RDCH 702
Quiz 3
Assigned 17 October 18
1st Due date: 23 October 18
2nd Due date: 26 October 18

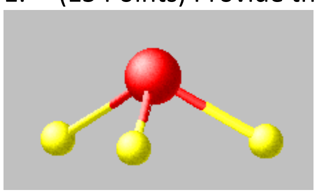
Last Name:___________________________________

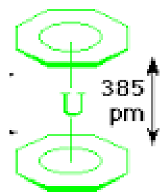
First Name:___________________________________

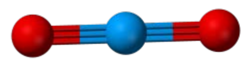
Quiz Topics
Lecture 4 Electronic Orbitals and Energetics, Lecture 5 Nuclear Models, and Lecture 6 Decay Kinetics

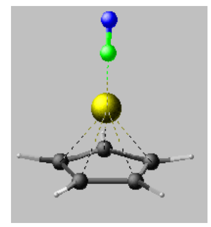
Use the lecture notes, chart of the nuclides, table of the isotopes, and web links to answer the following questions.

1. (15 Points) Provide the point group for the following









_____________________ ___________________

2. (10 Points) What are concepts used in molecular orbital theory?

❒ Molecular orbitals are comprised from the overlap of atomic orbitals

❒ Hard metal ion interact with hard bases

❒ Number of molecular orbitals equals the number of combined atomic orbitals

❒ Metal bonding can be described with effective atomic number

❒ Ligands can wrap around metal ion forming stronger complex

3. (5 Points) What are the different types of molecular orbitals described by molecular orbital theory?

3.1. ___________________________

3.2. ___________________________

3.3. ___________________________

4. (10 Points) In Lewis acid-base terms, which are softer metals, lanthanides or actinides? __________
   4.1. How is this fact used in separations of lanthanides from actinides?

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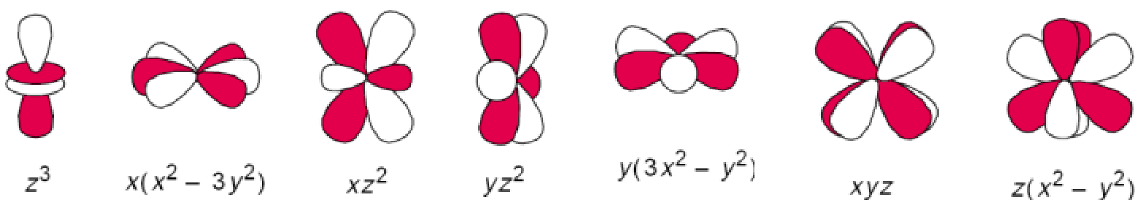
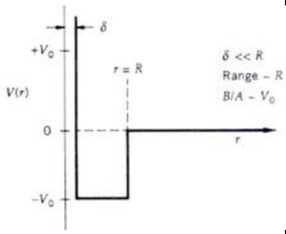
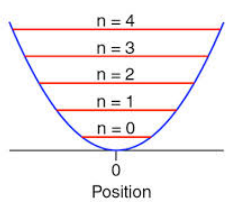
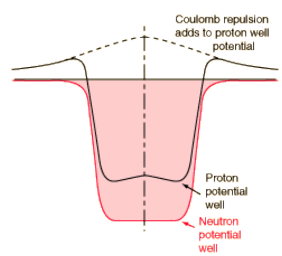
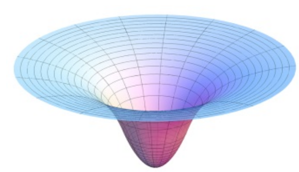
5. (10 Points) Select the uranium atomic f-orbitals that form the molecular orbitals for UO_2^{2+}. The oxygens contribute 1 s and 3 p orbitals, so there must be 4 f-orbitals from uranium that can mix with the oxygen orbitals.



10.1 ❒ 10.2 ❒ 10.3 ❒ 10.4 ❒ 10.5 ❒ 10.6 ❒ 10.7 ❒

6. (5 Points) What is the nuclear potential used in the shell model?

❒ Potential 1	❒ Potential 2	❒ Potential 3	❒ Potential 4
			

7. (15 Points) Consider the nucleus ^{47}Ti.
   7.1. Spin and parity from shell model: ________________________

   7.2. Spin and parity from chart of the nuclides: ________________

   7.3. Based on the actual spin and parity from the chart of the nuclides use the Nilsson diagram on the next page to answer the following questions. You can check your work at: http://www.sympnp.org/proceedings/58/B85.pdf

   7.4. Indicate which location on the Nilsson diagram (next page) would be occupied by unpaired neutron. **The** red dots indicate the possible locations_

