5. (8 points) After a dementor attack, Harry, the wizard, eats chocolate in order to feel better. When a wizard eats chocolate, the chocolate enters their bloodstream instantaneously and the body metabolizes and eliminates it from the bloodstream at the rate of 20% per hour.

(a) If Harry ate 1/2 pound of chocolate, write a formula for the amount of chocolate, Q (in pounds), remaining in his bloodstream t hours after he ate the chocolate.

Harry ate a 1/2 pound of chocolate, so $Q_0 = 1/2$. We're told that his body metabolizes and eliminates it from the bloodstream at the rate of 20% per hour. Since the function is changing at a constant *percent*, we have an exponential function with the growth factor of $(1 - .20) = .80$ Thus,

$$Q(t) = \frac{1}{2}(0.8)^t.$$

(b) If Harry's chocolate level in his bloodstream becomes lower than 0.2 pounds, he will go into shock. What is the maximum amount of time, t, that he can wait before eating more chocolate? Show your work.

The maximum value of time, t, that Harry can wait is the value of t that satisfies the equation $0.2 = \frac{1}{2}(0.8)^t$.
$\Rightarrow 0.4 = (0.8)^t$
$\Rightarrow ln(0.4) = t * ln(0.8)$
$\Rightarrow t = \frac{ln(0.4)}{ln(0.8)}$
So, $t \approx 4.1$hours.

6. (5 points) Let $f(x) = \sin(3x^2)$. Use the **definition** of the derivative to express $f'(2)$ as a limit. You do **not** need to simplify your expression or try to approximate $f'(2)$.

$$f'(2) = \lim_{h\to 0} \frac{f(2+h)-f(2)}{h}$$
$$= \lim_{h\to 0} \frac{\sin(3(2+h)^2)-\sin(12)}{h}$$