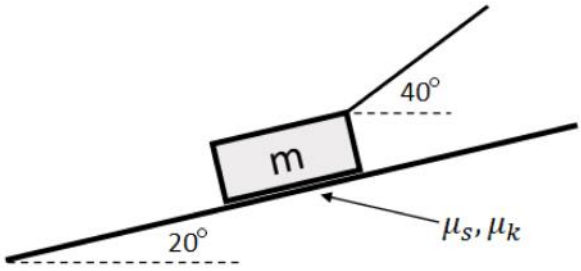
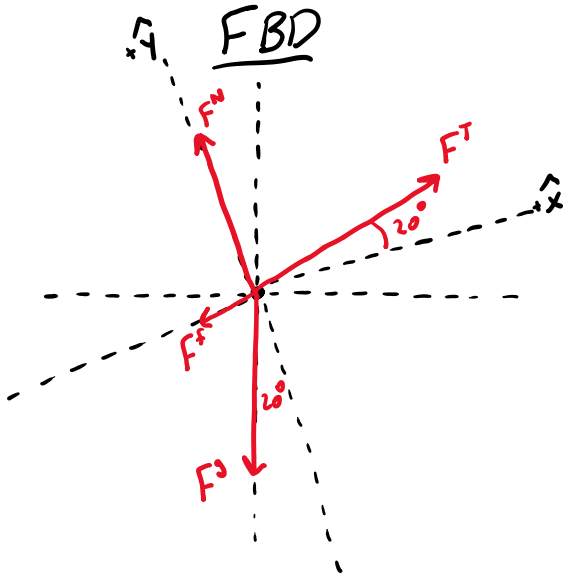
Week 5 Recitation Quiz

Part 1: Work on this question by yourself using this sheet of paper. You will have approximately 20 minutes to write your solution of this question. Please show all of your work. The solution process is MUCH more important than the final answer! Any numerical answer will usually be worth at most 10% of the total points.

1) A box of mass m = 2 kg is pulled up a ramp by a rope. The box is accelerated at a constant rate of a = 1.5 m/s². The box and ramp have static and kinetic coefficients of friction of $\mu_s = 0.5$, and $\mu_k = 0.2$. The ramp makes an angle of 20 degrees with the horizontal, while the rope makes an angle of 40 degrees with the horizontal

   (a) What is the magnitude of tension in the rope?





Force analysis

x

$$\Sigma f_x = ma_x$$

$$F_x^T + f^f + F_x^g = ma_x$$

$$|F^T| \cos 20^\circ - \mu_k |F^N| - mg \sin 20^\circ = ma_x$$

y

$$\Sigma f_y = ma_y^{\,0}$$

$$F^N + F_y^T + F_y^g = 0$$

$$F^N + |F^T| \sin 20^\circ - mg \cos 20^\circ = 0$$

Combining & solving the force analysis

From y ⇒ $F^N = mg \cos 20^\circ - |F^T| \sin 20^\circ$

↳ x-analysis ⇒ $|F^T| \cos 20^\circ - \mu_k (mg \cos 20^\circ - |F^T| \sin 20^\circ) - mg \sin 20^\circ = ma_x$

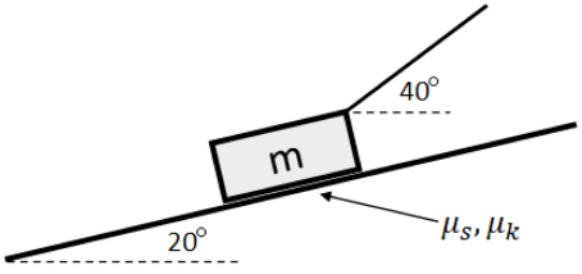
$$0.940\,|F^T| - 3.68\ \text{N} + 0.068\,|F^T| - 6.70\ \text{N} = 3\ \text{kg}\,\tfrac{\text{m}}{\text{s}^2}$$

$$|F^T| = 13.3\ \text{N}$$

Week 5 Recitation Quiz

Part 2: Work on this question in groups using a whiteboard and markers. Your group will have approximately 20 minutes to write your solution of this question. Please show all of your work. The solution process is MUCH more important than the final answer! Any numerical answer will usually be worth at most 10% of the total points.

2) A box of mass **m = 2 kg** is pulled up a ramp by a rope. The box is accelerated at a constant rate of **a = 1.5 m/s²**. The box and ramp have static and kinetic coefficients of friction of μ_s **= 0.5**, and μ_k **= 0.2**. The ramp makes an angle of **20 degrees** with the horizontal, while the rope makes an angle of **40 degrees** with the horizontal



(a) Draw a free body diagram with approximately scaled force vectors. Make sure to include and label all relevant forces. Also make sure to indicate your choice of coordinate system (which direction are the x and y?).

(b) Write out the force analysis (Newton's 2nd law) for the x-direction. Simplify any "knowns" such as $F^g = mg$ and $F^f = \mu_k F^N$, but do not plug any numbers in. An example: $mg\cos(\theta) + F^N{}_x = ma_x$. This is not the correct relationship!

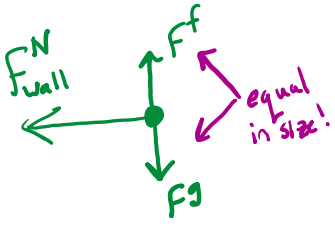
(c) Write out the force analysis for the y-direction in the same manner.

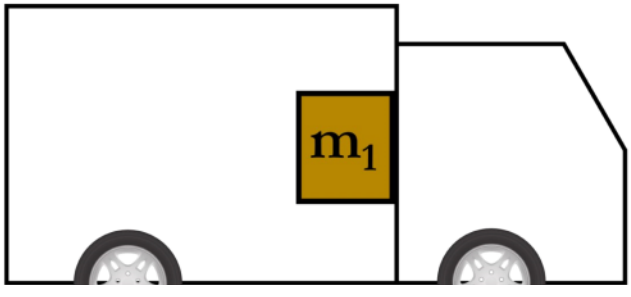
3) A delivery van is driving along a horizontal road. The truck could be moving at a constant speed, or accelerating in either the forwards or backwards direction. A box (m1) in the back of the van is up against the front end of the cargo area, not sliding on the wall. If the van was not accelerating, the box would slide downwards. There is friction between the box and the wall. For all parts of this question, analyze the situation as if you are standing on the Earth watching this van and box move in front of you.

(a) Describe with words, diagrams, etc… two scenarios of the van's motion that could result in the box not sliding relative to the wall, as shown in the figure.

(b) Sketch a FBD of the box system for one of the scenarios you described in part (a).

(b) FBD





(a) 1) $\vec{v} \rightarrow$ $\vec{a} \leftarrow$

2) $\leftarrow \vec{v}$ $\leftarrow \vec{a}$

3) $v = 0$ $\leftarrow \vec{a}$