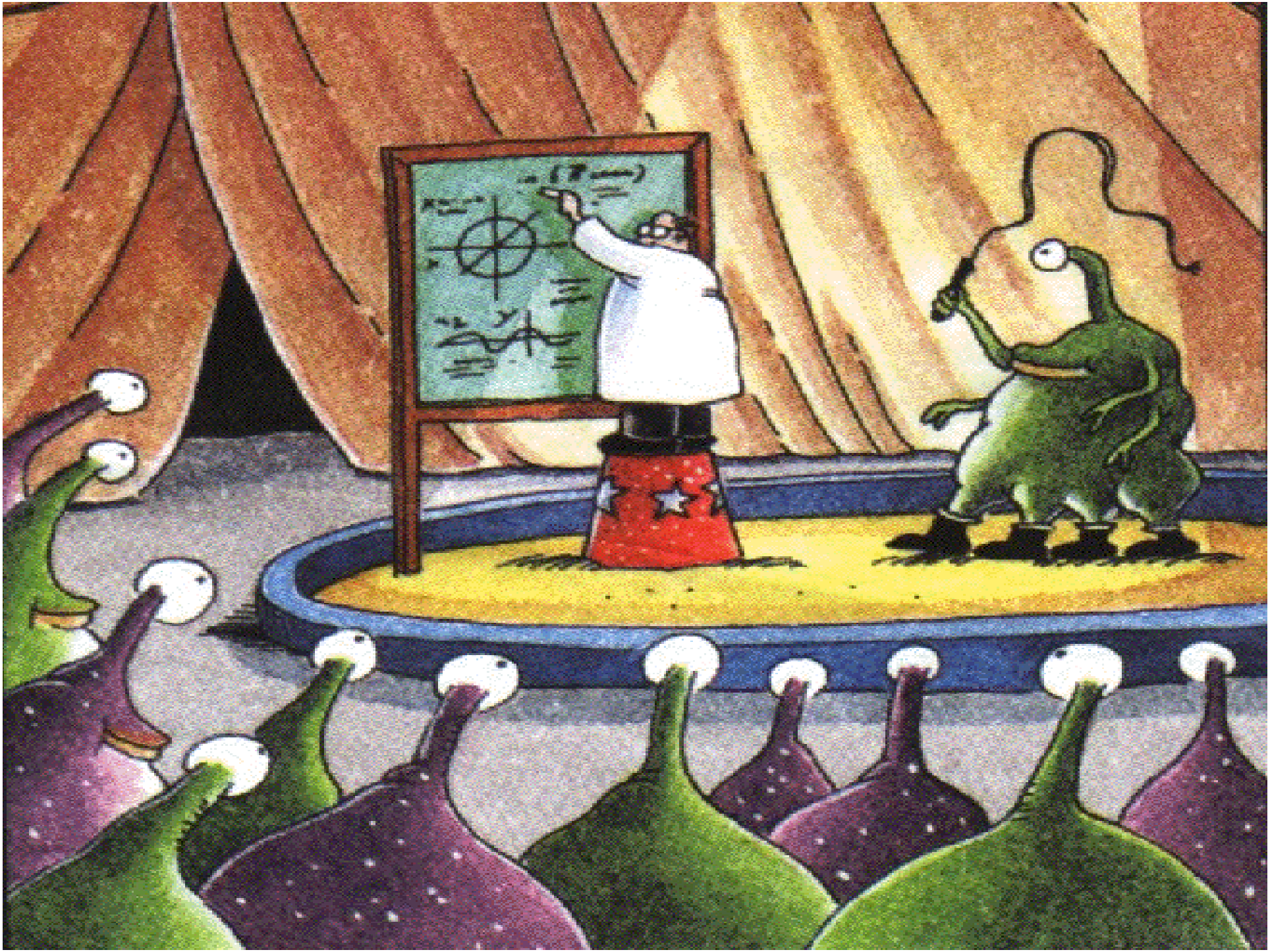

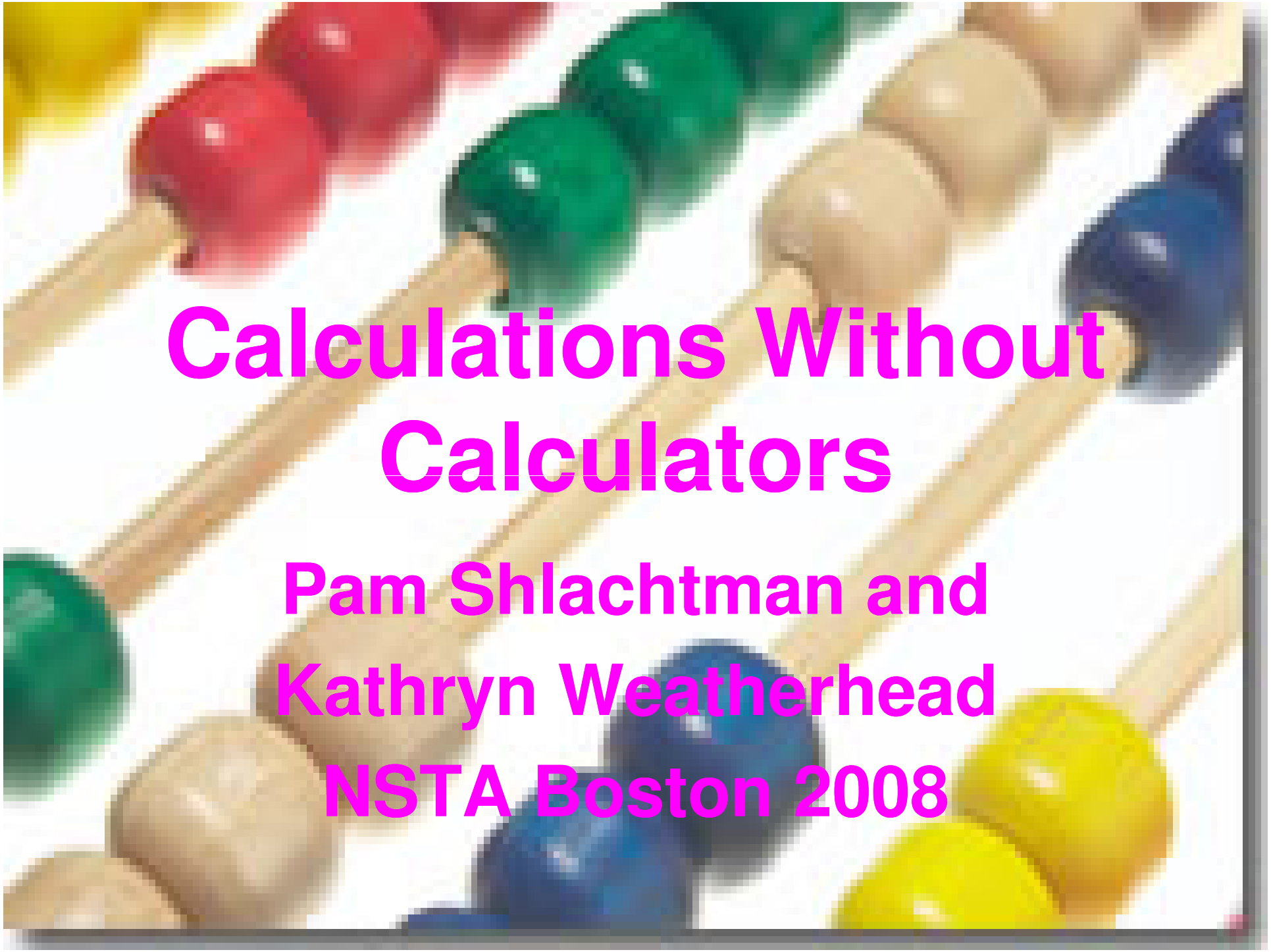

Calculations Without Calculators

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NSTA Boston 2008

The Problem:

How do we help our students achieve success on AP Environmental