I will hand out solutions when you turn this in

(7.1) Consider a nucleus with \( A = 120 \), and consider a \( 2^+ \rightarrow 1^+ \) transition with the emitted photon having an energy of 350 keV.
(a) What are all the possible gamma transitions (e.g. E1 etc)?
(b) Compute the Weisskopf estimates for the total rates for all possible transitions.
(c) Now compute the Weisskopf estimates for the branching ratios for the above. What would appear to be the dominant transition?

(7.2) Do the same as (1) but for \( 3/2^- \rightarrow 3/2^+ \).

(7.3) Both \( ^{172}\text{Dy} \) and \( ^{204}\text{Pb} \) have \( 0^+ \) ground states and \( 2^+ \) first excited states; thus the \( 2^+ \) excited states decay via E2, the \( ^{172}\text{Dy} \) with an energy of 99 keV and a half-life of \( 1.2 \times 10^{-9} \) s, and the \( ^{204}\text{Pb} \) with an energy of 0.9 MeV and a half-life of \( 2.2 \times 10^{-12} \) s. Compute the Weisskopf estimate for the half-lives for their transitions and then transform the experimental rates into Weisskopf units. Which transition is more collective?

(7.4) Take the plutonium isotopes 238, 239, 240, and 242, which all alpha-decay to uranium. Compute the Q-values for all of the alpha decays. There is sufficient data in Appendix C of the book. We have the approximate relationship

\[
t_{1/2} \cong C \exp\left(\frac{+k}{\sqrt{Q}}\right).
\]

Plot \( \ln t_{1/2} \) versus \( 1/\sqrt{Q} \); using the numerical values, fit to find \( C \) and \( k \). (You may use any method that is reasonable, for example using a fitting program, as long as you briefly explain what you did.) How well does the data fit?

(7.5) A tauon (\( \tau^- \)) decays into a muon (\( \mu^- \)) and possibly neutrino(s). Assume conservation of lepton flavor number and write down the neutrino(s), if any, included in the final decay product.

(7.6) The above decay is via the weak nuclear force. What is the force boson that mediates the above decay?
(7.7) Draw the Feynman diagram for the decay in problem (1), including the intermediate force boson. Be sure to include the approximate directions of time and space.

(7.8) Draw Feynman diagrams for the following decay processes. Which ones are strong/EM decays and which are weak decays? Use the online notes for help with quark content.

(a) \( K^+ \rightarrow \mu^+ + \nu_\mu \)
(b) \( K^0 \rightarrow \pi^+ + \pi^- \)
(c) \( \Delta^- \rightarrow n + \pi^- \)
(d) \( \Delta^0 \rightarrow p + \pi^- \)
(e) \( \Xi^- \rightarrow \Lambda^0 + \pi^- \)
(f) \( \Sigma^- \rightarrow n + \pi^- \)
(g) \( \pi^- \rightarrow \mu^- + \text{anti-}\nu_\mu \)