   7.5. Is ^{47}Ti oblate or prolate? __________________

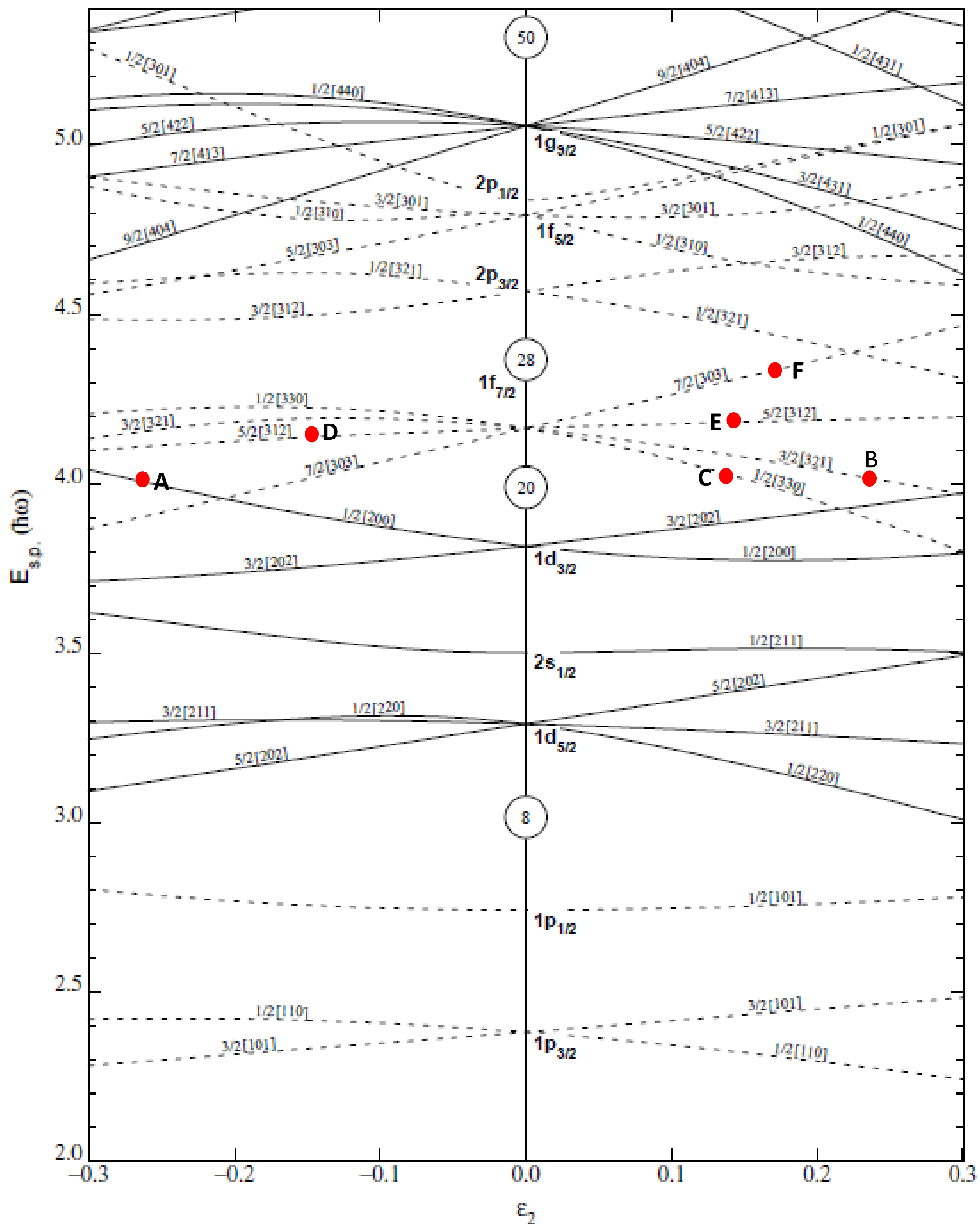
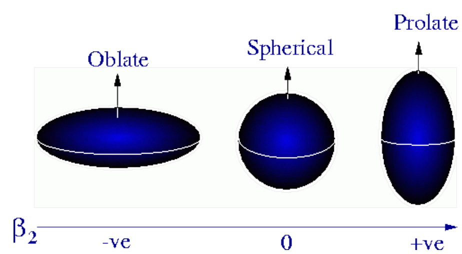


Figure 4. Nilsson diagram for protons or neutrons, Z or N ≤ 50 (ε_4 = 0).



8. (10 Points) Consider the isotope ^{239}Pu. What thermal neutron flux is needed so the induced fission rate of ^{239}Pu is equal to twice its alpha decay rate? The flux unit is neutrons $cm^{-2}\ s^{-1}$.

Neutron flux (neutrons $cm^{-2}\ s^{-1}$): ____

9. (20 Points) At time zero you have 1E9 Bq of ^{225}Ra and no other isotopes. Please provide the activity in Bq at the selected times for the isotopes in the table below. You can ignore the minor branching ratios. The ERG program is helpful for this calculation.

Time (hr)	^{225}Ra	^{225}Ac	^{221}Fr	^{217}At	^{213}Bi	^{213}Po	^{209}Pb	^{209}Bi
0	_______	_______	_______	_______	_______	_______	_______	_______
5	_______	_______	_______	_______	_______	_______	_______	_______
50	_______	_______	_______	_______	_______	_______	_______	_______
500	_______	_______	_______	_______	_______	_______	_______	_______
1000	_______	_______	_______	_______	_______	_______	_______	_______

9.1. Provide the number of atoms for the following isotopes at 50 hours

9.1.1. ^{225}Ra _______________

9.1.2. ^{225}Ac _______________

9.1.3. ^{221}Fr _______________

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Digital Signature