Physics 323, Spring Quarter 2016
Electrodynamics: Homework Assignment 8
**(a) Turn in all problems and clearly note all constants and assumptions you use.
(1-point penalty each otherwise)
(b) Use 8½ x 11 paper & staple
(1-point penalty each otherwise)
(c) Due May 26 either 9:00 am in class or 8:45 am in the instructor's mailbox;
late homework gets 0.**

Short problems in special relativity

1. Compton scattering. A photon carrying energy E_0 collides with an electron (mass m_e) at rest. For simplicity assume the photon scattters backwards after the collision. What's the energy of the scattered photon?

2. Velocity addition. A train is moving with speed $\beta=0.8$. A train passenger throws a ball forwards at speed $\beta=0.6$. Another passenger throws a ball backwards at speed $\beta=0.4$.
a. Find the speeds of the balls to an observer on the ground.
b. What is the speed of the forward-going ball in the rest frame of the backward-going ball?

3. Spacetime. An astronaut leaves Earth in a straight line trajectory at a constant acceleration. After an hour Earth time the speed of the astronaut is $\beta=0.8$ and the spaceship then stops accelerating. Just as the astronaut stops accelerating, she sends a light pulse towards Earth. Make an Earth-based spacetime drawing of the Earth, astronaut and light pulse.

4. Spacetime. A classic problem recast into Star Trek. A Federation spaceship is in Federation territory at rest with respect to the border between Federation and Klingon space. According to instruments on the Federation spaceship, the border is 6 light minutes distant. A Klingon spaceship flys close by the Federation ship directly towards the border at speed $\beta=0.6$. Just 5 minutes later according to the clock on the Federation spaceship, the Klingon emits a photon torpedo that eventually hits the Federation spaceship. Then a short time later, according to the instruments on the Federation spaceship, the Klingons cross back into their own space. Hint: I'm told a photon torpedo travel at the speed of light.

a. Make a Federation-spaceship-based spacetime drawing of these events, including the Federation spaceship, the Klingon spaceship, the photon torpedo, and the boundary.

b. According to instruments on the Federation spaceship, how long after the Klingon flys by the Federation spaceship does the photon torpedo hit the Federation spaceship? Hint: you can infer this from the spacetime diagram.

c. Also according to instruments on the Federation spaceship, how long after the Klingon blasts by the Federation spaceship does the Klingon spaceship cross the border? Hint: This can also be inferred from the spacetime diagram.

d. An interstellar war is at stake in the answer to this question. The Klingon commander claims that the Federation is wrong: according to instruments on the Klingon spaceship, the Federation spaceship was hit when the Klingon spaceship was actually in Klingon territory. According to instruments on the Klingon spaceship, when the Federation spaceship was hit, was the Klingon spaceship on its own side of the border? Hint: This can also be inferred from the spacetime diagram.

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