Homework #6

Due at 5pm on Monday, October 23

You may submit Parts 1, 3 and 4 either (a) electronically via Moodle or (b) on paper to my mailbox outside Merrill 213. Do NOT leave under my door or in the boxes outside my office.

Part 1 – Questions

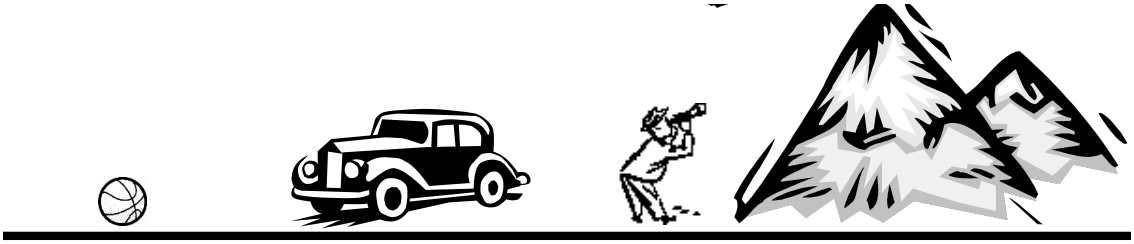
Exercise #1

Using the unit conversion skills that we've been working on in class this week, complete the following unit conversion problems. Show your work in all cases and make sure that your final answer has a unit.

a) Alpha Centauri, the closest star to the Sun, is 4.365 light years away. How far away is that in miles?
b) How many seconds are in one year?
c) How many mm are in 1km?
d) Neptune, the most distant planet from the sun in our solar system, is 40AU from the sun.
    i. How far is that in meters?
    ii. How far is it in miles?
    iii. How far is it in light years?
    iv. How far is it in light hours?
e) The moon subtends (takes up) an angle of 0.54 degrees in the sky. How big is that in arcseconds? (note: the moon is very large in the sky compared to most of the things we'll be talking about in this class, so arcseconds are usually what we'll use to talk about angles in the sky!)

Exercise #2

Description: The figure below shows several objects (A – D) of different masses located on the surface of the earth.



A B C D

A. **Ranking Instructions:** Rank (from greatest to least) the strength of the gravitational force exerted by Earth on each of the objects (A – D).

Ranking Order: Greatest 1 _____ 2 _____ 3 _____ 4 _____ Least

Or, the gravitational force exerted on each object is the same. _____ *(indicate with a check mark)*

Carefully explain your reasoning for ranking this way:

B. **Ranking Instructions:** Rank (from greatest to least) the strength of the gravitational force exerted by each of the objects A – D on Earth.

