1. Find $\frac{dy}{dx}$ for each of the following functions.

a. $y = (4 - \frac{x}{5})^7$ b. $y = \sqrt{25 - x^2}$ c. $y = e^{-x}\sin 5x$

d. $y = e^{\sin 3x}$ e. $y = \tan 6x$ f. $y = \sin(x^4)$

g. $y = \cos(\frac{\pi}{2} - x)$ h. $y = 24 + 11\sin(\frac{\pi}{6}(x-1))$ i. $y = \frac{5}{(3x-1)^2}$

j. $y = \frac{\sqrt{5}}{1-3x}$ k. $y = \frac{21}{x^2+9}$ l. $y = x\sin(\frac{1}{x})$

m. $y = \sin^2(5x)$ n. $y = e^3$

2. Determine the rate at which the number of hours of daylight per day is changing in Shoreline today. Assume that each month has 30 days, that we receive 16 hours of daylight on June 21 and 8 hours of daylight on December 21. Assume also that the number of hours of daylight varies sinusoidally with time.

3. The volume (in cubic centimeters) of water in a container at time t seconds is given by the function

$$V = 300 - 100\sin(\tfrac{\pi}{8}t) \quad , \quad 0 \le t \le 16$$

a. Find the instantaneous rate at which the volume of water in the container is changing at time $t = 14$ seconds.
b. Find the volume of water in the container when the water is leaking out at the rate of 10 cm^3/sec. (There are two possible answers.)

3. The population of a colony of bacteria at time h hours is given by the function $P = 500e^{\frac{2h}{5}}$. Find the rate at which the population is changing when there are 1000 bacteria in the colony.

4. A one gram sample of a gas is expanding at the rate of 6 cm^3/sec. Find the rate at which the density of the gas is changing when the volume is 100 cm^3.

5. The air pressure P (in atmospheres) at an altitude of k kilometers above sea level is given by the function $P = e^{-.1k}$.
a. Find $dP/dk\,|_{k=1}$ and interpret your answer.
b. The height (in kilometers) of a balloon t hours after noon is given by the function $H = 1.25 + .5\cos(t/3)$. Find the velocity of the balloon at 4:00 PM, and find the rate at which the air pressure of the balloon's surrounding environment is changing at that time.

6. Between 0°C and 30°C, the volume V in cubic centimeters of one kilogram of water at a temperature T is given approximately by the formula

$$V = 999.87 - .06426T + .0085043T^2 - .0000679T^3$$

a. Find the instantaneous rate of change in the density of water (measured in g/cm^3) with respect to temperature at a temperature of 10°C.

b. A beaker of water is being heated so that its temperature increases at the constant rate of 2°C/sec. Find the rate at which the density of the water is changing when the temperature of the water is 10°C.