Name: _____ *Chemistry*

Date: _____ Period: _____

POGIL: Cracking the Periodic Code

Why?

As charts go, the periodic table is a bit odd. It's not square and large portions of the table appear to be 'missing' at the top. It's not organized alphabetically, so it can be hard to find elements. But to a chemist, the periodic table is a very powerful tool. The periodic table is organized by properties – both chemical and physical – which relate to the electronic structure of the atoms of each element.

Success Criteria

- Identify the major orbital blocks (s, p, d, and f) on the periodic table.
- Predict the electron configuration for an atom of any element using only the periodic table as a guide.

Prerequisites

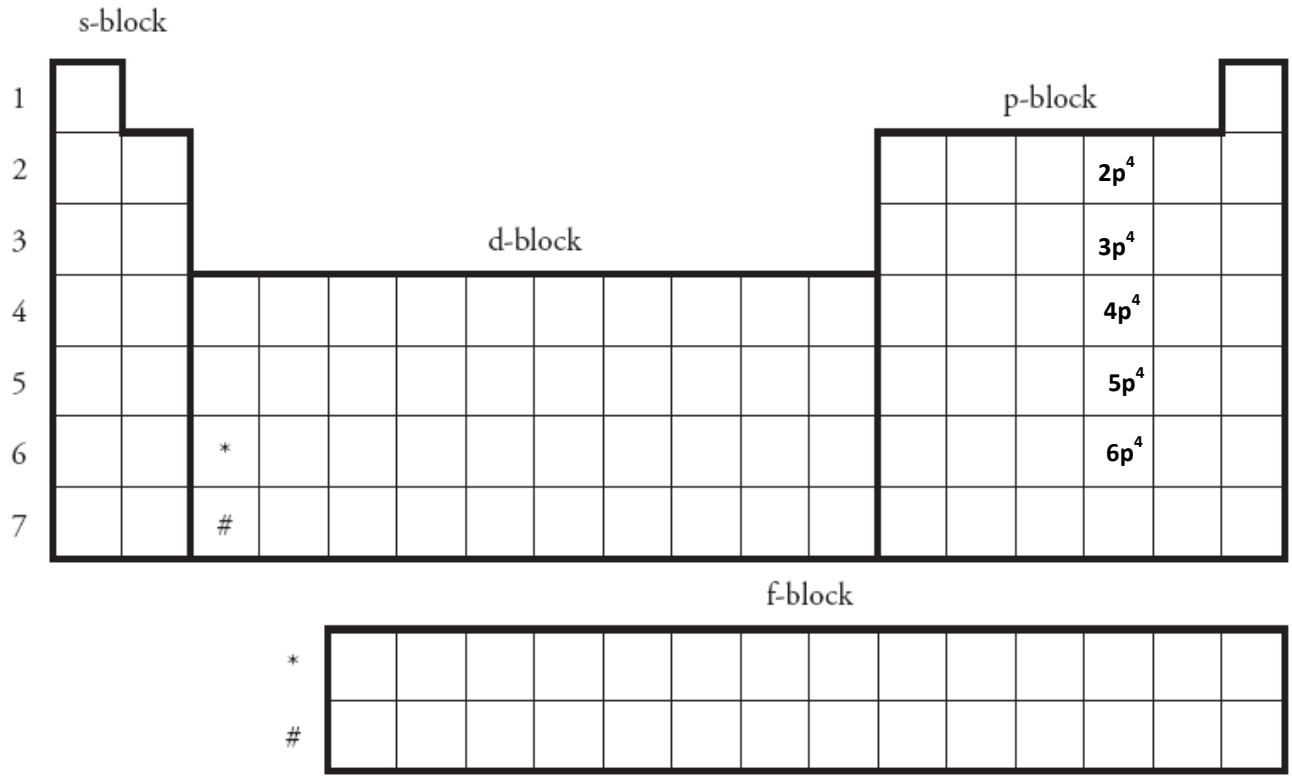
- Identify an element by its period and group designations.
- Determine the orbital diagrams, standard and shortcut electron configurations for an element.

Review Questions

Complete the following electron configurations.

ELEMENT	CONFIGURATION
Niobium ***Standard Configuration***	
Chlorine ***Standard Configuration***	
Nickel ***Orbital Filling***	
Indium ***Orbital Filling***	
Osmium ***Noble Shortcut Version***	
Thullium ***Noble Shortcut Version***	

MODEL 1 – Blank Periodic Table



1. Obtain a set of cards with electron configurations for various 'Teams' of elements. Complete the following chart for each team.

