Name: _____

Powers of 10 – How Small Is an Atom?

Guiding Questions

- If we could split a piece of gold into smaller and smaller pieces, how small could we get – and have it still be gold?
- How small is an atom, both qualitatively and quantitatively?
- How can I express the size of an atom of gold using scientific notation?

Instructions

1. In small groups, discuss the guiding question, "How small is an atom?" Make a prediction, using meters as your units and write it on your whiteboard. For example, is an atom $1/10^{th}$ of a meter across? $1/1000^{th}$? Etc.

2. Also on your whiteboard, make 2 columns titled "larger than one gold atom" and "smaller than one gold atom." With your group, discuss where each of the following items should be placed, and write your predictions in the corresponding column. (Don't copy them onto your paper until you check your answers in step 5.)
   - Grain of sand
   - Skin cell
   - Proton
   - Width of human hair
   - Grain of rice
   - Cell
   - Electron
   - Bacteria
   - Virus
   - Molecule
   - Cell nucleus

3. After your group has completed your prediction, go to the following website: http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html

4. Allow the program to run through once, and then you can select "Manual." Each picture is 10 times smaller than the picture that precedes it. The number in the bottom left corner provides the measurement in meters. The numbers are written in powers of 10, or scientific notation. Example: an individual leaf cell is 10^{-5} meters across, while a leaf cell nucleus is 10 times smaller, or 10^{-6} meters across.

5. After exploring the program, work with your group to make any corrections to your estimated size of an atom and the "larger" and "smaller" predictions on your whiteboards. Copy your corrected answers below.

   How small is an atom? _____

Larger than one gold atom	Smaller than one gold atom

6. Use the powers of 10 program to help you answer the questions below. The first one is complete for you as an example.

   Ex: How many times larger is the Milky Way galaxy than the earth?
   In order to solve:
   - Step 1: Manually move to the view of the Milky Way (*10^{+21} meters*). Write this out longhand (*1,000,000,000,000,000,000,000*)
   - Step 2: Manually move to the view of the Earth (*10^{+7} meters*). Write this out longhand (*10,000,000*).
   - Step 3: Count how many more zeroes are in the number for the Milky Way (*14, so the Milky Way is 10^{+14} or 100,000,000,000,000 times bigger than earth*)
   - Alternate solution: You can also do this using division – just find the difference between the two exponents (*10^{+21} meters/10^{+7} meters → the Milky Way galaxy is 10^{+14} times larger than the Earth*)

7. How many times larger is an oak leaf than the nucleus of an oak leaf cell?

8. How many times smaller is a carbon atom than an oak leaf?

9. How many times smaller is a proton than a DNA nucleotide?

10. How many times larger is the Milky Way than our solar system?

Challenge Questions

11. Just how small is a gold atom? The diameter of an atom of gold is about 0.00000000027 meters. Write this out in scientific notation.

12. If you have 6.02×10^{23} gold atoms, laid out in a row, how long would it be?