Name:____

Do Now: **Find the derivative of the following equation with respect to t, (d/dt) if v, r and h are variables**

$$V = \pi r^2 h$$

$$dv/dt = \pi r^2 \, dh/dt + h(2\pi r) \, dr/dt$$

Related Rates

Many things change with time. Our goal is to find the rate at which some quantity is changing by relating the quantity to other quantities whose rates of change are known

Mr. C's steps to solving related rate problems:

1) Draw a picture if applicable
2) Identify what quantity you are looking for
3) Identify the given information; the rates $\frac{d(variable)}{dt}$ can often be identified by the problem stating changing, increasing or decreasing. If the rate is decreasing be sure to make the quantity negative.
4) Take the derivative of the equation that relates the variables with respect to "t" (remember to make use of the derivative rules) before you plug the given information in
5) Substitute the given rates and values into the derivative equation
6) Use the original equation before you took the derivative to solve for any other variables necessary to find the desired quantity you were originally looking for.
7) Solve for the desired quantity

General

The power P (watts) of an electric circuit is related to the circuit's resistance R (ohms) and current I (amperes) by the equation $P = I^2 R$.
Given: R=5 ohms, P=45 watts, I is *decreasing* at $\frac{1}{3}\, amps/sec$, R is *increasing* at 2 $ohms/sec$ find $\frac{dP}{dt}$.

1. Given Information:

$R = 5$ $\quad \frac{dI}{dt} = -\frac{1}{3}$

$P = 45$ $\quad dR/dt = 2$

2. Looking for:

dP/dt

3. Equation to be used

$P = I^2 R$

4. Derivative of the equation:

$$dP/dt = I^2 \frac{dR}{dt} + 2IR\frac{dI}{dt}$$

5. What is "I" equal to:

$$P = I^2 R$$
$$45 = I^2(5)$$
$$\sqrt{9} = \sqrt{I^2}$$
$$I = 3$$

6. Solve:

$$dP/dt = 3^2(2) + 2(3)(5)\left(-\frac{1}{3}\right)$$
$$dP/dt = 8 \text{ watts/sec}$$

Circle

When a circular shield of bronze is heated over a fire its radius increases at the rate of $\frac{1}{5}$ cm/sec. At what rate is the shields area increasing when the radius is 50 cm?

1. Given Information:

$dr/dt = \frac{1}{5}$ $\quad r = 50$

2. Looking for:

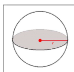
dA/dt

3. Equation to be used:

$A = \pi r^2$

$$dA/dt = 2\pi r \, dr/dt$$
$$dA/dt = 2\pi(50)\left(\frac{1}{5}\right)$$
$$= 20\pi \, cm^2/sec$$

Sphere

	The **volume** of a sphere is given by the equation: $V = \frac{4}{3}\pi r^3$	The **surface area** of a sphere is given by the equation: $S = 4\pi r^2$

Question: A spherical snowball with an outer layer of ice melts so that the *volume* of the snowball decreases at a rate of 2 cm^3/min.

(a) How *fast is the radius changing* when diameter of the snowball is 10 cm?

1. Given Information:

$dv/dt = -2$ $\quad d = 10$, $r = 5$

2. Looking for:

dr/dt

3. Equation:

$V = \frac{4}{3}\pi r^3$

4.

$$dv/dt = 4\pi r^2 \, dr/dt$$
$$-2 = 4\pi(5)^2 \, dr/dt$$
$$\frac{-2}{100\pi} = \frac{100\pi \, dr/dt}{100\pi}$$
$$\frac{-1}{50\pi} = dr/dt \qquad \frac{-1}{50\pi} \, cm/sec$$

(b) How fast is **surface area** of the snowball *decreasing* at this time?

1. Given Information

$r = 5$

$dr/dt = -\frac{1}{50\pi}$

2. Looking for:

ds/dt

3. Equation:

$S = 4\pi r^2$

4.

$$ds/dt = 8\pi r \, dr/dt$$
$$= 8\pi(5)\left(-\frac{1}{50\pi}\right)$$
$$= \frac{-40}{50} \, cm^2/sec \rightarrow -4/5 \, \frac{cm^2}{sec}$$