Team	Team Name	Element Examples	Configuration Ending(s)	Similarities
EX	**CHALCOGENS**	**O, S, Se, Te, Po**	**$2p^4$, $3p^4$, $4p^4$, $5p^4$, $6p^4$**	**All end as p^4**
1	Alkali Metals			
2	Transition Metals			
3	Rare Earth Metals			
4	Halogens			
5	Alkaline Earth Metals			
6	Pnictogens			
7	Transition Metals			
8	Rare Earth			
9	Noble Gases			

2. Locate where each 'Team' of elements should be in Model 1.
   a. Write the last orbital notation in the configuration for each element on Model 1. (Chalcogens are already completed for you.)
   b. What is the relationship between the ending configurations and an element's location on the periodic table?

3. Fill in the chart for each of the sublevel blocks on the periodic table.

SUBLEVEL	# Orbitals	# Electrons it Can Hold	# of Columns for this "Block" on Periodic Table
s			
p			
d			
f			

What is the relationship between the block size and the number of electron that sublevel can hold?

4. Looking at your filled in Periodic Table for Model 1, what is the relationship between where an element is located within a "block" of the table and the superscript at the end of the configuration?

5. Obtain an Electron Energy Levels handout from your teacher. Compare the handout to Model 1.
   a. Remembering that we start filling the lowest energy sublevel first, explain why there are only TWO elements in the first row of the periodic table.

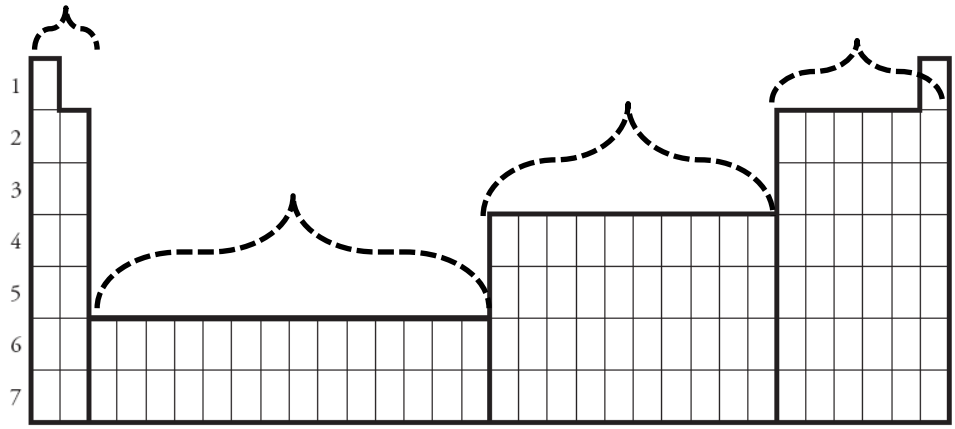
   b. Why does the second row of the periodic table not have a "d-block" section?

   c. The third energy level in an atom contains a d sublevel. Why does the "d-block" start in the fourth row of the periodic table?

6. What is the relationship between the row of the periodic table and the "d-block" principal energy level?

MODEL 2 – Periodic Table (Long Form)

Obtain a Periodic Table Handout from your teacher. Cut along the dotted lines and reassemble the table in sequential order of atomic number.



7. Using your reconstructed periodic table, label the sublevel "blocks" in Model 2.

8. Compare the periodic in Model 1 with the periodic table of Model 2. What section of the table was moved?

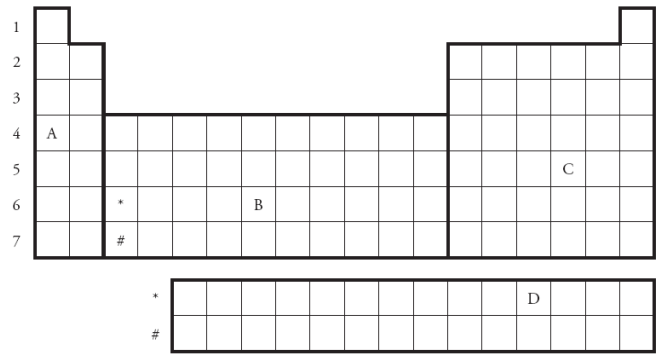
9. What do the * and # symbols in Model 1 indicate?

10. The form of the periodic table seen in Model 2 is called the "long form". You do not often see this form in books or posters. What are the disadvantages of this form?

