ENGINEERING MECHANICS: STATICS

COLLEGE OF
ENGINEERING, ARCHITECTURE AND TECHNOLOGY

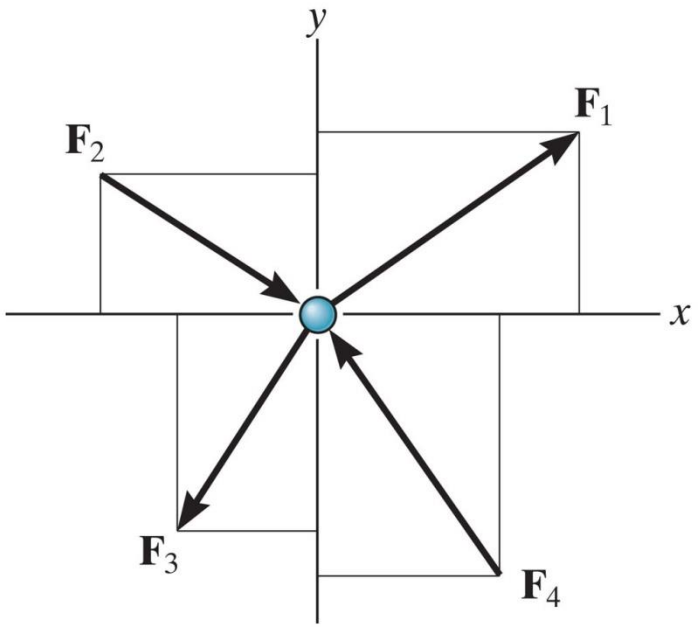
西南交通大學
Southwest Jiaotong University

3.1: Equilibrium of a Particle

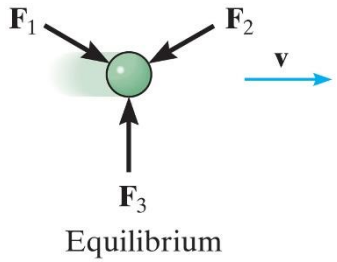
Particle: Any object which may be modeled as a concentrated point or mass.

Size and shape do not influence applied forces.

Forces applied to a particle must be "*concurrent*", with *line of action* passing through a common point.



Equilibrium: When an object remains at rest or at constant velocity if already in motion.



Equilibrium

Newton's first law of motion requires the resultant force of a particle in equilibrium to be equal to zero.

$$\sum F = 0$$

Newton's second law of motion states that a particle subjected to an unbalanced force experiences an acceleration.

Accelerated motion

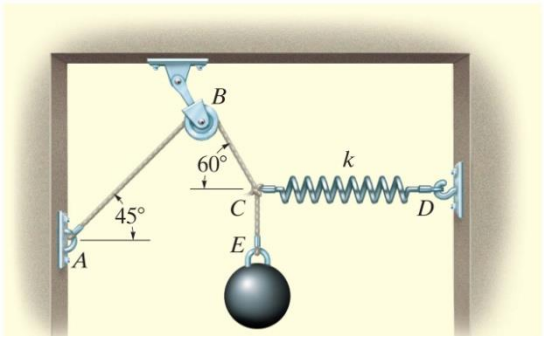
$$\sum F = m\cancel{a}^{0} = 0$$

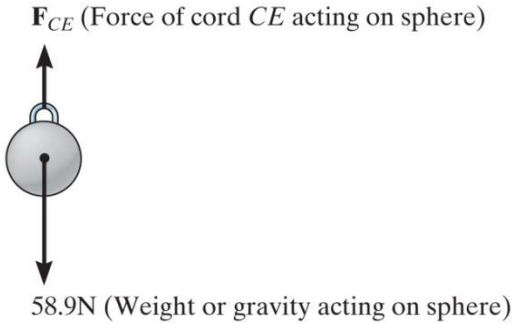
However, in equilibrium, acceleration is zero.

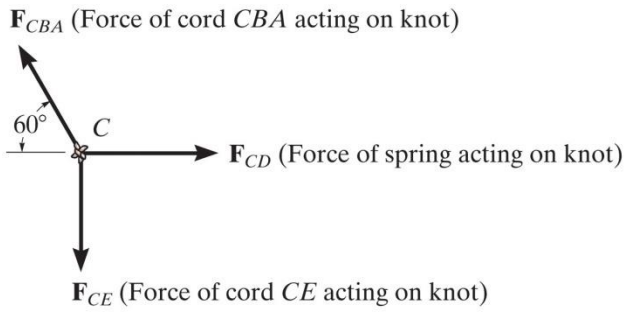
3.2: Free Body Diagrams (*FBD*)

A ***FBD*** is a sketch of a rigid body showing:

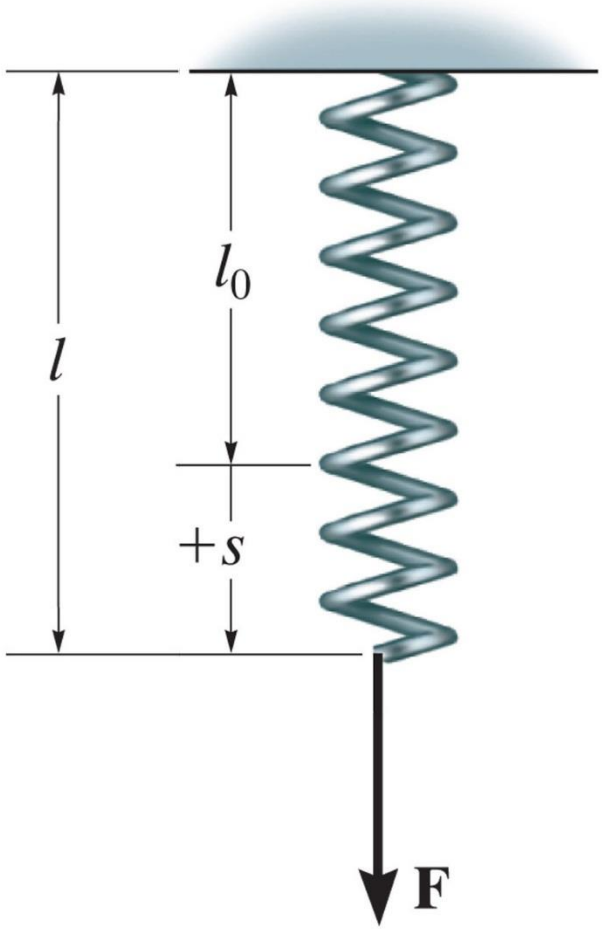
1) Outline shape of the body.
2) All forces (applied or reactive) affecting the body.
3) Labels for known & unknown forces & dimensions indicating locations of forces & size of body.







Springs: The length of a spring will change in direct proportion to the force acting on it.



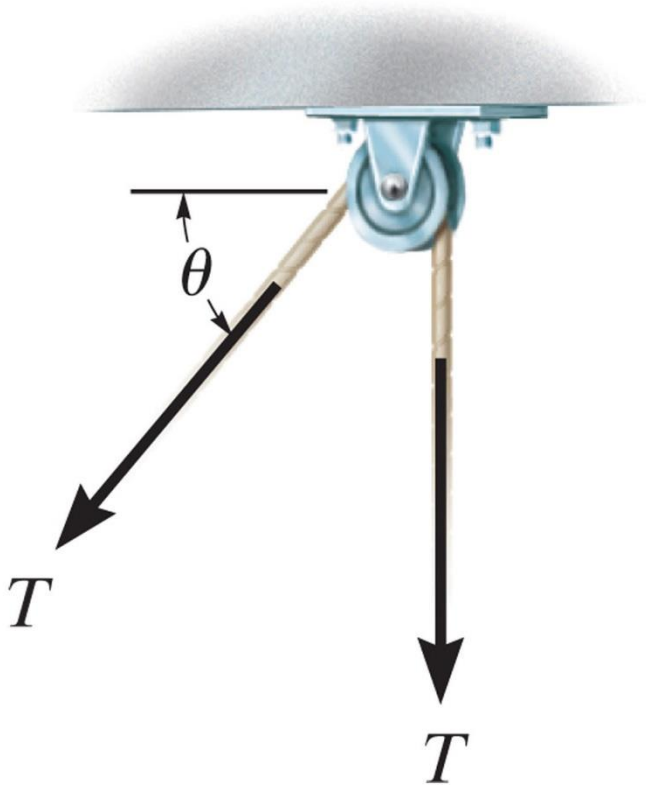
$$F = ks$$

where,

$k =$ spring constant

$$s = l - l_0$$

Cables and Pulleys: All cables will be assumed to have negligible weight and cannot stretch. Cables can support tension only (pulling force). Cables have constant magnitude as they pass over pulleys.



Steps to solve a Statics Problem:

1. Identify the unknowns
2. Draw the ***FBD*** for the problem
3. Apply equilibrium eqns to solve for unknowns

$$\sum F = 0$$

4. If there are more unknowns than equilibrium equations, go back to step 2 & 3 until all unknowns are found

Equilibrium Eqns in 2-D:

