Physics 20 Unit B - Dynamics

Friction

Page 1

Questions?

Page 2

Review: Define each concept. $\vec{F} = m\vec{a}$

a) Gravitational Force pulls downwards on everything.
$\vec{F}_g = m\vec{g}$

b) Normal Force
acts when objects are on a surface at a right
$\vec{F}_N = X$

c) Tension
Force in a rope/wire $\vec{F}_T = X$

d) Net Force total of all forces on an object. $\vec{F}_{net} =$

e) Applied Force Force on an object from outside source
$\vec{F}_{app} = X$

What is an eqn. to calculate any of these forces?

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Friction

Up until now, we have largely ignored the force of friction on objects. Today, we will start to examine this force.

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There are two main categories of friction: fluid and dry. In this class, we will look only at dry friction.

Dry friction is the resistive force arising when two surfaces come into contact with one another. This force stems from weak chemical bonds being created between the two surfaces.

We will examine two types of dry friction:

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Static Friction: the friction between two surfaces that are not moving relative to each other.

ex) The friction that keeps the tire on the incline.
ex) The friction that stops a brick dropped on a conveyor belt.

Kinetic Friction: the friction between two surfaces that are moving relative to each other.

ex) The friction that slows a car down on the highway.

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Question: What factors might affect friction?

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For our purposes, only two variables affect the amount of friction:

1. The surfaces which are in contact.
2. The amount of normal force between the surfaces.

The amount of surface area DOES NOT affect the amount of friction on an object (this is merely an empirical observation...)

Let's put Boxy in a situation with a little FRICTION!!!

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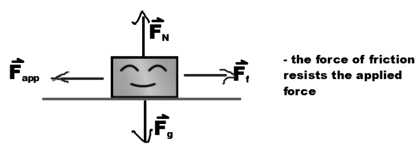
Consider: a box on a line...



From this diagram (and Newton's ____ Law) we know that the force of friction will balance any force applied to the object.

The force keeping the object in place until it starts to move is static friction. Once this is overcome, the friction acting against the moving object is kinetic friction.

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Calculating Friction

We can calculate the force of friction using:

$$\vec{F}_f = \mu \vec{F}_N$$

where:

μ = the coefficient due to friction (unit-less constant)
μ = Greek symbol "mew".

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The coefficient due to friction is found experimentally. The larger the coefficient, the larger the force of friction.

A list of many coefficients is given in your text on page 183.

Approximate Coefficients of Friction for Some Materials
Table 3.4

Material	Coefficient of Static Friction μ_s	Coefficient of Kinetic Friction μ_k
Copper on copper	1.6	1.0
Steel on dry steel	0.41	0.38
Steel on greased steel	0.15	0.09
Dry oak on dry oak	0.5	0.3
Rubber tire on dry asphalt	1.2	0.8
Rubber tire on wet asphalt	0.6	0.5
Rubber tire on dry concrete	1.0	0.7
Rubber tire on wet concrete	0.7	0.5
Rubber tire on ice	0.006	0.005
Curling stone on ice	0.003	0.002
Teflon™ on Teflon™	0.04	0.04
Waxed hickory skis on dry snow	0.06	0.04
Waxed hickory skis on wet snow	0.20	0.14
Synovial fluid	0.01	0.01

Question: Why is the $\mu_s > \mu_k$?

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ex) LD is pulling a sack of potatoes across the floor. The sack has a mass of 7.6 kg. The coefficient of kinetic friction between the floor and sack is 0.20. What is the force of friction?

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ex) A 750 kg car is traveling at 30 m/s on dry asphalt when it skids to a stop.

a) How far does the car take to stop?

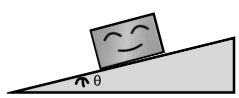
(Hint: use data from previous table.)

b) If the asphalt is wet, how much further will it take the car to stop?

Inclined Planes

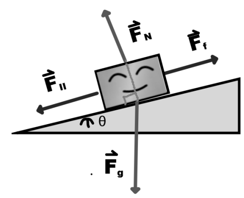
A good place to examine the effects of static and kinetic friction is on inclined planes.

Imagine a box living on such a plane:



θ = angle of incline

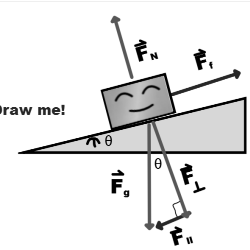
What forces are acting on this box? **next**



$\vec{F}_{\parallel}$ = force parallel (to the inclined plane). This is a component of the force of gravity.

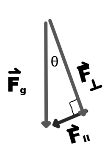
But things don't quite balance out here. Let's redraw our vectors into a different free body diagram.

*Draw me!



$\vec{F}_{\perp}$ = force perpendicular (to the plane).

This too is a component of the force of gravity.



All we have done is broken the force of gravity into components. The angle in the triangle is the same as the angle of incline.

ex) A box weighing 562 N is at rest on an incline of 30°. Find each force acting on the box.

Step 1: Draw a free-body diagram.

Step 2: Calculate the parallel and perpendicular forces using trig.

Hint - The direction of the box can just be "down the ramp".

ex) __________, mass 70 kg, is skiing down an incline of 38°. The snow is dry and the skis are hickory. What is _______'s acceleration?

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b) If the snow melts some and becomes wet, what is the new acceleration?

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c) What coefficient due to static friction is needed to keep _________ at rest?

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HW: pg 179 # 1 and 2

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