## Reference for Hadrons:

TABLE 32-2 Particles (stable under strong decay) ${ }^{\dagger}$

| Category | Particle <br> Name | Symbol | Antiparticle | Spin | $\begin{aligned} & \text { Rest Mass } \\ & \left(\mathrm{MeV} / c^{2}\right) \end{aligned}$ | $B$ | $L_{\text {c }}$ | $L_{\mu}$ | $L$ |  | Lifetime <br> (s) | Principal Decay Modes |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Gauge bosons | Photon | $\gamma$ | Self | 1 | 0 | 0 | 0 | 0 |  |  | Stable | $\mathrm{e} \nu_{\mathrm{e}}, \mu \nu_{\mu}, \tau \nu_{\tau}$, hadrons $\mathrm{e}^{+} \mathrm{e}^{-}, \mu^{+} \mu^{-}, \tau^{+} \tau^{-}$, hadrons |
|  | W | $\mathrm{W}^{+}$ | $\mathrm{W}^{-}$ | 1 | $80.33 \times 10^{3}$ | 0 | 0 | 0 | 0 |  | $3 \times 10^{-25}$ |  |
|  | Z | $\mathrm{Z}^{0}$ | Self | 1 | $91.19 \times 10^{3}$ | 0 | 0 | 0 |  | 0 | $3 \times 10^{-25}$ |  |
| Leptons | Electron | $\mathrm{e}^{-}$ | $\mathrm{e}^{+}$ | $\frac{1}{2}$ | $\begin{gathered} 0.511 \\ 0\left(<7.0 \times 10^{-6}\right)^{\ddagger} \\ 105.7 \\ 0(<0.17)^{\ddagger} \\ 1777 \\ 0(<24)^{\ddagger} \end{gathered}$ | 0 | +1 |  | 0 |  | Stable <br> Stable |  |
|  | Neutrino (e) | $\nu_{\text {c }}$ | $\bar{\nu}_{\text {c }}$ | $\frac{1}{2}$ |  | 0 | 1 | $\begin{aligned} & 0 \\ & 0 \end{aligned}$ | 00 |  |  |  |
|  | Muon | $\mu^{-}$ | $\mu^{+}$ | $\frac{1}{2}$ |  | 0 | 0 | $+1$ |  | 00 | $2.20 \times 10^{-6}$ | $\mathrm{e}^{-} \bar{\nu}_{\mathrm{c}} \nu_{\mu}$ |
|  | Neutrino ( $\mu$ ) | $\nu_{\mu}$ | $\bar{\nu}_{\mu}$ | 1 |  | 0 | 0 | +1 |  |  | Stable |  |
|  | Tau | $\tau^{\underline{-}}$ | $\tau^{+}$ | 1 |  | 0 | 0 | 0 |  |  | $2.91 \times 10^{-13}$ | $\mu^{-} \bar{\nu}_{\mu} \nu_{\tau}, \mathrm{e}^{-} \bar{\nu}_{\mathrm{e}} \nu_{\tau}$, hadrons $+\nu_{\tau}$ |
|  | Neutrino ( $\tau$ ) | $\nu_{\tau}$ | $\bar{\nu}_{\tau}$ | $\frac{1}{2}$ |  | 0 | 0 | 0 | +1 | 0 | Stable |  |
| Hadrons (selected) |  |  |  |  |  |  |  |  |  |  |  |  |
| Mesons | Pion | $\pi^{+}$ | $\pi^{-}$ | 0 | 139.6 |  | 0 | 0 | 00 |  | $2.60 \times 10^{-8}$ |  |
