Advanced General Physics 323/324

Classical Mechanics Unit R1: The Special Theory of Relativity

Read:

D. Kleppner and R. Kolenkow, *An Introduction to Mechanics* (K& K) Chapt. 11 - The Special Theory of Relativity; Chapt. 12 - Relativistic Kinematics

Comment

Chapter 11 is the more conceptual of the two chapters on relativity in K& K and sets the stage for the various applications in Chapter 12. You should attempt the problems in Chapter 11 which are not listed below and read through the solutions to get additional insight into this material. Quiz problems will be along the lines of those in Chapter 12, but less tricky. Be sure you understand the applications of the Lorentz transformations.

After completing this unit you should understand:

(a) The two postulates of special relativity.

1. The laws of physics are the same in all inertial frames of reference.
2. The speed of light is the same in all frames of reference.

(b) How the Lorentz transformation between two different inertial frames S and S',

$$\begin{aligned} x' &= \gamma(x - vt), & x &= \gamma(x' + vt'), \\ y' &= y, & y &= y', \\ z' &= z, & z &= z', \\ t' &= \gamma(t - vx/c^2), & t &= \gamma(t' + vx'/c^2), \end{aligned}$$

where $\gamma = 1/\sqrt{1 - v^2/c^2}$, is a consequence of Einstein's postulates.

(c) The invariance of the length squared of the space-time four-vector:

$$x^2 + y^2 + z^2 - c^2t^2 = x'^2 + y'^2 + z'^2 - c^2t'^2.$$

(d) How time dilation and length contraction are consequences of the Lorentz transformation.

(e) The relativistic addition of velocities, in particular how "$v + c = c$".

Problems:

Chapt. 12: Problems 1-3,5-10,14 .

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