Problem 9.2 *What quantum numbers, if any, are violated in the following processes? Would the reaction be strong, electromagnetic, weak, or unusually suppressed? Explain. (See CRC Handbook for particle properties.)*

(a) $\Lambda^0 \rightarrow p + e^- + \bar{\nu}_e$,
(b) $K^- + p \rightarrow K^+ + \Xi^-$,
(c) $K^+ + p \rightarrow K^+ + \Sigma^+ + \bar{K}^0$,
(d) $p + p \rightarrow K^+ + K^+ + n + n$,
(e) $\Sigma^+(1385) \rightarrow \Lambda^0 + \pi^+$,
(f) $\bar{p} + n \rightarrow \pi^- + \pi^0$.

) From Table 9.4 we have that

$$I_3(\Lambda^0) = 0, \; . \; I_3(p) = \frac{1}{2}, \quad S(\lambda^0) = -1, \quad S(p) = 0. \tag{9.15}$$

ıerefore, we see that the hadronic sector of the decay in

$$\Lambda^0 \rightarrow p + e^- + \bar{\nu}_e, \tag{9.16}$$

ɔlates both isospin and strangeness quantum numbers

$$|\Delta I_3| = \frac{1}{2}, \quad |\Delta S| = 1. \tag{9.17}$$

ıis represents a weak semi-leptonic decay process.

) The process

$$K^- + p \rightarrow K^+ + \Xi^- \tag{9.18}$$

seen from Table 9.4 of the text to satisfy conservation of all quan-m numbers. This is indeed a strong process.

) We note from Table 9.4 of the text that

$$\begin{aligned} I_3(K^+) &= \frac{1}{2}, \quad I_3(p) = I_3(\bar{K}^0), \quad I_3(\Sigma^+) = 1, \\ S(K^+) &= 1, \quad S(\bar{K}^0) = -1 = S(\Sigma^+), \quad S(p) = 0. \end{aligned} \tag{9.19}$$

herefore, the reaction

$$K^+ + p \rightarrow K^+ + \Sigma^+ + \bar{K}^0 \tag{9.20}$$

olates both isospin and strangeness quantum numbers

$$|\Delta I_3| = 1, \quad |\Delta S| = 2. \tag{9.21}$$

ecause strangeness changes by two units, it is a highly suppressed ıknown hadronic process.

) As in the earlier reaction, the process

$$p + p \rightarrow K^+ + K^+ + n + n \tag{9.22}$$

also a highly suppressed unknown hadronic reaction. We note that

$$\begin{aligned} I_3(p) &= \frac{1}{2}, \quad I_3(K^+) = \frac{1}{2}, \quad I_3(n) = -\frac{1}{2}, \\ S(p) &= 0, \quad S(K^+) = 1, \quad S(n) = 0, \end{aligned} \tag{9.23}$$