Momentum Conservation

- choose system such that $\vec{F}_{net} = 0 \Rightarrow \Delta \vec{P} = 0$

$$\sum P_i = \sum P_f$$

- $\vec{P} = m\vec{v}$

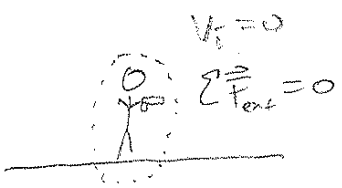
- A man standing on a very slick frozen lake fires a rifle horizontally. The mass of the man plus the rifle is 70 kg, and the mass of the bullet is 10 g. If the bullet leaves the muzzle at a speed of 500 m/s, what is the final speed of the man?

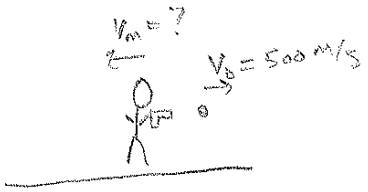
Newton's 2nd law

- FBD, $\sum F = ma$, find a, use kinematics to find v_{man}.
  - lots of work like this.

Conservation of momentum

before





$P_i = m_i v_i = 0$

$P_f = -m_m v_m + m_b v_b$

$$P_i = P_f$$

$$\Rightarrow 0 = -m_m v_m + m_b v_b$$

$$v_m = \frac{m_b}{m_m} v_b = \frac{0.01 \text{ kg}}{70 \text{ kg}} (500) = 0.07 \text{ m/s}$$

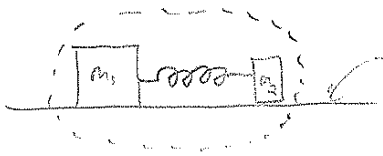
A strong person is compressing a lightweight spring between 2 weights. $m_1 = 3.3\ kg$, $m_2 = 5.3\ kg$. The weights are held stationary but then released, and they fly off in opposite directions. The lighter of the two is shot out at a speed of $6.0\ m/s$. What is the speed of the heavier weight.

Conservation of momentum

Before

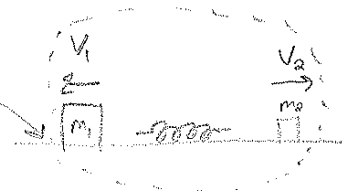
$V_i = 0$

$\sum \vec{F}_{ext} = 0$



frictionless

$\sum \vec{F}_{ext} = 0$



$P_i = 0$

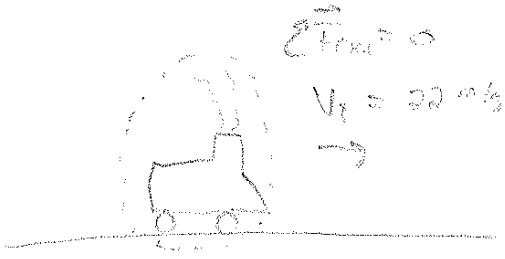
$P_f = -m_1 V_1 + m_2 V_2$

$P_i = P_f$

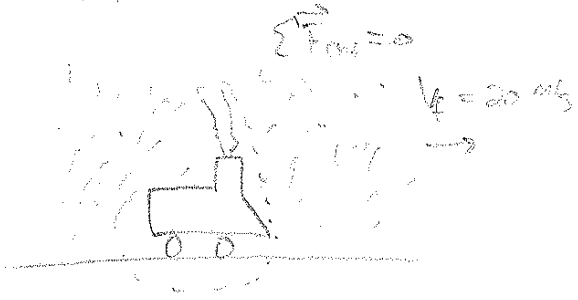
$0 = -m_1 V_1 + m_2 V_2$

A 5000 kg open train car is rolling on frictionless rails at 22 m/s when it starts pouring rain. A few minutes later, the cars speed is 20 m/s. What mass of water has collected in the car.

Before



After



$P_i = m_1 V_i$

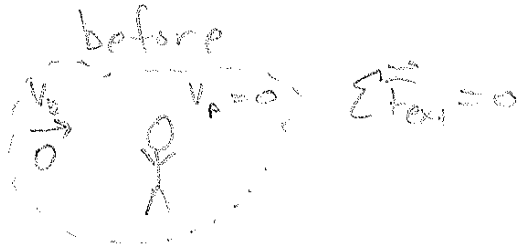
$P_f = m_2 V_2$

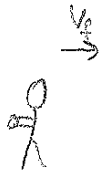
$m_{rain} = 500\ kg$

$P_i = P_f$

$m_1 V_1 = m_2 V_2 \Rightarrow m_2 = m_1 \frac{V_1}{V_2} = 5000 \frac{22}{20} = 5500\ kg$

A 71 kg baseball player jumps straight up to catch a home run. If the 140 g ball is moving horizontally at 28 m/s, and the catch is made when the ball player is at the highest point of his leap, what is his speed immediately after stopping the ball?





$$P_i = m_b V_b + 0$$

$$P_f = (m_b + m_p) V_f$$

$$P_i = P_f$$

$$m_b V_b = (m_b + m_p) V_f$$

$$V_f = \frac{m_b}{m_b + m_p} V_b = \frac{0.14\ kg}{71\ kg + 0.14\ kg} (28\ m/s)$$

$$= 0.055\ m/s$$