5.1) For the following parent (that is, initial) nuclides, deduce the daughter (final) nuclides for both $\beta^-$ and $\beta^+$ decays. Compare the ground state $J^\pi$ for both parent and daughters (from the NNDC database or from Appendix C in Krane) and compute all the possible multipolarities of the ground-state to ground-state transitions. Classify all decay modes (some won’t occur because of $Q$-values but never mind; for this problem do not compute the $Q$-value) as Fermi, Gamow-Teller (or both) or forbidden.

(a) $^{137}\text{Cs}$ ($Z=55$)
(b) $^{60}\text{Co}$ ($Z=27$)
(c) $^{18}\text{F}$ ($Z=9$)
(d) $^{25}\text{Na}$ ($Z=11$)
(e) $^{76}\text{As}$ ($Z=33$)

5.2) Isotope Y can $\beta^-$-decay to isotope Z or $\beta^+$-decay to isotope X. Both have exactly the same $ft$ values, but the $Q$-values for the $\beta^-$ decay is 3.3 MeV while that of the $\beta^+$ decay is 1.8 MeV. If the $\beta^-$ decay-rate is 56 s$^{-1}$, use Sargent’s rule to compute the $\beta^+$ decay rate. Compute the branching ratios for both the $\beta^-$ and $\beta^+$ decays.

5.3) Repeat problem (2) but change the assumptions: the $Q$-values are the same (say 3.3 MeV) but the $\beta^-$ decay has a log $ft$ value of 5.7 while the $\beta^+$ decay has 6.5.

5.4) For the following parent nuclides, estimate the branching ratios of $\beta^+$, electron capture, and $\beta^-$ decay. You will need to compute the $Q$-values of all 3 decays. Assume the log $ft$ values are the same. If a decay cannot occur due the $Q$-value having the wrong sign, state that fact. (For this problem do not consider if the transition is "allowed" or "forbidden." Note that "forbidden" does not actually mean a decay cannot occur, only that it has a slower rate--a longer half-life--than an "allowed" transition.)

(a) $^{104}\text{Rh}$
(b) $^{108}\text{Ag}$
(c) $^{63}\text{Cu}$

5.5) Consider the mirror decays $^{14}\text{C} \rightarrow ^{14}\text{N}$ and $^{14}\text{O} \rightarrow ^{14}\text{N}$. From experimental data (see e.g. NNDC website), (a) compute the relevant $Q$-values (b) and comparing actual half-lives and using Sargent's rule, extract the difference in log $ft$ values between the two decays.