## 1. Mixing.

Suppose you have a 300 liter fish tank full of water with 10 grams of salt dissolved in it. Water with a salt concentration of 0.8 g/L is entering the tank at a rate of 5 L/min. Assume that the tank is constantly mixed, that water is draining from the tank at a rate of 5 L/min, and that the rate at which salt is leaving the tank never exceeds the rate at which salt is entering the tank.

(a) Find the rate (in g/min) at which salt is entering the tank.

(b) Let's write $s$ for the amount (in grams) of salt dissolved in the tank at time $t$.
What is the value of $s$ at time $t = 0$?

(c) Find the concentration (in g/L) of salt in the tank, in terms of $s$.

(d) Find the rate (in g/min) at which salt is leaving the tank, in terms of $s$.

(e) Write down a differential equation relating $\frac{ds}{dt}$ and $s$. Hint: combine parts (a) and (d) above.

(f) Use separation of variables to find a formula for $s$ in terms of $t$.

(g) Find the amount of salt (in g) in the tank after 10 minutes.

## 2. "Newton's Law of Warming."

(This is really the same as Newton's Law of Cooling, but this time, we assume our object's initial temperature is *less* than the ambient, room temperature.)

Suppose a cold drink is sitting in the open air, on a hot summer day of constant temperature $A$. Also suppose that the drink warms up, at a rate proportional to the difference between its temperature $T$ and the air temperature $A$.

(a) Write a differential equation to model what will happen to the temperature $T$ of the drink over time. Your differential equation should involve the air temperature $A$, as well as another positive constant $k$, which we might call the "per degree warming rate."

Make sure your equation reflects the fact that $T$ is *increasing*.

(b) Solve your above differential equation using separation of variables, to obtain a formula for the temperature of the drink as a function of time $t$. Your answer should involve some unknown constants.

Remark: you may want to use the fact that $T < A$. (Why is this true?)

(c) Suppose the air temperature is 90°F; the drink warms up at a rate of 0.2°F per minute per °F of temperature difference; and the initial temperature of the drink is 36°F. Revise your answer to part (b) of this problem, to reflect all of this additional information.

(d) What will the temperature of the drink be after 5 minutes; after 10 minutes?

(e) How long will it take for the drink to reach 55°F?