Theory of Relativity – Quiz
July 9, 2014

Names of group:____________________________________

Below are short questions and problems. Answer to the best of your ability. Each question is worth 1 point.

1. (a) What is an inertial observer and why are they important? Please provide an answer which is common to both Galilean and special relativity. (b) How are inertial observers treated differently in Galilean and special relativity?

(a) Observers who are not accelerating (or rotating). Inertial observers/frames are in a state of constant, straight-line motion with respect to one another. The laws of physics (whatever they are at any moment of human history) are the same for all inertial observers. (b) They are related by different coordinate transformations, Galilean or Lorentz.

2. A rocket is moving away from you. According to special relativity, compared to its length at rest, you will measure its length to be (a) shorter, longer, or the same? Compared to the passage of time on your watch, the passage of time on the rocket's clock is (b) faster, slower, or the same? (c) Will any of your answers change if the rocket comes towards you.

(a) shorter (b) slower (c) no

3. Your friend is on a rocket ship traveling at a speed of $.5c$ away from you. How fast does your friend need to throw an object (even if massless) so that you measure its speed to be c? Provide an answer using both i) Galilean relativity (before 1905) and ii) special relativity (post 1905).

i) .5c ii) c (or, if you assumed massive objects, this is impossible)

4. Two inertial observers are traveling at a speed of 2×10^8 m/s relative to each other. They measure a moving airplane's position, length and velocity. According to special relativity which measurements will they agree on? Which measurements will they disagree on?

None of these.

5. In the opening scene of Back to the Future II Marty and Doc Brown travel from 1985 to 2015 without aging. According to special relativity is this possible? Can you estimate the speed of light in the movie's universe from this information?

According to SR this would be possible if they travel near the speed of light, which apparently is around 88 mph. Do we see length contraction or dilation?

6. (Bonus – 2 points) You and a friend are holding a very long (3×10^8 meter) iron rod. You are located at $(ct = 0m, x = 0m)$ and never moving in space. i) Draw a spacetime diagram for this situation showing you, your friend, and the rod. ii) Label your past and future. iii) At $ct = 0m$ your friend pushes on the rod while turning on a flashlight. Draw the light's path on your spacetime diagram. When does the light reach you? iv) When do you expect the rod to move – before, after or at the same time as the light? HINT: consider how you expect the force to be transmitted on an atomic scale.

The important aspects are i) the rod is initially in a region of spacetime you know nothing about. After 1 second you know about the push from light but atoms have mass and so the effect of the push (ie the rod moving) takes longer than 1 second to reach you.