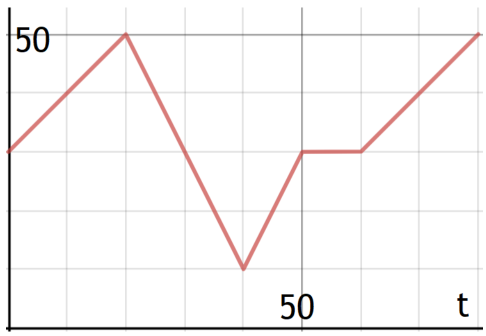
**MATH 102:112, CLASS 13 (THURSDAY OCT 18)**

(1) Calculate the derivatives.

$\frac{1}{3x^3+2}$ $\qquad\qquad$ $x\sqrt{4x^2-1}$

(2) The level of pollution in a lake is dependent on the population of humans by the lake. Let $P(H) = H^2$ equal the amount of human-created pollution, where $H$ is the number of humans (in thousands). Regular census-taking yields the graph of $y = H(t)$ shown. ($t$ in years)




We would like to understand how the pollution levels change with time.

(a) Calculate $\frac{dP}{dt}$ at $t = 30$.

(b) Calculate $\frac{dP}{dt}$ at $t = 10$.

(c) Calculate $\frac{dP}{dt}$ at $t = 55$.

(3) A circular bacterial colony has radius $r(t)$ and area $A(t)$ (so that $A(t) = \pi(r(t))^2$).
   (a) Suppose that $r(t)$ grows at a constant rate of 2. Calculate $\frac{dA}{dt}$ when $r = 5$.

   (b) Suppose instead that $A(t)$ grows at a constant rate of $20\pi$. Calculate $\frac{dr}{dt}$ when $r = 5$.

(4) (More optimization practice) An animal is deciding what proportion of its food-gathering time, $x$, it should allot between two different types of food (where $0 \leq x \leq 1$).
   (a) Suppose there are two types of food, 1 and 2, and the nutrition gained from spending $x$ portion of time on each is $F_1(x) = x^{1/2}$ and $F_2(x) = Nx$ for some positive constant $N$. What is the maximum amount of nutrition the animal can gain, and for what value of $x$ does this happen? Your answer will depend on $N$.

   (b) Same question, but for $F_1(x) = x^2$ and $F_2(x) = Nx$.