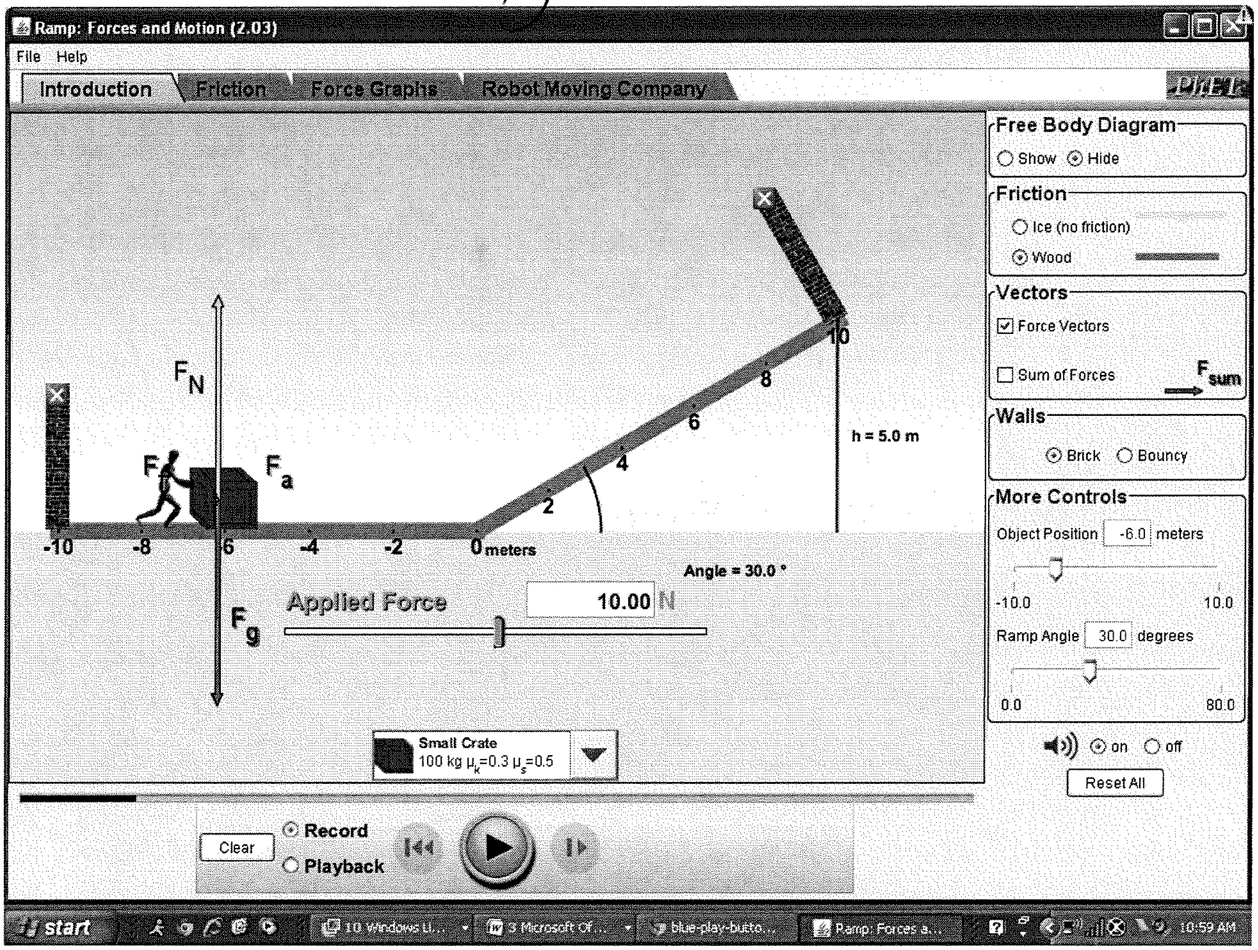
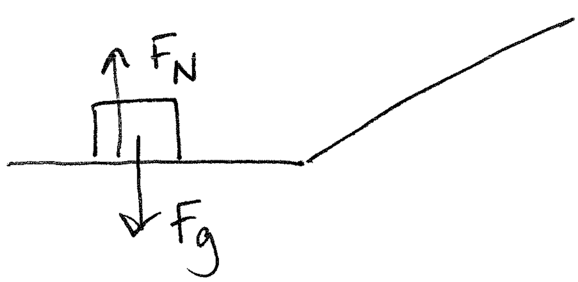
Forces Virtual Lab: Key



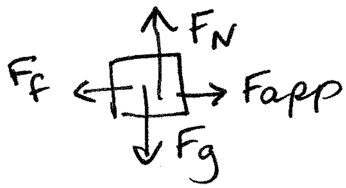
Go to http://phet.colorado.edu/en/simulation/ramp-forces-and-motion

You will be starting with a crate that has a mass of 100 kg and a coefficient of sliding friction of 0.3 and a coefficient of static friction of 0.5

1. Draw the Free Body Diagram (a picture showing the forces on the crate) before you apply any force.



2. Add 10 N of applied force, and push the button and record what happens. Include a free body diagram showing all the forces.



