Mr. Severino

S.T.E.M. Mathematics Link: The Mathematics of Chemistry

CCSS State Standards: A.CED.4; A.REI.3; S.ID.2

Mathematical Practices: 2, 6

Dimensional Analysis

Diamonds Are Forever: This is one of the most precious diamonds ever excavated—the Hope Diamond. This diamond has a long history, and it contains more than 45 carats. Diamonds are almost pure carbon with some trace elements mixed in. The carbon atoms form a unique structure, and it is this very structure that makes diamonds on of the hardest known substances. Yes, they are shiny, but a Cubic Zirconia is just as nice, right? In this project, you will practice some very important mathematical skills including scientific notation, dimensional analysis, and statistical analysis.

Chemists (and a lot of other scientists) often write numbers in scientific notation and solve problems using a method of unit conversion called dimensional analysis. Dimensional analysis involves stringing together ratios through multiplication, and then "cancelling out" the units that are not needed.

For example, the Hope Diamond weighs over 45 carats. One carat is equal to 200 mg. How many *grams* is the Hope Diamond?

Set up an equation that uses all of the necessary conversion ratios for the units involved. Arrange the ratios in such a way that all unwanted units will "cancel out" to 1, and the remaining units are the units sought after in the problem. Watch:

$$\frac{45\ carats}{1} \times \frac{200\ mg}{1\ carat} \times \frac{1\ gram}{1000\ mg}$$

Notice that the units are set up on diagonally from each other. Now, "cancel" out the units, multiply across, and simplify your answer, if necessary.

$$\frac{45\ carats}{1} \times \frac{200\ mg}{1\ carat} \times \frac{1\ gram}{1000\ mg}$$

So your answer is:

Problem 1: Go to http://en.wikipedia.org/wiki/List_of_diamonds. Look up the top three heaviest *uncut* diamonds in the world. Convert the weights to grams.

Problem 2: The Hope Diamond contains about 450,000,000,000,000,000,000,000 carbon atoms. Write this number in scientific notation. The Golden Jubilee Diamond is the largest faceted diamond ever cut at 545.67 carats. Convert this number to grams.

Problem 3: A carbon atom has a mass of 0.00000000000000000000001994 g. What is the total weight of all the carbon atoms in the Hope Diamond?

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1 Yard = 36 inches	1 meter = 39.37 inches	1 mile = 5,280 feet
1 Liter = 1000 cm3	1 inch = 2.54 centimeters	1 kilogram = 2.2 pounds
1 Gallon = 3.78 Liters	1 kilometer = 0.62 miles	

Use the chart above for the problems below.

Problem 4: Convert 11.3 square feet into square centimeters.

Problem 5: The mass of the Saturn V rocket was 6,200,000 pounds. Find this weight in kilograms.

Problem 6: Convert $\left(\frac{1000\ watts}{meters^2}\right)$ into $\frac{watts}{foot^2}$.

In the future, as fossil fuels begin to run out, renewable energy sources will have to fill the gap. Solar power has much promise, although in many respects, the industry is still in its infancy. Look at the solar panels below:

Solar panels contain *solar cells* which are made mostly of silicon. Solar panels use light energy (photons) from the sun to generate electricity through a photovoltaic effect. The first solar panels were used in outer space over 50 years ago.

Problem 7 - A house is being fitted for solar panels. The roof measures 50 feet x 28 feet. The solar panels cost \$1.00/cm^2 and generate 0.03 watts/cm^2. A) What is the maximum electricity generation for the roof in kilowatts? B) How much would the solar panels cost to install? C) What would be the owners cost for the electricity in dollars per watt?

Problem 8: The Sun converts 480 million tons of hydrogen into helium every *second*. How much hydrogen is converted into helium in one year? Express your answer using scientific notation.

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Units and Measurements

You may have read in stories of the past that units of measurement were very different. Precision was something that really wasn't *too* important for everyday things. As science began to grow, however, a **standard** for scientific data became necessary. Scientists need to report data and test that data in a consistent manner, and the **International System (SI)** is the standardized system established for such purposes.

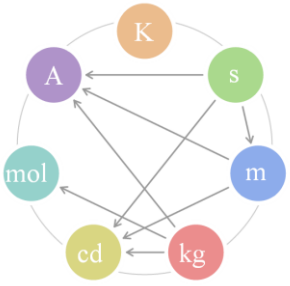
The table below illustrates the SI Base Units.

Quantity	Base Unit
Time	Second (s)
Length	Meter (m)
Mass	Kilogram (kg)
Temperature	Kelvin (K)
Amount of Substance	Mole (mol)
Electric current	Ampere (A)
Luminous Intensity	Candela

This table show the SI prefixes. **Complete the chart** based upon what you know about the metric system.

Prefix	Symbol	Numerical Value in Base Units	Power of Ten Equivalent
Giga-	G		
Mega-	M		
Kilo-	k		
-	-	1	
Deci-	d	0.1	
Centi-	c		
Milli-	m		
Micro-	μ		
Nano-	n		
Pico-	p		

This diagram illustrates the seven basic units of the International System.



Go to http://en.wikipedia.org/wiki/International_System_of_Units

Navigate to the bottom of the page? What are some proposed additional units to the SI system? Name at least four.