Science Exams when they cannot use calculators?

The College Board

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Solutions:

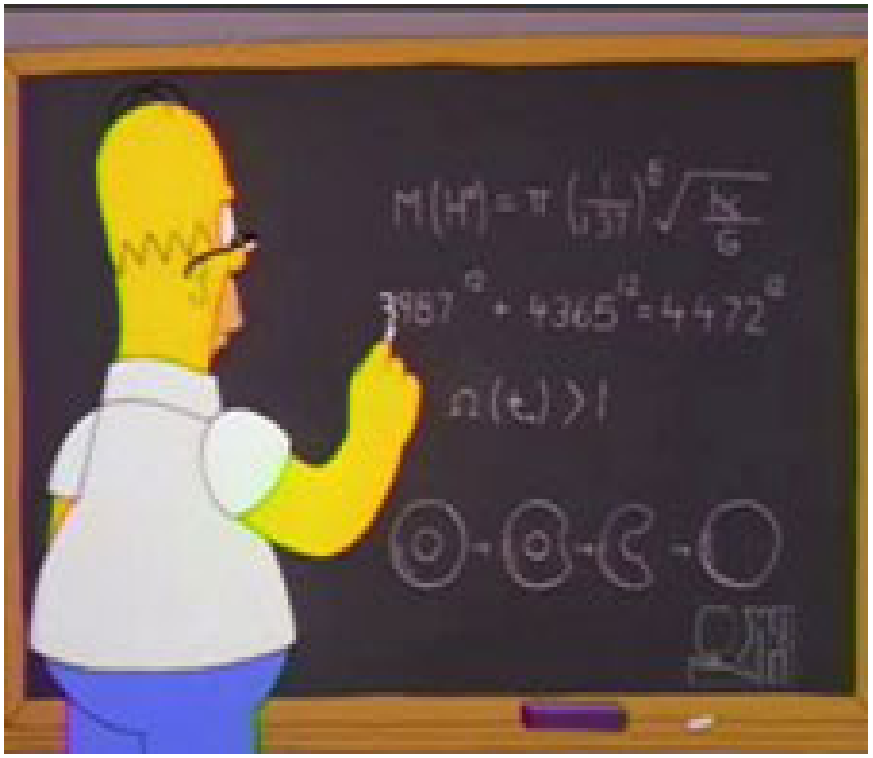
1. **Teach your students to use exponents whenever numbers are especially large or small.**

