Space, Time and Relativity
Solutions to tutorial sheet 2

(a)

- The speed of light IS necessarily the same in the two frames. This is one of the two Principles of Relativity and a bases for the whole theory of SR.
- The speed of an electron IS NOT necessarily the same in the two frames. Determining the speed of a particle depends on space and time measurements between events–such as flashes by the particle. The space and time separations between the events can be different for different observers. So their ratio–which gives the speed– can also be different.
- The value of the charge on the electron IS necessarily the same in the two frames. If different then the laws of physics would change, violating the first Principle of Relativity.
- The kinetic energy of a proton IS NOT necessarily the same in the two frames. Its value depends on the speed which is not necessarily the same in the two frames.
- The value of the electric field at a given point IS NOT necessarily the same in the two frames. It is measured by determining the force on a test charge. Force is measured by a change in velocity and since velocity an be different on the different frames then so can the change in velocity and hence the force and hence the electric field.
- The time between two events IS NOT necessarily the same in the two frames.
- The order of the elements in the periodic table IS necessarily the same in the two frames. If not we would be able to tell which frame we were in by counting atomic masses of the elements.
- Newton's First Law of Motion IS necessarily the same in the two frames as it is simply a definition of inertial frames.

(b) Yes he will see himself. Light leaves his face travels towards the mirror and is reflected back into his eyes all at a speed of c. It doesn't matter how fast he is travelling.

(c) Length-contraction causes a sphere to be squashed up into a pancake shape (with the squashing being along the line of flight). So each nucleus in the beam will occupy a smaller volume and hence have a higher density of nuclear matter.

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