

ADVANCED DYNAMICS — PHY 4241/5227

HOME AND CLASS WORK – SET 11

(March 12, 2010)

(37)

1. Show $1/\sqrt{1-\beta^2} = \cosh(\zeta)$. Due March 15 in class (2 points).
2. Show $\cosh(\zeta_2) \cosh(\zeta_1) + \sinh(\zeta_2) \sinh(\zeta_1) = \cosh(\zeta_1 + \zeta_2)$. Due March 15 in class (2 points).
3. Velocities are given by $\beta_1 = \tanh(\zeta_1)$ and $\beta_2 = \tanh(\zeta_2)$. Use the addition theorem of rapidities to express the velocity given by $\beta = \tanh(\zeta_1 + \zeta_2)$ in terms of β_1 and β_2 . Due March 24 in class (4 points).

(38) D mesons have a (mean) lifetime of 1051×10^{-15} s. Assume such a meson is created in a particle collision at Fermilab and moves at $0.995c$ with respect to the Lab frame. Compute the (mean) distance travelled by such a D meson. Due March 26 before class (6 points).

(39) Assume that a rocket ship leaves the earth in the year 2020. The rocket ship is so constructed so that it has an acceleration g in its own frame (to make the occupants feel comfortable). It accelerates on a straight-line path for 5 years (by its own clocks), decelerates at the same rate for 5 more years, turns around, accelerates for 5 years, decelerates for 5 years, and lands on earth. What year is on earth? Use $g = 9.81 [m/s^2]$, one year $= 365 \times 24 \times 3600 [s]$, and the speed of light c , and assume that earth defines an inertial system. Due March 31 before class (10 points).

(40)

1. Write down (again) the basic postulates of the Special Theory of Relativity. Due March 29 in class (2 points).
2. Let $S_{\alpha\beta}$ be a (covariant) symmetric tensor. Write $S_{\alpha\beta} dx^\alpha dx^\beta$ explicitly as a sum of ten terms. Due March 29 in class (2 points).
3. Let $F_{\alpha\beta}$ be a (covariant) antisymmetric tensor. Calculate $F_{\alpha\beta} dx^\alpha dx^\beta$ (write it as a sum of six terms. Due March 29 in class (2 points).
4. Calculate $h^\alpha_\beta = g^{\alpha\gamma} g_{\gamma\beta}$ and $r^\beta_\alpha = g_{\alpha\gamma} g^{\gamma\beta}$. (A) As g -tensor. (B) The explicit matrix and identify then with another well-known symbol. Due March 29 in class (2 points).
5. Write down explicitly the matrix (a^β_α) and its transpose (\tilde{a}^α_β) , $\tilde{a}^\alpha_\beta = a^\beta_\alpha$. Due March 31 in class (2 points).

(41) Continuation of (43). Seen from earth, how far away did the spaceship travel? Express the result in light years. Due April 2 before class (6 points).