   Scientific notation **is a way to express, numbers the form of exponents as the product of a number (between 1 and 10) and raised to a power of 10.**

   650 000 → 6.5×10^{5}

   0.000543 → 5.43×10^{-4}

In scientific notation remember to have one numbe to the left of the decimal and to use correct significant figures.



2. Practice math manipulations with exponents

- **When adding or subtracting numbers with exponents the exponents of each number must be the same before you can do the operation.**

Example:

$(1.9 \times 10^{-3}) - (1.5 \times 10^{-4})$

$(19 \times 10^{-4}) - (1.5 \times 10^{-4}) = 17.5 \times 10^{-4}$

When multiplying numbers with base 10 exponents, multiply the first factors, and then add the exponents.

Example, $(3.1 \times 10^5)(4.5 \times 10^5) =$
13.95×10^{10} or 1.4×10^{11}

When dividing numbers, the exponents are subtracted, numerator exponent minus denominator exponent.

Example: $\dfrac{9 \times 10^5}{3 \times 10^3} = 3 \times 10^2$

3. Use Dimensional Analysis or factor/label method for calculations

The following formula based on the cancellation of units is useful:

$$\text{Given Value} \times \frac{\text{Conversion factor}}{1} = \text{Answer}$$

OR

$$\text{old unit} \times \frac{\text{new unit}}{\text{1 old unit}} = \text{new unit}$$

Example:

$$25 \text{ ft} \times \frac{1 \text{ yd}}{3 \text{ ft}} \times \frac{1.094 \text{ m}}{1 \text{ yd}} = 9.117 \text{ meters}$$

4. Be sure to know how to convert numbers to percentages and percent change.

***Example*: If 200 households in a town of 10000 have solar power, what *percent* does this represent?**

200/10000 x 100%= ?

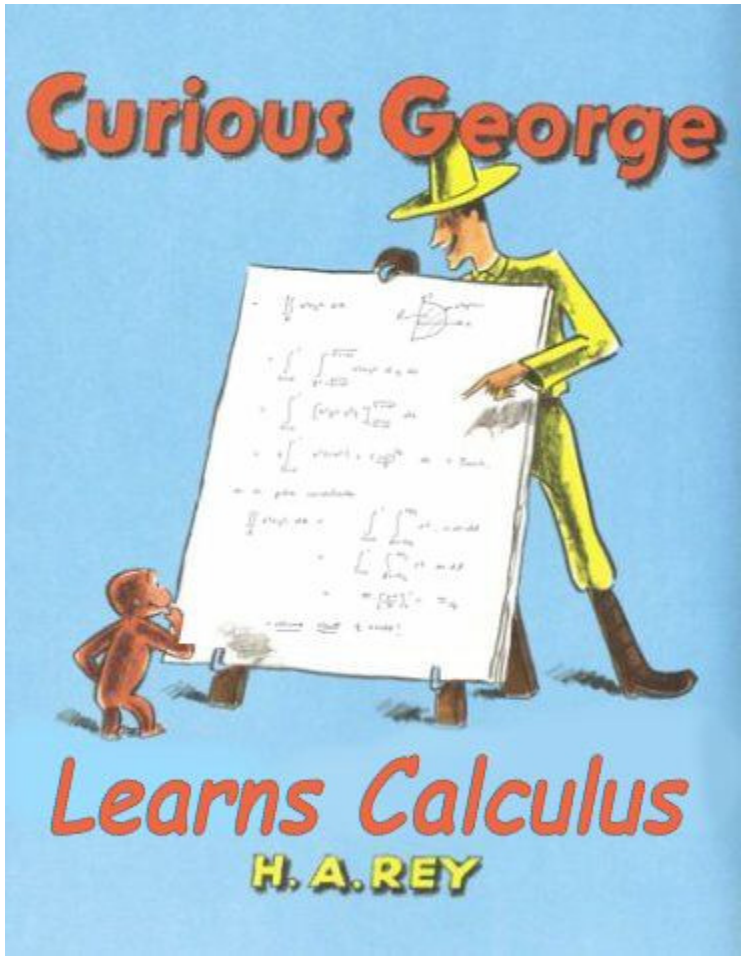
***Example*: If a city of population 10,000 experiences 100 births, 40 deaths, 10 immigrants, and 30 emigrants in the course of a year, what is its net annual *percentage* growth rate?**

