Physics 200-04
Assignment 1

1. Aberration: Fill in the details of Bradley's argument. Ie, assume that gamma-Draconis is directly overhead London (latitude 52) and that the angle of the earth's axis to the plane of the orbit is 23 degrees. Thus, the angle between the direction to the star and the earth's orbit is 75 degrees. Given the earths velocity in its orbit is 30km/s and the velocity of light is 300,000km/s. What would the aberration angle (the change in angle to the star due to the motion of the earth) be? Bradley believed that he could measure changes in angle of 1 second of arc. Is the aberration measurable?

2. Text book Problem 2-2: The following is a sample of the data from the Fizeau experiment as repeated in 1886 by Michelson and Morley:
Wavelength of light 5700 Angstrom
Length of each tube 6.15m
Velocity of water flow 7.65 m/sec
Mean fringe shift upon reversal of flow 0.86 ± 0.01
Compare the value of the "drag coefficient" implied by these data with the value $1 - \frac{1}{n^2}$ for water (n=1.33)

3. Maxwell suggested measuring the velocity of the sun through the aether by timing the exact time of the eclipse of one of the moons of Jupiter when Jupiter was in various orientations with respect to the fixed stars and when the earth was nearest to and furthest away from Jupiter. From the observations, the extra time it takes light to cross the orbit of the earth would depend on the speed of light. (This was Roemer's method for measuring the velocity of light) Now, if the sun traveled through the aether with velocity v, then the velocity of light as measured by the Roemmer experiment would be c+v if Jupiter were in front of the sun (with respect to its traveling through the aether) and c-v if behind. Estimate the magnitude of the velocity v that could be measured in this way, now and in 1850. (You will need to know what the best accuracy of clocks was then and now. Use google to try to find the history of the accuracy of the clock for example. You will also have to estimate how accurately you could measure the time of the eclipse of the moon by the planet Jupiter.)

4. Galilean Relativity and Maxwell's Force law:
Consider the following force law for a charged particle with charge e moving through a magnetic field $\vec{B}$ and electric field $\vec{E}$.

$$\vec{F} = e\vec{v} \times \vec{B} + e\vec{E} \tag{1}$$

where $\vec{v}$ is the velocity of the particle. We know that the left hand side of Newton's equations is invariant under Galilean transformation with constant velocity $\vec{v}_0$. Under such a transformation, the position of the particle changes by $\tilde{\vec{x}} = \vec{x} + \vec{v}_o t$. How does its velocity change? Is the force invariant under this transformation? Can one change one's definition of $\vec{E}$ and $\vec{B}$ so as to make the force be the same after the transformation?

5. Show that a rotation by 90 degrees of a body about the y axis, followed by a rotation of 90 degrees about the z axis is not the same as first rotating by 90 degrees about the z axis and then by 90 degrees about the y axis. The physical operations of rotations do not commute. (Two operations commute if it does not matter which order they are done in).