Physics 2A, Fall 2007
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Free-Body Diagrams: Newton’s Second Law

1. **Draw a sketch of the problem.** All angles involved in the problem should be labelled in the sketch. Off to the side of the diagram, assign a symbol to any numerical information given in the statement of the problem. For example, if the problem specifies that an object has a mass of 22.0 kg, label the object as “m,” and write \( m = 22.0 \text{kg} \) off to the side.

2. **Select an object from your sketch, and draw a dotted line around the object.** You may choose to make a separate drawing of this object by itself. If you draw a separate diagram of the object, **DO NOT ROTATE THE OBJECT!**
   a. If gravity is acting on the object, draw an arrow representing the gravitational force on the object. The tail of this arrow should be placed at the object’s center of mass.
   b. Notice every contact that the object of interest makes with other objects. At each contact, draw in the force vector or vectors acting on the object at that contact.
   c. Label every force vector TWICE by writing the vector symbol for the vector AND the magnitude of the vector next to the vector. Points will be deducted from your score for every unlabeled vector.

3. **Draw in the acceleration vector.** It is usually best to draw the acceleration vector off to the side of the diagram. Put two slashes through the acceleration vector to distinguish it from the force vectors.

4. (a) **Introduce a Cartesian coordinate system.** Usually, it is most convenient to orient the coordinate system so that as many of the vectors as possible are aligned with either the x-axis or the y-axis. If this criterion yields a tie between two possible alignments of the axes, it is usually most convenient to align your coordinate system so that one of the axes is aligned with the acceleration vector.
   (b) **If a vector is not aligned with either of the axes, determine the angle the vector makes with one of the two axes and indicate this angle on your sketch.**

5. (a) **Write down the x- and y- components of every force acting on the object.** Use the grid format demonstrated in lecture. Even if a component is zero, you should still write down that the component is zero.
   (b) **Write down the x- and y- components of the acceleration vector.** The components of the acceleration vector should be written separately from the components of the force vectors in order to avoid confusion.

6. **Plug your results from step 5 into the Newton’s second law of motion:** \( \Sigma F_x = ma_x, \Sigma F_y = ma_y \).

7. If there is more than one object of interest in your problem, repeat steps 2 – 6 for each object of interest. You should be sure to apply Newton’s second law, \( \Sigma F = m\ddot{a} \), separately to each object.

8. Get cracking with the algebra.