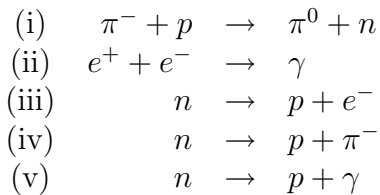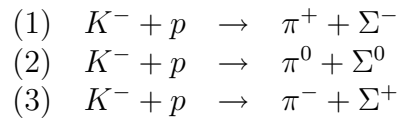# Homework Set #1.

Due Date: Tuesday October 14, 2008

Solve the following 6 exercises

1. State which of the following reactions are allowed by conservation laws and which are forbidden, and motivate your statement in either case:

$$
\begin{array}{llrcl}
\text{(i)} & \pi^- + p & \to & \pi^0 + n \\
\text{(ii)} & e^+ + e^- & \to & \gamma \\
\text{(iii)} & n & \to & p + e^- \\
\text{(iv)} & n & \to & p + \pi^- \\
\text{(v)} & n & \to & p + \gamma
\end{array}
$$

2. Find the relation between the total cross-sections (at a given center of mass energy) for the following reactions, in terms of the isospin amplitudes A_0, A_1 and A_2:

$$
\begin{array}{llrcl}
\text{(1)} & K^- + p & \to & \pi^+ + \Sigma^- \\
\text{(2)} & K^- + p & \to & \pi^0 + \Sigma^0 \\
\text{(3)} & K^- + p & \to & \pi^- + \Sigma^+
\end{array}
$$

3. In which isospin states can (1) $\pi^+\pi^-\pi^0$ and (2) $\pi^0\pi^0\pi^0$ exist?

4. The representation matrices for the adjoint representation of a Lie group are given by the structure constants:

$$(T^b)_{ac} = i f^{abc}.$$

   Show that the statement that the matrices T satisfy the Lie algebra

$$\left([T^b, T^c]\right)_{ae} = i f^{bcd}(T^d)_{ae}$$

   is equivalent to the Jacobi identity.

5. From the observation that the strong decay $\rho^0 \to \pi^+\pi^-$ exists but $\rho^0 \to \pi^0 + \pi^0$ does not, what information can be extracted about the ρ quantum numbers: (i) G-parity, (ii) isospin, (iii) spin, and (iv) intrinsic parity?

6. Define the valence quark content of the following quantum number combinations of baryons (Q stands for electric charge, S for strange content, C for charm, B for bottom), and find the name of a particle that corresponds to the given combination:

> (i)   Q=-1, C=0, S=-3, B=0
> (ii)   Q=2, C=1, S=0, B=0
> (iii) Q=1, C=1, S=-1, B=0
> (iv)   Q=0, C=1, S=-2, B=0
> (v)   Q=0, C=0, S=0, B=-1