Warm Up

Get a Chromebook, log in to Canvas, and complete the Section 4.6 Reading Quiz (under "quizzes").

Objective: SWBAT solve problems involving friction

Agenda:

- Warm Up
- Notes
- Practice
- Reflection

HW: pg. 121
39 – 53 odd

Notes: Static vs. Kinetic Friction

Friction is a contact force that opposes motion when an object tries to slide over a surface (we'll ignore rolling friction).

There are 2 types:

- Static Friction: Exerted on the object when there is no motion

- Kinetic Friction: Exerted on the object when it is moving

Notes: Defining Friction Force

The friction on an object is proportional to the normal force from the surface it slides over, and on what the surface is made of.

coefficient of static friction

Static Friction: $F_{f,\,static} \leq \mu_s F_N$

the minimum force required to move something

Once it's moving, kinetic friction takes over

$F_{f,\,kinetic} = \mu_k F_N$

Examples

1. A force of 102 N is required to get a 105 kg couch moving across a room. What is the coefficient of static friction for that floor?

need	not need	question
$F = 102\,N$		$\mu_s = ?$
$m = 105\,kg$		

$F_s = \mu_s F_N$

$F_N = mg$

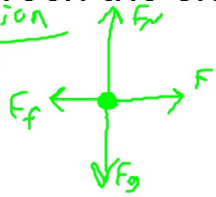
$F_s = \mu_s mg$

$\mu_s = \frac{F_s}{mg} = \frac{102\,N}{(105\,kg)(9.8\,m/s^2)}$

$= 0.0991$

2. A girl pulls a 52 N sled across a sidewalk at a constant speed with a horizontal force of 36 N. What is the coefficient of kinetic friction between the sidewalk and the metal runners?

need	not need	question
$F_g = 52\,N$		$\mu_k = ?$
$F = 36\,N$		
$a = 0$		



$f_f = 36\,N$

$f_N = 52\,N$

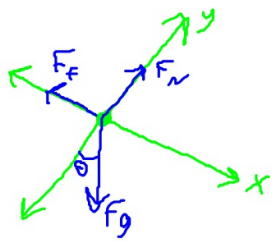
$F_f = \mu_k F_N$

$\mu_k = \frac{F_f}{F_N} = \frac{36\,N}{52\,N}$

≈ 0.69

pg. 110: A Block on a Ramp

question	need	not need
$\theta = ?$	$F_f = \mu_s F_N$	
	$\mu_s = 0.350$	
	$m = 2.50\,kg$	
	$a = 0$	

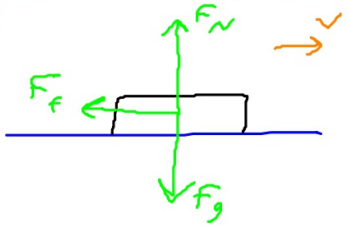


$F_N = F_{g,y} = mg\cos\theta$

$F_{net,x} = 0 = F_{g,x} - F_f$

$0 = mg\sin\theta - \mu_s mg\cos\theta$

pg. 111: The Sliding Hockey Puck

question	need	~~not need~~ diagram
$\mu_k = ?$	slows steadily (constant a) $\Delta x = 120\,m$ $v_0 = 20.0\,m/s$ $v_f = 0.00\,m/s$ $F_f = \mu_k F_N$	

no time:

$v^2 = v_0^2 + 2a\Delta x$

$v^2 - v_0^2 = 2a\Delta x$

$a = \frac{v^2 - v_0^2}{2\Delta x}$

$= \frac{0 - (20.0\,m/s)^2}{2(120\,m)}$

$= -1.67\,m/s^2$

$F_{net,y} = 0 = F_N - F_g \rightarrow F_N = mg$

$F_{net,x} = ma = -F_f$

$ma = -\mu_k mg$

$\mu_k = \frac{-a}{g} = \frac{-(-1.67\,m/s^2)}{(9.8\,m/s^2)} = 0.170$

Practice

Textbook practice problems

Reflection

What is the (qualitative) difference between static and kinetic friction?