Lecture 3: Statics of Particles Part 2

September 15, 2016 2:34 PM

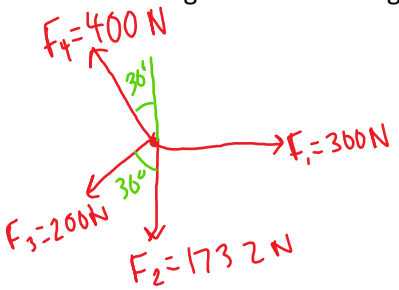
2.9 Equilibrium of a particle

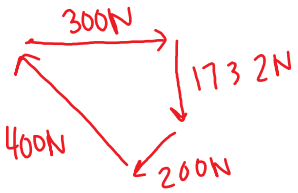
When the resultant of all the forces acting on a particle is zero, the particle is in **equilibrium**.

If a particle is in equilibrium and acted upon by only two forces, then those forces must have the same magnitude and the same line of action but in opposite directions. The result of these forces is zero.

Action + Reaction

Another case of equilibrium of a particle occurs when there are many forces acting on it and the polygon of forces drawn in tip-to-tail fashion results in the last arrow coinciding with the starting point, i.e. the resultant is zero





When a particle is in equilibrium we can write:

resultant

$\mathbf{R} = \sum \mathbf{F} = 0$

or

$\sum (F_x i + F_y j) = 0$

or

$(\sum F_x)i + (\sum F_y)j = 0$

component forces are also in equilibrium!

We can conclude that the **necessary** and **sufficient** conditions for the equilibrium of a particle are:

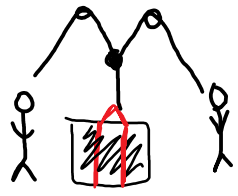
$\sum F_x = 0$ and $\sum F_y = 0$

2.10 Newton's First Law of Motion

"If the **resultant force** acting on a particle is **zero**, the particle will **remain at rest** (if originally at rest) or will move with constant speed in a straight line (if originally in motion)" ie. Statics

2.11 Free-body diagrams

A large number of problems involving actual structures can be reduced to problems concerning the equilibrium of a particle. A diagram drawn showing a specific particle with all the forces acting on it is called a **free-body diagram.**



Space Diagram

Free body diagram

(closed triangle only b/c it's in equilibrium!)

If there are more than 3 forces acting on a particle which is in equilibrium, we can draw a **force polygon** (graphical solution), *or* we can solve it analytically using the equations of equilibrium.
The **equations of equilibrium** can be solved for no more than **2 unknowns**.

concurrent coplanar

Common types of problems include those in which the 2 unknowns represent:

- the two components (or the magnitude and direction) of a single force
- the magnitudes of two forces, each of known direction
- maximum and minimum value of the magnitude of a force