JOSEPH LOUISE LAGRANGE'S COMMENTARY

On Newton's Ten Commandments

1. *Thou shalt draw thy free-body diagram for each object in the problem.*

Draw in each force that is relevant to the system at hand; simply go through each type of force and see if it is acting on the object. Certain forces are often omitted for simplicity; these need be included only if explicitly requested. Bear in mind always that certain quantities are called forces, and yet they are not forces and are **not** drawn in a free-body diagram. The chart below summarizes which quantity falls into which category.

Forces Studied in Detail	**Forces Only Mentioned**	**Not Forces (Despite Name)**
Gravity	Air Resistance/Drag	Net Force
Normal Force	Viscosity	Net Radial Force
Friction	Strong- and Weak-	Centripetal Force
Tension	Nuclear Force (2nd Sem)	Electromotive Force (EMF)
Elastic Force		
Electric Force (2nd Sem)		
Magnetic Force (2nd Sem)		

2. *Thou shalt pick a sensible coordinate system.*

What is a sensible coordinate system, and how is it found? A sensible coordinate system is one which simplifies the problem. While there is no one procedure which always works, experience provides the following hints:

a) If the direction of the acceleration of the object is known, align one of the axes with that direction.

b) If the direction of acceleration is not known or is zero, choose axes so that as many forces as possible point along one axis or the other.

c) If kinematics are involved, it is customary to put the origin at the initial position of the object. This is not a hard rule, especially if the forces change during the motion of the object.

3. *Thou shalt write down Newton's second law in components, and if necessary the torque equation ($\sum \tau = I\alpha$), for each object in the problem.*

It is not enough to merely write down Newton's second law. One must write it correctly in order to get useful information out. Whenever the direction of a force is known, write the components of that force in the form magnitude $\times$ trigonometric factor. In this case the magnitude is always positive and we put in plus or minus signs by hand. For example, $W_x = |\vec{W}| \sin\theta = m|\vec{g}| \sin\theta$ and $W_y = -|\vec{W}| \cos\theta = -m|\vec{g}| \cos\theta$. If the direction of the force is not known, simply write F_x and F_y (where $\vec{F}$ is the unknown force) and determine the sign of each component as a part of solving the problem.

When using the torque equation, recall that torques are always relative to some origin. The physicist who neglects following guidelines will suffer the scourge of incorrect equations:

a) If the object is experiencing both rotational and translational motion, as in the case of rolling, one must calculate torque about the center of mass.

b) If the object is rotating about a fixed axis, calculate the torques about that axis.

c) If the object is in static equilibrium, torques may be calculated about **any** point. A wise physicist will choose a point where an unknown force acts to simplify the algebra.

4. *Remember thy sign conventions to keep your equations consistent.*

Remember that positive and negative signs only make sense for *components*, not magnitudes of forces. Make sure that you have the correct signs for the axes you have chosen. Also remember that the sign of a torque does not depend on the direction of the force *per se*, but rather to whether it causes a counterclockwise (positive) or clockwise (negative) rotation about the reference point.