

Name: _____

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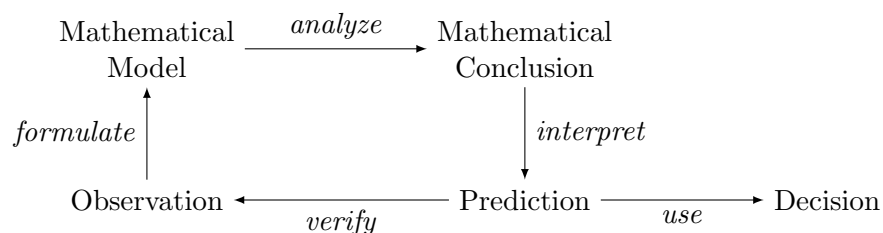
Mathematical Modeling

Goal: Capture patterns in precise, mathematical language.

Types of Models:

- *Analytical:* Turn a simple/simplified description of the pattern into a mathematical formula. This includes word problems where you must translate words into a formula.
- *Regression/Statistical:* You try to find a formula that fits some measured data well. This is the source for most equations that seem to come out of nowhere.

The Process of Modeling



Principles of Problem Solving

1. Understand the problem
 - (a) Read the problem carefully. What is *the unknown*? What are the *data*?
 - (b) Introduce names for relevant quantities. Consider sketching a diagram.
2. Think of a plan
 - (a) Find an equation linking the relevant parts of the problem.
 - (b) Try annotating the diagram to make the connections more clear.
3. Carry out the plan
 - (a) Apply mathematical tools (algebra, calculus, etc) to your equations and diagrams.
 - (b) Be sure you are answering your original question.
4. Look back
 - (a) Check your work!
 - (b) Can you use this result or method for another problem?

Adapted from Polya's *How To Solve It* and Stewart's *Calculus 7e*

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Principles of Sketching

There are four basic elements of a sketch

1. **The Drawing:** Sketch the physical objects being described. Try to match the scale and relations between things.
2. **Annotations:** Add names, labels, and explanatory notes.
 - Label quantities that change over time with *letters*. If a quantity (length, angle, etc) does *not* change over time, you can label the drawing with its value.
 - You might also want to add additional lines to create a shape like a triangle, which can be used along with trigonometry or the Pythagorean theorem.
3. **Arrows:** Draw arrows to indicate motion. Once drawn, these arrows can often help you find out where to fill in the missing lines to create a triangle.
4. **Notes:** Next to your drawing, write down any formulas that may be useful for relating the relevant quantities. Common examples are area, volume, trig, and distance formulas. You may also use facts about similar triangles.

Useful Formulas

1. Area for circle, triangle, rectangle. Volume for sphere, cylinder, cone, rectangular prism.
2. If a solid has a constant cross-section, its volume equals its surface area times its length.
3. The distance between (x_1, y_1) and (x_2, y_2) is $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
4. The Pythagorean theorem for right triangles.
5. In similar triangles, corresponding sides have the same proportion. i.e. $\frac{a}{a'} = \frac{b}{b'}$ in the triangle

