Names: _____ _____

_____ _____

Teamwork (5)	Discussion (5)	Completeness (5)	Correctness (5)	Total (20)

Introduction to Active Learning: The Scale of the Solar System

What can run but never walks,

Has a mouth but never talks,

Has a bed but never sleeps,

Has a head but never weeps?

What is it?

_____

Pre-Lab Quiz

Record your team's answers as well as your reasoning and explanations.

1.
2.
3.
4.
5.

Part 1: Exploring Astronomical Topics

1. Your group will be assigned one of the questions below. Using the internet, research it and prepare a brief summary to give to the class by writing in the space below.

1. What type of galaxy is the Milky Way? How far away is the Solar System from the center of our galaxy? How fast is the Sun orbiting our galaxy?
2. What is Proxima b and why is it important?
3. What are the mission goals of the spacecraft Juno?
4. What problems exist in sending people to Mars or any space travel?
5. Where else besides Earth is water thought to exist?
6. What are the mission goals of the spacecraft New Horizons?

Part 2: Exploring the Solar System

1. Including the **Moon** and **Pluto**, in the table below list the planets in order by their distance from the Sun. Then look up each planet's distance from the Sun (in Astronomical Units, AU) as well as its radius (in Earth radii).

Each ball in the demo roughly represents a planet on a scale of 1:1 billion (a billion times smaller). Associate each ball in the demo with its appropriate planet.

Fun Fact: *In this scale model, the Sun would be 1.5 meters in diameter and 150 meters away – roughly the size and distance of the clock on the clocktower to the south.*

Object	Distance from Sun (AU)	Radius (Earth Radii)	Ball #
		0.38	
	0.72		
Earth		1.0	
Moon	1.0		
		0.53	
	5.2		
		9	
	19.2		
		3.86	
	39.5		

2. Partnering with another group, answer the following questions, then write your answers on the white board where the TA has indicated:

a) What fruit do you think would represent Jupiter and Earth in this model?

b) Using your intuition, how many of these Earth-fruits do you think would fit inside the Jupiter-fruit?

3. **Class Discussion** Working with same group, use the equation for the volume of a sphere, $V = \frac{4}{3}\pi r^3$, as well as the radius of Jupiter in Earth radii, to estimate how many Earths would fit inside Jupiter.

Note: Remember from math that $(x^a/y^a) = (x/y)^a$; round the radius to a nice number to make the calculation easier. Do **NOT** look up the radius of Earth – it should cancel out in the end.

4. Using a new scale, 1:100 billion, calculate the distance of the planets + Pluto from the Sun in this model and fill in the table below. Use **Python** to do the calculations and note that there are 150 billion (150×10^9) meters in 1 AU.

Planet	Symbol	Scaled Distance (meters)
Mercury	☿	
Venus	♀	
Earth	♁ OR ⊕	
Mars	♂	
Jupiter	♃	
Saturn	♄	
Uranus	♅	
Neptune	♆	
Pluto	♇	

Python Programming

Open an *Anaconda Prompt*, type *jupyter qtconsole* and press return. Enter your distances from Problem 1 into a list called "au". You can then calculate the **real distance** in meters as follows (use *ctrl–shift–+* to enlarge the text):

```
In[1]: au = [0.3, 0.4, 1.2, 3.4, 6.7]          # example list of distances in AU
In[2]: for x in au:                             # iterate through each value; call it "x"
  ...:     print(x * 150e9)                     # convert "x" to meters; print to terminal
  ...:                                          # return again to complete the for-loop
```

To get the **scaled distance**, we simply need to divide the real distance by 100 billion (or 100e9 in computer syntax, where e9 indicates to multiply by 10^9):

```
In[3]: for x in au:
  ...:     print(x * 150e9 / 100e9)           # or simplifying, print(x * 1.5)
```

5. **Class Discussion** As a class, we will go out into the hallway and place the planets at their scaled distances that we calculated in the previous problem.

a) After looking at the scale model of the solar system, write down some of your thoughts and observations.

b) In this scale model, Voyager 1 would be located on Clinton Street (between Phillips Hall and the Pentacrest). Where do you think we would need to place Alpha Centauri, the nearest star to our Sun?

6. Alpha Centauri is a triple-star system that is 41 quadrillion (4.1×10^{16}) meters away and appears as the third brightest star in the night sky (Proxima Centauri is the faintest and nearest star in the system). Unfortunately, it is too far south to see it from Iowa City.

After partnering with another group, work out the following problems and show your work on a white board. Have your TA mark below when done.

1. Convert Alpha Centauri's distance to kilometers using unit conversions. You should be doing something analogous to: $5\,\text{bags}\left(\frac{8\,\text{apples}}{1\,\text{bag}}\right) = 40\,\text{apples}$
   - $1\text{ km} = 1000\text{ m} = 10^3\text{ m}$
2. Using our 1:100 billion scale model, calculate how far away Alpha Centauri would be in kilometers
   - $100\text{ billion} = 100 \times 10^9 = 10^{11}$
3. Using *Google Maps* and its **measure distance** tool, find a city that is roughly this distance from Iowa City.
   - Right click and select "measure distance" to use the distance tool. You can switch between metric and english units by clicking on the scale at the bottom right of the page.

TA	