Conservation Laws

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1. The following table is a list of some baryons, and leptons.

particle	Q/e	B	L_{e}	L_{μ}	S
p	$+1$	1	0	0	0
n	0	1	0	0	0
Λ	0	1	0	0	-1
Σ^0	0	1	0	0	-1
Σ^+	$+1$	1	0	0	-1
$\overline{\Sigma}^+$	-1	-1	0	0	1
π^+	$+1$	0	0	0	0
π^-	-1	0	0	0	0
π^0	0	0	0	0	0
K^+	$+1$	0	0	0	$+1$
K^-	-1	0	0	0	-1
K^0	0	0	0	0	$+1$
e^-	-1	0	1	0	0
e^+	$+1$	0	-1	0	0
μ^-	-1	0	0	1	0
μ^+	$+1$	0	0	-1	0
ν_{e}	0	0	1	0	0
ν_{μ}	0	0	0	1	0
$\overline{\nu}_{\mathrm{e}}$	0	0	-1	0	0
$\overline{\nu}_{\mu}$	0	0	0	-1	0

Use the table, and the conservation laws for charge, lepton number, baryon number and strangeness to identify whether the following reactions can or cannot occur.
Note: if a strange particle decays, then strangeness is not conserved.

   (a) $\mu^+ \rightarrow \mathrm{e}^+\nu_{\mathrm{e}}$
   (b) $\pi^+ \rightarrow \mu^+\nu_{\mu}$
   (c) $\pi^0 \rightarrow \mathrm{e}^-\mathrm{e}^+\gamma$
   (d) $\nu_{\mathrm{e}}\mathrm{n} \rightarrow \mathrm{e}^-\Sigma^+$
   (e) $\pi^+\mathrm{p} \rightarrow \Sigma^+\mathrm{K}^+$
   (f) $\Lambda \rightarrow \mathrm{p}\pi^-$
   (g) $\pi^+ \rightarrow \mathrm{e}^+\nu_{\mathrm{e}}$
   (h) $\pi^0 \rightarrow \pi^-\mathrm{e}^+\nu_{\mu}$

2. Use the above table to identify particle X in the following reactions.

   (a) $\mathrm{K}^-\mathrm{p} \rightarrow \mathrm{K}^+\mathrm{K}^0 + \mathrm{X}$

(b) $\pi^+ \mathrm{n} \to \Lambda + \mathrm{X}$

(c) $\mathrm{K}^0 \mathrm{p} \to \mathrm{K}^+ + \mathrm{X}$

3. Give two reasons why a neutron cannot decay according to $\mathrm{n} \to \pi^+ \mathrm{e}^-$.