11. Explain why the "f-block" does not appear until the 6th row, and why it fits between the "s" and "d" blocks.

12. For the elements in the "f-block", how is the row number related to the principal energy level for the last orbital notation of their electron configurations?

13. Write the last orbital notation in the electron configurations for the elements located at A, B, C, and D in the table below. You should not have to "count" electrons to do this if you understand the structure of the periodic table.



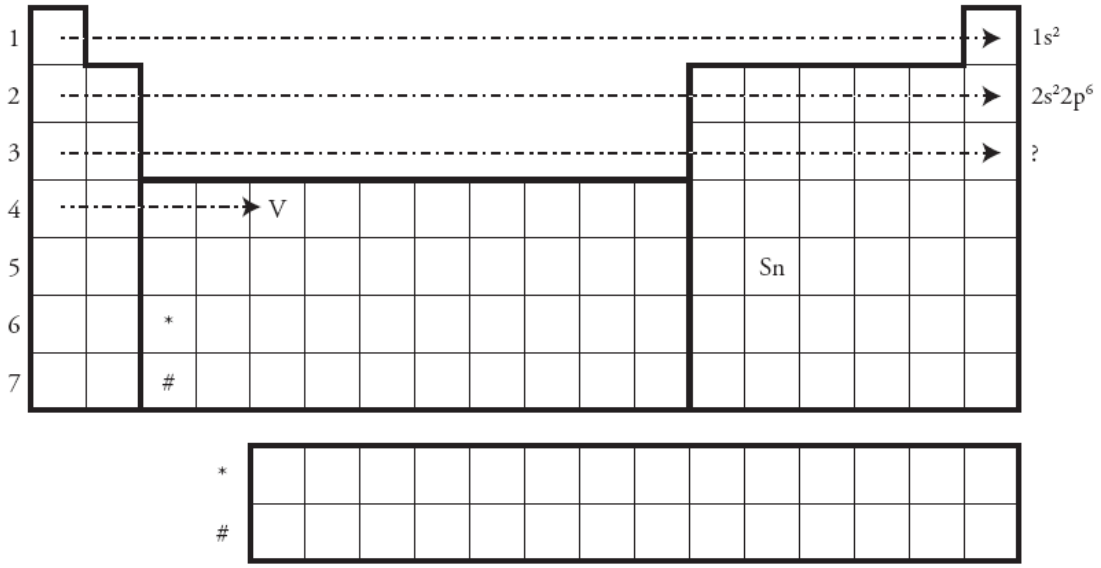
A = _____

B = _____

C = _____

D = _____

MODEL 3 – Use of the Periodic Table for Electron Energy Levels



14. Now that you understand how the structure of the periodic table relates to electron sublevels, you can use it as a "cheat sheet" for the order of filling of electrons in the sublevels of the atom. The following steps will help you write the ground state electron configuration for vanadium, V.
    a. Use your finger to trace a line across the top row of the periodic table in Model 3. Explain why the only two boxes in that row represent $1s^2$.

    b. Trace a line across row two of the periodic table. Explain why this row represents $2s^2 2p^6$.

    c. Trace a line across row three of the periodic table. Record the sublevels and the number of electrons that will be filled by the time you reach the end of this line.

    d. Trace a line across row four ending at vanadium, V, and record the sublevels and the number of electrons that are filled to reach that point.

    e. Combine the steps above to write the full ground state electron configuration for vanadium, V.

15. Using only a periodic table, write the full ground state electron configuration for a neutral atom of tin, Sn.

16. The electron configuration for an unknown element is: [Rn] $7s^2\ 5f^{14}\ 6d^4$
    a. Identify the element and write is symbol in its proper location of Model 3.

    b. Describe two different methods that could be used to identify this element.

PRACTICE PROBLEMS

1. Using only a periodic table, identify which set(s) of electron sublevels is NOT organized from the lowest energy to the highest energy.
   a. 2s, 2p, 3s, 3p, 3d, 4s
   b. 1s, 2s, 2p, 2s, 3p, 4s
   c. 2s, 2p, 3s, 3p, 4s, 3d
   d. 4d, 4f, 5s, 5p, 5d, 5f

2. Which element would have $4f^4$ as the last entry of its electron configuration?
   a. Cr b. Nd c. W d. Se

3. Using the Periodic Table "cheat sheet" method ONLY, write the expected ground state electron configuration for neutral atoms of the elements:

ELEMENT	CONFIGURATION
Hafnium (Hf)	
Indium (In)	
Bromine (Br)	
Nitrogen (N)	
Calcium (Ca)