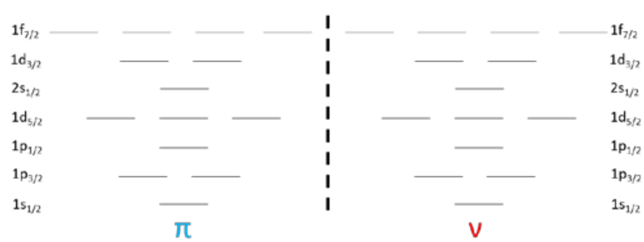
Name: ______________ PHYS 7501, FS 2021

Homework 2 **Due:** Start of class, September 14th

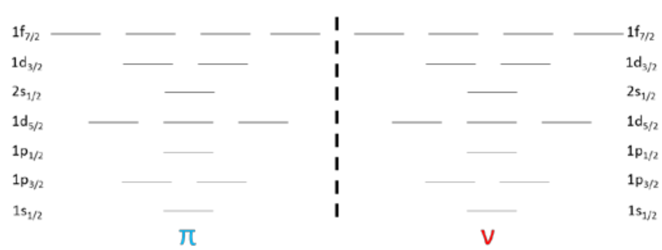
1. Which of the following level designations is non-sensical? Explain what the issue is.
    a. $d_{5/2}$
    b. $f_{3/2}$
    c. $s_{1/2}$
    d. $p_{1/2}$

2. Other than nuclear masses, nuclear mass differences, radii, electric quadrupole moments, cosmic abundances, and deformation, name at least two other pieces of evidence for magic numbers in nuclei. Provide citation(s) for your answers.

3. Fill-out the single particle levels and, based on this, determine J^{π} for the ground-state and first two excited states of ^{17}O. Explain how you came to your conclusions.
Verify your results with the NNDC database.



4. Fill-out the single particle levels and, based on this, determine J^{π} for the ground-state of ^{34}Cl. Explain how you came to your conclusions. Verify your results with the NNDC database.



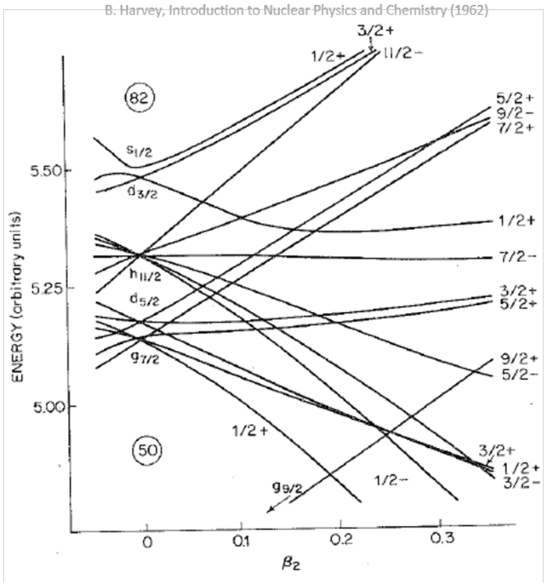
5. Where do we expect the magnetic dipole moment of ^{17}O to be located with respect to the Schmidt lines? Why? Compare your answer to the measured value.

6. $E(2_1^+)$ and $E(4_1^+)$ for ^{226}Ra are 68keV and 211keV, respectively. With a simple (~2 line) calculation, show that it is or is not a rigid rotor. Assuming it is, what is the expected value for $E(6_1^+)$? Compare to experiment.

7. ^{32}Mg has a deformation $\beta = 0.51$. What are the expected excitation energies for the 2+, 4+, and 6+ excited states, assuming it is a spheroidal rotor? Compare to the values from H. Crawford et al. Phys. Rev. C 2016.

8. Compare the ground-state J^{π} for ^{173}Lu from the non-deformed and deformed shell-models to the experimental value.

B. Harvey, Introduction to Nuclear Physics and Chemistry (1962)



9. Treating the nucleus as a Fermi gas, estimate the time it takes for a typical bound nucleon to cross the nucleus. Now, calculate the time for one revolution of a rigid rotor with $j = 2$, $I = 5000 amu\ fm^2$, and $A = 208$. You may find this helps justify the Nilsson model, where we treat the nucleon as if its orbiting around an essentially stationary rotor.

10. You have determined the spins for the excited states of some nucleus using β-decay, which tends to sample a small range of spins. You're now going to use your spin distribution to calculate the level density for the daughter nucleus of a reaction. Would you be more worried about systematic uncertainties if you were doing this for ^{59}Cu(p,γ) for the astrophysical rp-process or for ^{234}U(γ,n) for special nuclear material detection?