Forces

Weight, Normal Force and Friction

Fnet = F1 + F2 + F3 + F4

- The sum of all forces on an object is the Fnet. If Fnet = 0 N, the object is in equilibrium and the forces are balanced; If Fnet is NOT equal to 0 N, this "extra" force causes acceleration

- Fnet = ma

- If an object is at rest or moving with constant velocity, it is NOT Accelerating. Zero Net Force.

Free Body Diagram

- Draw/represent the object as a heavy dot.
- Draw all the forces acting on the body as arrows with appropriate direction.
- The sum of all the forces acting on the body is the net Force, Fnet.
- If Fnet is not zero, the object is accelerating in the same direction as Fnet.

Weight

- F g = m g (mass in kg; g depends on where you are located; F in Newtons, downward).

- g(earth) = - 9.8 m/s/s

- g(moon) = - 1.6 m/s/s

- g(Mars) = - 3.7 ms/s/s

- g(constant velocity drifting in space) = 0 m/s/s

Normal Force

- If an object has weight but is at rest on a horizontal surface, there must be an opposing force to balance and cancel the weight.

- The normal force, Fn, is perpendicular to the object and to the surface counterbalances the weight of the object. (In math "normal" means perpendicular)

- Fnet = Fn + Fg = 0 (at rest)

Friction

- Friction is a force always opposite the direction of the motion.
- Ff = u Fn
- Friction depends on the nature of the materials, u, and the Fn.
- Independent of surface area
- Please see the Reference Table, p. 1.

Static Friction vs. Kinetic Friction

- Kinetic Friction is the friction while an object is moving: Ff = u(kinetic) x Fn

- Static Friction is the friction while the object is at rest: Ff = u(rest) x Fn

- Static Friction is usually greater than Kinetic Friction: u(static) > u(kinetic)

- u is the coefficient of friction and has no units.

Example

- A force of 50 N is used to drag a 10 kg object across a horizontal table. If a frictional force of 15 N is present on the object, calculate the Fnet on the object and the acceleration of the object.

Answer to the Example

- Fapply = 50 N
- Fnet = Fapply + Ff = 50 – 15 = 35 N
- Fnet is the "extra" "unbalanced" force
- Fnet = 35 N = m a = 10 x a
- A = 35/10 = 3.5 m/s/s.

Example

- A student drags an object across a lab table at a constant velocity using an applied force of 12 N. Calculate the kinetic frictional force present on the object.

- The object is moving with constant velocity so a = 0 m/s/s so Fnet = 0 N.

- Fnet = 0 = Fapply + Ff = 12 + Ff.   Ff = - 12 N

Group Activity

- 1. In order to keep an object weighing 20 N moving at constant speed along a horizontal surface, a force of 10 N is required. The force of friction between the surface and the object is how much?

- 2. A horizontal force of 15 N pulls a 5 kg block along a horizontal surface. If the force produces an acceleration of 2 m/s/s, what is the frictional force acting on the block?

Group Activity

- 3.   A force of 40 N applied horizontally is required to push a 20 kg box at constant velocity across the floor. What is the coefficient of friction between the box and the floor?

- 4.   A 100 N box is moving on a horizontal surface. A force of 10 N applied parallel to the surface is required to keep the box moving at constant velocity. What is the coefficient of kinetic friction?