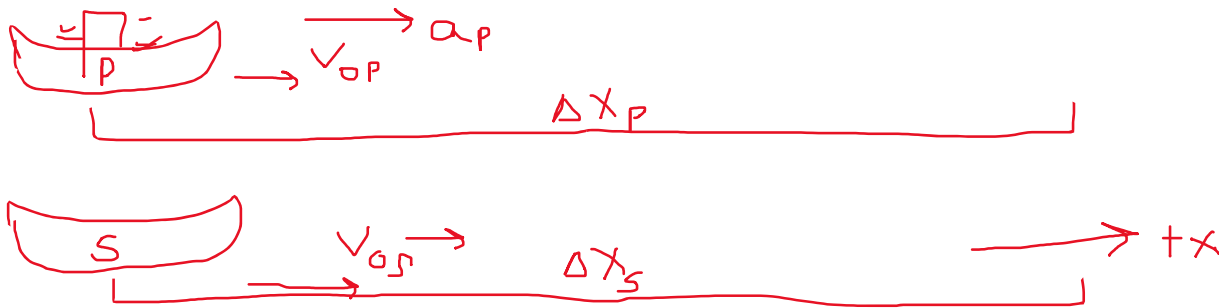**Class Activity**   **How do we know what step is next?**

A speedboat traveling at a constant velocity of 20 m/s passes a police boat at rest. The police boat starts up 8 seconds after the speedboat passes, and accelerates at 2.3 m/s² When and where does the cop catch the speedboat?

Qualitative Representation   **How did I know how to draw these sketches?**

Variables and Equations

How do I know what variables to list here? List them and explain how you know.

How do I know what equations I can use to get an answer? List them and explain how you know.
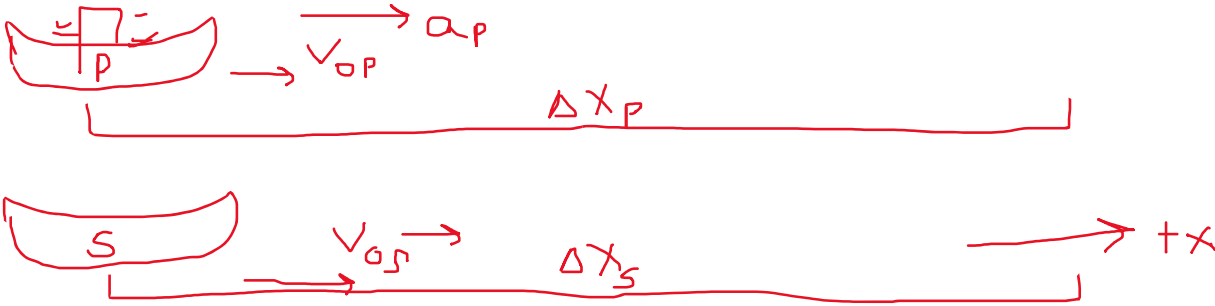
Solution (remember, show your reasoning and math)

Reasonability check?

A speedboat traveling at a constant velocity of 20 m/s passes a police boat at rest. The police boat starts up 8 seconds after the speedboat passes, and accelerates at 2.3 m/s² When and where does the cop catch the speedboat?

Qualitative Representation

Variables and Equations

$v_{0p} = 0$ $a_p = 2.3 \ m/s^2$ $\Delta t_p = \Delta t_s - 8 = ?$

$v_s = 20 \ m/s$ $\Delta x_p = \Delta x_s = ?$

$\Delta x = v_0 \Delta t + \frac{1}{2} a (\Delta t)^2$

Solution (remember, show your reasoning and math)

$\Delta x_s = v_{0s} \Delta t_s + \frac{1}{2} a_s (\Delta t_s)^2 = (20)\Delta t_s + 0$

$\Delta x_p = v_{0p} \Delta t_p + \frac{1}{2} a_p (\Delta t_p)^2 = 0 + \frac{1}{2}(2.3)(\Delta t_p)^2$

$\Delta x_p = \Delta x_s$

How do I know that the above is right, and that I should do those steps? Explain.
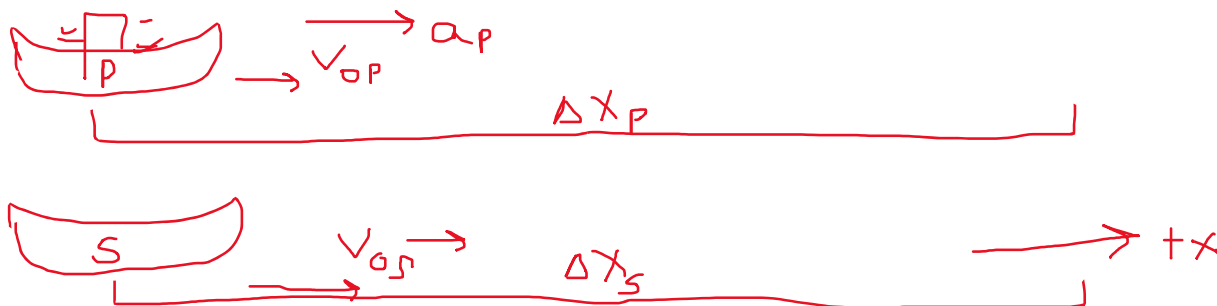
What comes next?

