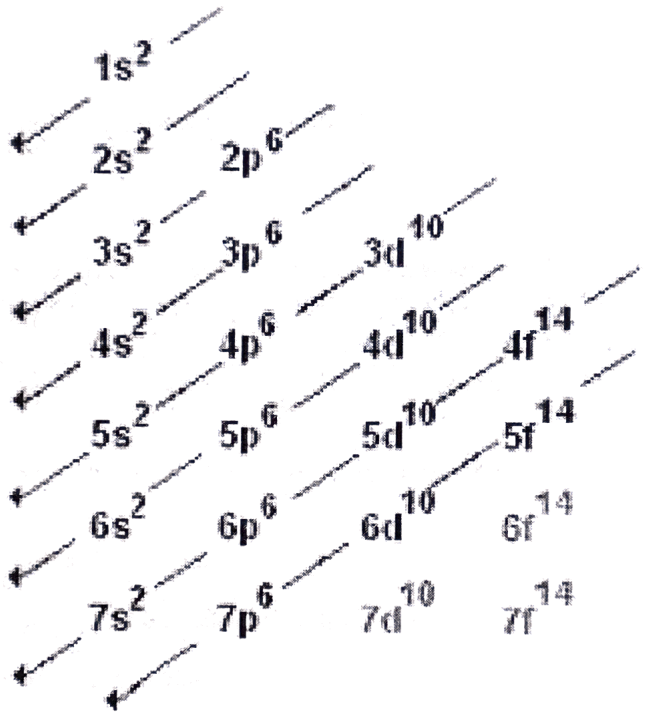
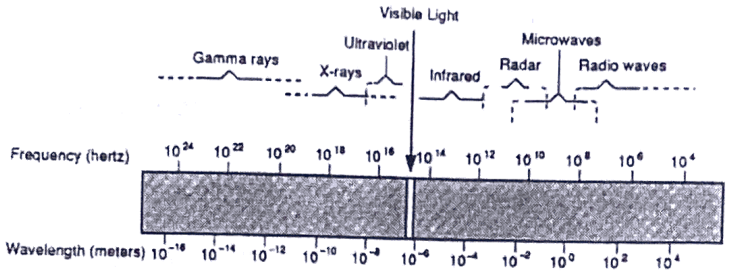
Chemistry Honors

Unit 2 Homework Packet

(Electronic Structure & Periodicity)



Chemistry: *Light Problems*



Directions: Solve the following problems. Show proper set-up, work, and units for full credit. Box in your final answer.

1. A wave has a frequency of 22 Hz and a wavelength of 4.0 m. What is its velocity?

2. What is the frequency of a wave if its wavelength is 3.6×10^{-9} m and its velocity is 3.0×10^{8} m/s?

3. As you move across the continuous spectrum from red to violet, what happens to…
   a. wavelength?
   b. frequency?

4. A beam of microwaves has a frequency of 1.0×10^{9} Hz. A radar beam has a frequency of 5×10^{11} Hz. Which type of radiation…
   a. has the longer wavelength?
   b. is nearer to visible light in the electromagnetic spectrum?
   c. is closer to X-rays in frequency value?

5. A bright line spectrum contains a line with a wavelength of 518 nm. Determine…
   a. the wavelength, in meters. (Hint: 1×10^{9} nm = 1 m)
   b. the frequency.
   c. the energy.
   d. the color of the line.

6. A photon has an energy of 4.00×10^{-19} J. Find…

   a. the frequency of the radiation.

   b. the wavelength of the radiation.

   c. the region of the electromagnetic spectrum that this radiation represents.

7. A photon of light has a wavelength of 3.20×10^{5} m. Find…

   a. the frequency of the radiation.

   b. the energy of the photon.

   c. the region of the electromagnetic spectrum that this radiation represents.

8. Determine the frequency of light with a wavelength of 4.257×10^{-7} cm.

9. How many minutes would it take a radio wave with a frequency of 7.25×10^{5} Hz to travel from Mars to Earth if the distance between the two planets is approximately 8.0×10^{7} km?

10. Cobalt-60 is an artificial radioisotope that is produced in a nuclear reactor for use as a gamma-ray source in the treatment of certain types of cancer. If the wavelength of the gamma radiation from a cobalt-60 source is 1.00×10^{-3} nm, calculate the energy of a photon of this radiation.