|  |  | $\pi^{0}$ | Self | $0$ | $135.0$ | 0 | 0 | 0 | 0 | $0$ | $0.84 \times 10^{-16}$ | $\begin{aligned} & \mu^{+} \nu_{\mu} \\ & 2 \gamma \end{aligned}$ |
|  | Kaon | $\mathrm{K}^{+}$ | K | 0 | 493.7 | 0 | 0 | 0 | 0 | $0+1$ | $1.24 \times 10^{-8}$ | $\mu^{+} \nu_{\mu}, \pi^{+} \pi^{0}$ |
|  |  | $\mathrm{K}_{\mathrm{S}}^{0}$ | $\overline{\mathrm{K}}^{0}$ | 0 | 497.7 | 0 | 0 | 0 | 0 | +1 | $0.89 \times 10^{-10}$ | $\pi^{+} \pi^{-}, 2 \pi^{0}$ |
|  |  | $\mathrm{K}_{\mathrm{L}}^{0}$ | $\overline{\mathrm{K}}_{\mathrm{L}}^{0}$ | 0 | 497.7 | 0 | 0 | 0 | 0 | +1 | $5.17 \times 10^{-8}$ | $\pi^{ \pm} \mathrm{e}^{\mp\left(-\sum_{\mathrm{e}}\right)}, \pi^{ \pm} \mu^{\mp}\left(\overline{\nu_{\mu}}\right), 3 \pi$ |
|  | Eta and others | $\eta^{0}$ | Self | 0 | 547.5 | 0 |  |  | $\begin{array}{ll} 0 & 0 \end{array}$ |  | $5 \times 10^{-19}$ | $2 \gamma, 3 \pi^{0}, \pi^{+} \pi^{-} \pi^{0}$ |
| Baryons | Proton | p | $\overline{\mathrm{p}}$ |  |  | +1 | 0 | 0 |  |  |  |  |
|  | Neutron | $\mathrm{n}$ | $\overline{\mathrm{n}}$ | $\frac{1}{2}$ | $939.6$ | +1 | 0 | 0 | 0 | ) 0 | $887$ |  |
|  | Lambda | $\Lambda^{0}$ | $\bar{\Lambda}^{0}$ | $\frac{1}{2}$ | $1115.7$ | +1 | 0 | 0 | 0 | ) -1 | $2.63 \times 10^{-10}$ | $\mathrm{p} \pi^{-}, \mathrm{n} \pi^{0}$ |
|  | Sigma | $\Sigma^{+}$ | $\bar{\Sigma}^{-}$ | $\frac{1}{2}$ | $1189.4$ | +1 | 0 | 0 | 0 | $0-1$ | $0.80 \times 10^{-10}$ | $\mathrm{p} \pi^{0}, \mathrm{n} \pi^{+}$ |
|  |  | $\Sigma^{0}$ | $\bar{\Sigma}^{0}$ | $\frac{1}{2}$ | 1192.6 | +1 | 0 | 0 | 0 | $0-1$ | $7.4 \times 10^{-20}$ | $\Lambda^{0} \gamma$ |
|  |  | $\Sigma$ | $\bar{\Sigma}^{+}$ | $\frac{1}{2}$ | 1197.4 | +1 | 0 | 0 | 0 | -1 | $1.48 \times 10^{-10}$ | $\mathrm{n} \pi^{-}$ |
|  | Xi | $\Xi^{0}$ | $\bar{\Xi}^{0}$ | $\frac{1}{2}$ | $1314.9$ | $+$ | 0 | 0 | 0 | ) -2 | $2.90 \times 10^{-10}$ | $\Lambda^{0} \pi^{0}$ |
|  |  | \# | $\Xi^{+}$ | $\frac{1}{2}$ | 1321.3 |  | +1 0 |  |  | $0-2$ | $1.64 \times 10^{-10}$ | $\Lambda^{0} \pi^{-}$ |
|  | Omega and others | $\Omega^{-}$ | $\Omega^{+}$ | $\frac{3}{2}$ | 1672.5 | +1 | 0 |  | $0-3$ |  | $0.82 \times 10^{-10} \Xi^{0} \pi^{-}, \Lambda^{0} \mathrm{~K}^{-}, \Xi^{-} \pi^{0}$ |  |

