

## Problem Set 7

Physics 363  
May 14, 2008

Spring Quarter 2008  
Due in class Wed. May 21.

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**Reading:** Perkins Chapter 7, Sections 7-13 to 7-18; Chapter 8, Sections 8.8-8.13. (this is again (even more than last week) a lot of reading on a number of elegant and important topics - more than a single sitting. Please give it several evenings.)

### Problems:

1. Work through the derivation from Equ. 7.31 to Equ. 7.33, including evaluating the expression for  $R$  given by 7.33. Can you explain in words why  $R$  has the order-of-magnitude it has?
2. Draw the Feynman box diagrams for  $K_L^0 \rightarrow \mu\mu$  including both the strange and charm quarks. At what order in the  $s$  and  $c$  quark mass ratio does the decay occur?
3. Derive the ‘Unitary Triangle’ relationship (due to Bjorken)

$$V_{ud}V_{ub}^* + V_{cd}V_{cb}^* + V_{td}V_{tb}^* = 0 \quad (1)$$

Using current values how close to being satisfied is it?

4. Compare CP violation in K decays and B decays (be quantitative). Are they from the same source?
5. Show that the SM Higgs boson has the right quantum numbers in  $SU(2) \times U(1)$  to couple the left-handed and right-handed fermions. If you had to construct a universe, what do you make the origin of the values of the couplings (masses)?
6. The LHC will turn on shortly. A much bally-hoed objective is the discovery of the Higgs. I confess that I find the derivation of the predicted upper limit on the SM Higgs mass to be fuzzy and confusing. To the extent that you can, write down a clear explanation of the upper limit on the mass (see, for example, Gunion, Haber, Kane, and Dawson- the Higgs Hunter’s Guide, Chapters 2 and 3), or go back to the original literature. (This is not easy, and is somewhat open-ended- treat it as you’d like.)