Forces

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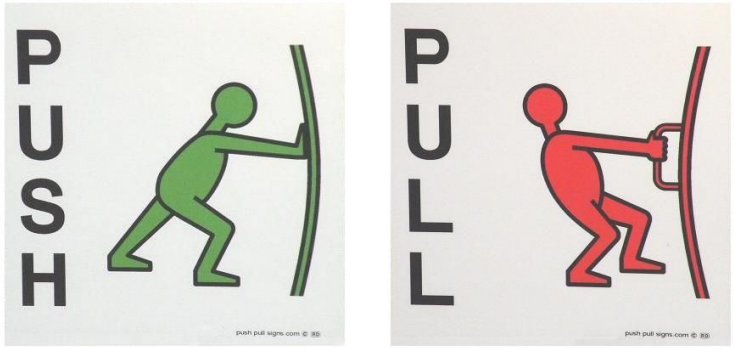
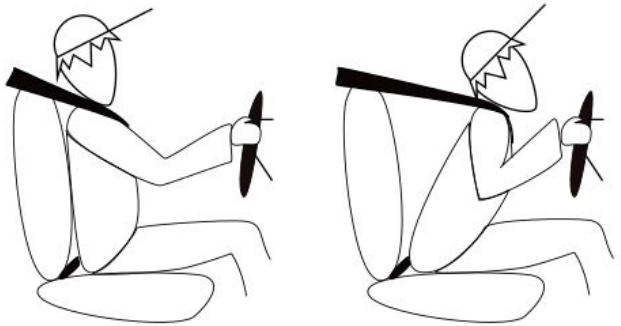
What is a force?



- A **force** is a vector, measured in Newtons (N)
  - 1 N = 1 kg•m/s2
- Defined as the **<u>push or pull on an object</u>**
- They are an important topic within dynamics (a branch of mechanics that describes why things move)

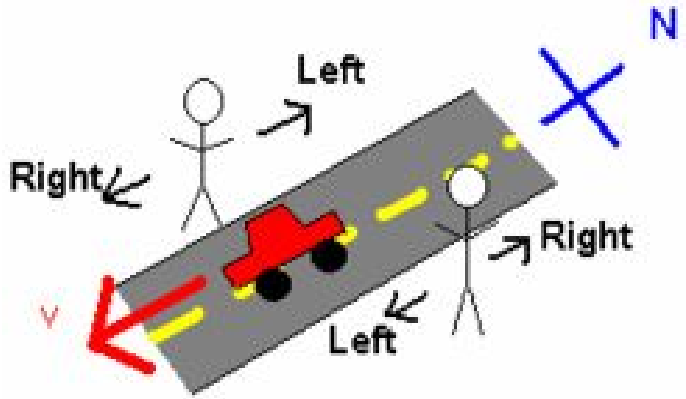
Newton's First Law

- An object continues in its state of rest or of uniform speed in a straight line unless acted upon by an external, unbalanced force
- Also called the law of inertia
- **Inertia: a body's resistance to changes in its motion**



Reference Frames

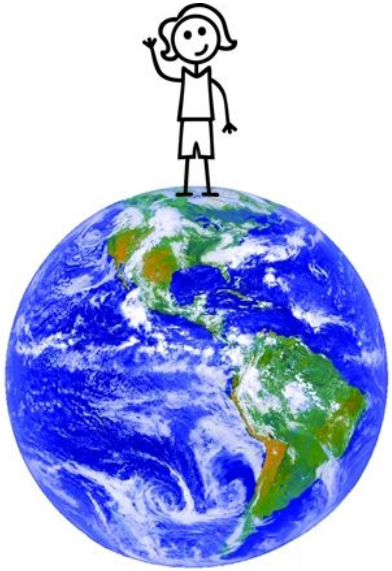
- Newton's First Law is not true in all reference frames it's only true in non-accelerating reference frames
  - Also called **inertial reference frames**
- The reference frame plays a major key in assessing a force as a force can be relative to one's frame



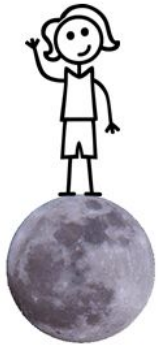
Mass vs. Weight (one common misconception)

- **Mass: the measure of inertia of a body**
- If you have more mass it's harder for the object to get moving from rest and harder to stop once it's moving
- **Weight: the force due to gravity**
- An astronaut weighs more here than
- on the moon because of the weaker gravity, but her mass is still the exact same