Reasonability check?

Class Activity   **How do we know what step is next?**

A speedboat traveling at a constant velocity of 20 m/s passes a police boat at rest. The police boat starts up 8 seconds after the speedboat passes, and accelerates at 2.3 m/s² When and where does the cop catch the speedboat?

Qualitative Representation

a_p

v_{op}

Δx_p

v_{os}

Δx_s

$+x$

Variables and Equations

$v_{0p} = 0 \qquad a_p = 2.3\ m/s^2 \qquad \Delta t_p = \Delta t_s - 8 =?$

$v_s = 20\ m/s \qquad \Delta x_p = \Delta x_s =?$

$\Delta x = v_0 \Delta t + \frac{1}{2} a (\Delta t)^2$

Solution (remember, show your reasoning and math)

$\Delta x_s = v_{0s} \Delta t_s + \frac{1}{2} a_s (\Delta t_s)^2 = (20)\Delta t_s + 0$

$\Delta x_p = v_{0p} \Delta t_p + \frac{1}{2} a_p (\Delta t_p)^2 = 0 + \frac{1}{2}(2.3)(\Delta t_p)^2$

$\Delta x_p = \Delta x_s$

$(20)\Delta t_s = \frac{1}{2}(2.3)(\Delta t_p)^2$

$(20)(\Delta t_p + 8) = \frac{1}{2}(2.3)(\Delta t_p)^2$

$20\Delta t_p + 160 = 1.15(\Delta t_p)^2$

$1.15\Delta t_p^2 - 20\Delta t_p - 160 = 0$

$\Delta t_p = 23.3\ s\ or -5.96\ s$

Police officer drives for 23.3 s; speedboat drives for 23.3 + 8 = 31.3s

$\Delta x_p = \frac{1}{2}(2.3)(23.3)^2 = 624.3\ m$ **distance they travel**

Reasonability check?
Speedboat distance $(20)\Delta t_s = 20(23.3 + 8) = 626\ m$ **– same distance, within rounding errors**
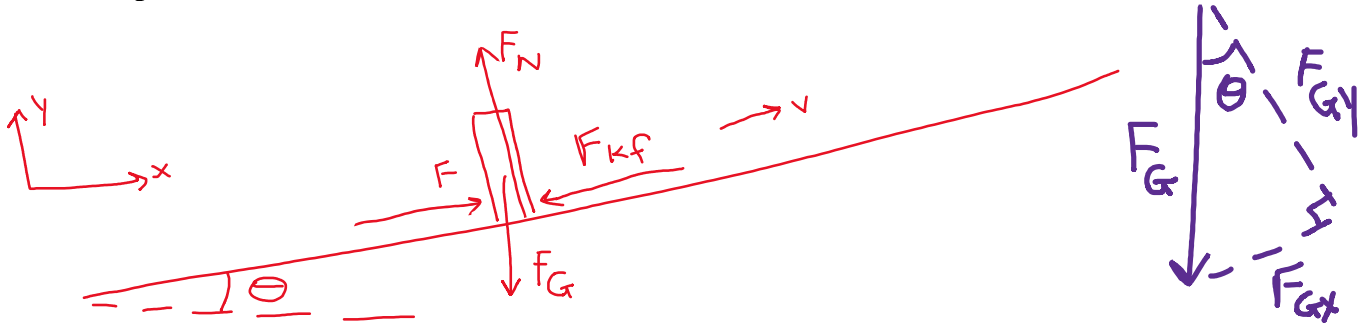**So these numbers check out**

A person pushes a filing cabinet up a ramp that's inclined 25 degrees from the horizontal, with a constant force (parallel to ramp) of 440 N, and it moves at a constant speed of 6.2 m/s. If the total mass of the filing cabinet is 82 kg, what is the coefficient of friction between the filing cabinet and the ramp?

Qualitative Representation

How do I know to create components for the gravitational force vector?

How do I know which trig function for x and y components of the gravitational force vector?

How do I know which forces are along the ramp, perpendicular to the ramp – or in another direction completely?

Variables and Equations

$\theta = 25°$ F = 440 N v_x = 6.2 m/s (constant) $a_x = 0$

m = 82 kg   g = 9.8 m/s² $a_y = 0$ μ_k =?