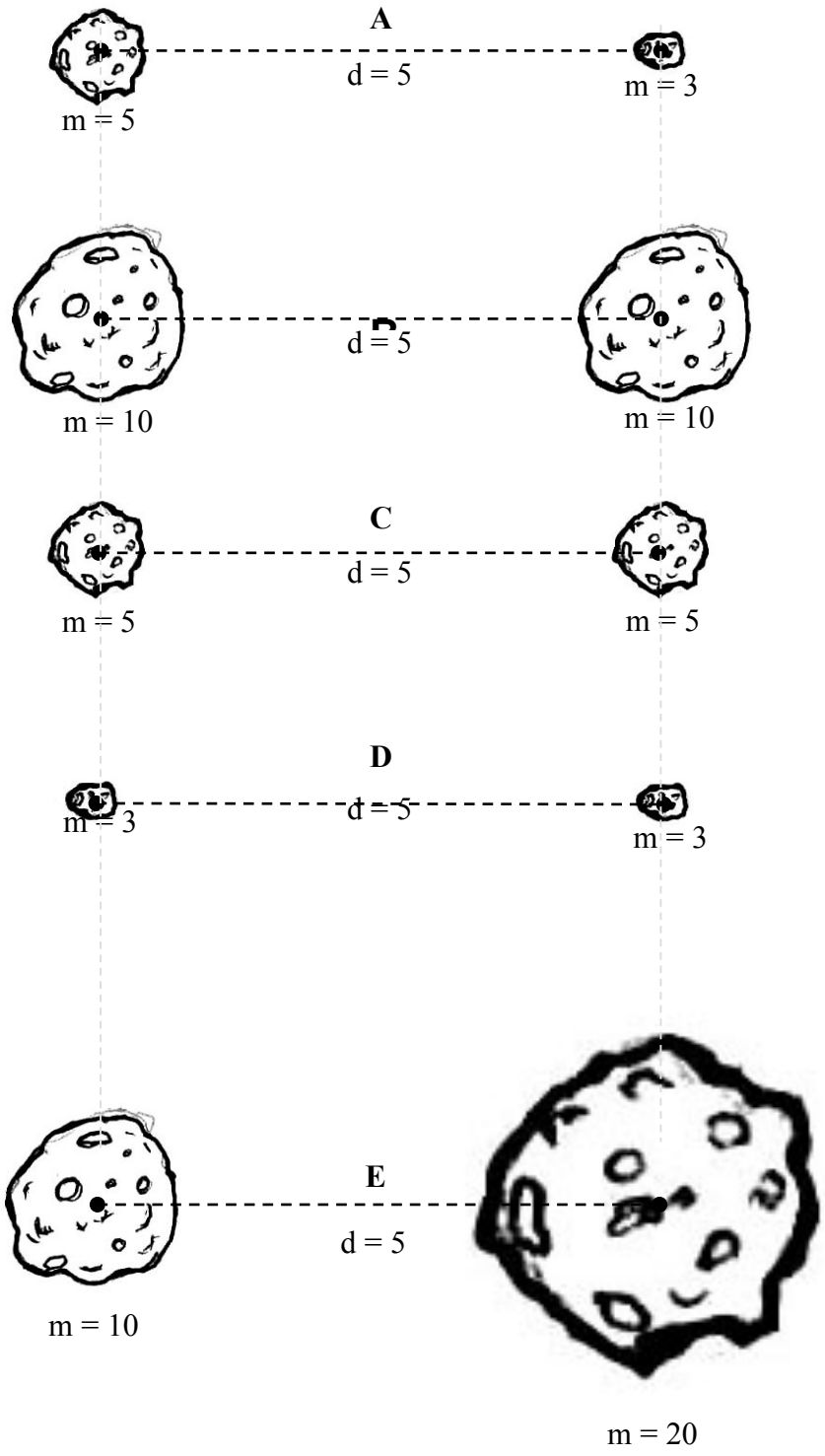
Ranking Order: Greatest 1 _____ 2 _____ 3 _____ 4 _____ Least

Or, the gravitational force exerted by each object is the same. _____ *(indicate with a check mark)*

Carefully explain your reasoning for ranking this way:

Exercise #3

Description: The figures below (A – E) each show two rocky asteroids with masses (m), expressed in arbitrary units, separated by a distance (d), also expressed in arbitrary units.



A. **Ranking Instructions:** Rank (from greatest to least) the strength of the gravitational force exerted on the asteroid located on the left side of each pair.

Ranking Order: Greatest 1 ____ 2 _____ 3 _____ 4 ____ 5 ____ Least

Or, the strength of the gravitational force exerted in each case is the same. _____ *(indicate with a check mark)*

Carefully explain your reasoning for ranking this way:

B. **Ranking Instructions:** Rank (from greatest to least) the strength of the gravitational force exerted on the asteroid located on the right side of each pair.

