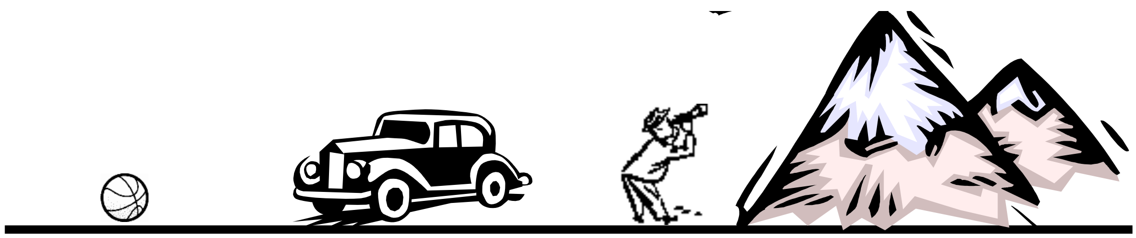
Homework 7

<u>Part 1 - Gravity and Newton's Laws</u>

Exercise #1

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:

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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:

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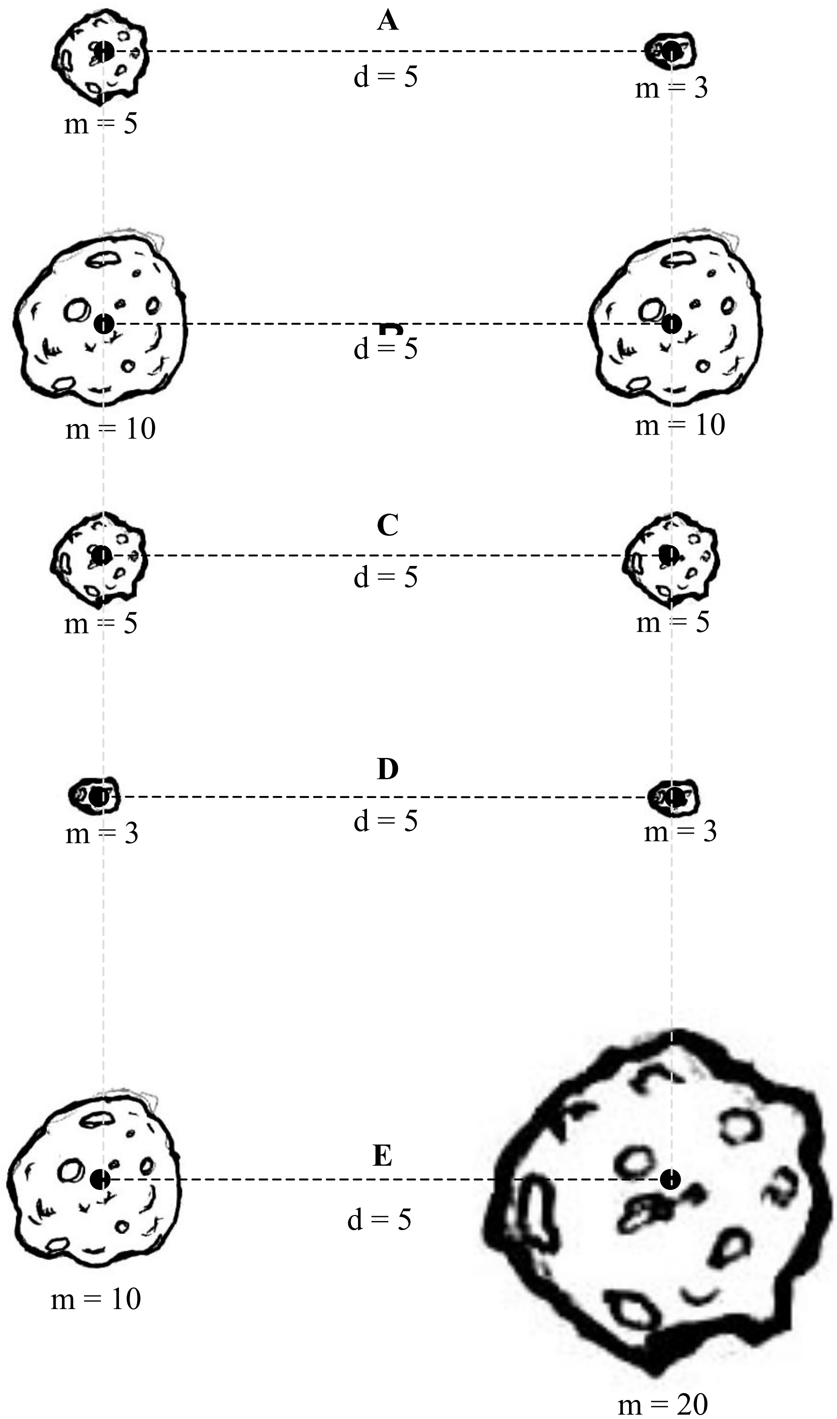
Exercise #2

