**Name: ____________________**

# Using Math in Environmental Science

Every AP Environmental Science Exam has one calculation problem in the free response section. Therefore, it is very important for you to know how to set up an calculate these types of problems because you will not be allowed to use a calculator on the exam.

## Part I: Scientific Notation

Environmental science often deals with very large numbers (e.g. billions of gallons of oil) and very small numbers (e.g. contamination of an aquifer of mercury.) To better manage these numbers and to decrease errors, scientists have developed a shorter method to express numbers using scientific notation which is based on powers of 10. Thus, for example, an environmental scientist calculates that 146,000,000,000 kilograms of biomass was produced in a test plot during the previous year. Using scientific notation, the number would be: $1.46 \times 10^{11.}$ To write a number in scientific notation, place the decimal after the first digit, drop the zeros and count the number of places from the decimal to the end of the number. Small numbers can be written using scientific notation using a negative exponent. For example, 0.00000123 would be written as $1.23 \times 10^{-6.}$

**Problems: convert the following numbers into or from scientific notation.**

1. 678,950,000,000 = ________________________________
2. 1,000,000,000,000 = ______________________________
3. .000000004567 = _________________________________
4. 8923 = ________________________________
5. $3.19 \times 10^{12}$ = ________________________________
6. $7.47 \times 10^{13}$ = ________________________________

## Part II: Scientific Notation Calculations

Multiplication: add exponents, multiply bases

$(3 \times 10^{3)}(4 \times 10^5) = 12 \times 10^8$ or $1.2 \times 10^9$

Division: subtract exponents, divide bases

$(5.2 \times 10^4) \div (2.6 \times 10^2) = 2 \times 10^2$

Addition: convert both numbers to the same exponent, and then add the bases; exponents stay the same

$(3000 \times 10^6) + (14 \times 10^5) = 3001.4 \times 10^6$ or $3.0014 \times 10^9$

Subtraction: convert both numbers to the same exponent, and then subtract bases; exponents stay the same

$(2000 \times 10^3) – (1000 \times 10^2) = 1900 \times 10^3$ or $1.9 \times 10^6$

**Problems:**

1. $(8.0 \times 10^3) \times (4.2 \times 10^{-9}) =$
2. $(5.0 \times 10^{18}) \times (8.0 \times 10^{22}) =$
3. $(8 \times 10^{-3}) \div (4 \times 10^{-9}) =$
4. $(5 \times 10^{18}) \div (8 \times 10^{22}) =$
5. $(3.5 \times 10^9) + (14.7 \times 10^6) =$
6. $(1.5 \times 10^4) + (25 \times 10^3) =$
7. $(8.5 \times 10^7) - (4.5 \times 10^7) =$
8. $(9.2 \times 10^9) – (1.5 \times 10^6) =$

**Part III: Metric Conversions:**

**Table 1** ■ Some Common Metric Conversions

| | | |
|---|---|---|
| gallons/liters | 1 U.S. gal. = 3.8 L | One U.S. gallon = 3.8 liters |
| liters/gallons | 1 L = 0.264 U.S. gal. | One liter = 0.264 U.S. gallons |
| meters/yards | 1 m = 1.094 yd | One meter = 1.094 yards |
| yards/meters | 1 yd = 0.914 m | One yard = 0.914 meters |
| grams/ounces | 1 g = 0.035 oz | One gram = 0.035 ounce |
| ounces/grams | 1 oz = 28.35 g | One ounce = 28.35 grams |
| kilograms/pounds | 1 kg = 2.2 lb | One kilogram = 2.2 pounds |
| pounds/grams | 1 lb = 454 g | One pound = 454 grams |
| miles/kilometers | 1 mi = 1.609 km | One mile = 1.609 kilometers |
| kilometers/miles | 1 km = 0.621 mi | One kilometer = 0.621 mile |

**Table 2** ■ Conversion Factors for Area

| | | |
|---|---|---|
| square miles/square kilometers | 1 $mi^2$ = 2.6 $km^2$ | One square mile = 2.6 square kilometers |
| square kilometers/square miles | 1 $km^2$ = 0.39 $mi^2$ | One square kilometer = 0.39 square miles |
| hectares/acres | 1 ha = 2.47 acres | One hectare = 2.47 acres |
| acres/hectares | 1 acre = 0.4 ha | One acre = 0.4 hectares |
| square yards/square meters | 1 $yd^2$ = 0.84 $m^2$ | One square yard = 0.84 square meters |
| square meters/square yards | 1 $m^2$ = 1.2 $yd^2$ | One square meter = 1.2 square yards |

How many meters are in 5 yards?

5 yards x 0.914m/yd. =4.57 meters

How many liters are in 3.6 cubic meters?

3.6 $m^3$ x 1000L/$m^3$ = 36000L

**Problems (show your work):**

1. How many kilograms are in 10 pounds?

2. How many miles are in 200 kilometers?

3. How many grams are in 2 ounces?

4. How many liters are in 42 gallons?

**Part IV: Dimensional Analysis**

Sample problem: A farmer started with 5 goats. He traded all of his goats for sheep at an exchange rate of 3 sheep for 1 goat. He then traded his sheep for pigs at a rate of 1 sheep for 2 pigs. Next, he traded his pigs for canaries. For every 3 pigs, he received 27 canaries. He then sold all of the canaries for a rate of $3.25 per canary. How much money did the farmer make on his canaries?

To solve the problem, first figure out what units you want to end up with what the problem started with?

5 goats = $

Then figure out the conversions you'll need to make to cancel out the units except the ending unit and calculate the answer.

$$\frac{5\ \cancel{\text{goats}}}{1} \times \frac{3\ \cancel{\text{sheep}}}{1\ \cancel{\text{goat}}} \times \frac{2\ \cancel{\text{pigs}}}{1\ \cancel{\text{sheep}}} \times \frac{27\ \cancel{\text{canaries}}}{3\ \cancel{\text{pigs}}} \times \frac{\$3.25}{1\ \cancel{\text{canary}}} = \$877.50$$

1. How many minutes are in three weeks?

   3 weeks x ______________days x __________hours x _____________minutes = _________min
   Weeks days hours

2. Convert 0.56 kg to mg.

3. Convert 2.0 inches to mm. (1 in = 2.54 cm)

4. Convert 5km/sec to miles/hour (1km = 0.621miles)

5. Convert 675 days into years

6. How many seconds are in a day?

**Part V: Percent change**

Environmental scientists often analyze trends. A popular approach to communicating these trends is percentage increase/decrease over time. In calculating percentage of these trends (whether an increase or decrease), you are concerned with the difference between two numbers and how much of the first number added to or subtracted from the first number will produce the second number. The three steps are as follows:

Subtract: original number – new number = change
Divide: by original number
Multiply by 100

$$\text{Percent change} = \frac{\text{original number} - \text{new number}}{\text{original number}} \times 100$$

Problems:

1. 234.98 to 324.77 = ______________ % change

2. 324.77 to 234.98 = _______________% change

3. $7.14 \times 10^7$ to $8.47 \times 10^8$ = ____________% change

4. In 2000, the level of ammonia in a river was 63 ppm. In 2004, the level was 112 ppm. What is the percentage increase since 2000?
5. A utility's operating costs for its electrostatic precipitator was the following :

   2001 = $345,000
   2002= $325,000
   2003 = $345,000

   What were the annual percentage changes?

   2001-2002:

   2002-2003: