AP Environmental Science Math and Equation Review

1) **Show all *work*.** No work, no credit. This is critically important for every calculation, even if it seems trivial. **Show all *units*.** Units provide valuable information.

2) **Develop good *"math sense" or "math literacy".*** The answers should make sense. If you calculate a cost of $50 billion per gallon of water, does this seem right?

3) **Know *simple conversion factors*** such as the number of days in a year or hours in a day. Other good numbers to know:
U.S. population = approx.. 300 million (300,000,000 or 3 x 10^8) – it's actually a little more
World population = approx. 7.1 billion (7,100,000,000 or 7.1 x 10^9) – it exceeded 7 billion in 2012

4) **Know and convert *metric prefixes.***

- T tera 10^{12} (trillion 1,000,000,000,000)
- G giga 10^9 (billion 1,000,000,000)
- M mega 10^6 (million 1,000,000)
- K kilo 10^3 (1000)
- H hector 10^2 (100)
- D or da Deka 10^1 (10)
- D deci 10^{-1} (0.1)
- C centi 10^{-2} (0.01)
- M milli 10^{-3} (0.001)
- μ micro 10^{-6} (one-millionth, 0.000001)
- n nano 10^{-9} (one-billionth, 0.000000001)

Quick tutorial here: https://youtu.be/pEDVddQvimI

5) **Be comfortable working with *negative numbers.*** Going from -8°C to +2°C is a 10°C change.

6) **Rates**

$\frac{\text{Rise}}{\text{Run}}$ $\frac{Y_2-Y_1}{X_2-X_1}$ slope $\frac{\text{change}}{\text{time}}$ y=mx+b $\frac{dX}{dt}$

- All of the above are ways to look at rates. The second equation is the easiest way to calculate a rate, especially from looking at a graph. Rates will often be written using the word 'per' followed by a unit of time, such as cases per year, grams per minute or miles per hour. The word 'per' means to divide, so miles per gallon is actually the number of miles driven divided by one gallon.
- Rates are calculating how much an amount changes in a given amount of time.

7) **Use dimensional analysis (factor label).** Conversions should show units of measurement and conversion factors.
Example: If water has a density of 62 pounds per cubic foot, how many tons of water are contained in a 4000 cubic foot tank?
4000 cubic foot tank x (62 pounds/cubic foot) x (1 ton/2000 pounds) = 132 tons

Example: If electricity costs $0.20 per kilowatt hour, calculate the cost to run a 1500 watt appliance for two hours.
1500 watts x (1 kilowatt/1000 watts) x 2 hours x ($0.020/kilowatt hour) = $0.60

8) **Calculate percentage and percent change.**
Percentage

17% = 17/100 = .17

- Remember that "percent" literally means divided by 100.
- Percentage is a measure of the part of the whole, or part divided by whole.
- Ex. 15 million is what percentage of the US population? 15 million / 300 million = .05 = 5%
- What is 20% of this $15 bill so that I can give a good tip? $15 x .20 = $15 x 20/100 = $3

Percent change
This commonly shows up on the APES exam. Remember the formula:

$$\text{Percent change} = \frac{\text{new value} - \text{old value}}{\text{old value}} \times 100$$

Example: old value = $400, new value = $500, percent change = $100 / $400 x 100 = 25% increase

9) **Calculate population growth rate and population density.** Growth rate = [b + i – d – e]
Population density = population divided by area

10) **Know the *Rule of 70* to predict doubling time.**
Doubling time = 70 divided by annual growth rate (in %)

11) **Recognize *Exponential Growth***

$N = N_0e^{rt}$

$R = (1/t) \text{ Ln } (N/ N_0)$

$T = (1/r) \text{ Ln } (N/ N_0)$

12) **Calculate *half-life.***
AMOUNT REMAINING = ORIGINAL AMOUNT)$(0.5)^x$; where x = number of half-lives
Half-life is a period of time, and is unique to each element.

13) **Calculate pH using –log $[H^+]$.** Log 10x = y and 10y = x.
Most pH problems are easily solved without a calculator. Remember that for every one-increment change in pH, the ion concentrations change by a factor of 10.

Examples: If pH = 6, then the concentration of hydrogen ions $[H^+] = 1 \times 10^{-6}$
If pH = 2, then the concentration of hydrogen ions $[H^+] = 1 \times 10^{-2}$
If the concentration of hydrogen ions $[H^+] = 1 \times 10^{-13}$, then the pH = 13

14) **Be familiar with units of energy and power.**
- Watt = Joule/sec = volts x amps
- Calorie = energy to raise on gram of water by one degree C
- BTU (British thermal unit) = energy to raise one pound of water by one degree F
- Kilowatts x hours = kilowatt hours
- Efficiency = energy out divided by energy in

15) **AP Graphing Tips**
- Label each axis, make sure you include units
- Set both axes to scale with consistent increments (they do not necessarily need to start at zero)
- Most of the time you connect the dots in APES
- Interpolate and extrapolate
- Include a title and key
- Make sure you can do them by hand