School Of Mathematics, Statistics, and Operations Research
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Module on Special Relativity: Assignment 3

This third assignment covers the special topic chapter on the Lorentz transformations, plus chapter 4 ("Trip to Canopus").
Some of the notes are also useful for a slightly different viewpoint on some of these ideas.

1. Do problem L-4 on page 113 (the "limits of Newtonian mechanics" problem).
2. Do problem L-5 on page 114 (the "limits Doppler shift" problem).
3. Do problem L-6 on page 114 (the "transformation of angles" problem).
4. Do problem L-7 on page 115 (the "transformation of y-velocity" problem).
5. Do problem L-8 on page 115 (the "transformation of velocity direction" problem).
6. Do problem L-9 on page 115 (the "headlight effect" problem).
7. Do problem L-16 on page 120 (the "Fizeau experiment" problem).
8. Two simple "composition of velocities" problems:
   (a) A rocket flashes by moving at 3/5 the speed of light with respect to the laboratory.
   He (the rocket) sees someone overtake him at a speed that appears to him to be 4/5 the speed of light.
   What is the speed of that second person with respect to the laboratory?

(b) A rocket flashes by moving at 3/5 the speed of light with respect to the laboratory.
He (the rocket) sees someone coming toward him at a speed that appears to him to be 4/5 the speed of light.
What is the speed of that second person with respect to the laboratory?

9. Consider the "composition of velocities" formula

$$v_{12} = \frac{v_1 + v_2}{1 + (v_2 v_2 / c^2)}$$

Mathematically deduce, by pure algebra, the necessary and sufficient conditions for

$$v_{12} = c$$

Interpret these necessary and sufficent mathematical conditions in terms of physics.

10. [trivial, if you are awake]

A rocket is seen to depart from Earth at speed V (as measured by someone on Earth), travel out to a star at some distance L (as measured by someone on Earth), turn around and come back at the same speed (as measured by someone on Earth).
How long [time] does the trip take as measured by someone on Earth?
How long [time] does the trip take as measured by someone travelling on the rocket?

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