ENSC 2113
Engineering Mechanics: Statics

Chapter 3:

Equilibrium of a Particle

(Section 3.3)

COLLEGE OF
ENGINEERING, ARCHITECTURE
AND TECHNOLOGY

Chapter 3 Outline:

3.1 Condition for the Equilibrium of a Particle

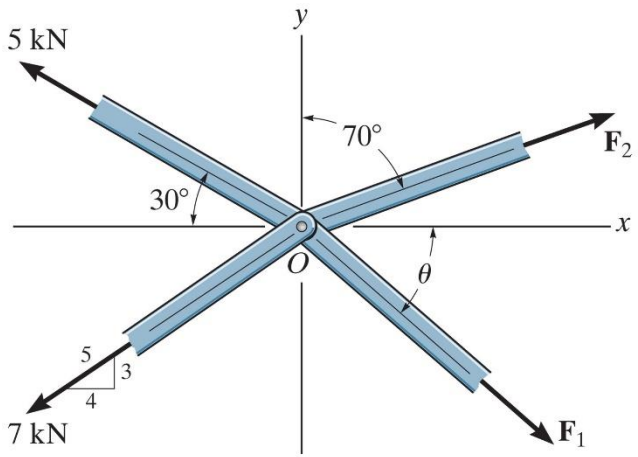
3.2 The Free-Body Diagram

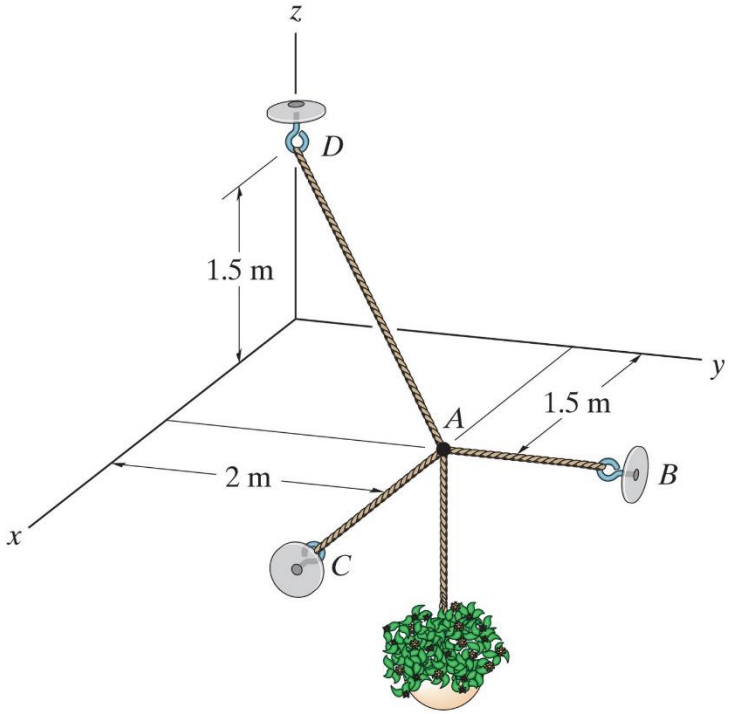
3.3 Coplanar Force Systems

3.4 Three-Dimensional Force Systems

Chapter 3 Objectives:

- To introduce the concept of the free-body diagram for a particle
- To show how to solve particle equilibrium problems using the equations of equilibrium

