Exercise 8

Please attempt all of the following problems before the due date. Your grade on this assignment will be calculated from the best two answers. For simplicity, assume that the time and distance units have been chosen so that $c = 1$.

Problem 8.1
Suppose that a curve in Minkowski spacetime is described by

$$
x^0(\lambda) = K \sinh(\lambda) \\
x^1(\lambda) = K \cosh(\lambda) - K \\
x^2(\lambda) = 0 \\
x^3(\lambda) = 0
$$

Find the tangent vector $v$ to this curve at parameter value $\lambda$, calculate $v \cdot v$, relate the parameter $\lambda$ to the proper time along the curve, and thus find the four-velocity $u$ of an object with this world-line.

Answer 8.1

Put all of your calculations here. When you have completed all of the problems, wrap the resulting file and e-mail it to me at rgowdy@saturn.vcu.edu.

Problem 8.2
Solve the relativistic form of the Lorentz force law

$$
\frac{d p^\alpha}{d \tau} = \frac{e}{m} F^\alpha{}_{\beta} p^\beta
$$

for the four momentum components $p^\alpha$ as functions of proper time when the Maxwell field tensor represents a constant electric field directed along the $x^1$ axis.

Answer 8.2

Put all of your calculations here. When you have completed all of the problems, wrap the resulting file and e-mail it to me at rgowdy@saturn.vcu.edu.

Problem 8.3
Solve the above relativistic form of the Lorentz force law when the Maxwell field tensor represents a constant magnetic field directed along the $x^1$ axis.

Answer 8.3

Put all of your calculations here. When you have completed all of the problems, wrap the resulting file and e-mail it to me at rgowdy@saturn.vcu.edu.