## Section 2.3: Modeling

1. The population of mosquitoes in a certain area increases at a rate proportional to the current population, and in the absence of other factors, the population doubles each week. There are 200,000 mosquitoes in the area initially and predators eat 20,000 mosquitoes/day. Determine the population of mosquitoes in the area at any time.
2. A pond initially contains 500,000 gallons of unpolluted water has an outlet that releases 10,000 gallons of water per day. A stream flows into the pond at 12,000 gallons per day containing water with a concentration of 2 grams per gallon of a pollutant. Find a differential equation that models this process and determine what the concentration of pollutant will be after 10 days.
3. An object with temperature $150^{\circ} \mathrm{F}$ is placed in a freezer whose temperatureis $30^{\circ} \mathrm{F}$. Assume that the temperature of the freezer remains essentially constant. If the object is cooled to $120^{\circ} \mathrm{F}$ after 8 min , what will its temperature be after 18 min ?
4. You just won the lottery. You put your $\$ 5,000,000$ in winnings into a fund that has a rate of return of $4 \%$. Each year you use $\$ 300,000$. How much money will you have twenty years from now?
5. A bottle of orange juice being taken out of refrigerator at $2^{\circ} C$ warms up to $5^{\text {circ }} C$ in 5 minutes while sitting in a room of temperature $23^{\circ} \mathrm{C}$. How warm will the orange juice be if left out for 15 min ?
6. A 50 kg object is shot from a cannon "straight up" with an initial velocity of $10 \mathrm{~m} / \mathrm{s}$ off a bridge that is 100 meters above the ground. If air resistance is estimated as $5 v(t)$ (with appropriate sign) determine the velocity of the mass when it hits the ground (you may assume the object does not hit the bridge on the way down).
7. Initially a tank contains 10000 litres of brine with a salt concentration of 1 kg salt per 100 litres. Brine with 2 kg salt per 100 litres enters the tank at a rate of 20 litres per second. The well-stirred mixture leaves at the same rate. Find the concentration of salt as a function of time.
(a) Take the same setup as in the previous example, but the mixture leaves the tank at only 10 litres per second. Of course the tank will eventually fill up, but we want to know the amount of salt at any time before this.
8. (You might use a calculator for this one)

The temp of a glass of iced tea is initially 5 deg. (all in C). After 5 minutes the tea has heated to 10 deg. in a room where the air temp is 30 deg .
(a) Determine the temp of tea as a function of $t$.
(b) What is the temp of the tea after 10 minutes?
(c) When will the tea reach a temp of 20 deg?
9. A home buyer can afford to spend no more than $\$ 800 /$ month on mortgagepayments. Suppose that the interest rate is $9 \%$ and that the term of the mortgage is 20 years. Assumed that interest is compounded continuously and that payments are also made continuously. Determine the maximum amount that this buyer can afford to borrow.
10. A tank initially contains 100 L of fresh water. A brine containing $200 \mathrm{~g} / \mathrm{Lof}$ salt salt flows into the tank at rate of $3 \mathrm{~L} / \mathrm{min}$. The solution inside the tank is keptwell stirred and flows out of the tank at the rate $2 \mathrm{~L} / \mathrm{min}$. Determinethe concentrationof salt at any time.
11. We want to use the logistic equation to model the number of people sick with the flu. We have a total population of 1000, and on the first day, one person was sick. On day there were 20 people sick. We want to find the appropriate constants and solve the DE.

HINT: For a short amount of time, we can get a fairly good model by using exponential growth.
12. A brine solution of salt flows at a constant rate of $4 \mathrm{~L} / \mathrm{min}$ into a large tank that initially held 100 L of pure water. The solution inside the tank is kept well stirred and flows out of the tank at $2 \mathrm{~L} / \mathrm{min}$. If the concentration of salt in the brine entering the tank is $0.2 \mathrm{~kg} / \mathrm{L}$, determine the mass of salt in the tank after t minutes.
13. (Sorry for the gruesome problem!)

Suppose a dead body is discovered at $3: 45 \mathrm{PM}$ in a room where the temperature is 20 $\operatorname{deg} \mathrm{C}$. At the time of discovery, the temperature of the body is 27 deg C . Two hours later (at $5: 45 \mathrm{PM}$ ), the temperature of the body is 25.3 degrees. What was the time of death?
Note that the normal adult human has a body temp of approx 37 deg C .

