CHEMISTRY | LEE

NAME _____

DATE _____ BLOCK _____

UNIT FOUR

PROBLEM SET

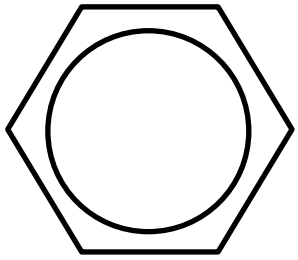
Score:

Do not cheat by copying the work of another person, or by allowing another person to copy your answers. Cheating results in a 0% grade for both parties involved.

Signature_____ Date_____

In the event any or all of this Problem Set is assessed for a grade, it must be signed and dated in order to receive a grade. The work shall be your own.

Problem Sets are generally not accepted late. Late assignments are 50% off.



Chapter 11 WS 1: Specific Heat Capacity Problems
$q=mC\Delta T$

1. How many joules of energy would be required to raise the temperature of 3.2 grams of mercury 4.2ºC? The specific heat of mercury is 0.14 J/(gxºC).

2. 32 joules of heat is added to a 255 gram iron bar How much will the iron bar's temperature change if the specific heat of iron 0.46 J/(gxºC)?

3. What is the mass of a silver coin if 5.2 J is required to raise its temperature from 21.0 to 25.0 ºC? The specific heat of silver is 0.24 J/(gxºC).

4. An unknown substance requires 567 J of heat to increase its temperature from 0 to 15 ºC. The sample weighs 42 grams. What is the substance's specific heat capacity?

5. A bottle contains 905 grams of chloroform, $CHCl_3$, with a specific heat capacity of 0.96 J/(gxºC). How many joules of energy must be added to increase the chloroform's temperature from 21.0 to 30.0 ºC?

6. Suppose 1.0×10^2 grams of ice absorbs 1255 J or heat. What is the temperature change of the ice? The specific heat capacity of $H_2O(s)$ = 2.1 J/(g°C).

Answers: 1)1.9 J, 2)0.27ºC 3)5.4 g 4)0.90 J/(gxºC) 5)7800 J 6)6.0°C

Name_____ Date_____

Chapter 11 WS 2: Heat and Changes of State Problems

1. How many grams of ammonia (NH_3) would be vaporized by 68.0 kJ of heat at its boiling point of 239.7K? ΔH_{vap} = 23.4 kJ/mol.

2. How much heat is absorbed when 21 grams of water becomes steam at 100°C? Water's heat of vaporization is 40.7 kJ/mol.

3. If the heat of fusion of water is 80.0 cal/g, the amount of heat energy required to change 26.0 grams of ice at 0°C to 26.0 grams of water at 0°C is _____

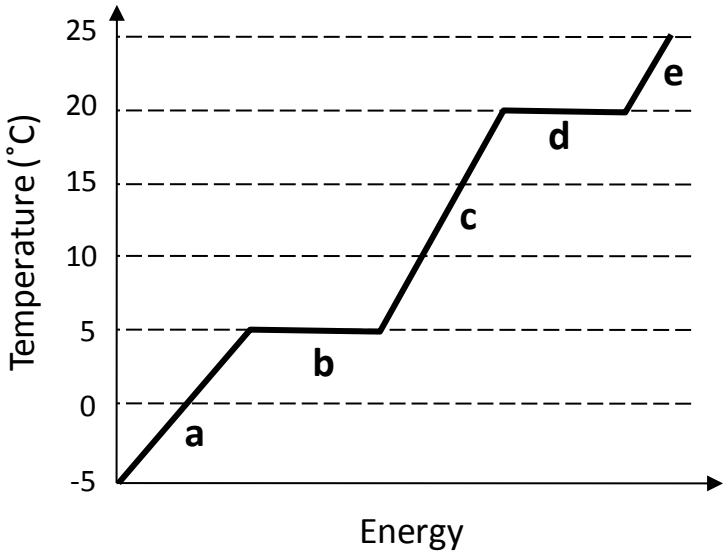
4. How many grams of liquid nitrogen (N_2) at its boiling point, 77.4K, would be converted to nitrogen gas by the addition of 1.2 kJ of heat? Nitrogen's heat of vaporization is 5.58 kJ/mol

5. How many kilojoules of heat must be removed to convert 28 liters of methane gas, CH_4, to liquid methane at methane's boiling point of 111.7K? ΔH_{vap} = 8.2 kJ/mol

6. How much heat is absorbed when 28.3 grams of $H_2O(s)$ is converted to a liquid at 0°C? Water's ΔH_{fusion} = 0.33 kJ/g

Answers:1)49.5 g NH_3, 2)47 kJ 3)2080 calories 4)6.0 g N_2, 5)10. kJ 6)9.34 kJ

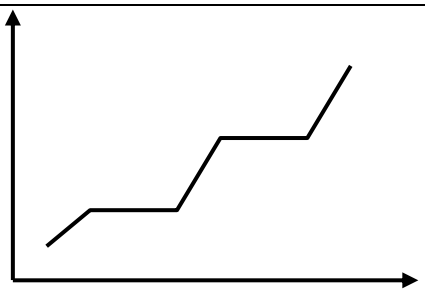
Ch 11 WS 3: Interpreting a Freezing and Boiling Point Graph



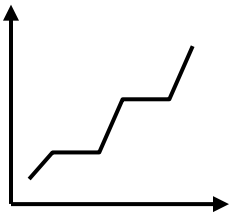
Answer the following questions using the chart above.

1. At what temperature does the substance freeze? _____
2. At what temperature does the substance boil? _____
3. At what temperature does the substance melt? _____
4. What letter represents the range where the solid is being warmed? _____
5. What letter represents the range where the liquid is being warmed? _____
6. What letter represents the range where the vapor is being warmed? _____
7. What letter represents the melting of the solid? _____
8. What letter represents the vaporization of the liquid? _____
9. What letter represents condensation? _____
10. What letter represents fusion (freezing)? _____

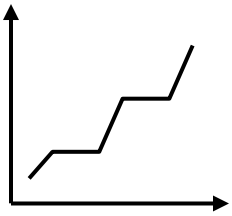
Ch 11 WS 4a Mixed Molar Heat and Specific Heat Capacity Problems

Specific heat capacity H2O(s) = 2.1 J/g°C Specific heat capacity H2O(l) = 4.2 J/g°C Heat of fusion H2O = 6.0 kJ/mol Heat of vaporization H2O = 41 kJ/mol	

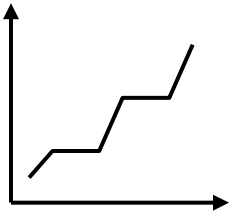
How much energy is needed to raise the temperature of 1100 grams of water from 20°C to 45°C?(Ans = 115,500 J or 120,000 J)



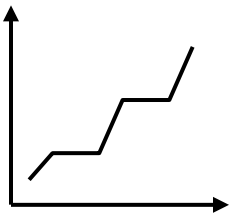
How much energy is needed to melt 82 grams of water at 0°C?
(Ans = 27.3 kJ)



How many grams of water would be vaporized at100°C by adding 640 kJ of heat? (Ans = 280 g water)



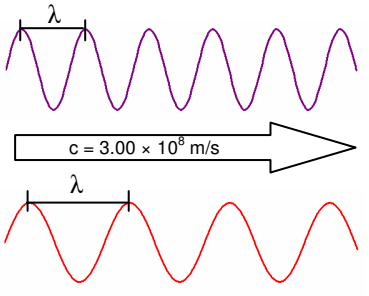
How much will the temperature of 850. grams of ice increase if 16000 Joules of heat is added?(Ans = 8.96°C or 9.0˚C)



Light Waves
Chem Worksheet 5-1

Name _____

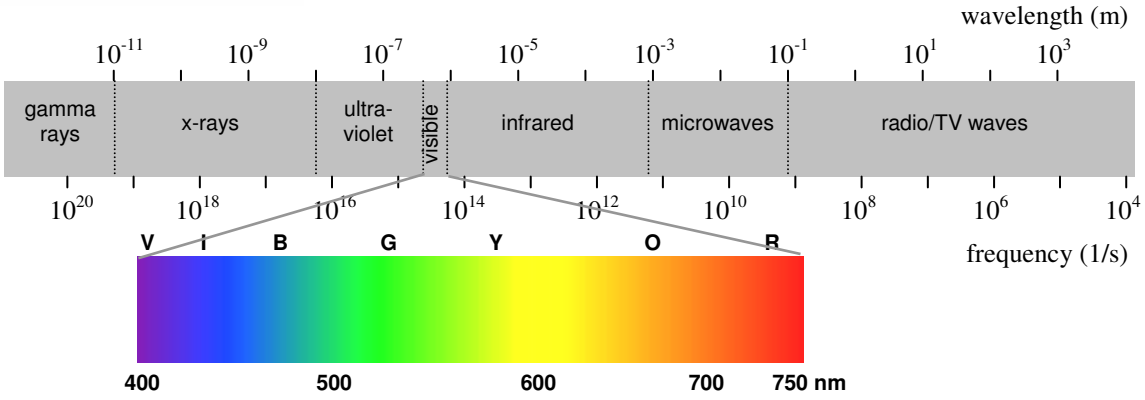
The behavior of light indicates that it is comprised of waves. The distance between successive waves is called the **wavelength (λ)** and the wavelength determines the type of light. The size of the waves determines the type of light. All of the various light waves move with the same speed, a value abbreviated (c) equal to 3.00×10^8 m/s. The **frequency (υ)** that light waves pass a given point is measured in waves/second or simply 'per second' (1/s). The unit 1/s is also given the name hertz (Hz).



Violet Light
Shorter wavelength (λ)
and higher frequency (υ)

Red Light
Longer wavelength (λ)
and lower frequency (υ)

useful equations	
$c = \lambda \times \upsilon$	$c = 3.00 \times 10^8$ m/s
$1\ m = 1 \times 10^3$ mm	$1\ m = 1 \times 10^9$ nm
$1\ m = 1 \times 10^6$ μm	$1\ m = 1 \times 10^{10}$ Å
1 MHz $= 1 \times 10^6$ Hz	1 GHz $= 1 \times 10^9$



Answer the following questions about light waves. Show all work

1. What type of light has a wavelength of: **a)** 5.0×10^{-4} m? **b)** 2.4×10^{-8} m? **c)**12 mm?
2. An ultraviolet light wave is used to kill bacterial. It has a frequency of 1.2×10^{15} 1/s. Find the wavelength.
3. An x-ray has a wavelength of 1.54×10^{-10} m. Find the frequency of this light.
4. A visible light wave has a frequency of 7.5×10^{14} 1/s. Find the wavelength in nanometers (nm) and determine the color of the light.
5. One of the light waves produced when hydrogen is energized has a wavelength of 410.5 nm. What is the frequency of this light?
6. The frequency of light used to heat food in a microwave oven is 2.45 GHz (2.45×10^9 1/s). What is the wavelength of this light?
7. A radio wave broadcast on the AM dial has a wavelength of 280.4 m. Find the frequency of this radio wave in hertz. Convert the frequency to kilohertz.
8. What is the wavelength of a radio wave broadcast with a frequency of 99.5 MHz (FM 99.5)?
9. Pilots often use waves of about 2.340 m to communicate. What is the frequency of this wave?
10. The light used in night vision devices has a wavelength of about 25 micrometers (μm). What is the frequency of this light? In what part of the electromagnetic spectrum are these waves?

Planck's Equation
Chem Worksheet 5-2

Name _____

Max Planck theorized that energy was transferred in chunks known as **quanta**, equal to *hν*. The variable *h* is a constant equal to 6.63×10^{-34} J·s and the variable *ν* represents the frequency in 1/s. This equation allows us to calculate the energy of photons, given their frequency. If the wavelength is given, the energy can be determined by first using the wave equation ($c = \lambda \times \nu$) to find the frequency, then using Planck's equation to calculate energy.

useful equations	
$c = \lambda \times \nu$	$c = 3.00 \times 10^{8}$ m/s
$E = h \times \upsilon$	$h = 6.63 \times 10^{-34}$ J·s
$1\ m = 1 \times 10^{9}\ nm$	1 kJ = 1000 J

