FRICTION NOTES

WHAT IS FRICTION?

What are the types of friction?
Starting (static), Sliding (kinetic), rolling, air, etc

What causes it?
Friction is the large scale representation of the electromagnetic force caused by the interaction between molecules of two surfaces. It is a force that always acts opposite the direction of motion. (opposite velocity, not necessarily A or F).

Always depends on ***the normal force (weight) or the push between the two surfaces, and also on all the molecular stuff: density, molecular size, stickiness, attractiveness, texture, etc..***

Which type of friction is strongest?
Static friction is always higher than kinetic friction.

How do we measure friction?

$F_f = \mu F_N$

Force of friction can be measured by pushing/pulling something at a constant velocity so Fnet = 0, then Ffriction = - Force push or pull
What is the coefficicnt of friction?
$F_f = \mu F_N$
$\mu = F_f / F_N$ ***It is a number that represents all the molecular interactions between two surfaces.. It has no units, and depends on the two surfaces. It is expressed as a ratio of the Friction force to the normal force.***
What is the normal force?
The normal force is the push, according to Newton's Third Law, between tow surfaces. If an object is on a horizontal surface, then the normal force is equal and opposite the weight. If the object is on a diagonal or there is another force also pushing down or pulling up, the normal force is the force perpendicular to the surface. On the ground then, usually $F_N=W$. On a ramp $F_N=W\cos\theta$

TO ANSWER:
A skier slides down a slope. What force causes him to go down?
A component of his weight (F down = W sin θ)
What force opposes him?
Friction opposes him.
What changes in environmental conditions might cause a change in the frictional force?
Friction could depend on the weight, the angle of the slope, or the snow conditions.
$F_f = \mu F_N = \mu W \cos\theta = \mu m g \cos\theta$

FRICTION PROBLEMS

1) $D = \frac{(Vi+Vf)}{2} * T$

2) $Vavg = \frac{(Vi+Vf)}{2}$

3) $Vf = Vi + A*T$

4) $D = Vi*T + \frac{1}{2}*A*T^2$

5) $Vf^2 = Vi^2 + 2*A*D$

Newton's Laws

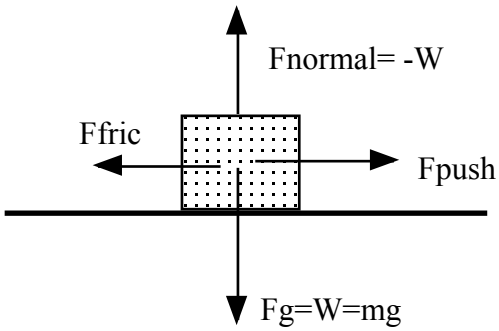
Fnet = m * A

F1 = F2

Weight = m * g

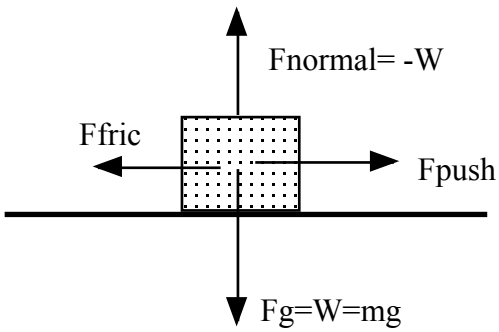
$F_f = \mu F_N = \mu W = \mu mg$). $\mu = F_f / F_N$

1) What net external force is required to give a 25 kg suitcase an acceleration of 2.2 m/s^2 to the right? Draw a free body diagram. **If it is wood on wood (**μ = .2 **what is the force of the push?**



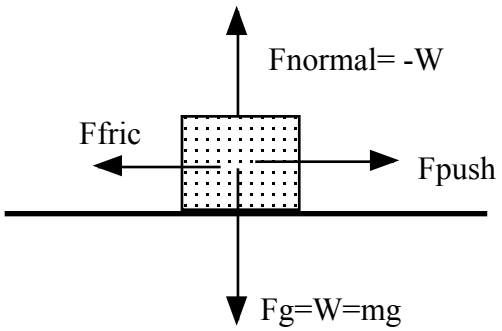
Fnet=Fpush-Ffric= m * A ,m=25 kg, A = 2.2 m/s²
so Fnet = 25*2.2 = 55 N
Fnormal = W = mg = 25 * 9.8 = 245 N
Ffriction = μF_N = .2 (245) = 49N
Fnet = Fpush – Ffrict
55 = Fpush – 49
Fpush = 55 + 49 = 104 N