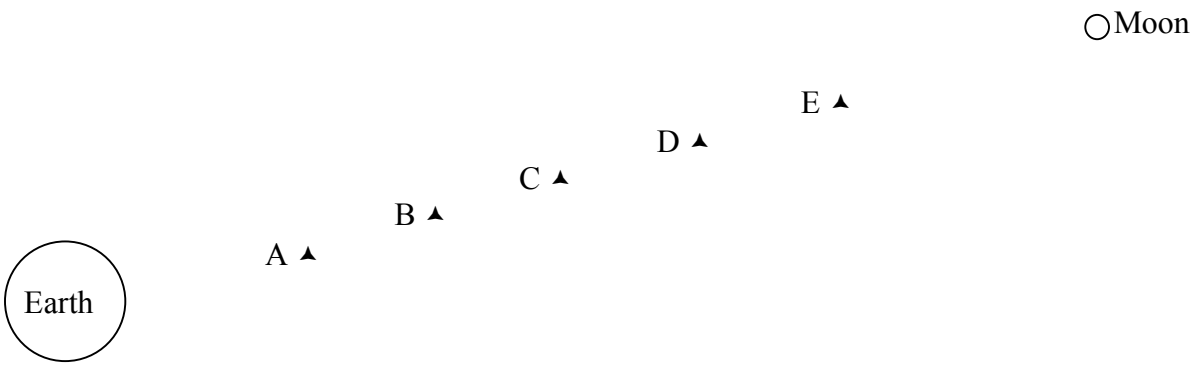
Ranking Order: Greatest 1 ____ 2 _____ 3 _____ 4 ____ 5 ____ Least

Or, the strength of the gravitational force exerted in each case is the same. _____ *(indicate with a check mark)*

Carefully explain your reasoning for ranking this way:

Exercise #4

Description: In the picture below, the Earth-Moon system is shown (not to scale) along with five possible positions (A - E) for a spacecraft traveling from Earth to the Moon. Note that position C is exactly half-way between Earth and the Moon..



A. **Ranking Instructions:** Rank (from greatest to least) the strength of the gravitational force at positions A - E exerted by the Moon on the spacecraft.

Ranking Order: Greatest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ Least

Or, the gravitational force exerted at each position is the same. _____ *(indicate with a check mark)*

Carefully explain your reasoning for ranking this way:

B. **Ranking Instructions:** Rank (from greatest to least) the strength of the net (or total) gravitational forces at positions A - E exerted by both the Earth and the Moon on the spacecraft.

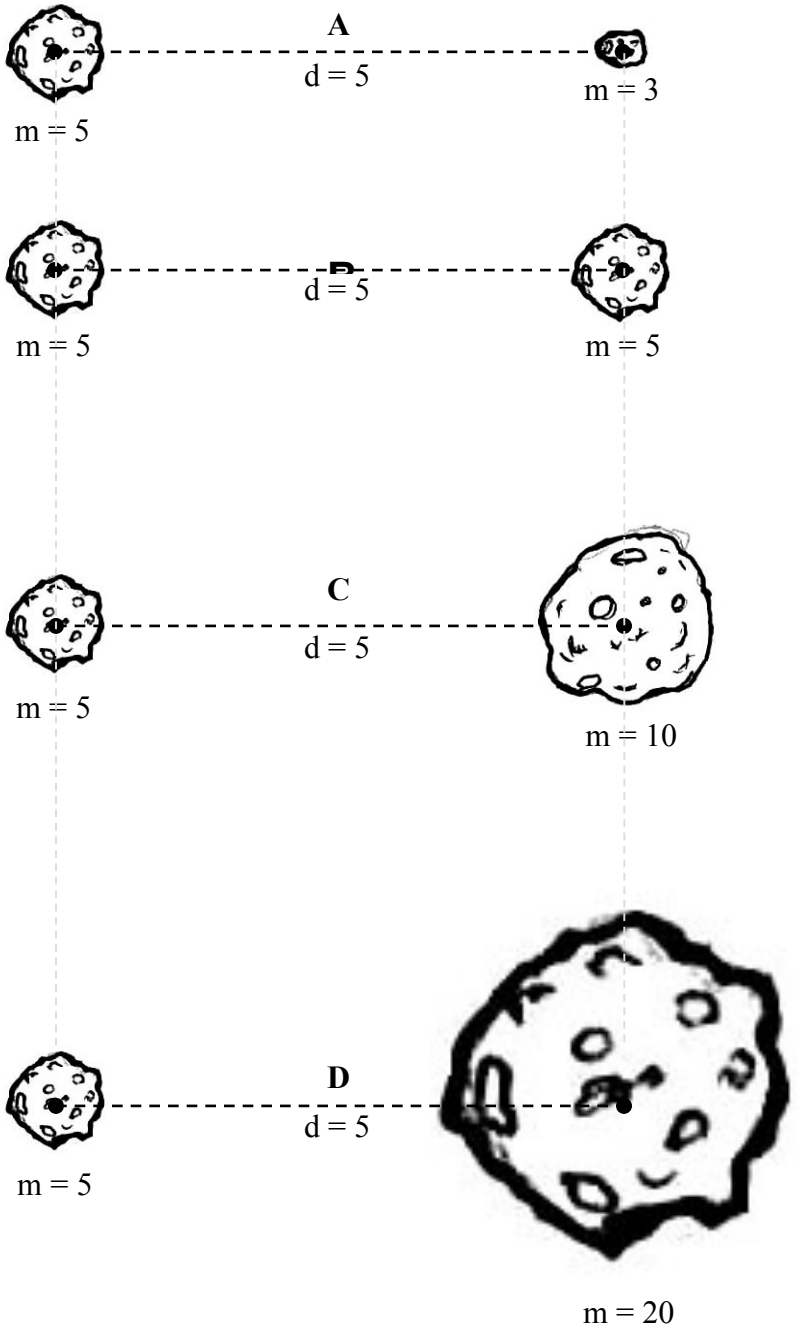
Ranking Order: Greatest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ Least