$$\sum F = 0 \quad \Rightarrow \quad \sum F_x = 0$$
$$\sum F_y = 0$$

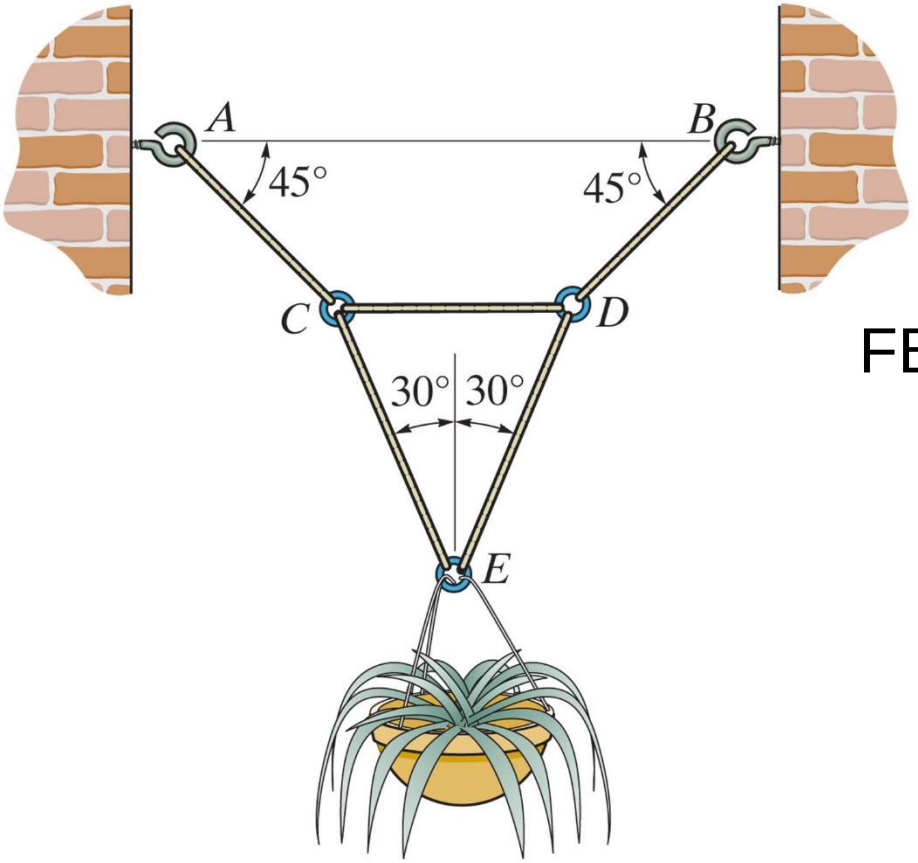
Two unknown values can be determined

Equilibrium Eqns in 3-D:

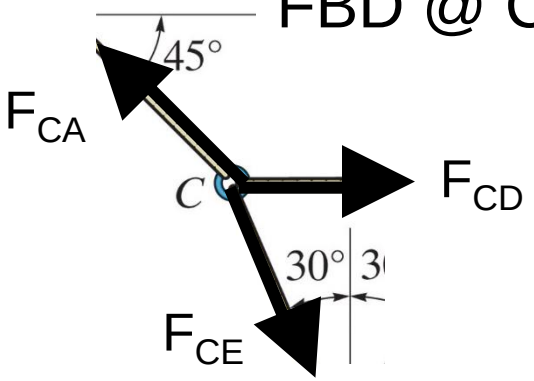
$$\sum F = 0 \quad \Rightarrow \quad \sum F_x = 0$$
$$\sum F_y = 0$$
$$\sum F_z = 0$$

Three unknown values can be determined

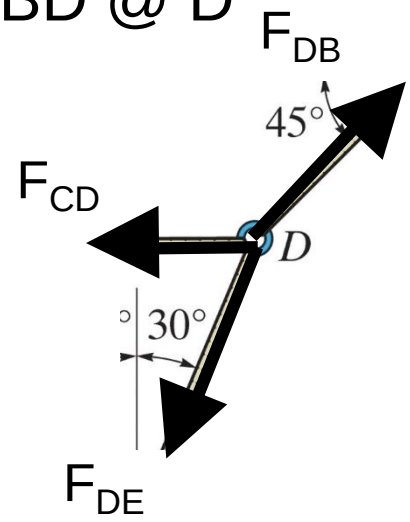
For some problems, multiple FBDs will be required to solve.



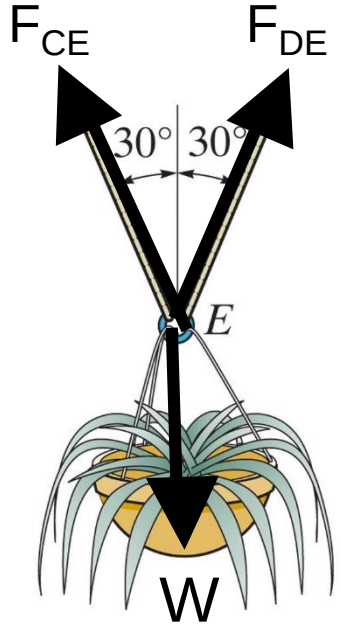
FBD @ C



FBD @ D



FBD @ E



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