Problem-Solving Strategy

Known				**Unknown**
Frequency (ν)		$E = h\nu$		Energy (E)
Wavelength (λ)	$\nu = \frac{c}{\lambda}$	Frequency (ν)	$E = h\nu$	Energy (E)
Energy (E)	$\nu = \frac{E}{h}$	Frequency (ν)	$\nu = \frac{c}{\lambda}$	Wavelength (λ)

example

Light with a wavelength of 525 nm is green. Calculate the energy in joules for a green light photon.

- find the frequency: $c = \lambda \times \upsilon$ $\quad \upsilon = \frac{c}{\lambda}$ $\quad \upsilon = \frac{3.00 \times 10^{8}\ m/s}{525\ nm \times \frac{1\ m}{1 \times 10^{9}\ nm}}$ $\quad \upsilon = 5.71 \times 10^{14} 1/s$

- find the energy: $E = h \times \upsilon$ $\quad E = (6.626 \times 10^{-34}\ J \cdot s)(5.71 \times 10^{14} 1/s)$ $\quad E = 3.78 \times 10^{-19}\ J\ /\ photon$

Use the equations above to answer the following questions.

1. Ultraviolet radiation has a frequency of 6.8×10^{15} 1/s. Calculate the energy, in joules, of the photon.
2. Find the energy, in joules per photon, of microwave radiation with a frequency of 7.91×10^{10} 1/s.
3. A sodium vapor lamp emits light photons with a wavelength of 5.89×10^{-7} m. What is the energy of these photons?
4. One of the electron transitions in a hydrogen atom produces infrared light with a wavelength of 7.464×10^{-6} m. What amount of energy causes this transition?
5. Find the energy in kJ for an x-ray photon with a frequency of 2.4×10^{18} 1/s.
6. A ruby laser produces red light that has a wavelength of 500 nm. Calculate its energy in joules.
7. What is the frequency of UV light that has an energy of 2.39×10^{-18} J?
8. What is the wavelength and frequency of photons with an energy of 1.4×10^{-21} J?

Wavelength, Frequency, Speed & Energy Worksheet

$c = \lambda v$ $v = c / \lambda$ $\lambda = c / v$ $E = hv$ $E = h c/\lambda$

c = speed of light (3.0×10^{8} m/s)
λ = wavelength
v = frequency
E = energy
h = Planck's constant (6.6262×10^{-34} J•s)

1. Calculate the **λ** given the **v** of radiation is $5.10 \times 10^{14}\ s^{-1}$

2. Calculate the **frequency** of red light with **λ** = 6.50×10^{-7}m

3. The more I shave my face, the shorter my beard is an example of a inversely proportional or directly proportional relationship? _____

4. The more I lift weights, the stronger I become, is an example of an inversely proportional or directly proportional relationship. _____

5. The longer the wavelength, the _____ the frequency, is an _____ relationship

6. Which color has the longest wavelength?_____
7. Which color has the shortest wavelength?_____
8. On the EM Spectrum, which type of wave has the longest wavelength? _____
9. On the EM Spectrum, which type of wave has the shortest wavelength? _____

10. What is the **energy** of x- radiation with a 1×10^{-6}m **wavelength**?

11. What is the **energy** (Joules) of Violet light with a **frequency** = $7.50 \times 10^{14}\ s^{-1}$.

12. The higher the frequency, the _____ (higher / lower) the energy. This is an example of a/an _____ (inverse/direct) relationship.

13. The higher the wavelength, the _____ (higher / lower) the energy. This is an example of a/an _____ (inverse/direct) relationship.