Example of Mass Vs. Weight



My WEIGHT on Earth is around 560N



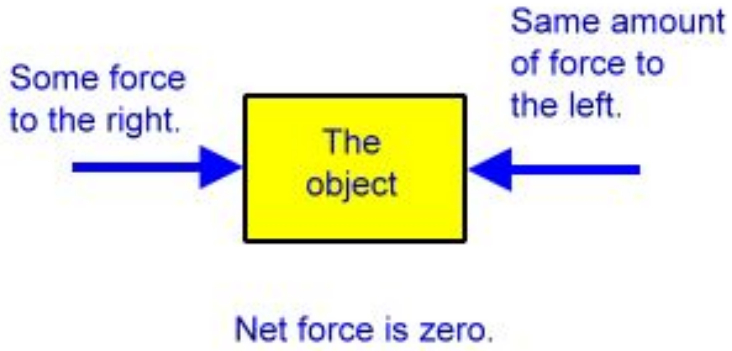
My WEIGHT on the moon is around 90N

My MASS is always 56kg!!

Net Force

- A net force gives rise to acceleration

1. A force on an object at rest will cause it to move
2. A force against the motion of an already moving object will cause it to slow down
3. A force perpendicular to an object's motion will cause the object to change directions

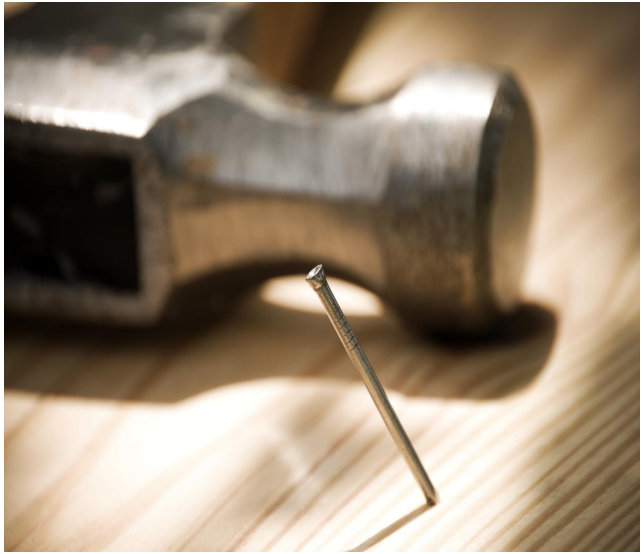


Newton's Second Law

- The acceleration of an object is directly proportional to the net force acting on it and is inversely proportional to its mass. The direction of the acceleration is the direction of the net force.
- $F=MA$ or Force= Mass x Acceleration
- Newton's second law relates the description of motion to the cause of motion: force

Newton's Third Law

- Whenever one object exerts a force on a second object, the second exerts an equal and opposite force on the first
- In every interaction there is a pair of forces acting on two interacting objects.
- Any force applied on an object is from the action of another object
    - This results in the first object exerting another force on the one coming in contact with it

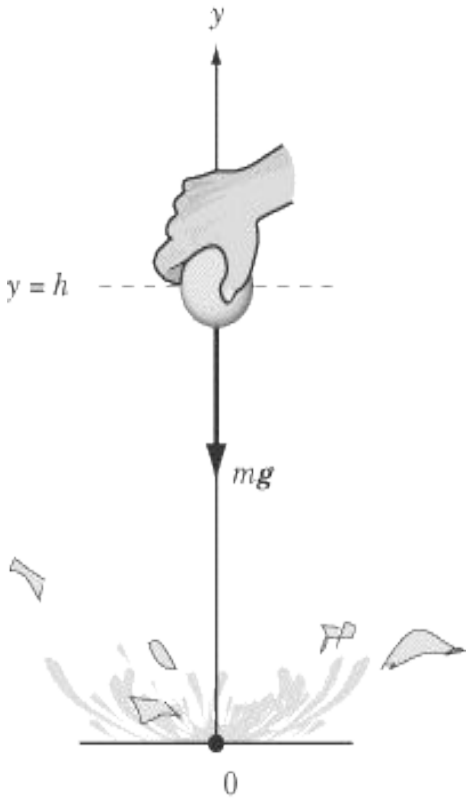


Action-Reaction pairs

- skydiver in freefall
- Skateboarder pushing on the ground
- Bowling Ball pushes pin leftward
- Balloon pushes compressed air inward
- skydiver pulls earth up
- The ground pushing back on the skateboarder
- Pin pushes ball leftward
- Compressed air pushes balloon outward

