?)