Name: _____

Geology 1 Exercise: Measurement

Objective: to gain insight into quantitative observations, measurements and scientific notation.

Measuring your pace:

A *pace* is two steps. Outside the building your instructor will show you a measured distance of 100m. Walk the distance with a natural gait, counting your paces as you go. Do this twice, once in each direction and record it below. If your count differs significantly do it again.

1. **Measure how many paces it takes for you to walk the 100m.**

   1st time) _____ 2nd time)_____ Avg) _____

   How many paces is it across Galloway Plaza? _____ paces

2. How long is your pace in meters? _____ m In feet? _____ ft

   How may meters is it across Galloway Plaza? _____ m How many ft? _____ ft

   How many paces would it take for you to walk 1km? _____ One mile? _____

3. How many meters are in a kilometer (km)? _____

   How many millimeters (mm) are in a meter? _____

   How many centimeters (cm) are in a meter? _____

Useful conversion info:

1 inch = 2.6 cm
1m = 3.2808 ft
1 ft = 0.3048m
1 mile = 5,280 ft

Putting the Solar System in Perspective

4. Suppose we were building an accurate scale model of the solar system starting with a basketball (24cm in diameter) representing the sun. Note that the sun's diameter is about 100x that of Earth. (See the table on page 4).

   What size sphere would we need to represent the earth? _____ cm.

   Suggest a common item we might use in our model? _____

   The distance from the sun to the earth defines one AU (Astronmical Unit). In our scale model one AU would be about 25m. Use the Table "Dimensions of the Solar System" on page 4 to answer these questions. In our model how far from the basketball/sun would we put:

   Mars _____ m Jupiter _____ m

   Pluto _____ m Nearest Star _____ m
   (Proxima Centauri)

Precision vs. Accuracy:

Accuracy is the correctness of a measured value; how close it is to the actual value.

Precision is the exactness of a measurement. For example, saying something is 4.2m long is more precise than saying it is 4m long. Saying it is 4.238m long is more precise still.

Greater precision does not always mean greater accuracy, however. For example: the statement "You have 8.342 toes" is very precise (four significant digits) but not very accurate (I hope!). "You have 10 toes" is more accurate but less precise.

Precision is usually described by the number of *significant digits*, that is, the number of digits to the left of the any placeholder zeros. The number **3**000 has one significant digit, **324**0 has three, and 1.2312 has five (the assumed trailing zeros are not written). A number with more significant digits has greater precision.

5. Circle the most **precise** number: 23,000 4.332 654.32

6. Circle the most **accurate** answer: 8 ÷ 11 = 0.727 0.7272 0.7273
   (Be careful of rounding!)

7. Express the following numbers in scientific notation (See explanation on page 4):

   a. 4,600,000,000 yrs (age of the earth) _____

   b. 0.00000000000000000000000000000091093 kg (mass of an electron)

   _____

   c. 0.00000000000000000000000000016726 kg (mass of a proton)

   _____

   d. 90,000,000,000,000,000 km (size of the Milky Way galaxy)

   _____

More Measurement:

Make the following measurements to a precision of 2 significant digits (**note the units!**):

8. What is the length of A-B in millimeters? _____ mm

9. What is the length of A-B in centimeters? _____ cm

10. What is the length of A-C in meters? _____ m

11. Describe something **permanent** on your hands that is 1cm in length or width (e.g. width of a fingernail, from one crease to another. Not the length of a nail this changes). Be specific!

    _____

12. Using any method you choose, determine your height in meters to a precision of one

    hundredth of a meter (0.01m). _____ m (which is the same as _____ cm)

13. Measure the length and width of the classroom by using your pace.

    Length _____m Width _____m

14. Measure all three of the dimensions of the classroom to the nearest 0.1m using a meter stick.

    Length _____m Width _____m Height _____m

    Now calculate the classroom's: Area _____m^2 Volume _____m^3

15. List as many ways as you can of how errors might be introduced into your measurements.

    _____

    _____

    _____

16. How many tennis balls would it take to fill the classroom? _____

    This will take some creativity and some estimation. Assume the room is empty of desks, chairs, students, etc. Show how you arrived at you answer below.

Scientific Notation:

Scientific notation is an easy way to express and do math with very large and very small numbers. In scientific notation numbers are always written as a power (exponent) of 10 with the form:

$$a \times 10^b$$

where **b** (the exponent) is an integer and a is a decimal number between 1 and 10. On most calculators a number like 5.7×10^6 will appear as 5.7E6.

You can think of the exponent as equal to how many decimal places you move the decimal point to make the "a" part a number between 1 and 10. Large numbers always have a <u>positive</u> exponent and small numbers (less than 1) always have a <u>negative</u> exponent.

Examples:

$$5.7 \times 10^6 = 5\underbrace{700000}_{1\ 2\ 3\ 4\ 5\ 6}. \qquad 6.5 \times 10^{-3} = 0.\underbrace{0065}_{-3\ -2\ -1}$$

Dimensions of the Solar System

	Distance from Sun		Diameter	
	AU*	**km**	**Earth Diameters**	**km**
Sun	0.00	0	109.20	1,392,300
Mercury	0.40	59,840,000	0.38	4,845
Venus	0.70	104,720,000	0.95	12,113
Earth	1.00	149,600,000	1.00	12,750
Moon	*1.00*	*149,600,000*	*0.25*	*3,188*
Mars	1.50	224,400,000	0.53	6,758
Jupiter	5.20	777,920,000	11.20	142,800
Saturn	9.50	1,421,200,000	9.40	119,850
Uranus	19.20	2,872,320,000	4.00	51,000
Neptune	30.10	4,502,960,000	3.90	49,725
Pluto	39.40	5,894,240,000	0.18	2,295
Nearest Star	280,000	4.19E+13		
*AU = Astronomical Units (=Earth's distance from the sun)				