Force Normal = F_N

- Force Normal (or the Normal Force, abbreviated F_N) =
- F_N = The contact force exerted by a surface on an object.
- The word "Normal" means "perpendicular to"...
- Therefore, the Normal Force is the force pushing in a direction perpendicular to the surfaces in contact.
- What's the normal force acting (pushing) on you?





The Normal Force is the force pushing in a direction perpendicular to the surfaces in contact.





(a) No acceleration (v = constant)

(b) Upward acceleration

(c) Downward acceleration

(d) Free-fall

Friction

WATCH FOR ICE

What is friction? The friction force is the force exerted by a surface as an object moves across it or makes an effort to move across it.

 There are at least two types of friction force —kinetic (sliding) and static (stationary) friction.

- Though it is not always the case, the friction force often opposes the motion of an object.
- For example, if a book slides across the surface of a desk, then the desk exerts a friction force in the opposite direction of its motion.
- Friction results from the two surfaces being pressed together closely, causing intermolecular attractive forces between molecules of different surfaces.

- As such, friction depends upon the nature of the two surfaces and upon the degree to which they are pressed together.
- The maximum amount of friction force which a surface can exert upon an object can be calculated using the following formula....

$F_f = \mu + F_{normal}$

- F_f = Force due to friction (opposite direction of motion)
- μ = (mu) = coefficient of Kinetic friction (μ_k) or coefficient of Static friction (μ_s).
 Depends on which type of friction you are finding.
- F_{normal} is equal and opposite to what force?
- F_{normal} is equal and opposite to Weight or Force of gravity! If you know mass you can find weight: Fg = mag

Sliding (kinetic) Friction $F_f = \mu_{kinetic} + F_{normal}$

- <u>Sliding (kinetic) friction</u> results when an object slides across a surface.
- As an example, consider pushing a box across a floor. The floor surface offers resistance to the movement of the box. We often say that the floor exerts a friction force upon the box. To find kinetic (motion) friction, apply force to object to keep it moving at a constant velocity.
- Why constant velocity? What forces are in balance?

Static Friction $F_f = \mu_{static} + F_{normal}$

- Friction forces can also exist when the two surfaces are *not* sliding across each other. Such friction forces are referred to as static friction.
- Static friction results when the surfaces of two objects are at rest relative to one another and a force exists on one of the objects to set it into motion relative to the other object.

• When exerting 5 Newtons of applied force on the

box, the static friction force has a magnitude of 5 Newtons. Suppose that you were to push with 25 Newtons of force on the large box and the box were to still remain in place. Static friction now has a magnitude of 25 Newtons. Then suppose that you were to increase the force to 26 Newtons and the box finally budged from its resting position and was set into motion across the floor. The box-floor surfaces were able to provide up to 25 Newtons of static friction force to match your applied force. Yet the two surfaces were not able to provide 26 Newtons of static friction force. The amount of static friction resulting from the adhesion of any two surfaces has an upper limit. In this case, the static friction force spans the range from 0 Newtons (if there is no force upon the box) to 25 Newtons (if you push on the box) with 2 5 Newtons of force).

Check it out!

<u>http://phet.colorado.edu/en/simulation/forc</u>
<u>es-and-motion</u>

- A smooth wooden block is placed on a smooth wood tabletop. You find that you must exert a force of 14.0N to keep the 40.0N block moving at a constant veolocity.
- What is the coefficient of sliding friction for the block and the table?

 If a 20.0 N brick is placed on the block, what force will be required to keep the block and brick moving at a constant velocity?

- A box of mass 20.0kg is pulled on a flat, cement street. The coefficient of static friction is 0.80 and the coefficient of sliding friction is 0.30.
- A: What is the force of gravity acting on the box?
- B: What force will be necessary just to get the box moving?
- C: What force is needed to keep the box moving at a constant velocity?
- <u>Once moving</u>, what force applied is necessary to accelerate the box at 3.0 m/s²?

- A box of mass 25.0kg is pulled on a flat, cement street. The coefficient of static friction is 0.85 and the coefficient of sliding friction is 0.35.
- A: Draw a free body diagram.
- B: What is the force of gravity acting on the box?
- C: What force will be necessary just to get the box moving?
- D: What force is needed to keep the box moving at a constant velocity?
- E: <u>Once moving</u>, what force applied is necessary to accelerate the box at 3.0 m/s²?

- The coefficient of sliding friction between rubber tires and wet pavement is 0.50. If the brakes are applied to a 950kg car traveling at 38m/s, and the car *skids to a stop...then...*
- A: What is the size and direction of the force of friction that the road exerts on the car?
- B: What is the magnitude and direction of the acceleration of the car? Why would it be constant?
- C: How far does the car travel before stopping?

Newton's 3rd Law

- If object A applies a force on object B, object B will apply an equal and opposite force back on A.
- For every action force, there is an <u>equal</u> and opposite reaction force.
- Notice: these forces are on two different objects so they **don't** cancel each other out. And, each force is acting on a different object...
- A pushes B
- B pushes A

3rd law pairs

- Action reaction pairs.
- Action: I push cart.
- Reaction:
- Question: If the force of gravity (Earth) pulling on me is the action force, what is the reaction?
- Axn: Earth pulls on me
- Rxn:
- WHO PULLS w/a GREATER FORCE???
- Answer:_____

Types of Forces

- Normal Force: Support Force
- Static Friction: Force opposing motion while object is at rest
- **Kinetic Friction**: Force opposing motion while object is sliding
- Tension: Force provided by a rope
- Weight: Force due to gravity

- **Thrust**: Force applied by an airplane, for example
- **Drag**: Force applied by air, or water; air resistance. Opposes motion.
- Contact vs. Non-contact Force: if I were to push on the wall, and make contact with the wall, then my push would be a contact force. Gravity is a non-contact force... a force at a distance...