5. Keep it simple. They don't expect you to do calculus!

Try reducing the fraction from the previous problem 200/1000 to 2/10= 1/5

Then solve:

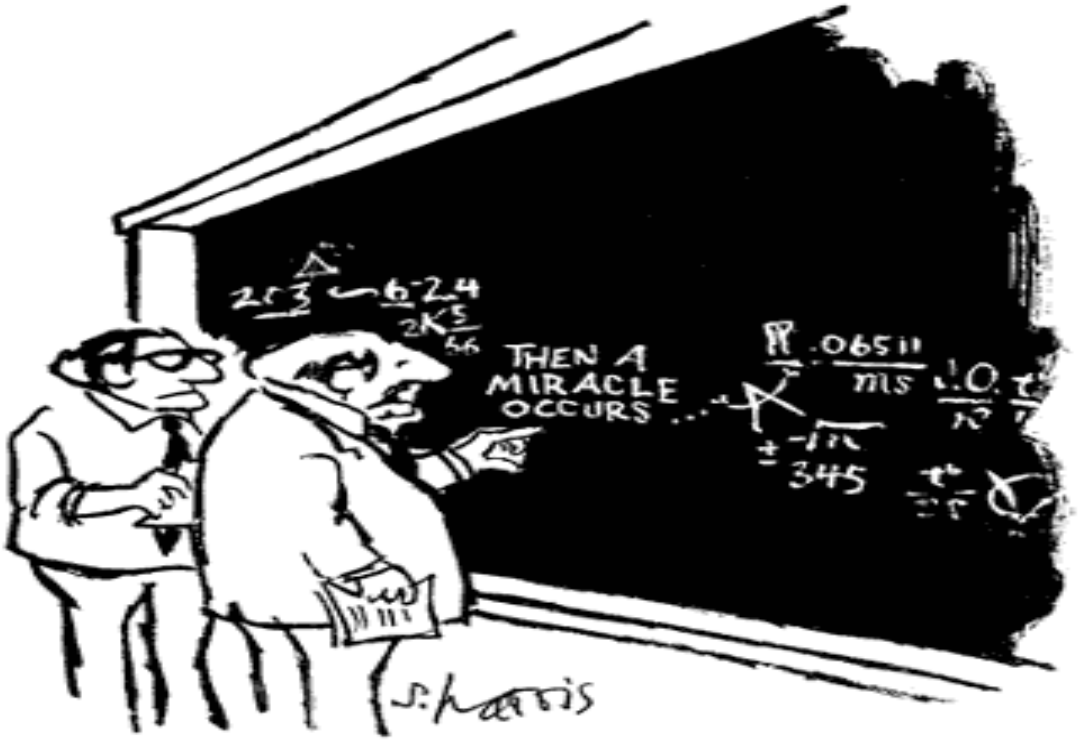
1/5 x 100%= 20%



6. Remember that the numbers will likely be simple to manipulate.

- **The APES folks know you only have limited time to do 100 multiple choice and 4 essays**
- **If you are getting answers like 1.365, then it is likely wrong**

