Now that we can solve differential equations analytically, we can solve application problems that utilize differential equations

Goal

1. Solve real world problems using differential equations

There are numerous real world problems that can be solved by using differential equations. Typical of these kinds of problems are exponential growth and decay problems and Newton's Law of cooling.

1. Population growth:
   (a) A population of bacteria continuously grows at a rate proportional to the current population. If the population doubles in size every 12 hours, what is the proportional growth rate per hour?

   (b) If the colony started with 1500 bacteria, at what time will it reach 1,000,000?

2. Exponential decay:
   (a) A certain radioactive substance continuously loses 5% of its radioactive material each day. If after 30 days of decay there remains 45 gm of radioactive material, how much radioactive material was there originally?

   (b) How much more time must elapse for there to be only 10 gm of radioactive material left?

3. Newton's law of cooling: Newton stated that a substance heats or cools proportionally to the difference of the temperature of the substance and the area surrounding it.

   (a) If you put tap water (60 degrees) into a freezer that maintains a constant temperature of 20 degrees, and the water cools at a proportional rate of 10% an hour, at what time will the water freeze (32 degrees)?

   (b) If you put boiling water (212 degrees) in the same freezer, how long will it take to freeze?