PP4: Example Sheet 3

Isospin, Strangeness

1. Which of these processes occur in Nature?

$$\pi^- p \to K^0 \Sigma^0$$
$$\pi^- p \to \pi^0 \Lambda$$
$$\pi^- p \to K^+ \Sigma^-$$
$$\pi^- p \to \pi^+ \Sigma^-$$
$$\pi^- p \to K^0 \Lambda$$
$$\pi^- p \to K^0 n$$

What quantum numbers are needed to solve this question? What does the term "Associated production" refer to in the above reactions?

2. Which interaction mediates the decay $K^\star \to K\pi$? Give an estimate for the lifetime or decay width of the $K^\star$. Show that parity is conserved in this reaction.
In the tables of the Particle Data Group, the branching ratio for the decay mode $K^\star \to K\pi$ is given as $\approx 100\%$. What are the individual particle decay modes? Derive their branching ratios.

3. Isospin is violated in the weak decays: $\Lambda \to p\pi^-,\ n\pi^0$. Gell-Mann suggested that the isospin violation would be as small as possible. What would the ratio of the decay modes be on the assumption $|\Delta I| = 1/2$ or $3/2$: the measured ratio is (1.79 ± 0.04):1 comment. This is an example of the $|\Delta I| = 1/2$ rule.

4. Two groups propose to study the Ξ^0 which they would produce via the following two reactions:

$$\pi^- p \longrightarrow \Xi^0 \mathrm{K}^0 \mathrm{K}^0$$
$$\mathrm{K}^- \mathrm{p} \longrightarrow \Xi^0 \mathrm{K}^0$$

discuss their relative merits from an experimental point of view.

5. The pseudo-scalar η meson, $J^{PC} = 0^{-+}$, is observed in the decay $\eta \to \gamma\gamma$. Show that the charge conjugation eigenvalue $C_\eta = 1$. Why are $\eta \to \pi^+\pi^-$ and $\pi^0\pi^0$ forbidden for strong and electromagnetic reactions?