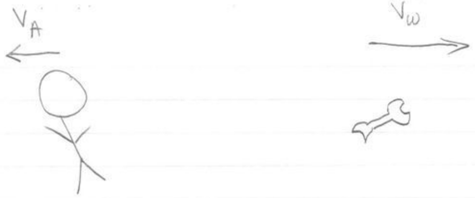


$$V_\omega - V_A = 3\,\text{m/s} \quad \rightarrow \quad V_A = V_\omega - 3\,\text{m/s}$$

$$m_A V_A + m_\omega V_\omega = 0$$

$$m_A\left(V_\omega - 3\tfrac{m}{s}\right) + m_\omega V_\omega = 0$$

$$m_A V_\omega - m_A 3\tfrac{m}{s} + m_\omega V_\omega = 0$$

$$\left(m_A + m_\omega\right) V_\omega - m_A 3\tfrac{m}{s} = 0$$

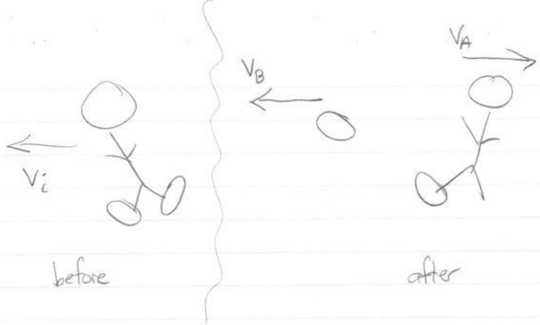
$$V_\omega = \frac{m_A 3\tfrac{m}{s}}{\left(m_A + m_\omega\right)} = 2.93\,\text{m/s}$$

$$\rightarrow \quad V_A = 2.93\,\text{m/s} - 3\,\text{m/s} = -0.07\,\text{m/s}$$

wrench: $x_\omega(t) = \left(+2.93\,\tfrac{m}{s}\right)t$

Al $\quad x_A(t) = \left(-0.07\,\tfrac{m}{s}\right)t$

c of mass $\quad X(t) = \emptyset \quad$ at all times!



$$p_i = -(m_A + m_B)V_i \qquad p_f = -m_B V_B + m_A V_A$$

$$V_A = \frac{-(m_A + m_B)V_i + m_B V_B}{m_A}$$

Now, we want Al to catch up to wrench in $t \leq 1000$

$$\text{position of Al} = -0.70\,m + V_A(t-10)$$

$$\text{position of wrench} = 0 + (2.93\,\tfrac{m}{s})t$$

So

$$-0.70\,m + V_A(t-10) \geq (2.93\,\tfrac{m}{s})t \quad @\ t=1000$$

$$-0.70\,m + V_A(990\,s) \geq (2.93\,\tfrac{m}{s})(1000\,s)$$

$$V_A \geq \frac{2930\,m + 0.70\,m}{990\,s} \geq 2.96\,\tfrac{m}{s}$$

So, use conservation of momentum to figure out the boot's speed:

$$\begin{array}{ccc} \text{before} & & \text{after} \\ (\text{Al} + \text{boot})\left(-0.07\ \tfrac{m}{s}\right) & = & (\text{Al})\left(+2.96\ \tfrac{m}{s}\right) + (\text{boot})\, v_B \end{array}$$

$$(m_A + m_B)\left(-0.07\ \tfrac{m}{s}\right) = m_A\left(2.96\ \tfrac{m}{s}\right) + m_B v_B$$

$$\rightarrow \quad v_B = \frac{(m_A + m_B)\left(-0.07\ \tfrac{m}{s}\right) - m_A\left(2.96\ \tfrac{m}{s}\right)}{m_B}$$

$$= \frac{(80\ \text{kg})\left(-0.07\ \tfrac{m}{s}\right) - (79\ \text{kg})\left(2.96\ \tfrac{m}{s}\right)}{1\ \text{kg}}$$

$$= -239\ \tfrac{m}{s}$$

The relative speed of the boot and Al is

$$\boxed{\approx 242\ \tfrac{m}{s}}$$

which is how fast Al must have thrown the boot away from his hand.

Wow!