7. Show ALL of your work and steps of calculations, even if they are too simple.

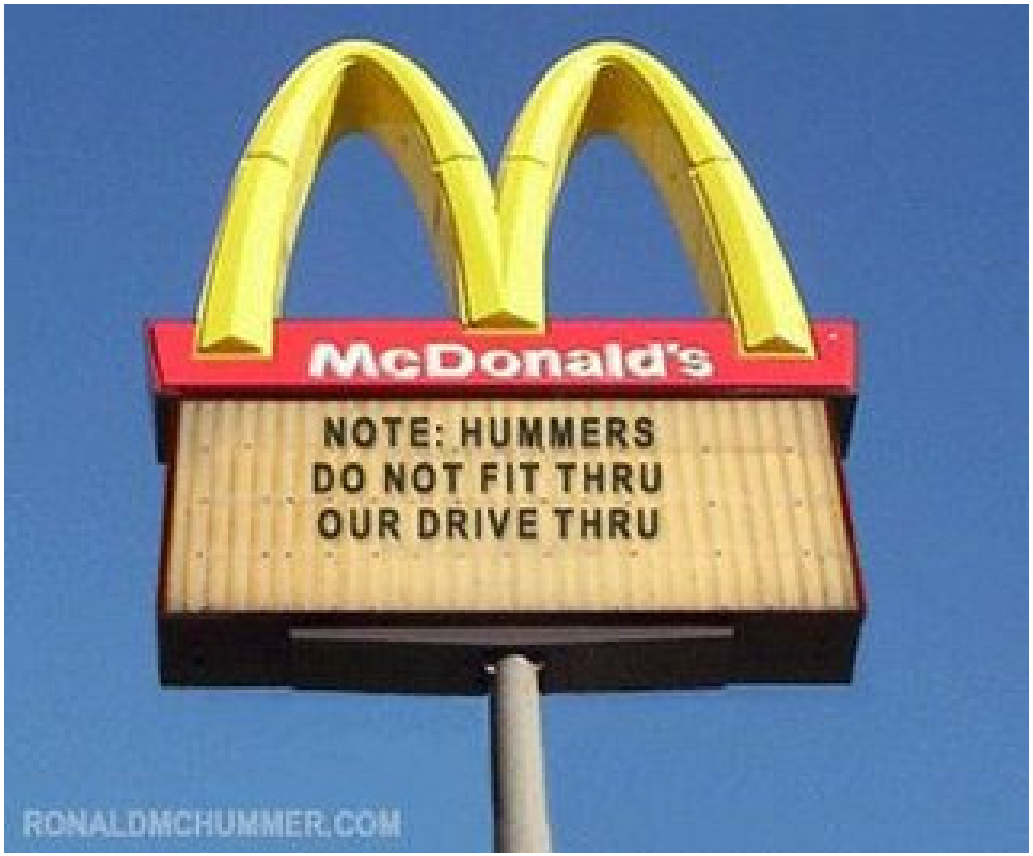


"I think you should be more explicit here in step two."

8. Show all of your units, too!

Numbers given without units are often not counted even if correct.

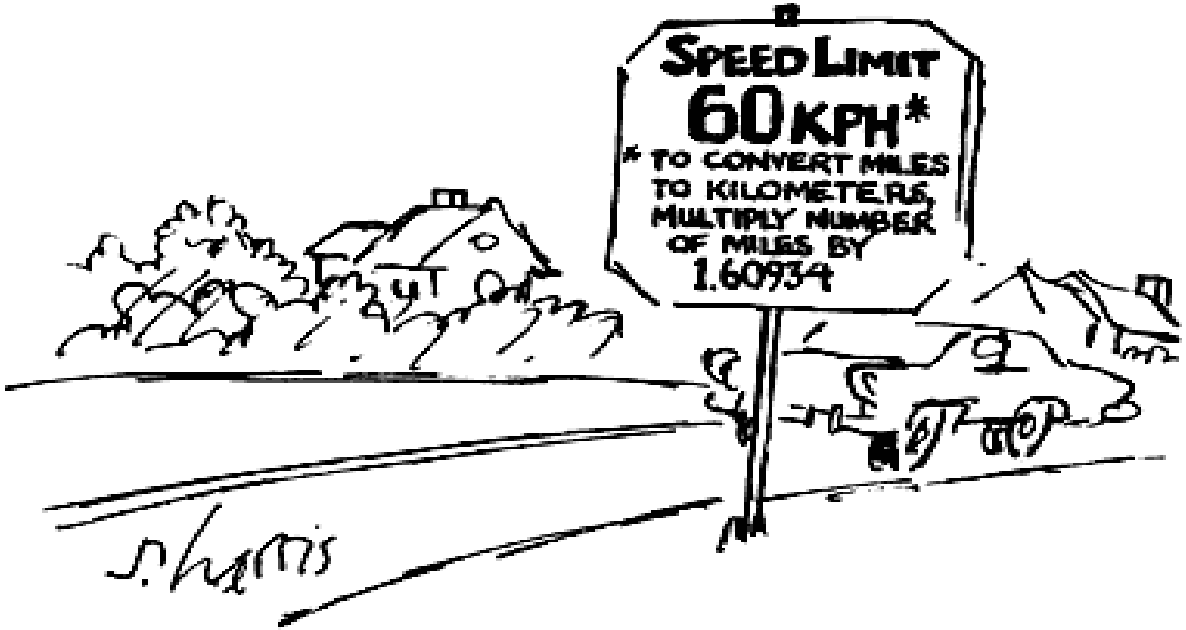
9. Answers should make sense! LOOK them over before you finish