$\Sigma F_x = ma_x$ $\Sigma F_y = ma_y$ $F_{kf} = \mu_k |F_N|$ $F_G = mg$ How did I know which equations to use? Explain how I know.

Solution (remember, show your reasoning and math)
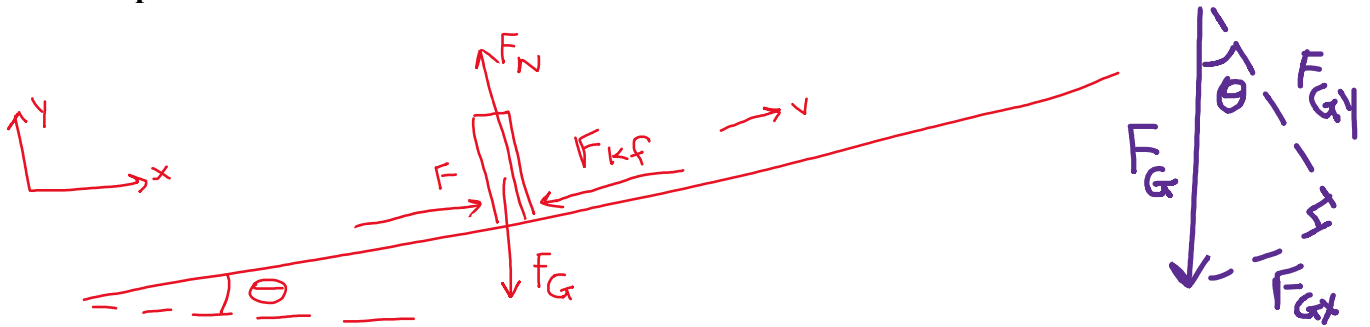
Reasonability check?

A person pushes a filing cabinet up a ramp that's inclined 25 degrees from the horizontal, with a constant force (parallel to ramp) of 440 N, and it moves at a constant speed of 6.2 m/s. If the total mass of the filing cabinet is 82 kg, what is the coefficient of friction between the filing cabinet and the ramp?

Qualitative Representation

Variables and Equations

$\theta = 25°$ F = 440 N v_x = 6.2 m/s (constant) $a_x = 0$

m = 82 kg   g = 9.8 m/s² $a_y = 0$ μ_k =?

$\Sigma F_x = ma_x$ $\Sigma F_y = ma_y$ $F_{kf} = \mu_k|F_N|$ $F_G = mg$

Solution (remember, show your reasoning and math)

$\Sigma F_y = ma_y$ why is this step necessary? Explain.

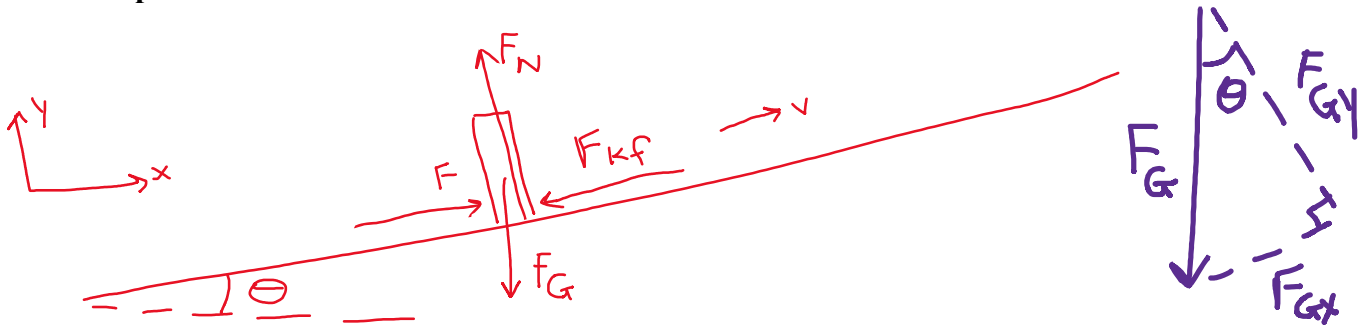**Reasonability check?**

A person pushes a filing cabinet up a ramp that's inclined 25 degrees from the horizontal, with a constant force (parallel to ramp) of 440 N, and it moves at a constant speed of 6.2 m/s. If the total mass of the filing cabinet is 82 kg, what is the coefficient of friction between the filing cabinet and the ramp?