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:

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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:

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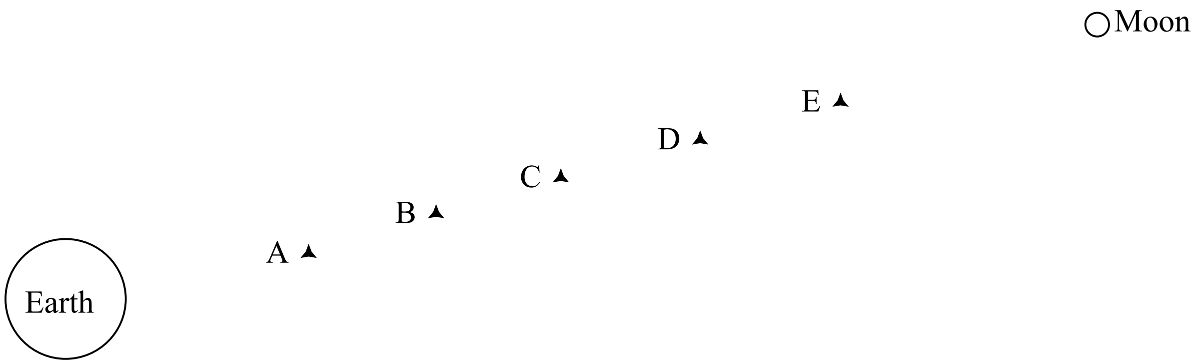
Exercise #3

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:

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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:

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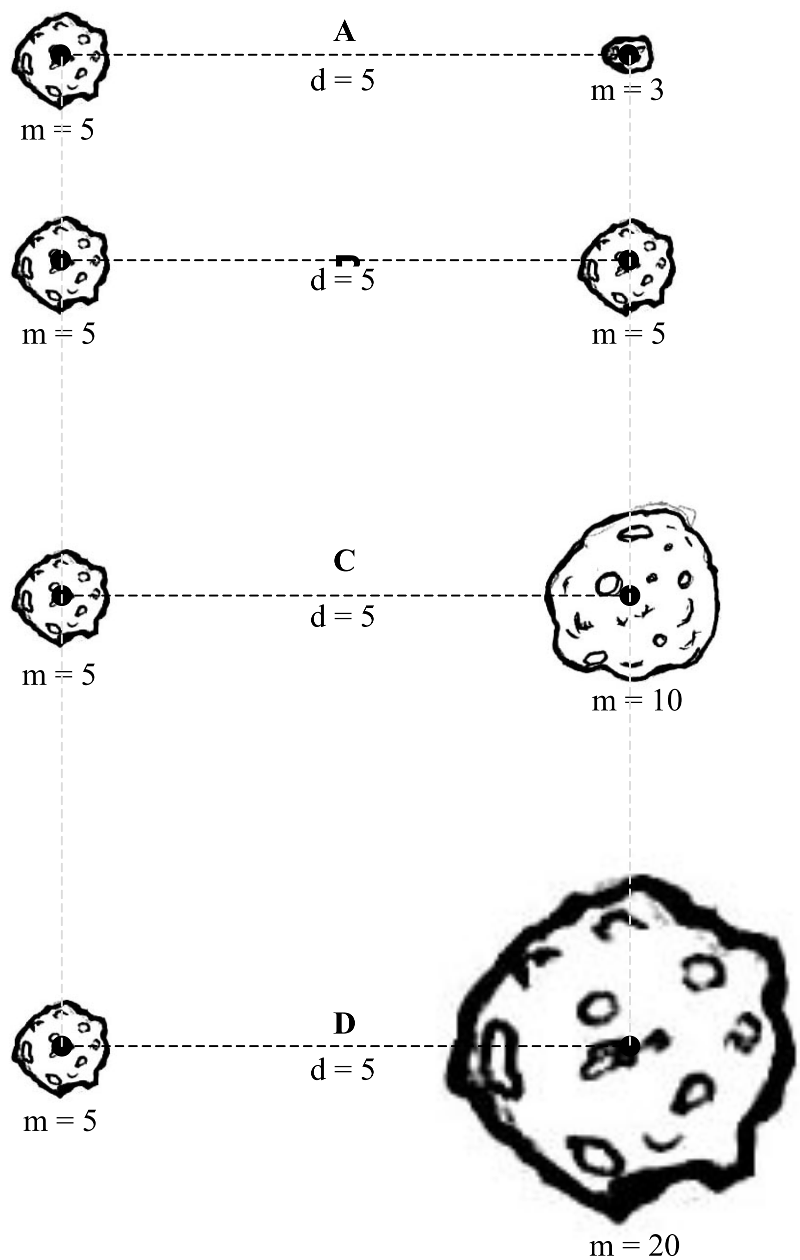
Exercise #4