Selected Answers:
1. 88 m/s
2. 8.3×10^{16} Hz
5a. 5.18×10^{-7} m
5b. 5.79×10^{14} Hz
5c. 3.84×10^{-19} J
6a. 6.03×10^{14} Hz
6b. 4.97×10^{-7} m
7a. 938 Hz
7b. 6.21×10^{-31} J
8. 7.047×10^{16} Hz
9. 4.4 minutes
10. 1.99×10^{-13} J

Electron Configuration

Name_____

Energy Level n	E Sublevel (type of orbital)	# of Orbitals in Sublevel	# of e^- in Sublevel	Total # of e^- in E level ($2n^2$)
1				
2				
3				
4				

Worksheet: Electron Distributions Name_____

1. There are four types of orbitals:
   - s : shaped like a _____
     An E level can contain only _____ s orbital, making up the "s sublevel".
   - p : shaped like _____
     An E level can contain _____ p orbitals, making up the "p sublevel".
   - d : shaped like double dumbbells
     An E level can contain _____ d orbitals, making up the "d sublevel".
   - f : too complex to draw or describe
     An E level can contain _____ f orbitals, making up the "f sublevel".

2. Each orbital can hold a maximum of _____ electrons. Since both electrons have a _____ charge, they _____. What keeps them from flying apart?

   Each electron _____ on its axis. One spins _____ and the other spins _____. When charged particles spin, they act like tiny magnets. Since the two electrons spin in _____ directions, one acts like the north pole of a magnet and the other acts like the south pole. This makes the electrons _____.

3. Since each orbital can hold _____ electrons:
   The "s sublevel" can hold _____ electrons.
   The "p sublevel" can hold _____ electrons.
   The "d sublevel" can hold _____ electrons.
   The "f sublevel" can hold _____ electrons.

We use this notation to describe an electron:

main _____ level → $3p^5$ ← # of e- in _____

↑ _____

How are electrons distributed within a sublevel?

According to Hund's Rule, each _____ within a sublevel is half-filled before any is _____.

An Electron's Address

Name: _____

Date: _____

Information: Energy Levels and Sublevels

As you know, in his solar system model Bohr proposed that electrons are located in energy levels. The current model of the atom isn't as simple as that, however.

Sublevels are located inside energy levels just like subdivisions are located inside cities. Each sublevel is given a name. Note the following table:

TABLE 1

Energy Level	Names of sublevels that exist in the energy level
1st energy level	s
2nd energy level	s and p
3rd energy level	s, p, and d
4th energy level	s, p, d, and f

Note that there is no such thing as a "d sublevel" inside of the 2nd energy level because there are only s and p sublevels inside of the 2nd energy level.

Critical Thinking Questions

1. How many sublevels exist in the 1st energy level?

2. How many sublevels exist in the 2nd energy level?

3. How many sublevels exist in the 3rd energy level?

4. How many sublevels would you expect to exist in the 5th energy level?

5. Does the 3f sublevel exist? (Note: the "3" stands for the 3rd energy level.)

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Information: Orbitals

So far we have learned that inside energy levels there are different sublevels. Now we will look at orbitals. Orbitals are located inside sublevels just like streets are located inside subdivisions. Different sublevels have different numbers of orbitals.

TABLE 2

Sublevel	# of Orbitals Possible
s	1
p	3
d	5
f	7

Here's an important fact: only two electrons can fit in each orbital. So, in an s orbital you can have a maximum of 2 electrons; in a d orbital you can have a maximum of 2 electrons; in any orbital there can only be two electrons.

Since a d sublevel has 5 orbitals (and each orbital can contain up to two electrons) then a d sublevel can contain 10 electrons (= 5 x 2). Pay attention to the difference between "sublevel" and "orbital".

Critical Thinking Questions

6. How many orbitals are there in a p sublevel?

7. How many orbitals are there in a d sublevel?

8. a) How many total sublevels would be found in the entire 2nd energy level?

   b) How many orbitals would be found in the entire 2nd energy level?

9. a) How many electrons can fit in an f sublevel?

   b) How many electrons can fit in an f orbital?

10. How many electrons can fit in a d orbital? in a p orbital? in any kind of orbital?

11. In your own words, what is the difference between a sublevel and an orbital?

12. How many electrons can fit in each of the following energy levels:

    1st energy level =

    2nd energy level =

    3rd energy level =

    4th energy level =

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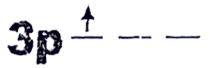
Information: Representing the Most Probable Location of an Electron

The following is an "address" for an electron—a sort of shorthand notation. The diagram below represents an electron located in an orbital inside of the p sublevel in the 3rd energy level.