Force of Gravity

- Newton's second law is used to derive the force of gravity equation
- $F_g = mg$
- Gravity acts the same on objects in freefall as it does with objects at rest
- **Normal Force: a contact force which acts perpendicular to a common surface of contact**

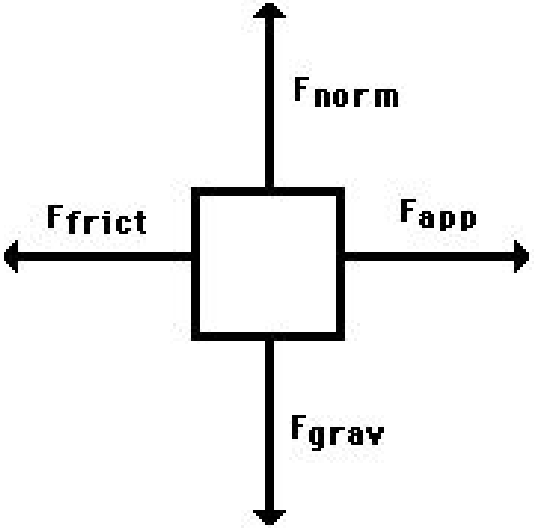


Free Body Diagrams

- Diagram showing all forces acting upon an object

1. Treat the object as the point
2. Draw arrows to represent each force acting on an object
3. Draw the arrows coming from the point

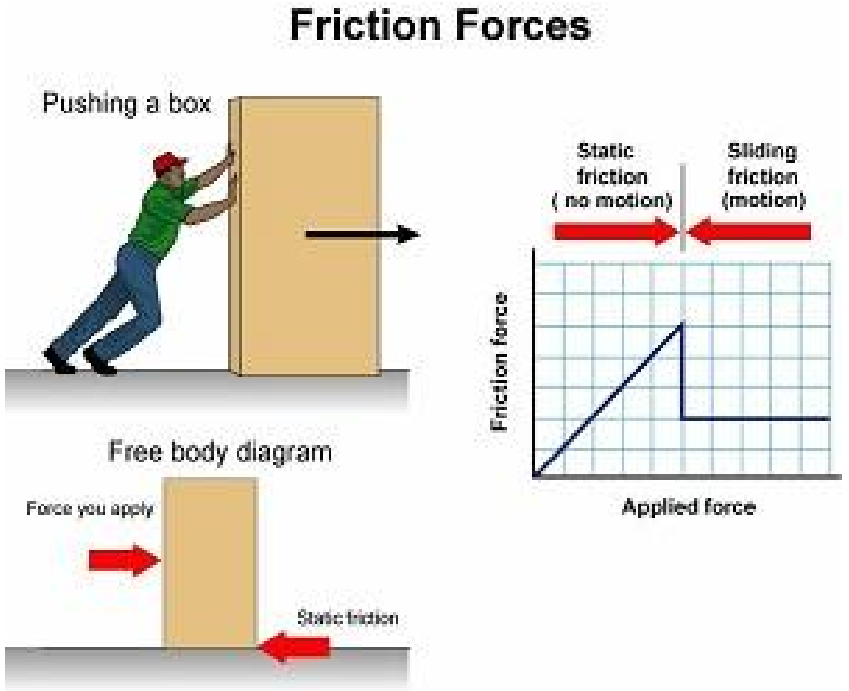
- Example:



Friction

- Friction is a contact force
- Occurs when **<u>one surface attempts to move along another</u>**

1. Kinetic (slide)
2. Rolling (roll)
3. Fluid (move through fluids [gases and liquids])
4. Static (not moving)

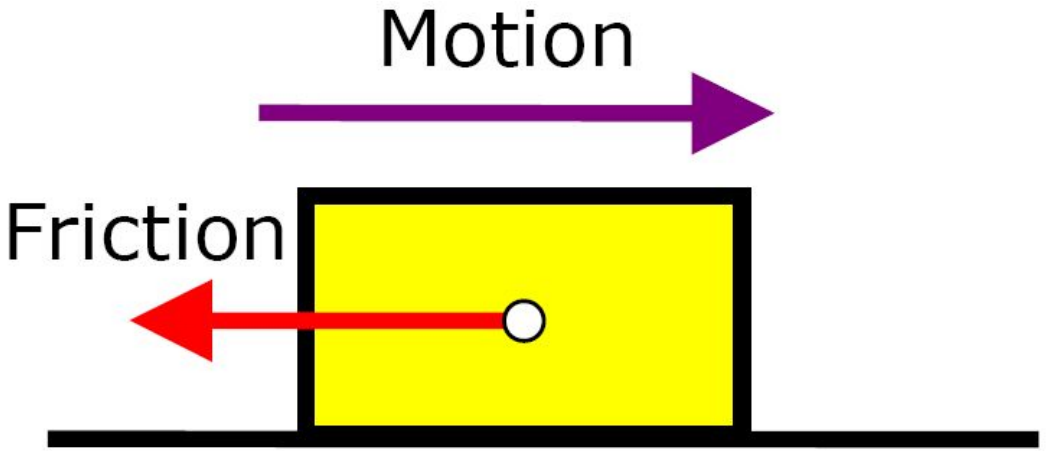


Friction Continued...

