**Free-Body Diagrams (FBD)**

A FBD is a picture that illustrates all of the forces acting on a particular object. The object is "free" from its environment, as only the forces are shown. FBDs are essential in Mechanics and will be **required** for all of your solutions to Dynamics (Newton's Laws) problems.

Steps:
1. Isolate the object being analyzed.
   Identify ALL forces that act ON the object; NOT the forces it exerts on its surroundings.

2. Draw a *convenient* coordinate system.

3. Represent the object as a dot at the origin, when possible (particle model).

4. Draw **vectors** representing each of the identified forces.
   (Tail of each force vector on the object. Illustrate angles.)

Free-Body Diagram Sketching: Dos and Don'ts

Example: top view of a box pulled by three ropes.
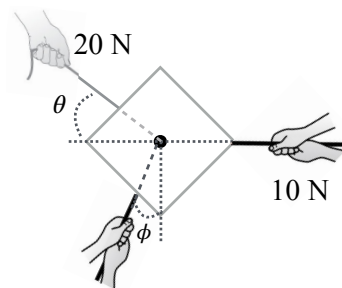
FBDs:
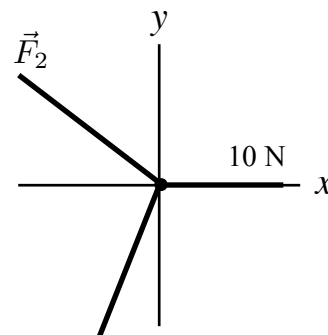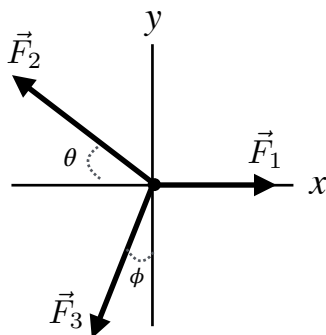
✓ **DOs:**

- Represent forces with vectors (arrows)

- Label each vector with a symbol

- Illustrate the angles wrt the coordinate axes

- Place the tail of the vector on the object (dot)

✗ **DON'Ts:**

- Represent forces with lines without arrowheads

- Label vectors with values, or leave unlabeled

- Forget to identify the angles

- Place the tail of the vector at random locations

Second (Components) Free-Body Diagram
If there are vectors not aligned with the axes in the first FBD, draw a second FBD where the non-aligned vectors are decomposed ("broken") along said axes.

This Second –or Components– FBD is a like copy of the first one:
- it must follow the same orientation of the axes; and
- it must include all force vectors.

The only difference between the two FBDs is that the latter illustrate the components of the non-aligned vectors.

(First FBD)   (Second FBD)
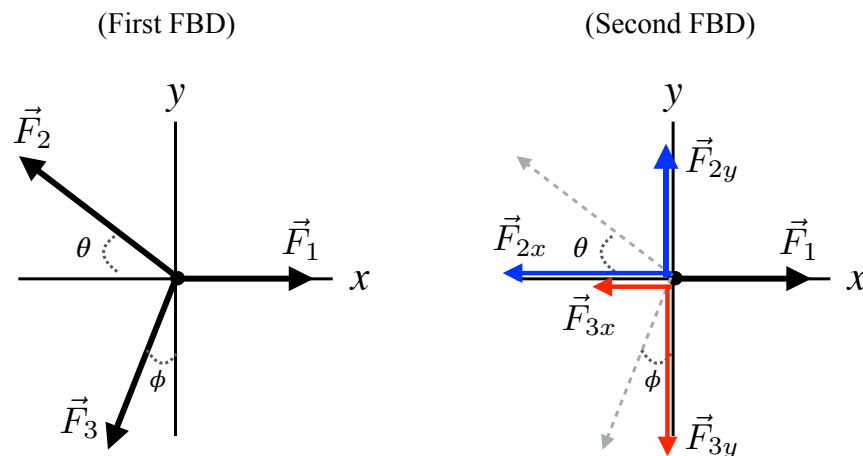
Vector Components:
After sketching the Components FBD, determine the *magnitude* of the vector components in terms of the original vector magnitude and the angle(s), that is, use trigonometry.

For example:

$F_{2y} = F_2 \sin \theta$

$F_{3y} = F_3 \cos \phi$

Note: these relationships only hold for scalars (magnitudes), not vectors. Do not cap these components with arrowheads.