EXAMPLE #1:

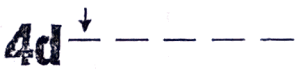


Some important facts about the above diagram:

- The arrow represents an electron.
- The upward direction means that the electron is spinning clockwise.
- "3p" means that the electron is in the p sublevel of the 3rd energy level.
- Each blank represents an orbital. Since there are three orbitals in a p sublevel, there are also three blanks written beside the p.
- In the diagram, the electron is in the first of the three p orbitals.

Here's another example:

EXAMPLE #2:



Critical Thinking Questions

13. In example #2, why are there 5 lines drawn next to the d?

14. In example #2, what does it mean to have the arrow pointing down?

15. Write the notation for an electron in a 2s orbital spinning clockwise.

16. Write the notation for an electron in the first energy level spinning clockwise.

17. What is wrong with the following notation? You should find two things wrong.

18. Write the notation for an electron in the 4th energy level in an f sublevel spinning clockwise.

Electron Configuration Practice Worksheet

In the space below, write the unabbreviated electron configurations of the following elements:

1) sodium _____

2) iron _____

3) bromine _____

4) barium _____

5) neptunium _____

In the space below, write the abbreviated electron configurations of the following elements:

6) cobalt _____

7) silver _____

8) tellurium _____

9) radium _____

10) lawrencium _____

Determine what elements are denoted by the following electron configurations:

11) $1s^2 2s^2 2p^6 3s^2 3p^4$ _____

12) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$ _____

13) [Kr] $5s^2 4d^{10} 5p^3$ _____

14) [Xe] $6s^2 4f^{14} 5d^6$ _____

15) [Rn] $7s^2 5f^{11}$ _____

Determine which of the following electron configurations are not valid:

16) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^{10} 4p^5$ _____

17) $1s^2 2s^2 2p^6 3s^3 3d^5$ _____

18) [Ra] $7s^2 5f^8$ _____

19) [Kr] $5s^2 4d^{10} 5p^5$ _____

20) [Xe] _____

Note: The electron configurations in this worksheet assume that lanthanum (La) is the first element in the 4f block and that actinium (Ac) is the first element in the 5f block. If your periodic table doesn't agree with this, your answers for elements near the f-orbitals may be slightly different.

1) sodium

2) iron

3) bromine

4) barium

5) neptunium

6) cobalt

7) silver

8) tellurium

9) radium

10) lawrencium

11) $1s^2 2s^2 2p^6 3s^2 3p^4$

12) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$

13) [Kr] $5s^2 4d^{10} 5p^3$

14) [Xe] $6s^2 4f^{14} 5d^6$

15) [Rn] $7s^2 5f^{11}$

16) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^{10} 4p^5$

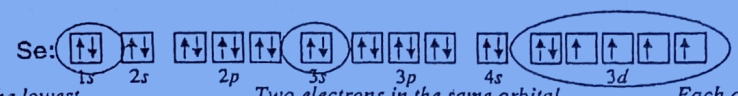
17) $1s^2 2s^2 2p^6 3s^3 3d^5$

18) [Ra] $7s^2 5f^8$

19) [Kr] $5s^2 4d^{10} 5p^5$

20) [Xe]

An orbital diagram uses boxes with arrows to represent the electrons in an atom. Each box in an orbital diagram represents an orbital. Orbitals have a capacity of two electrons. Arrows are drawn inside the boxes to represent electrons. Two electrons in the same orbital must have opposite spin so the arrows are drawn pointing in opposite directions. The following is an orbital diagram for selenium.



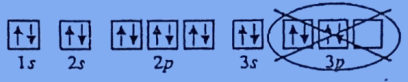
Electrons fill the lowest available energy levels first.

Two electrons in the same orbital must have opposite spin.

Each orbital is half-filled before being completely filled.

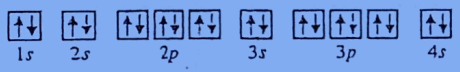
In writing an orbital diagram the first step is to determine the number of electrons. Normally this is the same as the number of protons, which is known as the atomic number. Next the boxes are drawn for the orbitals. Arrows are drawn in the boxes starting from the lowest energy sublevel and working up. This is known as the **Aufbau rule**. The **Pauli exclusion principle** requires that electrons in the same orbital have opposite spin. **Hund's rule** states that orbitals in a given sublevel are half-filled before they are completely filled.

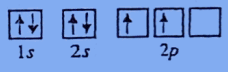
Boxes drawn for various sublevels		
s sublevel:	□	1 orbital
p sublevel:	□□□	3 orbitals
d sublevel:	□□□□□	5 orbitals
f sublevel:	□□□□□□□	7 orbitals

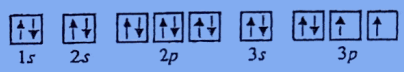


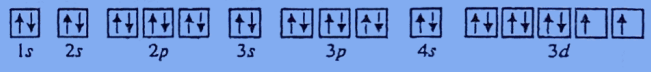
This violates Hund's rule. One electron should be distributed to each of the 3p orbitals before doubly filling any.

