Physics 1021

Spring 2012
Chapter 5

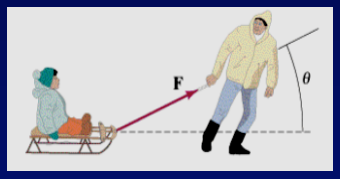
Special Forces:

Normal, tension, friction,…

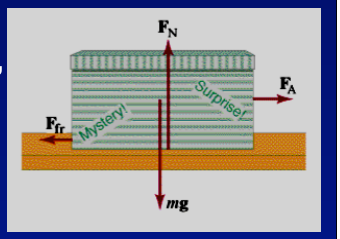
New Topic

Forces can be divided into two classes:

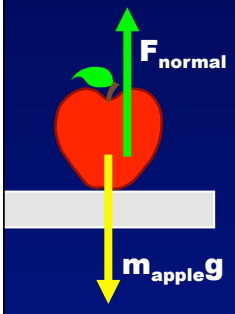
- Some forces are more Active: There is a contact force in the form of a pull or push.



- Others are more Passive: Where they adjust their size as a "response" to an active force
  - normal force
  - tension
  - friction
  - Centripetal force



Normal force



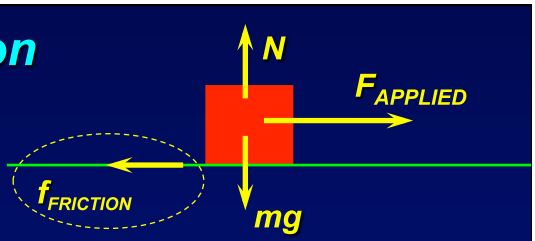
Why doesn't the apple fall through the table?

The table exerts a force which stops the apple.

This force is called the NORMAL force

"NORMAL" means *perpendicular*
The NORMAL force is always perpendicular to the surface.
But not necessarily up!

Friction



- What does it do?
  - It opposes motion!
- How do we characterize this?
  - Friction results in a force *parallel* to the surface, in a direction *opposite* to the direction of motion!
  - Frictional force is perpendicular to *N*ormal force
- Kinetic frictional force f_F is proportional to the normal force N.
  - $f_F = \mu_K N$
  - The "heavier" something is,

    the greater the friction will be…. makes sense!

Viscous Drag

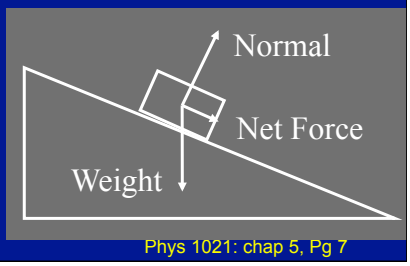
- What does it do?
  - It opposes motion!
- How do we characterize this?
  - Drag results in a force in a direction *opposite* to the direction of motion!
  - Drag force is proportional to v (small, slow objects) or v^2 (large, fast objects)
- For microscopic objects (paramecium, e.coli).
  - $F_D = -6K\pi\eta r v$ η = viscosity, r = radius, v = velocity
    K = geometric factor, K = 1 for a sphere
  - The "faster" something goes …

    … the greater the drag will be….

ConcepTest 5. 5 Sliding Down I

A box sits on a flat board. You lift one end of the board, making an angle with the floor. As you increase the angle, the box will eventually begin to slide down. Why?

1) component of the gravity force parallel to the plane increased
2) coeff. of static friction decreased
3) normal force exerted by the board decreased
4) both #1 and #3
5) all of #1, #2 and #3



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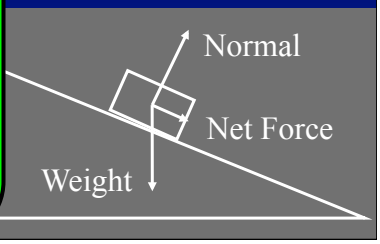
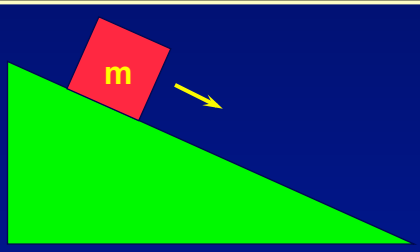
As the angle increases, the component of weight parallel to the plane increases and the component perpendicular to the plane decreases (and so does the Normal force). Since friction depends on Normal force, we see that the friction force gets smaller and the force pulling the box down the plane gets bigger.



ConcepTest 5.6 Sliding Down II

A mass *m* is placed on an inclined plane ($\mu > 0$) and slides down the plane with constant speed. If a similar block (same μ) of mass *2m* were placed on the same incline, it would:

1) come to a stop
2) slide down with decreasing speed
3) slide down with increasing speed
4) slide down with constant speed
5) slide up with constant speed



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The component of gravity acting down the plane is double for *2m*. However, the normal force (and hence the friction force) is also double (the same factor!). This means the two forces still cancel to give a net force of zero.