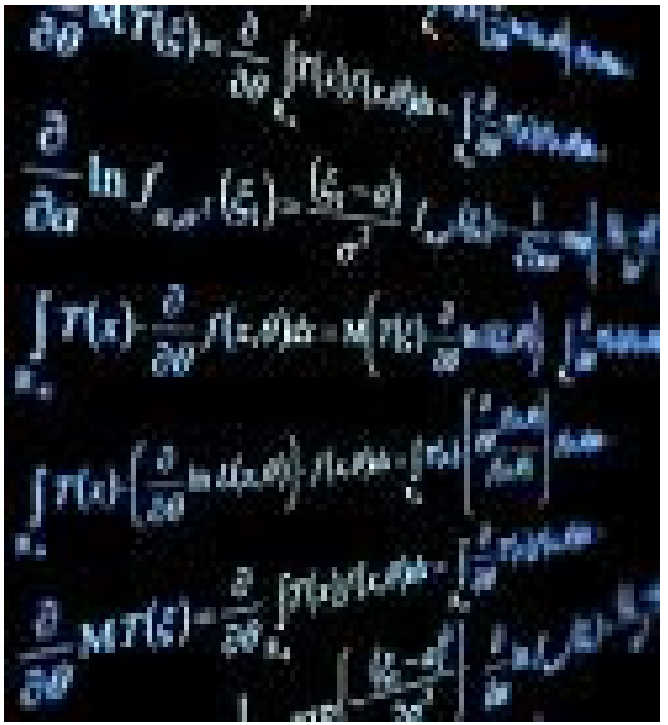
Example:

No one is going to spend 1 billion dollars per gallon of water!

10. Know some basic metric prefixes for simple conversions



Giga	G	$10^{9} = 1\,000\,000\,000$
Mega	M	$10^{6} = 1\,000\,000$
Kilo	k	$10^{3} = 1\,000$
Base (m, l, g)		$10^{0} = 1$
Milli	m	$10^{-3} = .001$
Micro	μ	$10^{-6} = .000\,001$
Nano	n	$10^{-9} = .000\,000\,01$
Centi	c	$10^{-2} = .01$



Conversions from US to metric will probably be given and do not need to be memorized. They should be practiced, however.

Gallons to Liters	1 gal= 3.8 L
Liters to Gallons	1 L, l= .264 gal
Meters to Yards	1 m= 1.094 yd
Yards to Meters	1 yd= .914 m
Grams to Ounces	1 g= .035 oz
Ounces to Grams	1 oz= 28.35 g
Kilograms to Pounds	1 kg= 2.2 lb
Pounds to Kilograms	1 lb= 454 g
Miles to Kilometers	1 mi= 1.609km
Kilometers to Miles	1 km= .621 mi

11. Know some simple energy calculations

12. Remember some other common formulas like the Rule of 70

The growth rate (in %) for a given period into 70 then you will get the crude population doubling period for that population.