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:

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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:

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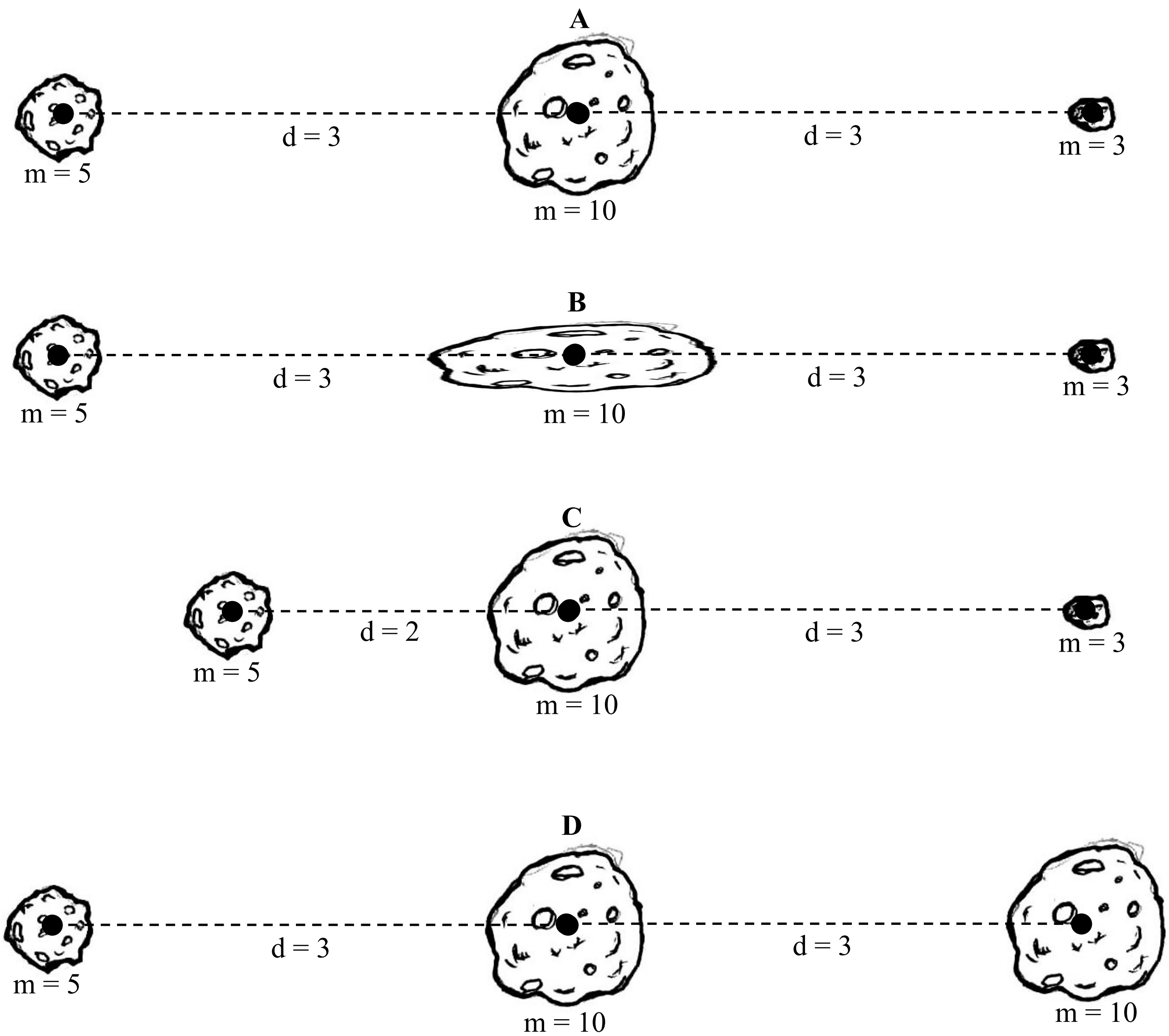
Exercise #5

