Quiz 3
Assigned 25 October 13
Be prepared to discuss in class on Wednesday 30 October 13

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

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

1. (10 Points) Provide three possible structures for a 6 coordinate compound? Describe how the structures are related and provide their point groups?

2. (10 Points) What is the relationship between molecular orbital theory, crystal field theory, and ligand field theory?
3. (10 Points) The earth is 4.5E9 years old.

3.1. Provide the $^{235}\text{U}$ to $^{238}\text{U}$ ratio at the origin of the earth.

3.2. Provide the $^{235}\text{U}$ to $^{238}\text{U}$ ratio 2.5 billion years from today.

4. (20 Points) Use the ERG program (http://www.ergoffice.com/downloads.aspx) to answer the following question.
You have prepared a sample of $^{98}\text{Sr}$. At time zero you have $10^9$ atoms. Please provide the activity and number of atoms for all the isotopes from $^{98}\text{Sr}$ to the stable end chain member for the following times.

4.1. 500 ms
4.2. 1000 ms
4.3. 3000 ms
4.4. 5000 ms
4.5. 13000 ms
4.6. 33000 ms
4.7. 50000 ms
4.8. 100000 ms
5. (20 Points) Using the Shell model find the spin and parity of the following isotopes. Compare with the actual values. Explain any differences.

5.1. $^{64}\text{Cu}$

5.2. $^{234}\text{Pa}$

5.3. $^{46}\text{Sc}$

5.4. $^{145}\text{Sm}$

5.5. $^{201}\text{Hg}$

5.6. $^{204}\text{Tl}$

5.7. $^{242}\text{Am}$

5.8. $^{239}\text{Pu}$

5.9. $^{211}\text{Fr}$

5.10. $^{206}\text{At}$

5.11. $^{179}\text{Hf}$

5.12. $^{67}\text{Ni}$
6. **(10 Points)** Consider the isotope $^{23}\text{Na}$. What is the shape of the nucleus based on the observed spin and parity using the Nilsson diagram?
7. (5 Points) Describe ligand to metal and metal to ligand charge transfer reactions. How would these compare to the absorbance one observes for uranyl around 415 nm?

8. (10 Points) You have a sample of $^{95}$Zr that is counted for 180 second and has an activity of 702 Bq. Consider this the activity at time zero. Please provide the activity in Bq and the % error in the counts for the following times after time zero for 1 minute counting. Assume you have 50 % decay detection.

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>Activity (Bq)</th>
<th>% error</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>702</td>
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<tr>
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<td>65.0</td>
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<td>135.8</td>
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<tr>
<td>365</td>
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<td>700</td>
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9. (5 Points) What are the basic assumptions in using radionuclides for dating?

10. (5 Points) A 0.150 g sample of $^{248}\text{Cm}$ has an alpha activity of 0.636 mCi. What is the half-life of $^{248}\text{Cm}$?