Qualitative Representation

Variables and Equations

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$\Sigma F_x = ma_x$ $\Sigma F_y = ma_y$ $F_{kf} = \mu_k|F_N|$ $F_G = mg$

Solution (remember, show your reasoning and math)

$\Sigma F_y = ma_y$

$F_N - F_{Gy} = 0$

$F_N - F_G \cos\theta = 0$

$F_N = (82)(9.8)\cos 25° = 728.3N$
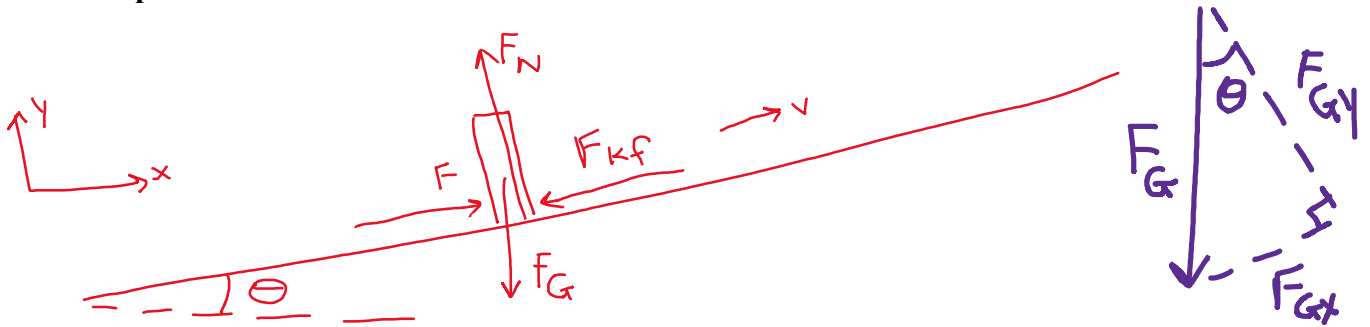
What step is next? How do I know what to do?

Reasonability check?

A person pushes a filing cabinet up a ramp that's inclined 25 degrees from the horizontal, with a constant force (parallel to ramp) of 440 N, and it moves at a constant speed of 6.2 m/s. If the total mass of the filing cabinet is 82 kg, what is the coefficient of friction between the filing cabinet and the ramp?

Qualitative Representation

Variables and Equations

$\theta = 25°$ F = 440 N v_x = 6.2 m/s (constant) $a_x = 0$

m = 82 kg   g = 9.8 m/s² $a_y = 0$ $\mu_k =?$

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$\Sigma F_x = ma_x$

What do I do with this? Explain.
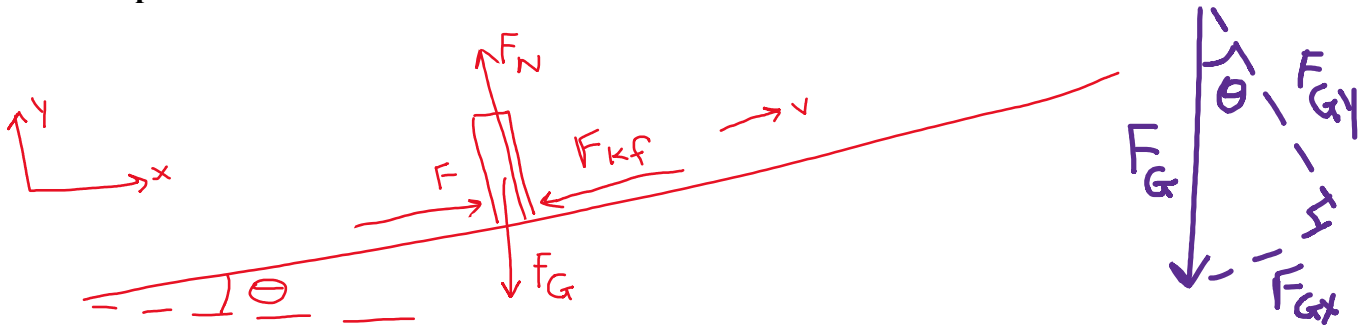
Reasonability check?

Class Activity   **How do we know what step is next?**

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Qualitative Representation

Variables and Equations

$\theta = 25°$ $F = 440$ N $v_x = 6.2$ m/s (constant) $a_x = 0$

$m = 82$ kg $g = 9.8$ m/s^2 $a_y = 0$ $\mu_k =?$

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$F_N - F_{Gy} = 0$

$F_N - F_G \cos\theta = 0$

$F_N = (82)(9.8)\cos 25° = 728.3N$

$\Sigma F_x = ma_x$

$F - F_{kf} - F_{Gx} = 0$

$440 - \mu_k(728.3) - (82)(9.8)\sin 25° = 0$

$100.38 = \mu_k(728.3)$

$\underline{\mu_K = 0.138}$

Reasonability check?

The coefficient of kinetic friction should be between 0 and 1. The value close to 0.1 indicates this ramp might be a little smoother than the average floor, but it isn't super slippery.