14. Which color has the most energy?_____
15. Which color has the least energy?_____
16. On the EM Spectrum, which type of wave has the most energy? _____
17. On the EM Spectrum, which type of wave has the least energy? _____

Building Schrodinger's Quantum Mechanical Model

1. Classical Physics:
    a. _____
    b. _____
    c. _____
    _____
2. Neils Bohr
    a. _____
    b. _____
    c. _____
    _____
3. Dual Nature of Light
    a. _____
    b. _____
    c. _____
    d. _____
    e. _____
4. Photoelectric Effect
    a. _____
    b. _____
    c. _____
    d. _____
5. Louis DeBroglie
    a. _____
    b. _____
    c. _____
    d. _____
6. Quantum Physics
    a. _____
    b. _____
    c. _____
    _____
7. Heisenberg Uncertainty Principle
    a. _____
    b. _____
    c. _____
8. Erwin Schrodinger Equation
    a. _____
    b. _____
    c. _____

Electron Configuration & Orbital Filling Diagram WS

Using the Long Method, give the Electron Configuration:

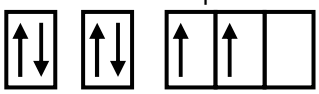
1. Magnesium (Mg):_____
2. Potassium (K):_____
3. Lithium (Li):_____
4. Nickel (Ni):_____

Identify the following Elements:

5. $1s^2\ 2s^2\ \ 2p^2$:_____
6. $1s^2\ 2s^2\ \ 2p^6$:_____
7. [Ar] $4s^2\ 3d^{10}\ 4p^5$:_____
8. [Kr] $5s^2\ 4d^1$:_____

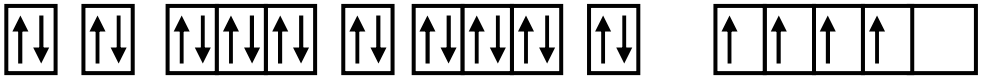
Orbital Filling Diagrams

9. 1s 2s 2p



is the element _____

11. 1s 2s 2p 3s 3p 4s 3d



element _____

12. C

13. Ni (short cut)

Identify the following elements:

12. _____ $1s^2\ 2s^2\ 2p^4$
13. _____ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
14. _____ $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^9$
15. _____ [Ne] $3s^2\ 3p^3$
16. _____ [Ar] $4s^2\ 3d^{10}\ 4p^6$
17. _____ [Kr] $5s^2\ 4d^6$

Determine the Electron Configuration using the short Method:

18. sulfur [ ]_____
19. strontium [ ]_____
20. bromine [ ]_____
21. zirconium [ ]_____
22. molybdenum [ ]_____ _____

Electron Configuration Review

1. The s orbital is _____ shaped, appears in _____ (a number) shape/s, and can hold ____ e-.
2. The p orbital is _____ shaped, appears in _____ (a number) shape/s, and can hold ____ e-.
3. The d orbital is _____ shaped, appears in _____ (a number) shape/s, and can hold ____ e-.
4. The f orbital is _____ shaped, appears in _____ (a number) shape/s, and can hold ____ e-.
5. The Aufbau Principle states that _____
6. Hunds Rule states that _____
7. Pauli exclusion principal states that _____
8. In the electron cloud model, _____ percentage of electrons are predicted to be located in the cloud/orbital.
9. Valence electrons are _____ e- and Core electrons are _____ e-
10. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^3$ is: _____
11. What element has its outermost electron is $7s^1$? _____
12. Fluorine - Long e- config: _____
    Short e- config: _____
    Orbital filling diagram _____
13. Silicon - Long e- config: _____
    Short e- config: _____
    Orbital filling diagram _____
14. Gold - Long e- config: _____
    Short e- config: _____
15. Xe - Long e- config: _____
    Short e- config: _____
16. U short e-config: _____
17. Oxygen long e-config: _____
18. Ba short e-config: _____
19. Pb long e-config: _____

20. Label the adjacent pictures as

    highest & lowest frequency
    longest & shortest wavelength
    highest & lowest energy
    highest & lowest amplitude

21. The formula **E** = hc/**λ**, energy and wavelength are _____ proportional.
22. The formula **E** = h **v**, energy and frequency are _____ proportional:
23. Wavelength and frequency are _____related. As one _____ the other _____.
24. Calculate the **wavelength** given the **frequency** of radiation is 6.10×10^{14} Hz

25. Calculate the **frequency** of light with **wavelength** = 2.50×10^{-7}m

26. What is the **energy** of cell phone radiation with a 1m **wavelength**?

27. What is the **energy** (Joules) of Violet light with a **frequency** = $7.50 \times 10^{14}\ s^{-1}$.

28. The formula **$\lambda = h/mv$** stated that it was now possible to calculate the _____ of an electron given its mass and velocity.

