THE UNIVERSITY OF NEW SOUTH WALES
SCHOOL OF PHYSICS

PHYS3050 NUCLEAR PHYSICS

Professor Seán Cadogan

Assignment 2, due Monday, October 30, 2006 (Week 14)

Marked out of 40 but worth 10% of final mark

Question 1 [5 marks]

Consider the nuclear fission reaction $n + {}^{235}_{92}U \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3n$. Calculate the energy released (in MeV) in the reaction. [Atomic masses: ${}^{235}_{92}U$ = 235.043915, ${}^{141}_{56}Ba$ = 140.9139, ${}^{92}_{36}Kr$ = 91.8973 u. The neutron mass is 1.008665 u].

Question 2 [7 marks]

Following on from Q1, you wish to run a 1000 MW power reactor using ${}^{235}_{92}U$ fission.

(a) How much ${}^{235}_{92}U$ (in kg) is required for one day's operation ?

(b) If the density of ${}^{235}_{92}U$ is 18,700 kg/m^3, calculate the diameter of a pure ${}^{235}_{92}U$ sphere required for one day's operation.

Question 3 [10 marks]

Two protons, each with 70.4 MeV kinetic energy, collide head-on. This reaction produces a proton and a positive pion, each at rest. A third particle is also produced.

(a) Comment on the charge, momentum and kinetic energy of the unknown particle and hence determine the Q (in MeV) of this reaction.

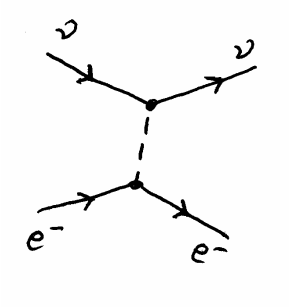
(b) Determine the mass of the unknown particle and hence its identity.

Question 4 [18 marks]

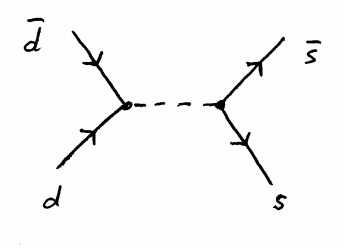
(a) What processes are described by the following Feynman diagrams ? (Identify the particles involved and in (3) identify the particles represented as quark-composites

(b) Identify the type of interaction i.e. Strong, Weak, Electromagnetic or Gravitational, described by these Feynman diagrams. (Explain clearly the reason for ruling out 3 of the 4 fundamental interactions in each case. For the purpose of this question you many assume that all neutrinos have zero mass).

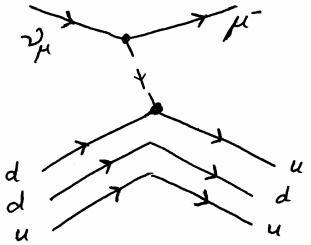
(c) Identify the 'particle' mediating or being exchanged in each reaction (the 'particle' is represented by the dotted line). Explain your choices.



(1)



(2)



(3)