Or, the gravitational force exerted at each position is the same. _____ *(indicate with a check mark)*

Carefully explain your reasoning for ranking this way:

Exercise #5

Description: The figures below (A – D) each show two rocky asteroids with masses (m), expressed in arbitrary units, separated by a distance (d), also expressed in arbitrary units.



A. **Ranking Instructions:** Rank (from greatest to least) the strength of the gravitational force exerted on the asteroid located on the left side of each pair.

Ranking Order: Greatest 1 ____ 2 _____ 3 _____ 4 ____ Least

Or, the strength of the gravitational force exerted in each case is the same. _____ *(indicate with a check mark)*

Carefully explain your reasoning for ranking this way:

B. **Ranking Instructions:** Using Newton's Second Law, rank the acceleration (from greatest to least) that the asteroids located on the left side of each pair would experience due to the gravitational force exerted on it.

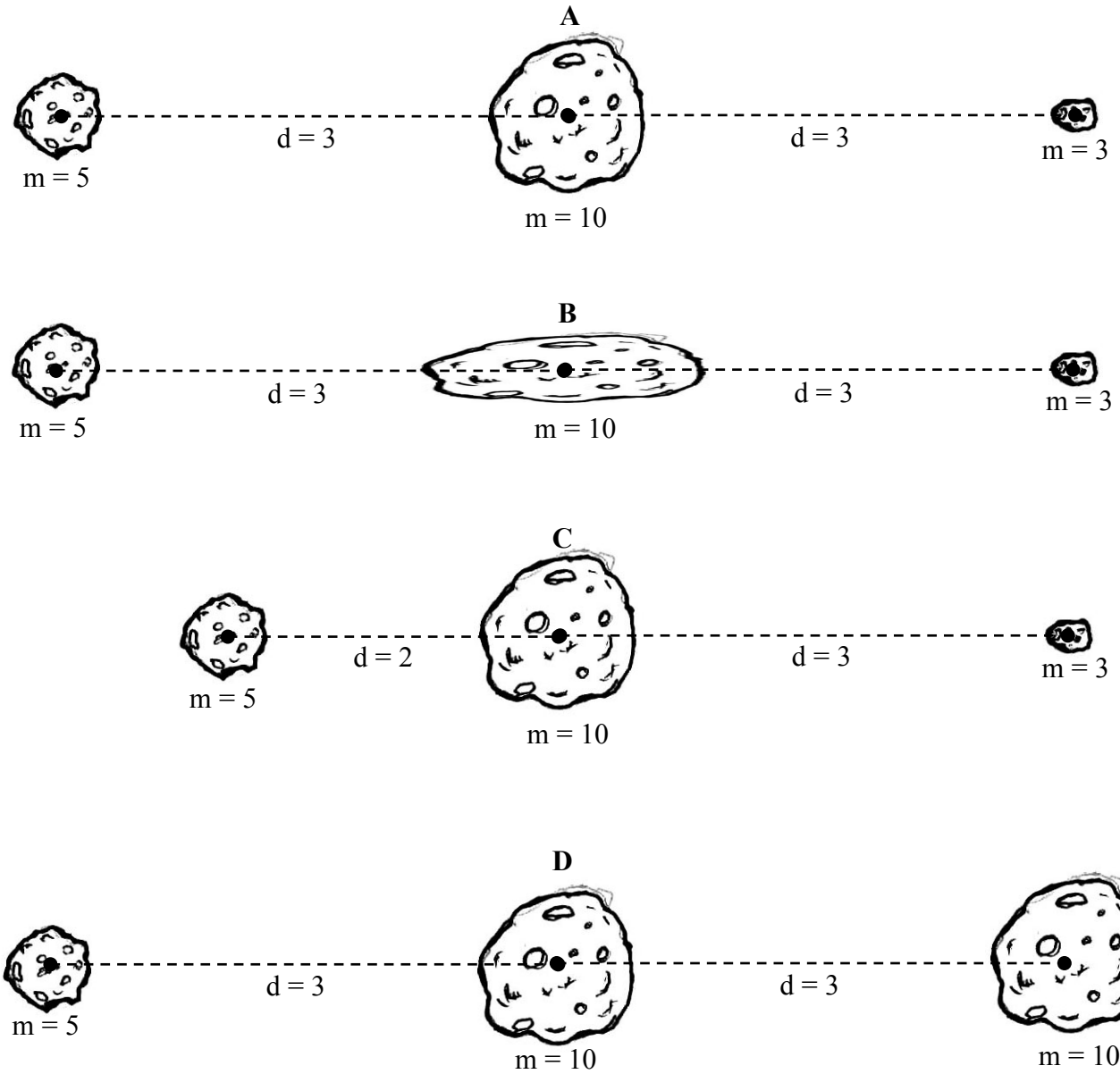
Ranking Order: Greatest 1 _____ 2 _____ 3 _____ 4 _____ Least

Or, the accelerations for each asteroid is the same. _____ *(indicate with a check mark)*

Carefully explain your reasoning for ranking this way:

Exercise #6

Description: The figures below (A – D) each show a large central asteroid along with two other asteroids located to the right and left of the central asteroid. The masses (m) of the asteroids are expressed in arbitrary units, and the distance (d) from the center asteroid is also expressed in arbitrary units.



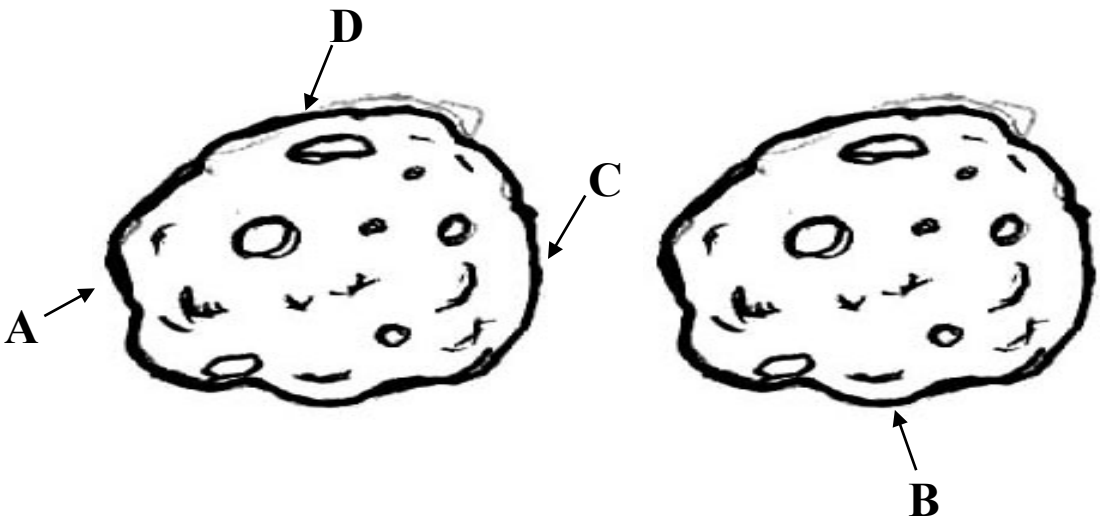
Ranking Instructions: Rank (from greatest to least) the strength of the net (or total) gravitational force exerted on the center asteroid by its two neighboring asteroids.
Ranking Order: Greatest 1 _____ 2 _____ 3 _____ 4 _____ Least

