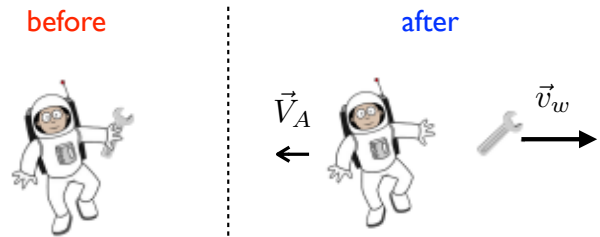$\vec{p}_{Ai} + \vec{p}$

$0 +$

## Momentum

1. **Recoil of an astronaut:** An astronaut of mass $m_A$ = 95 kg, is initially at rest and holds a wrench of mass $m_w$ = 1800 g. He throws the wrench with a velocity $\mathbf{v}_w$ = 7 m/s.

   What is the recoil velocity $\mathbf{V}_A$ of the astronaut?

before

after

$\vec{p}$

$m_A\vec{v}$

$v$

$$\sum \vec{p}_i = \sum \vec{p}_f$$
$$\vec{p}_{Ai} + \vec{p}_{wi} = \vec{p}_{Af} + \vec{p}_{wf}$$
$$0 + 0 = \vec{p}_{Af} + \vec{p}_{wf}$$

$$\vec{p}_{Af} = -\vec{p}_{wf}$$
$$m_A\vec{v}_{Af} = -m_w\vec{v}_{wf}$$
$$v_{Af} = -\frac{m_w v_{wf}}{m_A}$$

2. **Perfectly inelastic collision:** Two masses sliding on a frictionless surface have a completely inelastic head-on collision. Following impact, the velocity of the 4 kg mass is:

$m_1$ 2 kg 3 m/s    2 m/s $m_2$ 4 kg
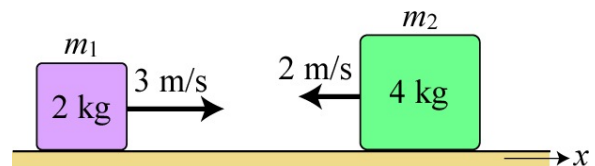
3. **Billiards:** A cue ball of mass $m_c$ strikes a stationary eight ball of mass $m_8$ with speed $v_i$. It continues at angle $\theta$ with speed $v_f$. What is the velocity of the eight ball?
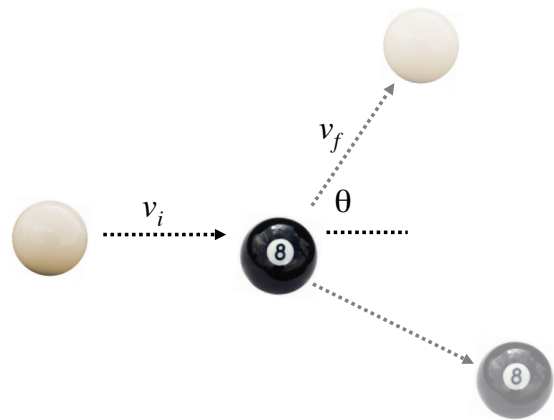
Let $m_c$ = 170 g, $m_8$ = 160 g, $v_i$ = 12 m/s, $v_f$ = 2.1 m/s and $\theta$ = 30°.
(Ans: $v_8$ = 10.88 m/s, $\phi$ = 5.91°)

4. On a frictionless horizontal air table, puck A (with mass 0.251 kg) is moving toward puck B (with mass 0.375 kg), which is initially at rest. After the collision, puck A has velocity 0.120 m/s to the left, and puck B has velocity 0.650 m/s to the right.

   • What was the speed $v_{Ai}$ of puck A before the collision?
   • Calculate $\Delta K$, the change in the total kinetic energy of the system that occurs during the collision.