3-7

1. (Warm-up)

   (a) Find the derivative of $f(x) = (x^2+1)^{\sin x}$.

   (b) Find the derivative of $f(x) = \cos\left(100a\,\frac{3-x}{\sqrt{2}}\right)$ *in the most efficient manner*.

2. Let $n = f(t)$ model the number of voles in my garden starting in year 2000 where n counts the number of voles and t is measured in years. Assume that in 2000, five voles lived in the garden and that I estimate that the number of voles doubles every three years.

   (a) Find $f(0),\ f(3),\ f(6)$, and $f(9)$ using the assumptions above. (include units)

   (b) Find an expression for $n = f(t)$ in general.

   (c) Find and interpret $f'(10)$.

3. The position of a particle moving along a straight line is given by: $s(t) = 3\sin(\pi t/2)$ for $t \geq 0$ where t is measured in seconds and s is measured in feet.

   (a) Find the position at which the particle starts.

   (b) Where is the particle 3 seconds after starting?

   (c) When is the particle in position 0?

   (d) Find the velocity and the acceleration of the particle.

   (e) When is the particle at rest?

   (f) When is the particle moving in the positive direction?

   (g) Find the total distance the particle travels in the first 4 seconds.

   (h) Sketch a diagram of the motion of the particle.

4. The volume of a growing spherical cell is modeled by $V = \frac{4}{3}\pi r^3$ where r is the radius of the cell measured in micrometers ($1\mu m = 10^{-6} m$.)

   (a) Find and interpret $V(4)$. (include units)

   (b) Find the average rate of change of the volume of the cell when its radius increases from 4 to 4.1 μm.

   (c) Find the instantaneous rate of change of the volume with respect to radius when $r = 4\mu m$ and interpret your answer.

   (d) What familiar formula is given by dV/dr and can you give an intuitive explanation for why this is?