

This assignment must be submitted electronically on Blackboard. You may either upload a document or type directly into the dialogue box (NOT the “Comments” box!) on the submission page. Either is acceptable as long as the questions are numbered properly. DO NOT reproduce the questions! Just provide answers.

This exercise is designed to keep you thinking about the size and scale of the universe and the objects in it.

These first seven questions should be answered “cold” – that is, just answer them based on what you know. You shouldn’t be looking up any of this information. The idea is to get out what you think you know ahead of time so we can see how our ideas and perceptions change with deeper understanding and better context.

1. How many stars are in our solar system? <specify an exact number>
2. Do we know for certain that other solar systems exist? <yes/no> If so, about how many?
3. Do we know for certain that there Earthlike planets orbiting other stars? <yes/no> If so, about how many?
4. Are there other galaxies out there in the Universe? <yes/no> If so, about how many?
5. Does the universe have a finite size or is it infinite in extent? <finite/infinite>
6. Do we know for certain that there is any kind of life somewhere else (besides Earth) out there in the Universe? <yes/no>
7. If you found out that the answers to any of the previous 6 questions were significantly different than what you now believe, would it change anything about the way you view your own existence? <yes/no> If so, how? If not, why not?
 - In class we watched the short film *Powers of Ten* (1969 & 1977; 09:01) by Charles & Ray Eames. You can watch it again [here \(https://www.youtube.com/watch?v=0fKBhvDjuy0\)](https://www.youtube.com/watch?v=0fKBhvDjuy0) if you like.
 - Now point your web browser to each of these and click “Play”. Take time exploring both of them.
 - <http://htwins.net/scale/>
 - <http://htwins.net/scale2/>
 - Spend a few minutes using the slider (or arrow keys) to poke around the universe, pausing here and there to take note of the objects and their sizes used as examples.
 - Once you’ve been all the way through each slider at least once, take a few minutes to record your responses to the following questions.
8. Recall the *Powers of Ten* video we watched in class. Use scientific notation for numerical answers. I will not count zeroes!
 - a. The smallest thing in the video is a proton. What is its size in meters?
 - b. The largest thing in the video is “large-scale structure” in the universe, i.e. many galaxies in the field of view simultaneously. What is its size in meters?

9. Now refer to the web interactive. Use scientific notation for numerical answers. I will not count zeroes!
 - a. What is the smallest thing in its range? What is its size in meters? How many times smaller is it than the object in 8.a?
 - b. What is the largest thing in its range? What is its size in meters? How many times larger is it than the object in 8.b?
10. In a few sentences, briefly describe how these web interactives are different from, and how they are similar to, the *Powers of Ten* video we watched in class. (Note: I am not referring to the obvious differences in format and presentation; I want you to comment on the depth of knowledge and content itself.)
11. Refer back to class where you reflected upon what you thought were the smallest and largest things that exist and what their sizes are.
 - a. What did you put for the smallest thing and its size?
 - b. What did you put for the largest thing and its size?
12. Has seeing this information changed how you think about the universe and/or your existence? If so, how? If not, why not?
13. Most people are reasonably good at estimating sizes and scales for objects they are familiar with. But that “calibration” tends to break down when we are asked to operate outside the bounds of our comfort zone. Briefly comment on how well calibrated you are and discuss where you think the difficulties lie.