

Names : \_\_\_\_\_

## **Solar System Size and Scale Lab**

### **Part 1: Classroom**

1. What was your first reaction to the scale model of the Sun and Mercury that we just created in the classroom? Is it anything like what you first pictured in your mind when you were asked to space the planets out in the classroom yourselves?
  
2. What is the ratio of the number of paces to Mercury in your original model to the number of paces in the scale model? How far off were you as a percentage?
  
3. How much space do you now think we will need to construct a complete scale model of the solar system?

### **Part 2: Pima Campus**

We will now create a model of the solar system that is accurate in relative sizes of the planets and the distances between them. The group assigned to each planet will present what they found to the class as we pace out the model.

#### **Your job is to record:**

- (1) The object representing each planet in our scale model (marble, peppercorn, mustard seed, etc.) in column 2
- (2) The size of the object representing each planet as measured by one of your classmates in column 3
- (3) The distance between the planets in our model *in paces* in column 4
- (4) The most interesting thing about that planet that you learn from the classmates presenting it

*You'll fill out the other columns when we complete this lab on Thursday. Make sure to place this with your class materials and bring it to the next class*

Planet	Object in Our Model	Diameter of that Object	Real Diameter of that Planet (in km)	Distance to that object in our model (in paces)	Real Distance to that Planet (in $10^9$ km)	Interesting Fact About That Planet
Sun	Yellow ball	8 in	1,391,000	0 paces (center!)	0	
Mercury			4879		57.9	
Venus			12,104		108.2	
Earth			12,756		149.6	
Mars			6792		227.9	
Jupiter			142,984		778.6	
Saturn			120,536		1433.5	
Uranus			51,118		2872.5	
Neptune			49,528		4495.1	
Pluto			2930			

### **Part 3: Investigate Your Model**

Before you begin, make sure that if you recorded paces **between** planets as we were going through the lab, you go back and add them up so that each number is the **total** number of paces from the sun to each planet. (a blank column is provided for this if you didn't do it to begin with).

1. You recorded the type of object that was used to mark each planet. These objects are at the front of the classroom now together with a set of rulers. **Measure the diameter of each in centimeters and record it in the second column of the table on the next page.** In order to be truly systematic about this, you should measure the diameter of several of the more irregular objects (peppercorns, mustard seeds) and average them, then record that number in your table in column 3.
2. Centimeters are a much nicer unit for our purposes than inches because we can be more precise in measuring the objects with a smaller unit. The diameter of the "Sun" that we used to establish our model, however, is still listed in *inches*. You will need to convert this to centimeters using the fact that there are 2.54cm in 1 inch. Show your work below, then record the diameter of the sun in cm in the table underneath the "8in".
3. Now, assuming that we used our "sun" to establish the **scale factor** for our model. A scale factor is the conversion from real physical distance units in the solar system to distance units in our scaled down model. (Hint: 8in (rather, 8in converted to cm) is our model's equivalent to the real physical diameter of the sun, 1,391,000km). Show your work below and then fill in the scale factor.

Model Scale factor: \_\_\_\_\_ cm = \_\_\_\_\_ km (use scientific notation!)

4. You will often find it convenient to know what one unit in your scale model is equivalent to in real physical units. To find out how many real kilometers one centimeter in our model represents, simply divide both sides of the scale factor you wrote above by the number of centimeters you filled in on the lefthand side. Fill in this equivalent scale factor below.

Model Scale factor: 1 cm = \_\_\_\_\_ km

5. One nice thing about having converted into cm for our model is that we now have both set of measurements in metric system units. One thing we could do now is find out what fraction (or percentage) of the true size of the solar system our model represents. To do this, you will first need to make the units in your scale equal (by either converting cm to km or vice versa). Show your work below.
  
6. Now, you should have two numbers in either cm or km (one of them will be very small or very large, depending on which way you went). In either case, divide the smaller number by the larger below and write your answer in *scientific notation* and *rounded to one significant figure* below.
  
7. We now want to represent this as a fraction, which is a little easier for us to wrap our minds around conceptually when considering scales. For example, if you had ended up with the answer  $8 \times 10^{-3}$ , or 0.008, that is equivalent to 8/1000. This would mean that our model was eight one-thousandths the size of the true solar system! What is the real scale between our model and the true solar system represented as a fraction? If it is still unclear to you how to convert a number in scientific notation into a fraction, ask your instructor for help.

8. Venus and Earth were the same size in our model (both peppercorns). Is this strictly accurate? Use your scale factor (either version will do!) to convert the true diameter of both the Earth and Venus to a diameter in our scale model (in cm).

Earth:

Venus:

9. In order to compute our error in using a peppercorn for each one, use the “percent error” formula. In this case, do the following for both the Earth and Venus:

$$\text{Percent Error} = \frac{\text{Calculated scaled diameter} - \text{true size of peppercorn}}{\text{Calculated scaled diameter}} \times 100$$

Earth:

Venus:

10. Finally, let's evaluate the accuracy of our pacing measurement. Develop a method for establishing the "average" pace size of the members of our class. Describe your method and then do it, putting your final answer in the blank at the bottom of the page

Description of Method:

Data:

\_\_\_\_\_ cm = 1 pace

11. When we made our scale model, we were using a precalculated model for the number of paces between each of the planets. In fact, every distance in our model (sizes of planets AND distances between them) was established when we chose an 8in diameter ball to represent the sun. Because of this, there was actually a “correct” answer for the number of centimeters represented by 1 pace. To find it, follow the same methodology you used with the last scale factor. Use the planet Mercury, for example. You know how many paces we used to represent the real physical distance to Mercury in km (careful, because the table in your lab actually lists the distances in units of  $10^6$  km). Write this scale below and then convert it to a 1pace = \_\_\_\_\_ km scale, just as you did earlier.

Scale factor: \_\_\_\_\_ paces = \_\_\_\_\_ km

Scale factor: 1 pace= \_\_\_\_\_ km

12. Now, compute the percent error in the pace scale that we calculated in class. After computing this, reflect on how we could have been more accurate in our measurement. Can you think of a better way to have computed the average human pace length than the one that you developed and carried out?