- Friction always opposes motion
- Electrostatic forces can cause chemical bonding on an atomic level
- Factors that affect the force of friction:

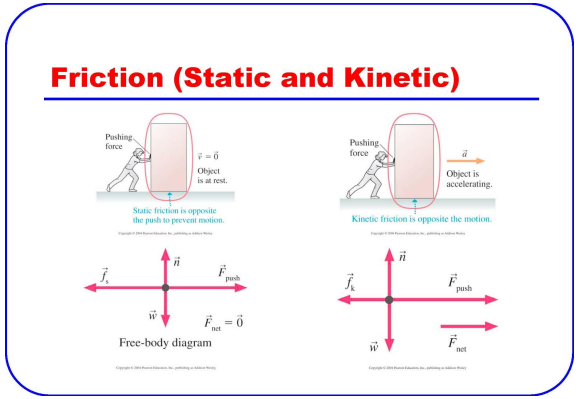
1. Relative Roughness
2. Weight
3. Normal force

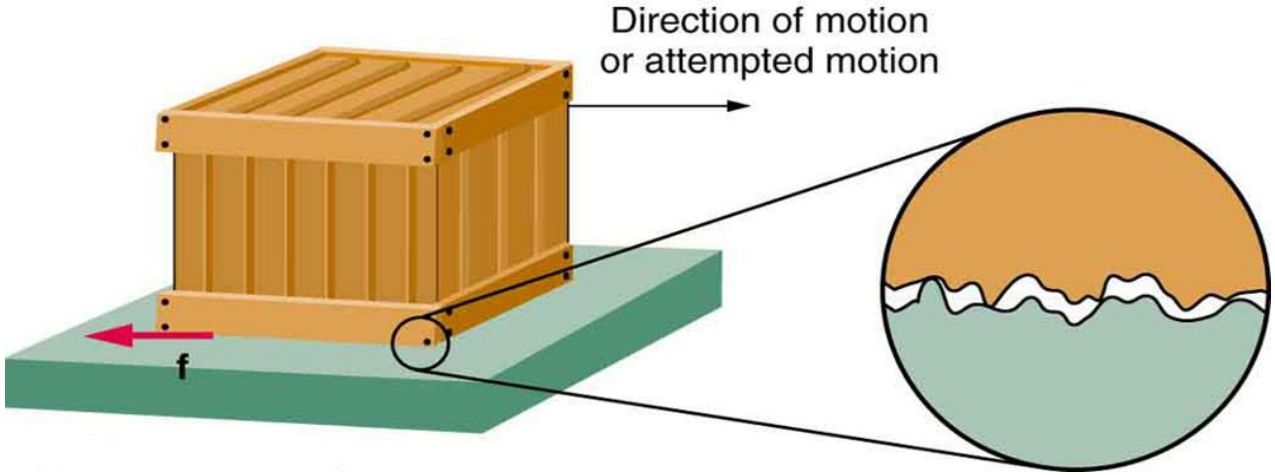
- $F_f = \mu F_N$



Kinetic Vs. Static Friction

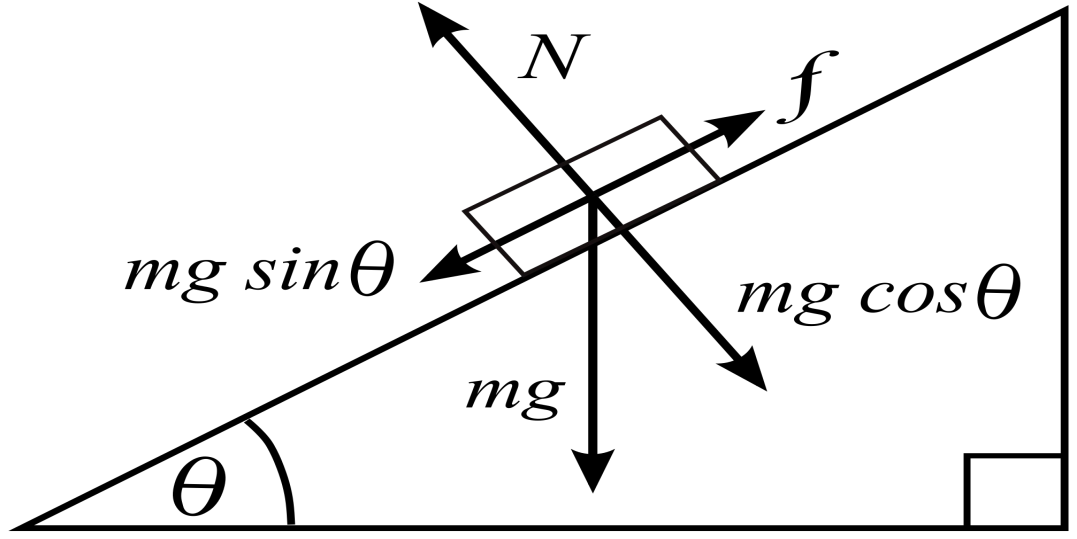
- Kinetic: Kinetic friction, also known as sliding friction or moving friction, is the amount of retarding force between two objects that are moving relative to each other.
- Static: the friction that exists between a stationary object and the surface on which it's resting.





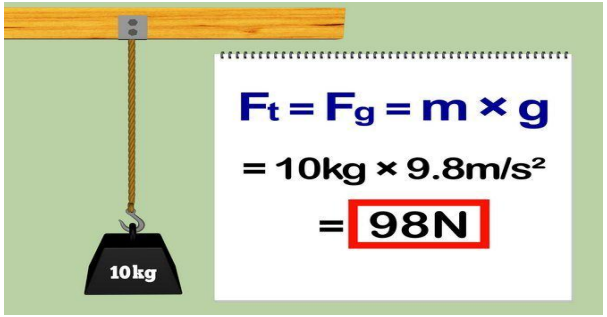
Objects on an Incline

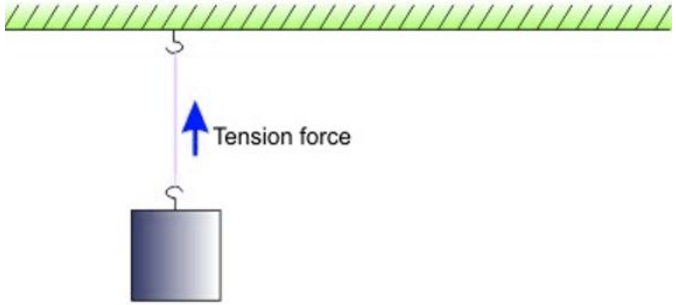
- Typically more convenient to think about vectors acting parallel and perpendicular to the incline
- $F_{II} = F_g \sin\theta$
- F



Tension

- Tension is a force applied to an object when a flexible cord pulls an object
- The chord will feel uniform strain across its entire length as long as the mass of it has negligible mass
- This force acts parallel to the chord itself as the chord can only pull and not push to a different direction
- Pulleys can greatly affect the force needed to lift an object
    - They can do this by reducing the force by 50% with each





Equilibrium

- An object is in **equilibrium** if the net force acting on it is zero
- An example of this is terminal velocity
- **Terminal Velocity: the highest velocity attainable by an object as it goes through a fluid (most commonly air)**
- Reached when $\mathbf{F_{drag} = F_g}$

2nd common misconception

- When you push or throw an object there continues to be a force in the direction of motion
- It is common sense to think that you need a driving force to keep an object moving at a constant speed, but this isnt true because there are many forces acting on an object that can always be seen

3rd Common Misconcception

- Things can fall without any forces acting on them
- This is not true because there is always at least one force acting on us and all objects at all times (gravity)

Important Formulas

- $\Sigma F_x = MAX$
- $\Sigma F_y = MAY$
- $Fnet = \sqrt{Fx^2 + Fy^2}$
- $N = Kg \cdot m/s^2$
- $F_f = \mu F_N$

Stratagies for tackeling free response questions

- First check to make sure all unit are in proper form, and if not convert them
  - ex) grams↠kilograms
- Write out all the units you are given and their corresponding variables
- Identify what you are looking for and find an equation with it and your other given info
- Rewrite the equation with your unknown variable isolated on one side
- Plug in your given values and solve

Kahoot

https://play.kahoot.it/#/k/06960260-fbe9-4191-b09c-c16f842b7222