Number of years to double= 70 / annual percentage growth rate

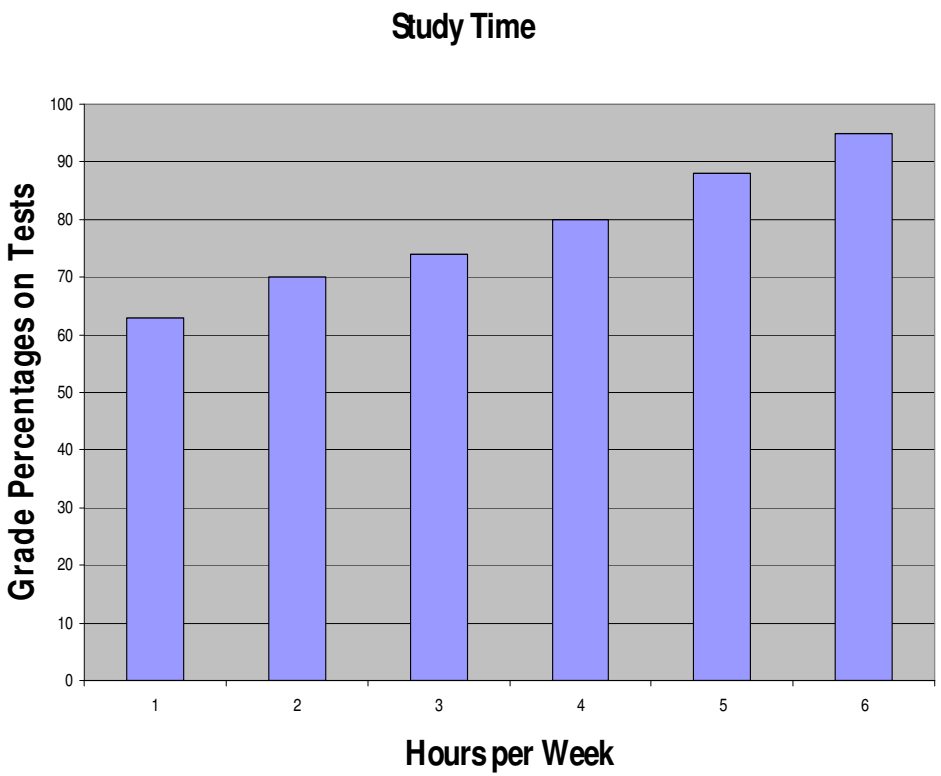
13. Be able to calculate half life

Example:

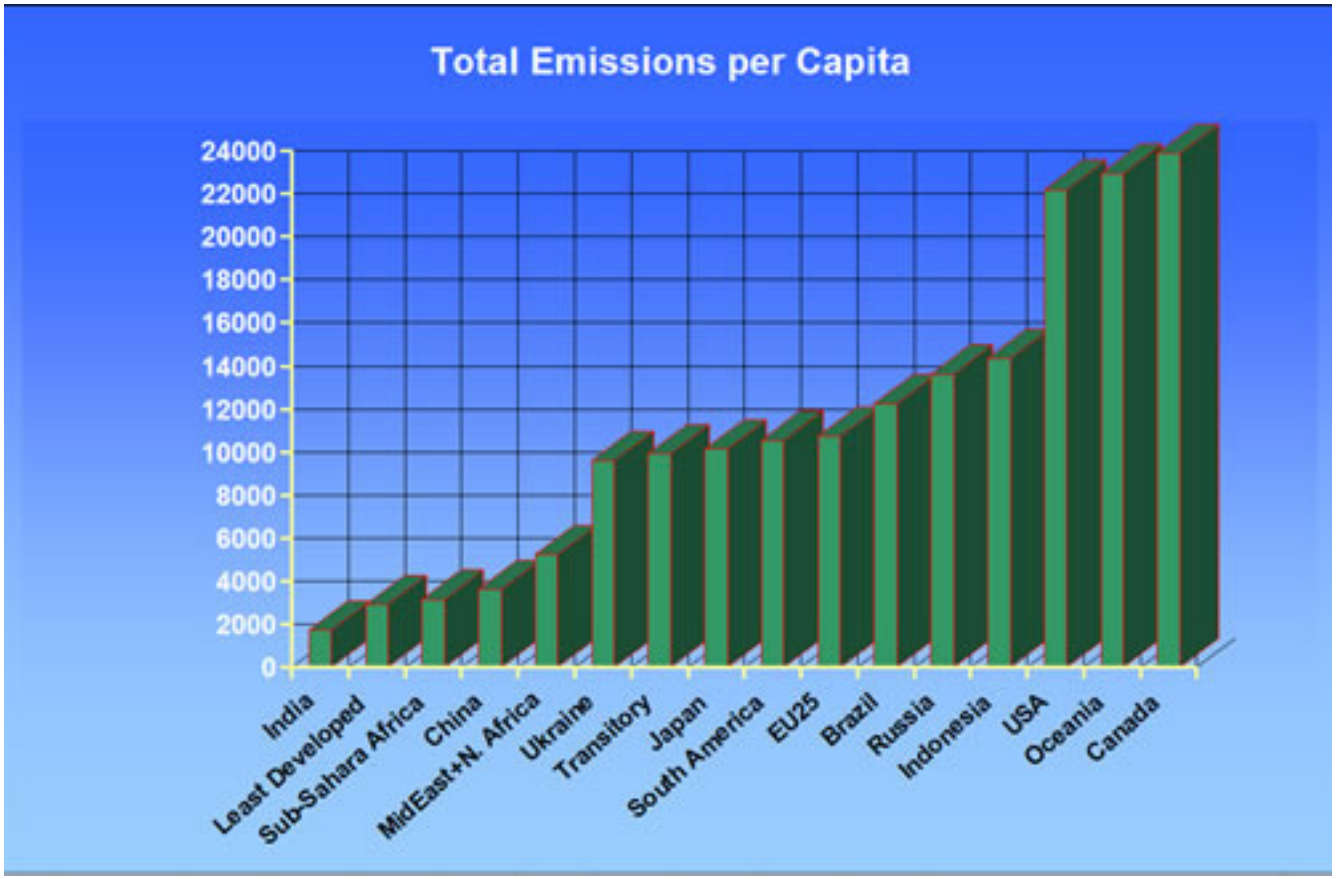
A sample of radioactive waste has a half-life of 10 years and an activity level of 2 curies.
After how many years will the activity level of this sample be 0.25 curie?

