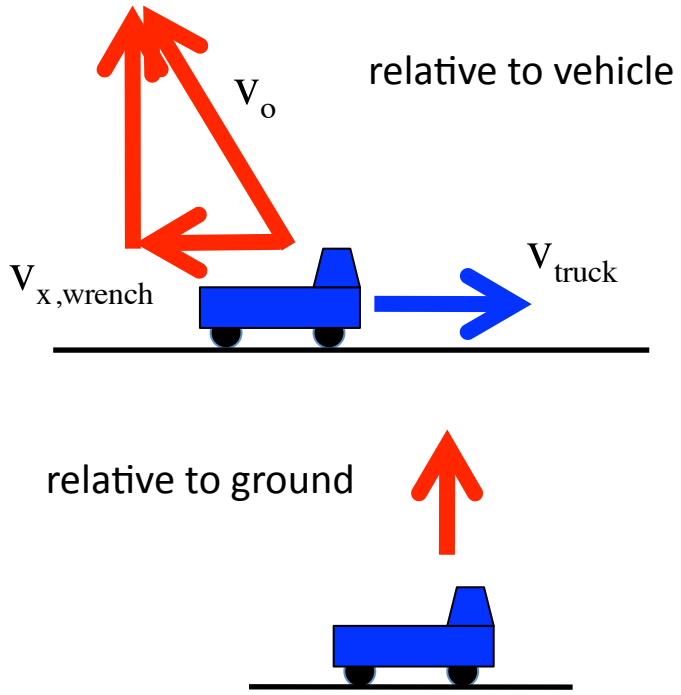
Problem 4.43

For the wrench to appear to move vertically upward with no horizontal displacement, from the perspective of the ground, the x-component of its velocity would need to equal the speed of the vehicle (so the wrench wouldn't be moving along the x-axis). Sooo . . .



$$v_x = v_o \cos 60^\circ$$
$$= v_{truck}$$
$$= 10 \text{ m/s}$$
$$\Rightarrow \quad v_o = 20 \text{ m/s}$$

Velocity at top is zero, so we can write:

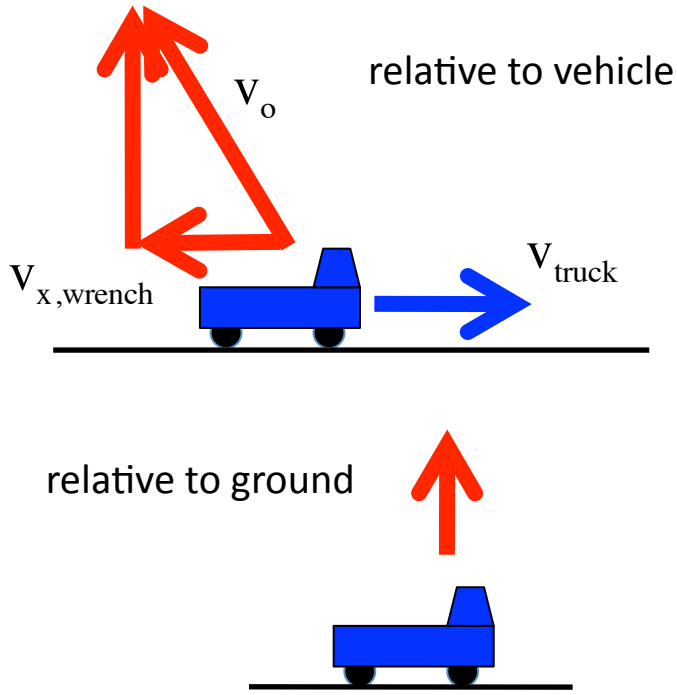
$$a_y = -g = \frac{v_{top,y} - v_{1,y}}{\Delta t}$$

$$= \frac{0 - v_o \sin 60^\circ}{\Delta t}$$

$$\Rightarrow \quad \Delta t = \frac{v_o \sin 60^\circ}{g}$$

$$= \frac{(20\ \text{m/s}) \sin 60^\circ}{(9.8\ \text{m/s}^2)}$$

$$= 1.77\ \text{seconds}$$



which means:

$$\Rightarrow \quad y_2 = y_1 + v_{o,y}\Delta t + \frac{1}{2} a_y \Delta t^2$$

$$= v_o \sin 60^\circ (\Delta t) + \frac{1}{2}(-g)(\Delta t)^2$$

$$= (20\ \text{m/s}) \sin 60^\circ (1.77\text{s}) - \frac{1}{2}(9.8\ \text{m/s}^2)(1.77\text{s})^2$$

$$= 3.85\ \text{m}$$