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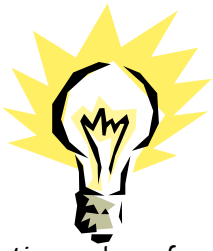
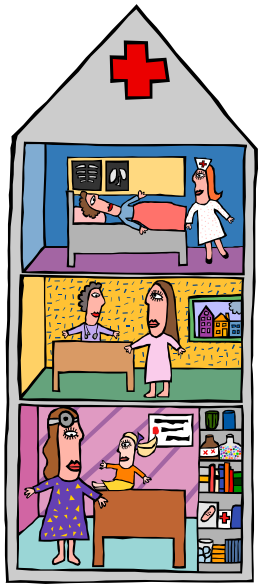
4.7 Polynomials And Rational Functions Project

Choose *one* of the following project options:

1. The luminous intensity I, measured in candela (cd), of a 100 watt light bulb is 130 cd. The law of illumination states that E = $\frac{I}{d^2}$ where E is the illumination and d is the distance in meters to the light bulb. Suppose you hold a book 1 m away from a 100-watt bulb and begin walking away from the bulb at a rate of 1 m/sec.
   a. Express E in terms of the time t in seconds after you begin walking.
   b. Graph the illumination function on the domain $1 \le x \le 10$.
   c. When will the illumination of the book be 50% of its original value? When will the illumination be 1% of the original value?



2. The following data gives the *cumulative* number of reported case of AIDS in the United States from 1982 to 1996. <Source: Department of Health and Human Services>



Year	Cases
1982	1563
1983	4647
1984	10,845
1985	22,620
1986	41,662
1987	70,222
1988	105,489
1989	147,170
1990	188,872
1991	232,383
1992	278,189
1993	380,601
1994	457,789
1995	529,282
1996	598,433

   a. Draw a scatter plot of the data.
   b. Find a quadratic, a cubic, and a quartic regression equation for the data.
   c. Which equation best models the data? Explain your reasoning.
   d. Graph your best-fit model on the same coordinate plane as the scatter plot.
   e. According to your best-fit model in part (c), how many cumulative cases would there be in 2001? In 2010?

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3. For some international sailing competitions, the rating R of a yacht is a function of several variables: R(A, L, V) = 0.9 ($\frac{L\sqrt{A}}{12\sqrt[3]{V}} + \frac{L+\sqrt{A}}{4}$) where A = surface area of the sails in square meters, L = length of the yacht in meters, and V = volume of water yacht displaces in cubic meters. To be in the R-5.5 class, a yacht must have a rating less than 5.5.

   a. Does a yacht that has 37 m^2 of sail, is 10 m long, and displaces 8.5 m^3 of water qualify? Justify your answer.
   b. If a yacht is 10 m long, graph the rating function in terms of A versus V on the domain $0 \le V \le 20$.
   c. Given a 10 m long yacht, what is the minimum surface area of the sails to displace at least 5 m^3 of water?
   d. Compare your analysis of part (b) and (c) with the yachts raced in the America's Cup Race?

4. (100 points Can Do Calculus) A cylindrical can of volume 70 cubic inches (approximately 1 quart) is to be designed. For convenient handling, it must be at least 1 inch high and 2 inches in diameter.
   a. Write the surface area function in terms of radius of the can.
   b. What dimensions (radius and height) will use the least amount of material?
   c. If the cost of material to make the can is 5 cents per square inch for the top and bottom and 3 cents per square inch for the sides, what dimensions should be used to minimize the cost of making the can?