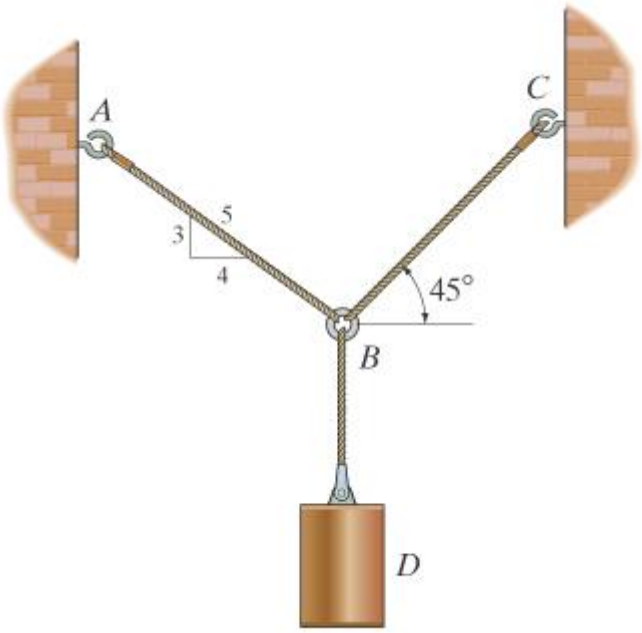


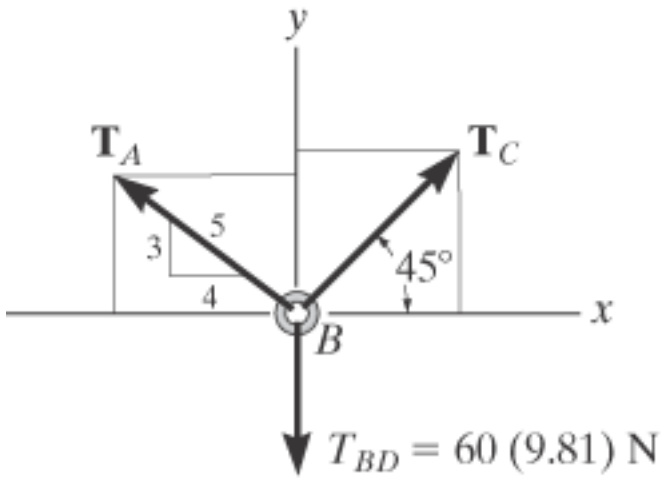


Review:

Free-body diagram:

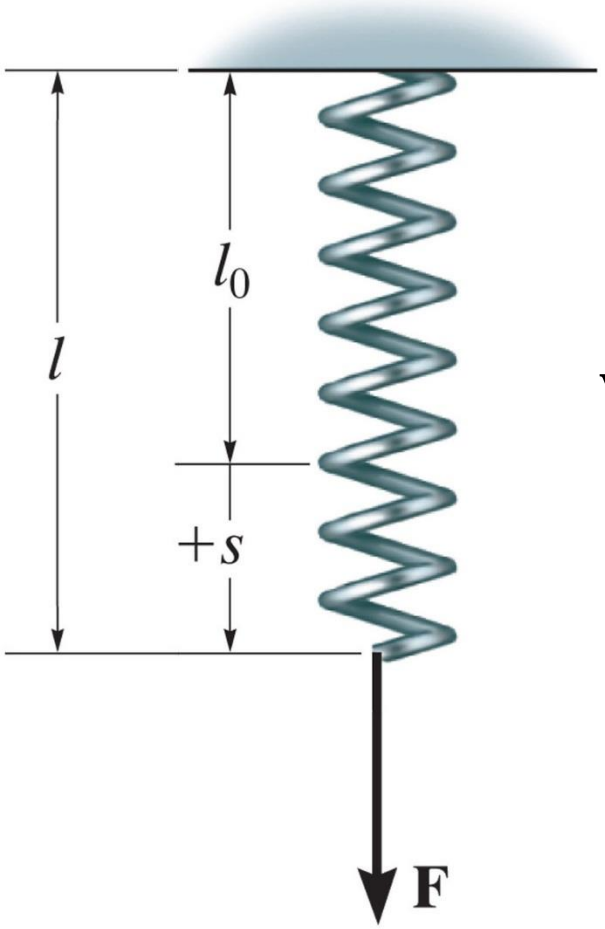
- A drawing that shows the particle as isolated and free from its surroundings
- Includes *all* forces acting on the particle





Review:

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



$$F = ks$$

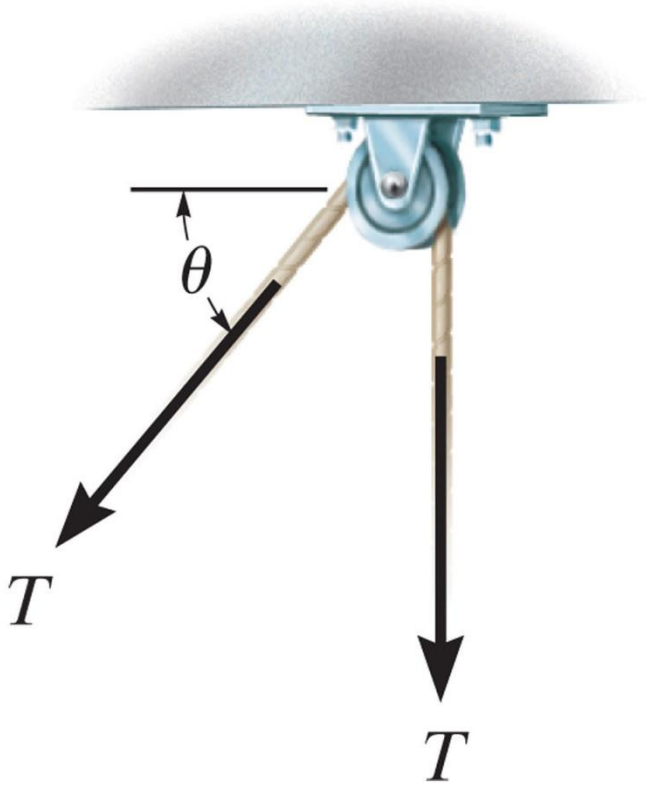
where,

$k =$ spring constant

$$s = l - l_0$$

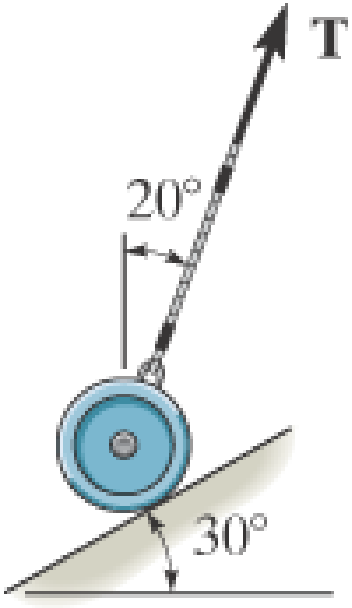
Review:

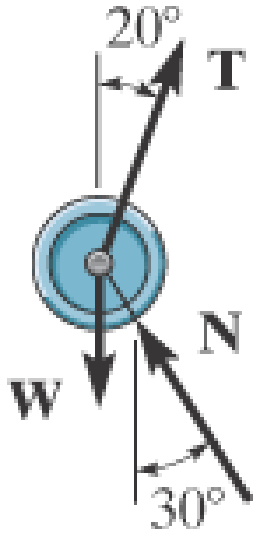
Cables and Pulleys: All cables will be assumed to have negligible weight and cannot stretch. Cables can support tension only (pulling force). Cables have constant magnitude as they pass over pulleys.



Review:

Smooth Contact: If an object rests on a smooth surface, the surface will exert a force on the object normal to the surface at the point of contact

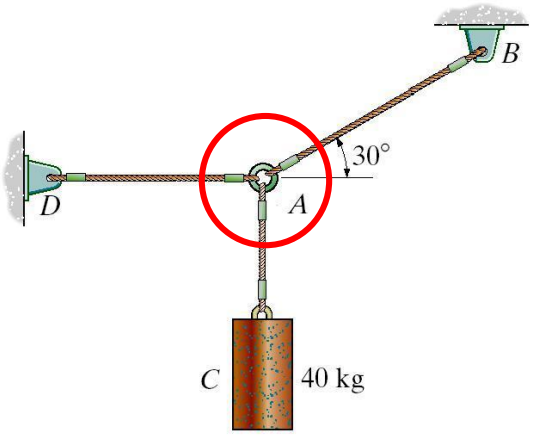




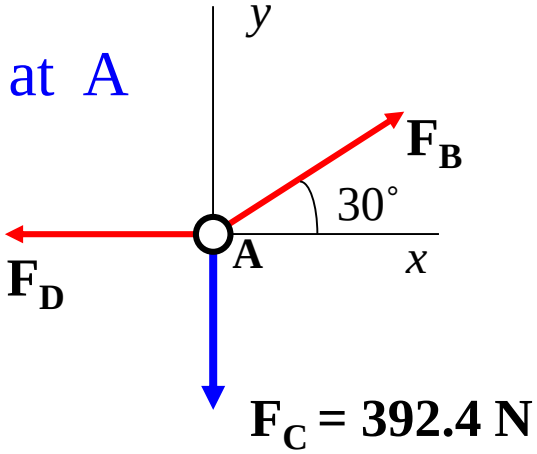
The Free-body Diagram:

Procedure:

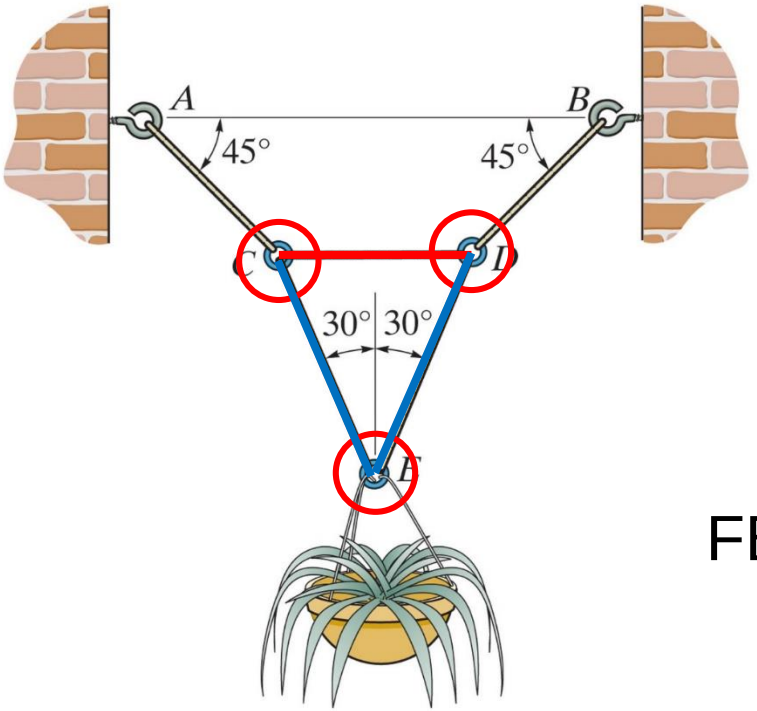
- Draw the Outlined Shape
  - Isolate the system by removing the supports and drawing the outlined shape
- Show All Forces
  - Active forces that set the particle in motion
  - Reactive forces that prevent motion
- Identify Each Force
  - Knowns
  - Unknowns



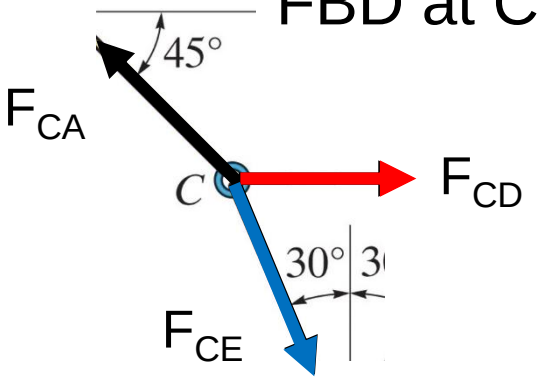
FBD at A

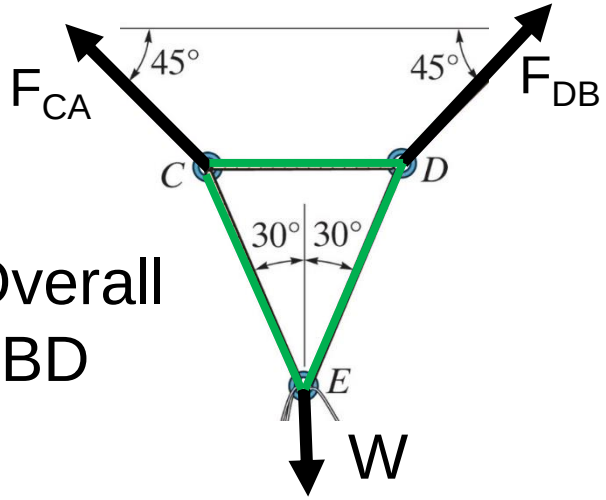


For some problems, multiple FBDs will be required to solve.