Or, gravitational forces are all the same strength. _____ (indicate with a check mark)

Carefully explain your reasoning for ranking this way:

Exercise #7

Description: The figure below shows two identical asteroids located very near one another but moving in an orbit that keeps them from colliding.



Ranking Instructions: Rank (from greatest to least) the net (or total) gravitational force that would be exerted on an astronaut if he/she were standing on the asteroids at the various locations (A – D).

Ranking Order: Greatest 1 _____ 2 _____ 3 _____ 4 _____ Least

Or, the net force exerted on the astronaut would be the same at each location. _____ (indicate with a check mark)

Carefully explain your reasoning for ranking this way:

Part 2 – Mastering Astronomy

Please complete this part through the course Moodle page. It's due at the same time as the rest of the assignment.

Part 3 – Checking in

Answer this portion on the same sheet of paper as Part 1.

a) What was the most interesting concept that you learned in class last week?
b) What was the most difficult concept that you learned in class last week? What is still confusing about it?

Part 4 – Observing

This Part must be on a separate sheet of paper or must be submitted separately through Moodle.

This week you will observe the annual Orionid meteor shower, which occurs because the Earth is making its annual trek through a cloud of debris left behind by Halley's comet (you may have heard of it!) when it last passed by the Earth in 1987. This causes a number of "shooting stars" (meteors) near the constellation of Orion. The shower peaks this year on the night of the 22nd, but is visible from ~ the 20th through the 24th. As with last week's assignment, if it's cloudy on the 20, 21 and 22, I will extend the deadline to the 25th at noon.

The location from which meteors will be coming will be rising around 10:00pm, so you can begin your observations as early as then, but I suggest you wait until midnight for the best viewing of the full range of directions the meteors will travel. You should go to a dark location (e.g. Book and Plow Farm) a little ahead of when you're going to start your meteor counting and sketch your horizon looking East. Sketch the constellations of Orion and Gemini (all of Orion may not be visible if you start at 10, so sketch only what you see). The meteors will all originate in this area, but leave some room around Gemini and Orion (i.e. don't draw them too big), as some of the meteors will trace quite long paths that you'll want to record.

Once you've sketched your horizon and reference constellations (and given your eyes some time to adjust), set a timer for 30min. Each time you see a meteor, sketch its path relative to the constellations on your drawing. The constellations will continue to rise over this 30min period, so it may be that some of the meteors extend below what you've drawn as your horizon (new stars may appear here too, most notably Sirius – the brightest star in the sky, and you can sketch these in below your horizon as well as reference points for your meteor paths).

Label each meteor path on your diagram with the time (to the nearest minute) as well as anything else you noticed about it (e.g. if it was particularly bright or long).

Questions:

1. Did the meteors originate from a common point or area of the sky? If so, where? If not, describe how varied the apparent points of origin were.

2. Use the explanation above for the cause of the meteor shower to explain the geometry that you observed.
3. How many total meteors did you see, and what was the average rate in meteors per minute?
4. How much variation did you observe in the (a) arrival time, (b) length of the meteor's path and (c) brightness? Did any of those measureables seem to vary together?
5. How did this observation compare to what you expected to see? Describe at least one thing that you found surprising about it.