Question

Elementary Particle Quantum Numbers: Which of the following reactions can occur? State the conservation principles violated by the others.

(a) $\Lambda^0 \rightarrow \pi^+ + \pi^-$
(b) $\pi^- + p \rightarrow n + \pi^0$
(c) $\pi^+ + p \rightarrow \pi^+ + p + \pi^- + \pi^0$
(d) $\gamma + n \rightarrow \pi^- + p$

Solution

a) Reaction cannot occur

Λ^0	$\rightarrow$	π^+	$+$	π^-	
1	$\rightarrow$	1	$+$	-1	Baryon number not conserved
-1	$\rightarrow$	0	$+$	0	Strangeness number not conserved
$\frac{1}{2}$	$\rightarrow$	0	$+$	0	Spin not conserved
0	$\rightarrow$	1	$+$	-1	Charge conserved

b) Reaction can occur

π^-	$+$	p	$\rightarrow$	n	$+$	π^0	
0	$+$	1	$\rightarrow$	1	$+$	0	Baryon number conserved
0	$+$	0	$\rightarrow$	0	$+$	0	Strangeness number conserved
0	$+$	$\frac{1}{2}$	$\rightarrow$	$\frac{1}{2}$	$+$	0	Spin conserved
-1	$+$	1	$\rightarrow$	0	$+$	0	Charge conserved

c) Reaction cannot occur

π^+	$+$	p	$\rightarrow$	π^+	$+$	p	$+$	π^-	$+$	π^0	
0	$+$	1	$\rightarrow$	0	$+$	1	$+$	0	$+$	0	Baryon number conserved
0	$+$	0	$\rightarrow$	0	$+$	0	$+$	0	$+$	0	Strangeness number conserved
0	$+$	$\frac{1}{2}$	$\rightarrow$	0	$+$	$\frac{1}{2}$	$+$	0	$+$	0	Spin conserved
1	$+$	1	$\rightarrow$	1	$+$	1	$+$	-1	$+$	0	Charge not conserved

d) Reaction can occur

γ	$+$	n	$\rightarrow$	π^-	$+$	p	
0	$+$	1	$\rightarrow$	0	$+$	1	Baryon number conserved
0	$+$	0	$\rightarrow$	0	$+$	0	Strangeness number conserved
1	$+$	$\frac{1}{2}$	$\rightarrow$	0	$+$	$\frac{1}{2}$	Spin not conserved *
0	$+$	0	$\rightarrow$	-1	$+$	1	Charge conserved

* Angular momentum must conserved rather than spin.