

Forces and Newton's Laws

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Forces:

Definition of Force: the push or pull on an object

Force is a vector (has magnitude and direction).


- Measured in Newtons (N)
- The force you apply forward on an object is equal to the force friction applies backward.

Normal Force: contact force which acts perpendicular to a common surface of contact.

Net Force: the sum of all forces acting on an object



Newton's 3 Laws:

1. “Law of Inertia”- an object continues in its state of rest or of uniform speed in a straight line unless acted on by an external, unbalanced force.
 2. “One of the most important relationships in physics”: $F = ma$ - The acceleration of an object is directly proportional to its mass. The direction of the acceleration is the direction of the net force acting on the object.
 3. Whenever one object exerts a force on a second object, the second exerts an equal and opposite reaction.
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Important Equations/Ideas:

- $F=ma$: force equals mass times acceleration
- $1 \text{ N} = 1 \text{ kg} \times \text{m/s}^2$
- $F_g = mg$: force equals mass times gravity
- $F_f = \mu F_N$: force of friction equals coefficient of friction times normal force
- $F_{\parallel} = F_g \sin\theta$
- $F_{\perp} = F_g \cos\theta$



Example: Mass vs. Weight

What is the mass of a cat that weighs 65 N?

What's the weight of a box with a mass of 13.8 kg?



Mass vs. Weight

★ Mass and weight are NOT the same thing!

Mass: a measure of the inertia of the body.

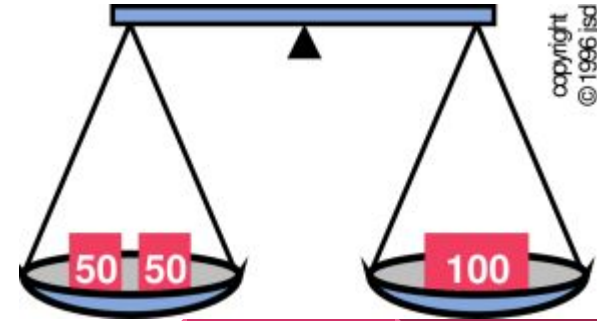
- More mass= harder to change motion

Weight: the magnitude of the force of gravity.



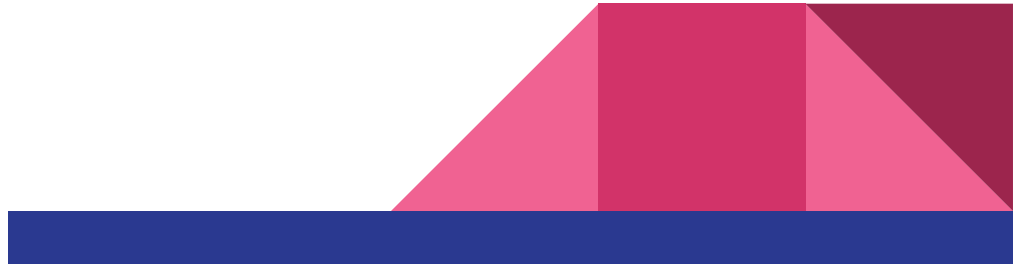
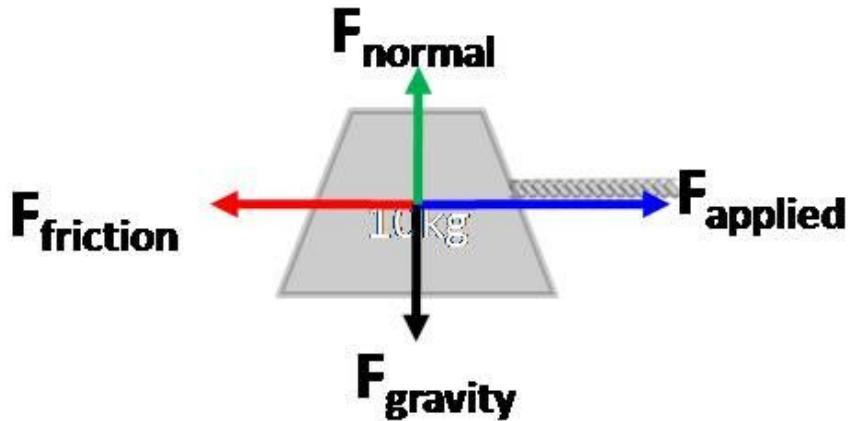
Definition of Equilibrium

- When the net force is ZERO
- That means that forces acting upon it must be equal or balanced



Free Body Diagrams

- A drawing that shows all of the forces that act on an object
- You have to use arrows, to show where each force is acting
- Have to label each arrow with its correlating force



Friction:

Friction occurs when one surface attempts to move along another

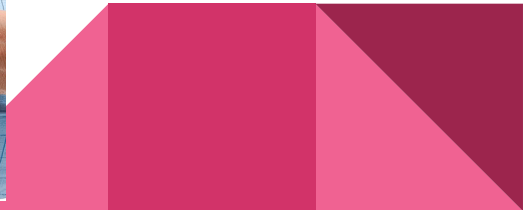
Different types of Friction:

1. Rolling
 2. Kinetic
 3. Static
 4. Fluid
- Static friction is friction when object is at rest.
 - Kinetic friction is the force opposing motion proportional to normal force.



Different Types of Forces

- Force of Gravity (F_g) Gravity on Earth= 9.81 meters per seconds squared
 - It is the attraction to all objects in the universe
- Normal Force (F_n) Normal Force= mass x gravity or Normal Force= mass x cose(gravity)
 - Force that acts perpendicular to the surface of an object
- Tension Force (T)
 - A force applied through a rope or string that pulls on an object



Different Types of Forces

- Applied Force (F_{app})
 - Is the force that applied by something
- Air Resistance (F_{air})
 - A frictional force that opposes motion but through the air
- Spring Force (F_{spring})
 - A force exerted by a spring, that is compressed or stretched that is connected to an object



Examples: (for us)

Draw the Free-Body Diagram for:

1. An object is motionless
2. An object slows down while moving across a surface due to friction
3. An object is suspended from a ceiling

Example: Sarah has a mass of 95kg

a) What is Sarah's weight on Earth?

b) How much will she weigh on Jupiter where acceleration due to gravity is 24.5 m/s^2 ?

Class Example

A big ant is rolling down a hill after he tripped over his foot. The ant has a mass of 5 grams. The hill is inclined at 20 degrees to the horizontal. The coefficient of friction between the ant and the ground is 0.15. We are on Earth.

- a) Draw a Free-Body Diagram
- b) Find the normal force acting on the big ant
- c) Find the force of friction on the big ant



Review:

1. Which one of Newton's Laws is called the Law of Inertia?
2. What's the difference between mass and weight?
3. 1 Newton= ?
4. We say a system is in equilibrium when?



Answers

1. 1st Law
2. Mass: measure of inertia on body and weight is the magnitude due to the force of gravity
3. $1 \text{ kg} \times \text{m/s}^2$
4. When net force on it is 0.

