PH 107 Supplemental Problems 15 (10/7/26)

Knight 5.6

This problem will be graded on completion/participation, not accuracy.

Problem:

A 1500 kg car is traveling at a speed of 30 m/s when the driver slams on the brakes and skids to a halt. Determine the stopping distance if the car is traveling up a 10° slope as it brakes. You may assume that the car feels kinetic friction while skidding with kinetic coefficient μ_k = 0.80.

Let's break this down into steps:

a) Draw a picture of what is happening. Label your variables. Draw your coordinate system. You should set the positive x direction pointing UP the ramp, and the positive y direction pointing perpendicular to the ramp.

b) You will need to choose one of the following equations to find stopping distance, which one is it?

$$v_{f,y} = v_{i,y} + a_y \Delta t$$

$$(v_{f,x})^2 = (v_{i,x})^2 + 2a_x \Delta x$$

c) Notice that you need to find acceleration in the x-direction a_x. You can do that with Newton's 2nd law in the x-direction… Write "ok" if you read this statement.

d) Draw a FBD of a car on the ramp as it skids to a stop. You will need to include normal force (perpendicular to the ramp direction), force of gravity (straight down), and kinetic friction pointing against the direction of motion and parallel to the ramp. Show how you would decompose your gravity into the x and y direction by drawing the $F_{g,x}$ and $F_{g,y}$ vectors that make up the F_g vector. You should see a small right triangle. Mark where theta (ramp angle) is.

e) Write Newton's Law in the x-direction: $F_{net,x} = ma_x$. Remember that F_{net} means you are adding all the x-direction forces. You can "read off" your forces from the FBD.
Hint: In the x-direction, we have kinetic friction and the x component of the force of gravity.

f) Note that $F_g = mg$. What is $F_{g,x}$? You'll need to use trig. As a checkpoint, you should find that $F_{g,x} = -2552.6$ N.

g) Let's find the value of kinetic friction f_k. Use the equation $f_k = \mu_k N$ where N is the normal force. You can solve for normal force using Newton's second law in the y-direction: $F_{net,y} = N - mg\cos(\text{theta}) = 0$. As a checkpoint, you should find that the normal force is 14476.6 N. Now find the amount of kinetic friction. You are given the coefficient of kinetic friction mu_k in the problem.

h) Put everything together to find a_x using Newton's second law that you wrote out in part e. As a checkpoint, you should find $a_x = -9.42$ m/s^2.

i) Answer the original question! I.e. Determine the stopping distance if the car is traveling up a 10° slope as it brakes. You'll want to use the kinematic equation you picked in part b now that you have a_x.

Checkpoint: You should find that the car slides delta x = 47.8 m.