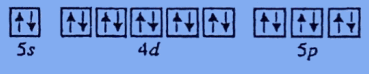
Write the name and symbol for the elements with the following orbital diagrams.

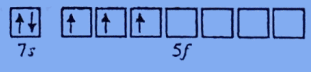
1. 

2. 

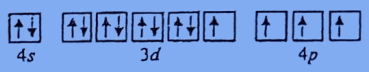
3. 

4. 

5. [Kr] 

6. [Rn] 

There is an error with each of the following orbital diagrams. Explain the error.

7. [Ar] 

8. 

Write orbital diagrams for the following. You may abbreviate using a noble gas.

9. hydrogen
10. boron
11. sodium
12. krypton
13. chromium
14. phosphorus
15. carbon
16. cobalt
17. platinum
18. plutonium
19. oxygen
20. potassium

Electron Configurations

Name _____

Date _____ Per _____

PART A – ORBITAL DIAGRAMS & LONGHAND ELECTRON CONFIGURATION

Use the patterns within the periodic table to draw orbital diagrams and write longhand electron configurations for the following atoms.

	Symbol	# e^-	Orbital Diagram and Longhand Electron Configuration
1.	Mg		
2.	P		
	V		
4.	Ge		
5.	Kr		
6.	O		

10

	Symbol	# e⁻	Shorthand Electron Configuration
7.	Ca		
8.	Pb		
9.	F		
10	U		

PART B – RULES OF ELECTRON CONFIGURATIONS

Which of the following "rules" is being violated in each electron configuration below? Explain your answer for each. ***Hund's Rule, Pauli Exclusion Principle, Aufbau Principle***

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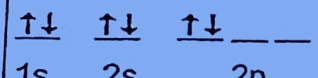

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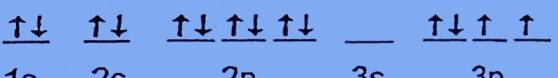

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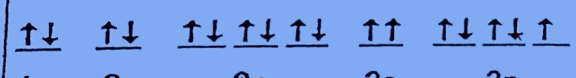

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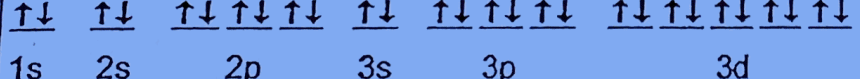

Name: _____
Hour: ____ Date: _____

Chemistry: *Electron Configurations*

Write out the electron configuration for each of the following elements.

1. H
2. Li
3. Na
4. K
5. Rb
6. Be
7. Mg
8. Ca
9. Sr
10. C
11. O
12. S
13. F
14. Cl
15. Br
16. I
17. He
18. Ne
19. Ar
20. Kr
21. Xe
22. Fe

*Looking over your electron configurations, are there any elements above that have similar **valence** electron configurations to those of other elements? If so, list below the elements that are similar (in terms of valence electrons) and state the similarity for each of the groups.*

Name: _____

Hour: ____ Date: _____

Chemistry: *Orbital Diagrams*

Using forward slashes (/) and backslashes (\ ), construct the orbital diagram for each of the following elements.

	Orbitals...																												
Element	*1s*	*2s*	*2p*			*3s*	*3p*			*4s*	*3d*					*4p*			*5s*	*4d*					*5p*				
H																													
Li																													
Na																													
K																													
Rb																													
Be																													
Mg																													
Ca																													
Sr																													
C																													
O																													
S																													
F																													
Cl																													
Br																													
I																													
He																													
Ne																													
Ar																													
Kr																													
Xe																													
Fe																													

13

Name: _____
Hour: ____ Date: _____

Chemistry: *Vocabulary – The Periodic Table and Periodicity*

Directions: Define each of the following terms. For some of the terms, you may need to consult sources other than your textbook, such as a dictionary or encyclopedia.

1. ***actinides***

2. ***alkali metals***

3. ***alkaline-earth metals***

4. ***anion***

5. ***atomic radius***

6. ***cation***

7. ***coinage metals***

8. ***electronegativity***

9. ***group***

10. ***halogens***

11. ***ion***

12. *ionic radius*

13. *ionization energy*

14. *lanthanides*

15. *main block elements*

16. *metal*

17. *metalloid (semimetal)*

18. *noble gases*

19. *nonmetal*

20. *period*

21. *periodic law*

22. *shielding effect*

23. *transition elements*

Name: _____
Hour: _____ Date: _____

Chemistry: *The Periodic Table and Periodicity*

Directions: Answer each of the following questions. You need not use complete sentences.

