Atoms to Universe
Physics 340
Assignment 4

1. Aristotle, Newton, and Einstein all had different theories of what caused bodies to fall to the earth, or kept the planets moving. Compare and contrast their various theories.

2. In special relativity the quantity $\sqrt{1-\frac{v^2}{c^2}}$ (the square root of the (one minus the speed squared the object over the velocity of light squred) plays a crudial role. The length contraction is by that factor. The time dilation is by that factor.

Consider a traveller who is a twin who decides to take a trip of his own to Alpha Centaurus, the nearest star to the earth, about 4 light years away (How far away is it in kilometers?) According to his twin on earth, he travels at .8 of the speed of light and does not stop on Alpha Centaui and turns around and flies back at the same speed. How long would it take for him to get to Alpha Centauri and back? How much older would he be when he came back? How much older would his brother on earth be?

3. Explain in some way the "paradox" of the pole in the garage. (Assume that at rest a pole and a garage are the same length. The pole now approaches the garage as .8 times the velocity of light. The pole appears shorter (How much?) from the viewpoint of the garage, and easily fits in. However according the person riding beside the pole the garage is shorter (by how much?) and there is no way the pole can fit. What is going on here?

4)Aberation: Consider someone looking at a pole sticking up from the ground. He suddenly begins to move at close to the speed of light toward the pole. what happens to the height of the pole as seen by the person just after he begins to move? Recall what Bradley found for Gamma Draconis. (You do not need to solve this numerically)

5)a)Consider a disk rotating so that its speed at the circumference is .6 times the speed of light. Assume that the radius of the disk is 1 meter. What happens to the cicumference according to special relativity? What happens the radius of the disk?

b)What would happen if the person riding on the circumference tried to synchronize the clocks around the circumference? (again you need only answer this qualitatively).

Note that the web page https://www.pitt.edu/~jdnorton/teaching/HPS_0410/chapters/Reciprocity/index.html might help to understand special relativity paradoxes from a different point of view. The whole book, http://www.pitt.edu/~jdnorton/teaching/HPS_0410/chapters/ might be helpful.

[Brief table of commonly used prefixes: n = nano = 10^{-9} = 1/1,000,000,000
μ = micro = 10^{-6} = 1/1,000,000
m = milli = 10^{-3} = 1/1,000
c = centi = 10^{-2} = 1/100
d = deci = 10^{-1} = 1/10
h = hecta= 10^{2} = 100
K = kilo = 10^{3} = 1000
M = Mega = 10^{6} = 1,000,000
G = giga = 10^{9} = 1,000,000,000]

It is interesting that in scientific notation, names are given only up to Y= Yotta= 10^{24}, whereas in classical Japanese there are names for numbers at least all the way up to 10^{52}.

http://en.wikipedia.org/wiki/Japanese_numerals.

(The Japanese use 10000=10^4 as the multiple for names, rather than our 1000.) Why in the 16th century anyone would need to give such a large number a name I do not know. This aside is of course totally irrelevant to the course.