Scaling Problems

Taken From Arnold B. Arons, *A Guide to Introductory Physics Teaching*, (John Wiley & Sons, New York, 1990), Appendix 1A.

1. Suppose we make a saline solution by dissolving 176 g of salt in 5.00 L of water. (The resulting total volume of the solution is very nearly 5.00 L.)

(a) Calculate the concentration of the solution, explaining your reasoning briefly.

(b) Using the result obtained in part (a), calculate how many cubic centimeters of solution must be taken in order to supply 10.0 g of salt. Explain your reasoning briefly.

(c) Make up a problem which involves the density concept and in which the steps of reasoning are exactly parallel to the steps in (a) and (b) above. Be sure to select reasonable numerical values for the physical situation you describe. Present the solution of the problem, explaining the steps briefly.

2. We have a cylindrical container, called "C". A second container D has the same shape as C, but the length scale, in all three dimensions, is larger by a factor of 1.80.
Answer the following questions by using appropriate scaling ratios only. There should be no appeal to formulas for areas or volumes of particular shapes. Evaluate final results in decimal form. Explain reasoning briefly in each instance.

(a) How will the circumference of container D compare with that of container C, that is, what is the numerical value of the ratio C_D / C_C?

(b) How many times larger is the cross-sectional area (i.e., the area of the base of D, denoted by S_D) than the cross-sectional area S_C?

(c) If C contains 25.0 L of water when filled to the brim, how many liters of water will D hold when similarly filled?

3. The earth has an equatorial radius of 3963 mi. (There are 5280 ft in one mile.)
Imagine a string wrapped around the equator of a perfectly smooth earth. Suppose we now add 15.0 ft to the length of the string and shape the longer string into a smooth circle with its center still at the center of the earth.
How far will the string now stand away from the surface of the earth? (Be sure to make the calculation in the simplest and most economical way; avoid doing irrelevant calculations and using irrelevant data. The sketch of an appropriate straight line graph can be more helpful than a stream of words in explaining your line of reasoning.)