how to solve Newton's Second Law problems

1. Write down a symbol or expression to identify the **question**.
FREE BODY DIAGRAM
2. Identify the **object** you will apply Newton's Second Law to. This is usually the object whose mass is mentioned in the problem.
3. Start a **Free-Body Diagram** for the object by drawing a force vector for the object's **weight**.
4. Complete the **Free-Body Diagram** by drawing a force vector from **each thing that is *touching* the object**. Remember that if a surface is exerting a normal force, it may also be exerting a frictional force. The diagram should include only the forces exerted *on*, not *by*, the object.
FORCE TABLE
5. Write down **axes** and **positive directions**. When applicable, choose axes that are parallel to the direction of movement.
6. Start a **Force Table**. For each force, write down the magnitude and direction of the **overall vector**. Where possible, use a formula to calculate the magnitude. The forces with special formulas are weight, kinetic friction, *maximum* static friction, and spring force: $w = m\dot{g}$, $\dot{f}_k = \mu_k \dot{n}$, $\max \dot{f}_s = \mu_k \dot{n}$, $\text{sp}\, \dot{F} = k\dot{x}$ There are no special formulas for normal force, tension, or *actual* static friction. If there's no special formula for a force, and its magnitude is unknown, represent the magnitude with a dotted variable.
7. For each force, break the force into **components**. *Always include a "+" or "-" sign on each nonzero component.*
NEWTON'S SECOND LAW EQUATIONS
8. Write down the **Newton's Second Law Equations** with the equations arranged horizontally from each other: $\sum F_x = ma_x$, $\sum F_y = ma_y$ For the remaining steps, write each new version of each equation under the previous version (not to the side of the previous version).
9. For each Newton's Second Law Equation, **add or subtract** all the relevant individual **force components** on the left side of the equation, using the components from the object's Force Table.
10. For each Newton's Second Law Equation, where possible, substitute numbers or expressions for the **mass**.
11. For each Newton's Second Law Equation, where possible, substitute numbers or expressions for the **acceleration**, including signs. Do not substitute g for a. If an object is motionless in a component, then that component of its acceleration is 0. If an object has constant velocity in a component, then that component of its acceleration is 0.
12. When you have one equation with one unknown, or when you have two equations with two unknowns, you can use algebra to **solve** for the unknowns.