14. Know how to graph data

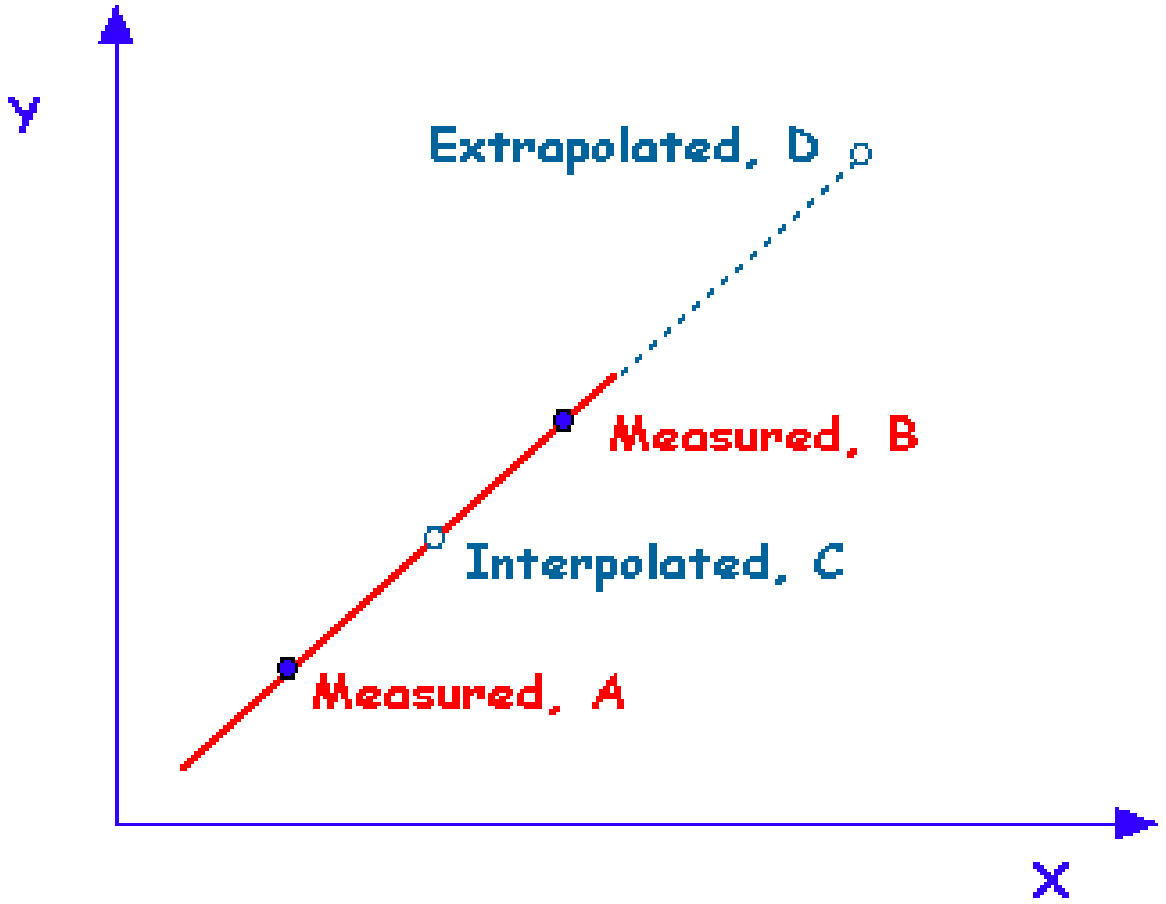
- Title the graph
- Set up the independent variable along the X axis
- Set up the dependent variable along the Y axis
- Label each axis and give the appropriate units
- Make proportional increments along each axis so the graph is spread out over the entire graph area
- Plot points and sketch a curve if needed. Use a straight edge to connect points unless told to extrapolate a line.
- Label EACH curve if more than one is plotted.



15. Know what is meant by “per capita” when solving a problem or interpreting a graph



16. Be able to *interpolate* and *extrapolate* data



"Mr. Osborne, may I be excused? My brain is full."

Powerpoint available at Kathryn Weatherhead's website:

http://web.beaufort.k12.sc.us/education/staff/staff.php?sectiondetailid=5121