Honors Calculus AB Name:________________________
Related Rates Notes 1 December 2006

Remember, **related rates** is implicit differentiation where *everything* depends on <u>time</u>.

Guidelines for Solving a Related-Rate Problem

1. Identify all *given* quantities and all quantities to be determine. If possible, make a sketch and label the quantities.

2. Write and equation that relates all variables whose rates of change are either given or to be determined.

3. Differentiate both sides of the equation *with respect to time.*

4. Substitute into the resulting equation all known values of the variables and their rates of change. Solve for the required rate of change.

The table below shows the mathematical models for some common rates of change that can be used in the first step of the solution of a related-rate problem.

Verbal Statement	Mathematical Model
The velocity of a car after traveling one hour is 50 miles per hour.	x = distance traveled (miles) $\frac{dx}{dt} = 50 \frac{miles}{hr}$ when $t = 1$ hour
Water is being pumped into a swimming pool at the rate of 10 cubic fee per minute.	V = volume of water in pool ft^3 $\frac{dV}{dt} = 10 \ \frac{\text{ft}^3}{\text{min}}$
A population of bacteria is increasing at the rate of 2000 per hour.	x = number in population $\frac{dx}{dt} = 2000 \ \frac{\text{bacteria}}{\text{hr}}$
Revenue is increasing at the rate of $4000 per month.	R = revenue (money earned) $\frac{dR}{dt} = 4000 \ \frac{\text{dollars}}{\text{month}}$

Notice how useful the units are in determining which rate of change goes with which variable. You will also need to be able to generate perimeter, area, surface area, volume and right triangle relations between variables.

Abstract Practice Problems:

1. $x^2 + y^2 = 25$ find a) $\frac{dy}{dt}$ when $x = 3$, $y = 4$, and $\frac{dx}{dt} = 8$

b) $\frac{dx}{dt}$ when $x = 4$, $y = 3$, and $\frac{dy}{dt} = -2$

(this models something going around a circle of radius 5, units unknown)

2. The radius r of a circle is increasing at a rate of 2 inches per minute. Find the rate of change of the area when (a) $r = 6$ inches and (b) $r = 24$ inches.

3. The radius r of a sphere is increasing at a rate of 2 inches per minute. Find the rate of change of the volume when (a) $r = 6$ inches and (b) $r = 24$ inches.

4. All edges of a cube are expanding at a rate of 3 centimeters per second. How fast is the surface area changing when each edge is (a) 1 centimeter and (b) 10 centimeters?