1. (3 points) If 
\[ y = (\ln x)^x \]
find \( dy/dx \) in terms of \( x \).

Take the natural log of both sides to get 
\[ \ln(y) = \ln((\ln x)^x) = x \ln(\ln x) \]

Take the derivative of both sides, with respect to \( x \): 
\[ \frac{1}{y} \frac{dy}{dx} = \ln(\ln x) + \frac{1}{x} \ln(\ln x) \]
so 
\[ \frac{dy}{dx} = y(\ln(\ln(x)) + 1/\ln(x)) = (\ln x)^x \left( \ln(\ln x) + \frac{1}{\ln x} \right) \]

2. (3 points) The position (in meters) of a particle at time \( t \geq 0 \) is given by 
\[ s(t) = \frac{t^3}{3} - 2t^2 + 10t + 17 \]

What is the particle’s acceleration when the particle’s velocity is 15 meters/second? Put units on your final answer.

The velocity is 
\[ v(t) = s'(t) = t^2 - 4t + 10 \]
and the acceleration is 
\[ a(t) = v'(t) = 2t - 4. \]

We want acceleration when \( v(t) = 15 \), so set 
\[ 15 = t^2 - 4t + 10 \implies 0 = t^2 - 4t - 5 = (t - 5)(t + 1) \implies t = -1 \text{ or } t = 5 \]

We only want positive times, so take \( t = 5 \) seconds. Then 
\[ a(5) = 2 \cdot 5 - 4 = 6 \text{ meters/second}^2 \]

3. (4 points) A population of rabbits is growing at a rate proportional to its size. At year 2, there are 20 rabbits, and at year 4, there are 120 rabbits. How fast is the rabbit population growing at year 10? Put units on your final answer.

The first sentence says that \( (dP/dt)/P = k \), for \( k \) a constant. Thus, \( dP/dt = kP \), so \( P(t) = Ce^{kt} \). We have 
\[ 120 = Ce^{4k} \]
\[ 20 = Ce^{2k} \]

Dividing the first by the second gives \( 6 = e^{2k} \implies k = \ln(6)/2 \). Thus, 
\[ 20 = Ce^{2\ln(6)/2} = Ce^{\ln(6)} = C \cdot 6 \implies C = 10/3 \]

We have two ways to go from here. One way:
\[ \left. \frac{dP}{dt} \right|_{t=10} = kP(10) = \frac{\ln(6)}{2} \cdot \frac{10}{3} e^{\ln(6)/2 \cdot 10} = \frac{5 \ln(6)}{3} e^{5 \ln(6)} = \frac{5 \ln(6)}{3} \cdot 6^5 \text{ rabbits/year} \]
and another way:
\[ \frac{dP}{dt} = \frac{10}{3} e^{\ln(6)/2 \cdot t} \ln(6) = \frac{5 \ln(6)}{3} e^{\ln(6)/2 \cdot t} \implies \left. \frac{dP}{dt} \right|_{t=10} = \frac{5 \ln(6)}{3} e^{\ln(6)/2 \cdot 10} = \frac{5 \ln(6)}{3} \cdot 6^5 \text{ rabbits / year} \]