2) What acceleration will you give to a 24.3 kg box if you push it with a force of 85.5 N? **If it is aluminum on steel so (**μ = .47 **what is the acceleration?)**



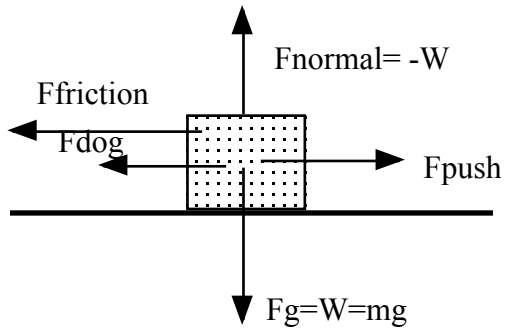
Fnormal = W = mg = 24.3 * 9.8 = 238.14 N
Ffriction = μ F_N = .47 (238.14) = 111.93N
Fnet = Fpush – Ffrict
Fnet = 85.5 – 111.93
Fnet = -26.43 N = m*A
-26.43 = 24.3 * A , A = 26.43/24.3 = -1.088 m/s^s
This object actually would not move at all,
because friction can't all of a sudden make it go backwards!

3) A 1850 kg car is moving to the right at a constant velocity of 1.44 m/s. What is the net force on the cart? **If it is rubber on concrete so (μ = .8 what is the force?)**



Fnormal = W = mg = 1850 * 9.8 = 18130 N
Ffriction = μ F_N = .8 (18130) = 14504N
If velocity is constant, A=0, so Fnet=0,
Fnet=Fpush-Ffric so
Fpush=Ffriction
Fpush = 14504 N

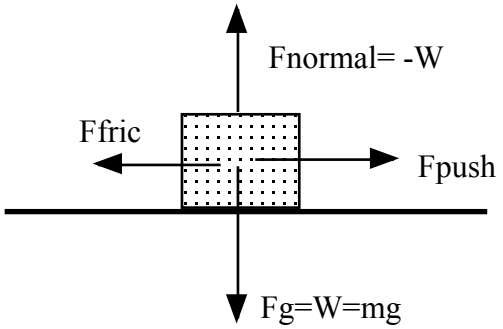
4) A man is pushing a 200 Newton box with a force of 50 Newtons along the floor. A dog is pushing against him with a force of 4 N . What is the acceleration of the box? Draw a free body diagram for the box. **If it is glass on glass so (μ = .4 what is the acceleration?)**



Fnormal = W = mg = m * 9.8 = 200 N ,
m = 200/9.8 = 20.4 Kg

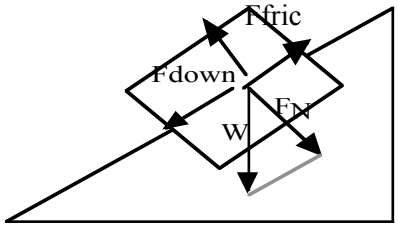
Ffriction = μ F_N = .4 (200) = 80N
Fnet = Fpush –Fdog-Ffric
= 50N – 4N – 80 N
= -34 N =Fnet= mA
= 20.4 * A,
A = -1.67 m/s^2 Note that once again, this is impossible so the box would NOT move!

9) A 1200 kg boat moves through the water with two forces acting on it. One is a 2100 N forward push by the motor, and the other is a 1800 N resistive **friction** force of the water. **What is the coefficient of friction?**



Fnormal = W = mg = 1200 * 9.8 = 11760 N
Ffriction =1800 = μ F_N = μ (11760)
μ= 1800 / 11760 = .153

** Honors:
13) A block with a mass of 50 kg is sliding down a ramp, **that is wood on wood,** that is at an angle of 60 degrees. What is the component of the force causing it to slide? **What is the force of of friction?** What is its acceleration? Draw a picture and force diagram.



Fdown = W sin ø
Fnormal = W cos ø

W = m * g = 50 * 9.8 = 490 N , μ= .2 for wood on wood
Fdown =Fparallel=Fpush= W sin θ = 490 sin 60 = **424.35 N**
F_N = W cosθ = 490 cos 60 = 245 N

Ffric = $\mu F_N = \mu W \cos\theta$ = .2 (245) = **49 N**

Fnet = Fpush – Ffric = 424.35 – 49 = 375.35 N = Fnet

Fnet = m * A, 375.35 = 50 * A , **A =7.5 m/s^2**