Math 111
Exercise answers: 3.8 & 3.9

3.8

1. It is determined that an invasive species of fish grows with a constant relative growth rate and that the population doubles in 3 years

   (a) How long does it take to increase by a factor of 10? (9.97 years)

   (b) What is the value of the relative growth rate? (0.231 fish/year/fish)

2. A certain radioactive material has half-life of 2.5 years.

   (a) How long until a mass of 300 grams of this material decays to 5 grams? (14.77 years)

   (b) What is the decay rate at the time it reaches mass 5 grams? (-1.39 gram/year)

3. Let $v(t)$ be the velocity of a falling object of mass 1 kg. A simple model for the velocity is the equation $v' = 9.8 - 0.1v$.
   (In this model, 9.8 is the acceleration due to gravity, and $0.1v$ is the drag force that the object experiences as it falls.)

   (a) Find a formula for $v(t)$ if $v(0) = 0$. ($v(t) = 98(1 - e^{-0.1t})$)

   (b) Determine what happens to the velocity as $t \to \infty$. ($v \to 98$. This is the terminal velocity.)

3.9

1. A cylindrical tank of radius 5m is being drained at a rate of 3m^3/min. How fast is the depth of the water in the tank decreasing when the depth is 7m? ($-3/25\pi$)

2. Police radar is stationed near a road. The officer aims the radar gun at a passing car and the gun is at an angle of $45°$ to the road If the officer records the distance between the car and the radar is decreasing at a rate of 100 km/hr, how fast is the car travelling? (141.42 kph)

3. Sand is dumped on a pile in the shape of a cone at a rate of 30 ft^3/min. The diameter and the height of the cone remain equal as the pile grows. How fast is the height of the pile increasing when the height is 10 ft? ($6/5\pi$)

4. Two cars start off from the same point. One travels west at 25 mph, the other south at 60mph. At what speed are they moving apart 2 hours later? (65 mph)

5. In a certain species of fish, brain weight (in grams) as a function of body weight (in grams) is determied to be $B = 0.007W^{2/3}$. Body weight as a function of body length is determined to be $W = 0.12L^{5/2}$. How fast is the fish brain growing when the fish is 5 cm and growing by 0.1cm/day? (8.3×10^{-4} grams/day)

6. If the radius of a cylinder is decreasing by 2cm/min, and the height is increasing at a rate of 10 cm/min, how is the volume of the cylinder changing when the radius is 5 cm and the height is 15 cm? (-50π)

7. The area between two varying concentric circles is at all times 9π in^2. If the area of the larger circle is increasing by 10π in^2/sec, how fast is the circumference of the smaller circle changing? (1.25 in/sec)

8. A swimming pool is 12 m long, 7 m wide, 1.2 m deep at the shallow end and 3 m deep at the deep end. Water is being pumped into the pool at a rate of $\frac{1}{3}$m^3/min. How fast is the water rising when the water is 1 m deep at the deep end? (1/140 m/min)