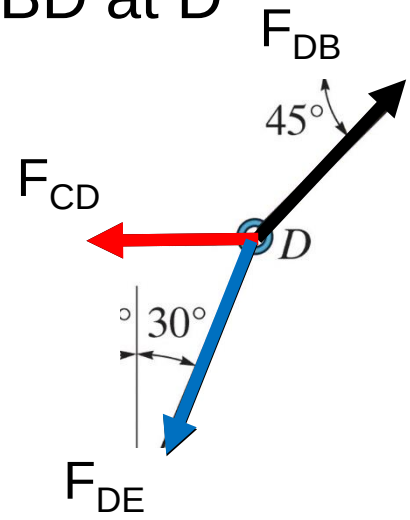
FBD at C



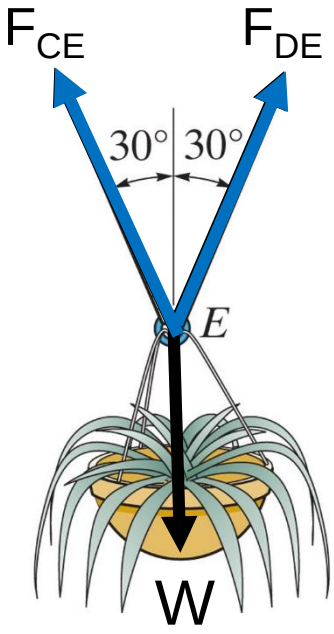


Overall FBD

FBD at D



FBD at E



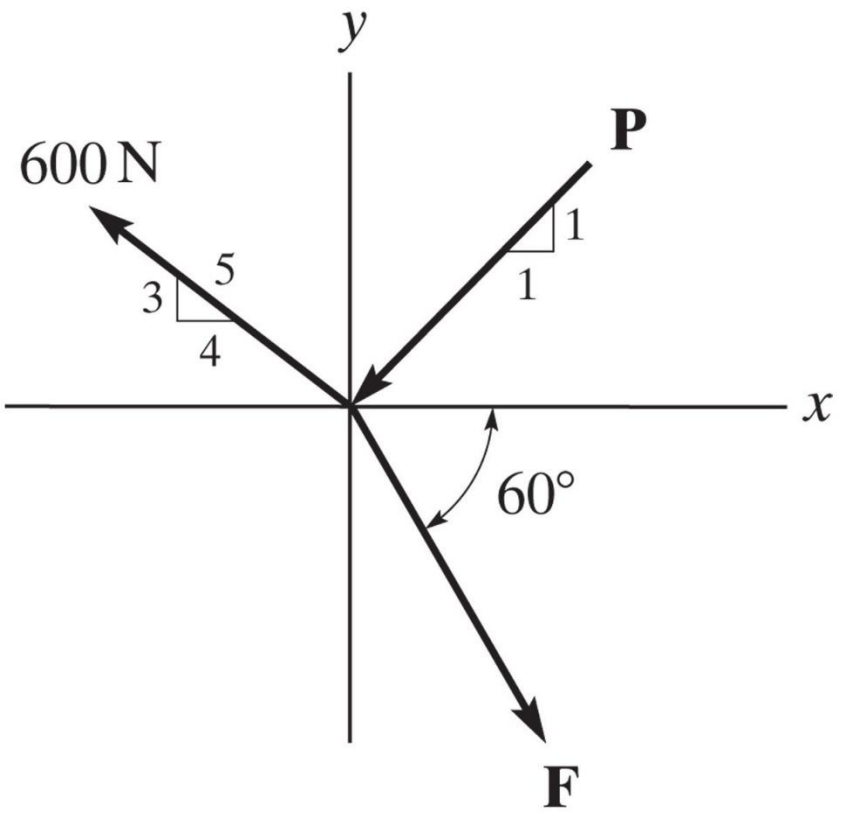
Equilibrium:

Equations in 2-D:

- With two equations, two unknowns can be solved

$$\sum F_x = 0$$

$$\sum F_y = 0$$



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