Name_____Period _____ Date_____

UNIT 5 WORKSHEET 3: Newton's 2nd Law & Friction

Force of Friction

There are two main types of friction:

1) **Kinetic Friction** – The force exerted on one surface by a second surface when the 2 surfaces rub against one another because one or both of the surfaces are moving. The symbol in an equation is F_k

   Example: Rubbing your hands together, object sliding down a ramp, etc

   A) This kinetic friction depends on how rough or smooth the surface is on each of the objects. If the surfaces are rough like sand paper the friction would be high, but if the surfaces are smooth like ice the friction would be small. The "coefficient of friction" is a decimal number (always less than 1) that represents how the surfaces interact because of how smooth or rough they are. This number has NO UNITS and the symbol in the equation is a "mu" which looks kind of like a u . . . . **μ.** The symbol will be μ_k.

   B) Kinetic friction also depends on how hard the surfaces are pressed together. This can be determined by the Normal Force (you have calculated this out 50 times by now). If the normal force is high then the friction increase because of how hard the surfaces are pressed together.

Equation $$F_k = \mu_k F_N$$

2) **Static Friction** – The force exerted on one surface by a second surface when there is no motion between the two surfaces. The symbol is F_s.

   Exampe: A computer sitting on a desk with no force trying to move it horizontally has NO static friction, but as soon as a force is applied to TRY and move it, **but it doesn't move**, there is static friction. The static friction is equal to the force that is being applied. At some point the force applied will be greater than the maximum static friction that is possible and the object will start to accelerate.

   A) Static friction also has a coefficient of friction . . . μ_s. It works the same way as kinetic friction.

   B) The Normal Force has the same effect here also.

Equation $$F_s \leq \mu_s F_N$$

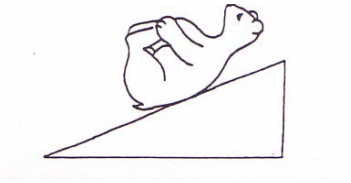
   NOTICE this equal has a ≤ instead of an equal sign. If the object isn't moving and some type of force is being applied to try and make it move than the static friction force is equal to μ_s X F_N. If there is no force being applied to try and make it move than the staic friction is zero making it less than μ_s X F_N.

*** This really just adds one more thing to calculate. You will still use a force diagram and the sum of the forces in the same way you have used them for 3 weeks now. You will just have to use the sum of force statement to find the Normal Force and then use the equation to find the frictional force.
Example Problems

Ex 1) Brian is walking through the school cafeteria but does not realize that the person in front of him has just spilled his glass of chocolate milk. As Brian, who weighs 420 N, steps in the milk, the coefficient of sliding friction between Brian and the floor is suddenly reduced to 0.04. What is the force of sliding friction between Brian and the slippery floor?

Ex 2) While redecorating his apartment, Kitty slowly pushes an 82 kg cabinet across the woodent dining room floor, which resists the motion with a force of friction. If the coefficient of sliding friction between the china cabinet and the floor is 0.2 and Kitty pushes with a force of 200N, what is the acceleration of the cabinet?

Ex 3) At sea world, a 900 kg polar bear slides down a wet slide inclined at a 25° angle to the horizontal. The coefficient of friction between the bear and the slide is 0.05. What frictional force impedes the bear/s motion down the slide and what is the bear's acceleration?



1. A block weighing 300. N is moved *at constant speed* over a horizontal surface by a force of 50. N applied parallel to the surface.

   a. Construct a force diagram for the block.

   b. What is the coefficient of kinetic friction?

   c. What would be the acceleration of the block if μ_k is changed to zero?

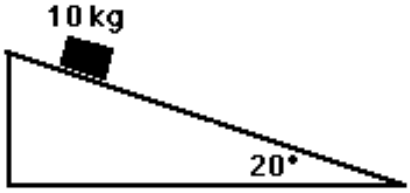
2. A 100 N force is applied horizontally to a 50 kg crate resting on a level floor. The coefficient of kinetic friction is 0.15.

   a) Draw a force diagram to represent this situation.

   b) What is the acceleration of the crate?

3. Use the situation described above, but coefficient of static friction is changed to $\mu_s = 0.25$. Is the 100 N force sufficient to cause the crate to accelerate? Draw a force diagram, then explain why or why not.

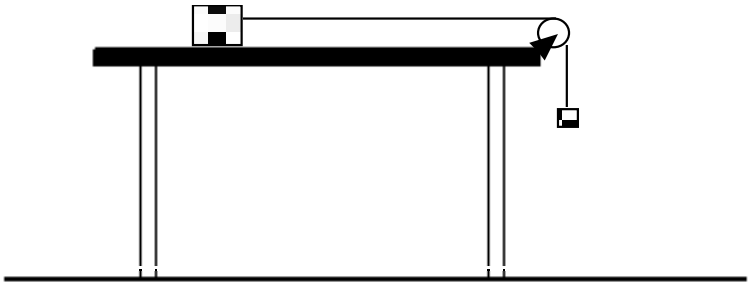
4. A 10 kg block is allowed to slide down a ramp with $\mu_k = 0.15$.



a) What is the value of the frictional force opposing the block's slide down the ramp?

b) What is the acceleration of the block?

5. Suppose a hanging 1.0 kg lab mass is attached to a 4.0 kg block on the table.



a. If the coefficient of kinetic friction, μ_k is 0.20., what is the acceleration of the block and the tension in the rope?

b. What would be the minimum value of the coefficient of static friction, μ_s, in order for the block to remain motionless?