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:

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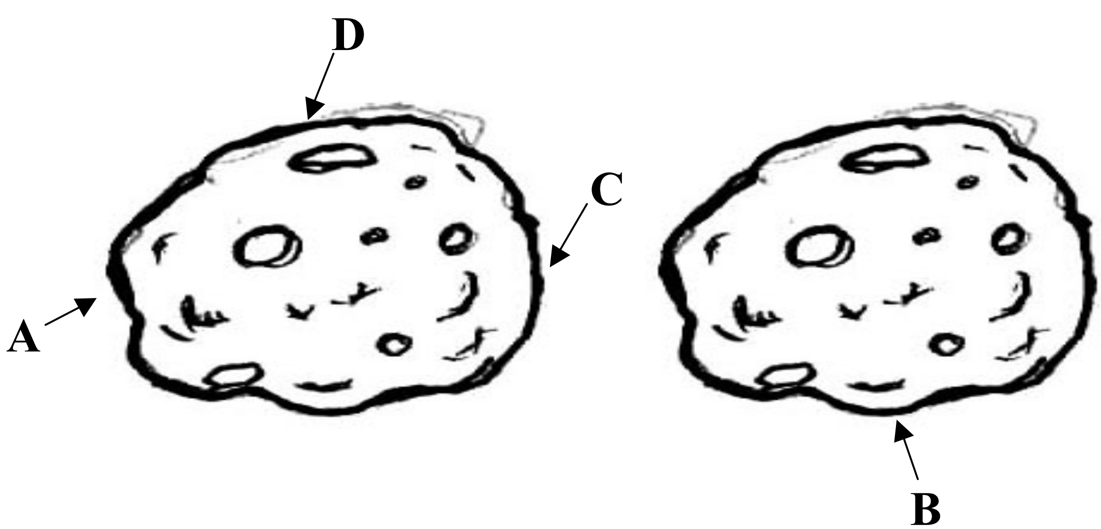
Exercise #6

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:

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Part 2 – Calculate Weights on Other Planets!

How much is "100lbs" on Earth equivalent to on other planets.

1. Use the conversion factor 1kg=2.2lb to **convert 100lb on Earth to mass in kg**.

Technically, pounds are a measurement of gravitational force NOT weight. 1kg=2.2lb is a conversion factor that only works on Earth, but an object's mass in kilograms is a true measurement of how much "stuff" there is.

The equation for gravitational force is

$$F_g = \frac{GM_1M_2}{r^2}$$ where G is $6.67 \times 10^{-11}\ m^3\ kg^{-1}\ s^{-2}$

Now G is a big annoying unit and so we don't necessarily want to plug it in every time. Instead, let's just plug in G, the mass of Earth (5.97×10^{24}kg) and the radius of Earth (6.37×10^{6}m)one time and then scale everything to that single value.

2. Calculate the value of $G*M_E/r_E^2$ and INCLUDE UNITS (figure out what cancels and what's left!)!

3. (a) Since the masses and radii of the planets in the table below are already scaled to Earth values, calculating the Gravitational strength in terms of Earth gravities is just a matter of plugging those values into the formula for gravitational strength=M/r^2 and fill it in in the table

(b) Your "gravitational strength" value is really just a scale factor between that planet's gravity and Earth's gravity. Since you've already done the work of plugging the giant numbers into the equation once, you don't have to do it again. Multiplying your "gravitational strength" by your answer for 2 and then by your answer to 1 (the mass M_1 in your equation) gives you the "weight" in units of Newtons, which is what we traditionally use to measure gravitational force. We can now convert this into pounds using the conversion factor 4.45N=1lb. Fill your final values in Newtons and pounds into the table.

Planet	Planet Mass (in Earth Masses)	Planet Radius (in Earh Radii)	Gravitational Strength Scale Factor (in "Earth gravities")	Weight
Mercury	0.055	0.38		
Venus	0.82	0.95		
Earth	1.00	1.00	1.00	100lb
Mars	0.11	0.53		
Jupiter	318	11.21		
Saturn	95	9.45		
Uranus	14	4.01		
Neptune	17	3.88		