Didn't move

3. Add 100 N of applied force and push the button. What changed?

Still didn't move
Friction and Fapp arrows got longer

4. Use the friction equation to calculate how much force would be required to get it moving. Show your work here..... Try it out. What happened? How did you fix the problem to get it moving?

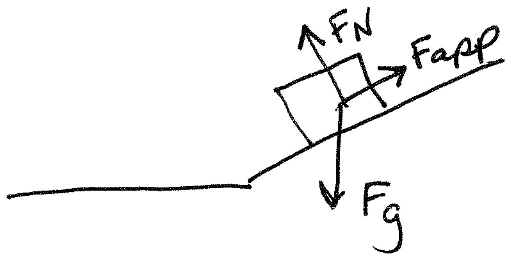
$F_f = \mu F_N = \mu m g$

$F_f = .5(100)(9.8) = 490N$

490 N didn't make it move but if you increase it to 491 N, it does move.

5. What happened as the crate moved up the ramp? Show the free body diagram while the crate is on the ramp. What force is working against your applied force?

Crate slowed down and stopped ½ way up the ramp



The Force working against the applied force is the parallel component of gravity $F_{g\parallel}$

6. Reset all. Predict what you think would happen if you increased the angle. What actually happened? Explain why you saw what you saw.

Increase angle – doesn't go up as high on ramp
$F_{g\parallel}$ increases so it slows it down more

7. Reset all. Predict what you think would happen if you decreased the angle. Try it out. Why? Crashes into wall at 15° & goes up higher. Less parallel force to slow it down.

8. Place the crate on the ramp with the angle at 20°. What is true about the parallel force and the friction force if the crate does not go down the ramp? Slowly increase the angle until the block JUST starts to move. Use the angle to calculate μ_s and compare to the given value for μ_s for the crate.

$F_{g\parallel} = F_f$ if no applied force

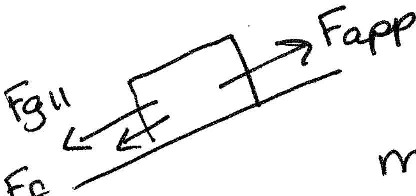
angle it moves at is 27°, so use 26°

$\cancel{m}\cancel{g}\sin 26 = \mu \cancel{m}\cancel{g}\cos 26$

$\mu = \frac{\sin 26}{\cos 26} = \tan 26$ $\mu = .49$ – very close to .5!! :)

9. Calculate how much force you would have to apply to the crate to get it to go at constant speed up the 30° ramp. Show your work below and record your answer to the tenth of a Newton (Hint: Remember it's moving now, so which μ do you need to use?)

const speed means forces are equal up/down



$F_{g\parallel} + F_f = F_{app}$

$mg\sin 30 + \mu mg\cos 30 = F_{app}$

$100(9.8)\sin 30 + .3(100)(9.8)\cos 30 = F_{app}$

$F_{app} = 744.6\ N$

10. Go to the "Forces Graph" tab. Reset all. Input your applied force and push play. Stop the crate before it crashes into the wall. Is your net force = 0 ($F_{sum\parallel}$)? What does that tell you about the motion of the crate?

yes, $F_{sum\parallel} = 0 = F_{net}$ which means no accel which means const speed :)

11. Place the block at the top of the 30° ramp (Position = 8.9 m). What is the net force on the block down the ramp? (Show your calculation below). What is the acceleration of the block down the ramp? (Include in your calculation). What would be the final velocity of the block at the bottom of the ramp?

$F_{net} = F_{g\parallel} - F_f$

$F_{net} = mg\sin 30 - \mu mg\cos 30$

$F_{net} = (100)(9.8)(\sin 30) - .3(100)(9.8)\cos 30$

$\boxed{F_{net} = 235.4\ N}$

$F_{net} = ma$

$235.4 = 100a$

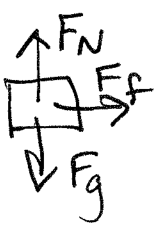
$\boxed{a = 2.354\ m/s^2}$

$V_f^2 = v_i^2 + 2ax$

$v_f^2 = 0^2 + 2(2.354)(8.9)$

$\boxed{V_f = 6.473\ m/s}$

12. What force is acting on the crate once it hits the flat part at the bottom of the ramp? What is the magnitude and direction of that force?



F_f only $= \mu mg$

$= .3(100)(9.8)$

$= 294N \rightarrow$ negative direction

13. What will be the acceleration of the crate on the flat part at the bottom of the ramp?

$F = ma$

$-294 = 100a$

$a = -2.94\ m/s^2$

14. Calculate how far the crate should slide at the bottom. Try it out. How did your calculation compare to the applet result?

$V_f^2 = v_i^2 + 2ax$

$0 = (6.473)^2 + 2(-2.94)(x)$

$x = 7.1\ m$ Actually goes 7.0m

very close again!