Physics UN2801 Professor Christ
due 11/17/2022

Assignment #9

Reading: *Nov 15* Kleppner and Kolenkow 7.1 - 7.6
Reading: *Nov 17* Kleppner and Kolenkow 7.7 - 7.10
Problems:

66. This problem appeared in Problem Set #8 but should be turned in with the solutions to these problems.

67. Kleppner and Kolenkow 12.17

68. Kleppner and Kolenkow 13.1

69. Kleppner and Kolenkow 13.2

70. Kleppner and Kolenkow 13.3

71. Kleppner and Kolenkow 13.10

72. Assume (x, t) and (x', t') are the coordinates of the same event as located in the coordinate system Σ and a second system Σ' moving with respect to Σ with velocity v along the positive x-direction. Assume that the space-time origins of Σ and Σ' coincide. Show by explicitly expressing the coordinates (x, t) in terms of the coordinates (x', t') that the "length" $x^2 - (ct)^2 = (x')^2 - (ct')^2$.

73. Consider a possible model of the universe in which space takes the form of a circle. For simplicity, ignore the y and z directions, but imagine that from the point of view of the reference system Σ, space appears to be a circle of circumference L. Thus, Σ would observe that a person traveling a distance L in the $+x$ direction will return to their starting point, approaching it from the $-x$ direction.

    (a) In a massive public works project, observers in the Σ system set up a chain of N carefully synchronized clocks spaced at distance intervals of L/N along the x direction. By construction, the i^{th} clock at $x = iL/N$ is synchronous with the $i + 1^{st}$ at $x = (i + 1)L/N$. Happily, Σ finds that the N^{th} clock is also synchronous with *both* it neighbors, the $N - 1^{st}$ and the 1^{st}. Explain how the timing of this array of clocks appears to a observer Σ' moving with velocity v in the $+x$ direction. If Σ' attempts to set up a similar chain of synchronized clocks moving with her, what does she find?

    (b) Consider the "twin paradox" in this universe. Two twins (of equal age) separate, one stays at rest (in the Σ system) at $x = 0$ and the second sets off moving at constant velocity v in the $+x$ direction to explore the universe. After a time $t = L/v$ the twin at rest sees the moving twin approaching him from the $-x$ direction. What is the difference in the ages of the two twins when they meet this second time? Explain your conclusion from the perspective of each twin.