

Introduction to Particle Physics 723/823

Midterm Exam

Dr.M. Amarian

November 9, 2006

1. Classify the following as charged or neutral current reactions:

$$a) e^+ + e^- \rightarrow \nu_\tau + \bar{\nu}_\tau$$

$$b) \bar{\nu}_e + p \rightarrow e^+ + n$$

$$c) e^- + p \rightarrow \nu_e + n + \pi^+ + \pi^-$$

$$d) \nu_e + p \rightarrow \nu_e + p$$

2. Draw Feynman diagrams for the following decay of D mesons:

$$a) D^0 \rightarrow K^- + \pi^+$$

$$b) D^0 \rightarrow \pi^+ + \pi^-$$

$$c) D^0 \rightarrow K^+ + \pi^-$$

3. Explain how CP eigenstates can be constructed for $K^0 - \bar{K}^0$ system, and show that, neglecting the effects of CP violation one can decay to a two-pion final state and the other to a three-pion final state.

4. For ep scattering quark model predicts

$$2xF_1^{ep} = F_2^{ep} = \sum e_i^2 xq_i(x, q^2)$$

Without detailed mathematics explain the origin of the relationship between F_1 and F_2

5. Neglecting the contributions from strange quarks and antiquarks and heavier partons, show that

$$\int_0^1 \frac{1}{x} (F_2^{ep} - F_2^{en}) dx = \frac{1}{3}$$

How would you expect the ratio F_2^{en} / F_2^{ep} to behave as $x \rightarrow 0$ and $x \rightarrow 1$?

6. Write brief accounts of the following:

- a) The roles of $SU(2)$ and $SU(3)$ symmetry in particle physics;
- b) Deep inelastic scattering of neutrinos and antineutrinos;
- c) Experimental technique for separation of charged particles, based on measurement of velocity
- d) Elastic $e^- \mu^-$, $e^- p$ and $e^- n$

7. Write brief account of the following:

a) CP violation;

b) QCD and color forces;

c) Electroweak unification and experimental tests thereof;