

## PROBLEM SET 1

PHY 255 - MODERN PHYSICS

### PROBLEMS FROM TAYLOR CHAPTER 1

After some of the tutor sessions you will be given a small test to complete and on other occasions you will be given a set of problems to complete and hand in for grading purposes. The question is **bold** have to handed in together with the project as defined below.

The following problems have to be done before or in the tutor class

**9**, 11, 14, **17**, **18**, **19**, 21, 24, 26, **27**, 31, 32, 33, **37**, 41, **44**, 45

PROJECT 1 - DUE DATE TO BE ANNOUNCED IN CLASS

(A) **Time Dilation, Length Contraction and Lorentz Transformations**

In section 1.8 and 1.10 we studied respectively the relativity of time and time dilation and length contraction. We worked through some details and ended up with equations

$$(1) \quad \Delta t = \frac{\Delta t'}{\sqrt{1 - \beta^2}}, \quad l \leq \frac{l_0}{\gamma}$$

where  $\Delta t'$  is the change in time in the moving reference frame and  $l_0$  is the length of the object as measured in its rest frame. Show how to obtain equations (1) using a Lorentz transformation.

(B) **Application of Lorentz Transformation**

In an intergalactic cricket game planet Earth is playing against Naboo. The spectators at home have two reference frames from which they can enjoy the game,  $S$  (with origin at the bottom of middle stump) and  $S'$  with coinciding origins at  $t = t' = 0$ , with  $x$  and  $x'$  axis parallel and relative velocity along  $Ox$ . Their relative speed is  $0.5c$ . Dale Steyn strikes the middle stump on the  $y$ -axis at  $y = 10$  light-seconds (distance travelled by light in one second) at time  $t = 4$  s in frame  $S$ . What are the coordinates of the above event as measured in  $S'$ ?