1. Who first published the classification of the elements that is the basis of our periodic table today?

2. By what property did Mendeleev arrange the elements?

3. By what property did Moseley suggest that the periodic table be arranged?

4. What is the periodic law?

5. What is a period? How many are there in the periodic table?

6. What is a group (also called a family)? How many are there in the periodic table?

7. State the number of valence electrons in an atom of:

   a. sulfur b. calcium c. chlorine d. arsenic

8. Give the names and chemical symbols for the elements that correspond to these atomic numbers:

   a. 10 b. 18 c. 36 d. 90

9. List, by number, both the period and group of each of these elements.

	Symbol	Period	Group
a. beryllium	Be		
b. iron	Fe		
c. lead	Pb		

10. Which of the following pairs of elements belong to the same period?

    a. Na and Cl b. Na and Li c. Na and Cu d. Na and Ne

11. Which of the following pairs of elements belong to the same group?

    a. H and He b. Li and Be c. C and Pb d. Ga and Ge

12. How does an element's period number relate to the number of the energy level of its valence electrons?

13. What are the transition elements?

14. In what type of orbitals are the actinide and lanthanide electrons found?

15. Would you expect strontium to be, chemically, more similar to calcium or rubidium and WHY?

16. What are the coinage elements?

17. What is the heaviest noble gas? What is the heaviest alkaline earth metal?

18. In going from top to bottom of any group, each element has _____ more occupied energy level(s) than the element above it.

19. What are the Group 1 elements called?

20. What are the Group 2 elements called?

21. What are the Group 17 elements called?

22. What are the Group 18 elements called?

23. What is the name given to the group of elements that have the following valence shell electron configurations?

a. s^2 b. s^2p^6 c. s^2p^5 d. s^1

24. List the three lightest members of the noble gases.

25. List all of the alkali metals.

26. Which alkali metal belongs to the sixth period?

27. Which halogen belongs to the fourth period?

28. What element is in the fifth period and the eleventh group?

29. Why do all the members of a group have similar properties?

30. What do we mean by the "atomic radius?"

31. Within a group, what happens to the atomic radius as you go down the column?

32. Explain your answer to Question 31: Why does the atomic radius change?

33. What is coulombic attraction?

34. Within a period, what happens to the atomic radius as the atomic number increases?

35. Explain your answer to Question 34: Why does the atomic radius change?

36. What two factors determine the strength of coulombic attraction?

37. What is the shielding effect?

38. How are the shielding effect and the size of the atomic radius related?

39. How are neutral atoms converted into cations? How are neutral atoms converted into anions?

40. Metals usually form what type of ions? Nonmetals usually form what type of ions?

41. What is ionization energy?

42. What is the equation that illustrates ionization energy, and what does each symbol represent?

43. What do we mean by the first, second, and third ionization energies for a particular atom?

44. Why does each successive ionization require more energy than the previous one?

45. What is the general trend of ionization energy as you go from left to right across the periodic table?

46. What is the general trend of ionization energy as you go down a group on the periodic table?

47. Which of these elements has the highest first ionization energy: Sn, As, or S?

48. When an atom becomes an anion, what happens to its radius?

49. When an atom becomes a cation, what happens to its radius?

50. For each of the following pairs, circle the atom or ion having the larger radius.

a. S or O
b. Ca or Ca^{2+}
c. Na^{1+} or K^{1+}
d. Na or K
e. S^{2-} or O^{2-}
f. F or F^{1-}

51. For each of the following pairs, identify the smaller ion.

a. K^{1+} or Ca^{2+}
b. F^{1-} or Cl^{1-}
c. C^{4+} or C^{4-}
d. S^{2-} or F^{1-}
e. O^{2-} or F^{1-}
f. Fe^{2+} or Fe^{3+}

52. Where, generally, are the metals located on the periodic table?

53. Where, generally, are the nonmetals located on the periodic table?

54. A. List some properties of metals.

B. List some properties of nonmetals.

C. What kinds of properties do metalloids have?

55. What is electronegativity?

56. Who determined the scale of electronegativity most often used today?

57. List the following atoms in order of increasing electronegativity: O, Al, Ca

58. List the following atoms in order of decreasing electronegativity: Cl, K, Cu

59. What is the general trend of electronegativity as you go down the periodic table?

60. What is the general trend of electronegativity as you go left to right across the periodic table?