

Some More Word Problems

1. Jim's grandparents started a "life-insurance with cash value" policy when he was born in 1990 with an initial investment of \$10,000. Now that Jim is leaving the house his grandparents have transferred the funds into his name. In 2010, the investment has a cash value of \$24,121.51 (so if Jim decides to cash out he will be given the cash value of the investment). What effective annual interest rate would his grandparents had to acquire (through Cash Deposits (CDs) or a bank's savings account) to have had the same return? Assuming this rate will continue for the next few years, would you leave the money there or move it?
2. An advertisement for real estate published in the 26 July 2004 electronic edition of the New York Times states:

Did you know that the percent increase of the value of a home in Manhattan between the years 1950 and 2000 was 721%? Buy a home in Manhattan and invest in your future.

Suppose instead of buying a home in Manhattan in 1950, someone had invested money in a bank account that compounds interest once per month. What annual interest rate would he bank have to pay to equal the growth claimed in the above ad?

3. Browsing cars in a car-lot you see a sign in the window of a \$15,000 car that offers you a choice between two deals. \$1,000 back now (which people tend to use towards the principal) or 1.5% reduced interest rate. The standard rate for a loan between \$12,000 and \$20,000 is 5.29%. for 5 years. Which offer do you take?
4. You have four ten-year subsidized loans you took out to pay for college. Below is a table fo the loans taken and their respective effective annual interest rates (AIR):

loan (\$)	8,000	9,000	10,000	12,000
AIR (%)	3.51	4.22	5.01	6.31

After graduation you are given the option of consolidating (that is take out one loan to pay off *all* the balances on your current loans). What rate would you need to be offered on a ten year loan to make this worth doing?

5. The world's population was about 6.1 billion in 2000 and it was increasing with an exponential rate of growth of 1.4%. When will there be standing room only? (Assume each person needs about 4ft² to stand.)
6. A scrap of paper taken from the Dead Sea Scrolls was found to have a carbon-14 to carbon-12 ratio of .795 times that found in plants living today. Given that the half-life of carbon-14 is 5,730 years, estimate the age of the scroll.

7. When an underwater light beam is turned on in sea water, the resulting intensity of the light decays exponentially along the direction of the beam. In fact, in clear sea water, the approximate percentage of the original intensity x meters from the source measured along the beam is given by intensity $[x] = 100e^{-1.4x}$
- Use this calculation to help explain why in any ocean almost no plants can grow at a depth of more than 10 meters.
8. From the Money section of the newspaper USA Today, June 18, 1992: “Rates on credit card applications don’t take into account monthly, and sometimes daily, compounding of finance charges. The average rate on credit cards is 18.5%, but most consumers pay effective rates of 20% or more because of compounding methods.” What does this mean?
9. Assume that the vinegar in this problem has a pH level of 3.1 and your stomach acid has a pH level of 1.6.
- How many times stronger is stomach acid than vinegar?
 - If you found a substance X whose $[H^+]$ was three times as intense as vinegar, what would its pH measure be?
10. Dr. Card finds that coffee burns his tongue if it is above 140°F and tastes bad if it is below 105°F . Initially Dr. Card used the paper cups provided by metro coffee that have a constant $k = 0.05$, but then he bought his own coffee mug that has a constant $k = 0.03$ (we are of course referring to the k that shows up in Newton’s Law of cooling).
- Which container does a better job keeping the coffee warm? How does knowing the values of k allow you to figure out the answer?
 - If Dr. Card gets a cup of coffee that is 160° at 8:30am and the outside temperature is 42°F , how long should he wait to drink the coffee so that he does not burn his mouth?
 - How long does Dr. Card have to drink the coffee before it starts to taste bad?
11. Go to a PayDay Loans location and find out how much the company will charge you to borrow \$100 for a year. This is actually complicated since they don’t offer loans for a full year (you will have to take out a loan after 3 months or so to pay off your initial loan and then repeat until a year has past but don’t forget the fees!). After you find out the total cost of the \$100 loan for one year from PayDay Loans, compute the interest rate that a credit card would have to charge (with continuously compounded interest) to make the same money as PayDay Loans.