29. The **height** of the wave_____

30. The **distance** between two crests_____

31. The number of **cycles per second**_____

32. The primary characteristics of waves are _____, _____, _____

33. List the types of electromagnetic radiation:

    _____, _____, _____, _____,

    _____, _____, _____, _____,

34. photons are: _____

35. The dual nature of light deals with light as _____and light as _____:

36. Einstein used the *photoelectric effect* to prove that light has _____.

37. Another name for the Quantum Mechanical Model is the _____

38. In the Quantum Mechanical Model,_____ percent of electrons are predicted to be located in the electron cloud

39. When absorbed energy, electrons go from the ground state to the excited state. As they return to the ground state, they release their energy in the form of:_____

40. According to quantum mechanics, subatomic particles move in _____-like motions:

41. Red color _____ all colors _____ its own.

42. Which color of light has the **most** energy: _____

    Why?_____

43. Which color of light has the **least** energy: _____

    Why?_____

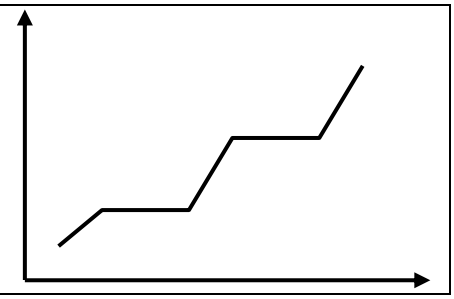
44. Which color of light has the **highest** frequency: _____

45. Which color of light has the **longest** wavelength? _____

46. Violet light has more energy than red light because …….

Ch 11 WS 4b Mixed Heat Problems

Substance	m.p. °C	b.p. °C	Specific heat capacity, solid J/(g°C)	Specific heat capacity, liquid J/(g°C)	ΔH_{fus} J/mol	ΔH_{vap} J/mol
H_2O	0	100	2.06	4.18	6010	4070
Au	1063	2660	0.129		1270	31100
Ag	961	2193	0.240		9520	25200
Cu	1083	2567	0.385		8520	32200



1. How much heat is needed to melt 65 grams of gold that is at 1063°C?(Ans = 420 J)

2. How much heat is needed to melt 75.0 grams of water that is at zero Celsius?(Ans = 2.5×10^4 J)

3. How much energy is needed to warm 320 grams of silver from 21°C to its melting point of 961°C?(Ans = 72000 J)

4. What mass of copper could be melted at 1083°C by adding 4.0×10^5 Joule of energy?(Ans = 3.0×10^3 g)

5. How much energy is needed to vaporize 1000. grams of gold at 2660 degrees Celsius?(Ans = 1.58×10^5 J)

6. What is the specific heat capacity of a metal if 3400 J is needed to raise the temperature of 6400 grams by 5.0°C?(Ans = 0.11 J/g°C)

Chapter 13 WS 1 Electron Configuration Practice

1s
2s 2p
3s 3p 3d
4s 4p 4d 4f

Use your periodic table to fill out the complete electron configurations for the following elements. Identify the number of valence electrons and the valance electrons' primary energy level (period #) Box the valence electrons

element	configuration	# valence electrons	valence shell #
1. lithium			
2. phosphorus			
3. nitrogen			
4. calcium			
5. arsenic			
6. helium			
7. chlorine			
8. argon			
9. boron			
10. aluminum			
11. vanadium			

Write the electron configurations for the following elements using the abbreviated format for the core electrons.

element	configuration	# valence electrons	valence shell #
12. strontium	$[Kr]5s^2$	2	5
13. bromine			
14. antimony			
15. silicon			
16. krypton			

Ch 13 WS 1A Aufbau Diagram Practice

Fill in the following Aufbau diagrams

Nitrogen

1s	2s	2p	2p	2p	3s	3p	3p	3p	4s

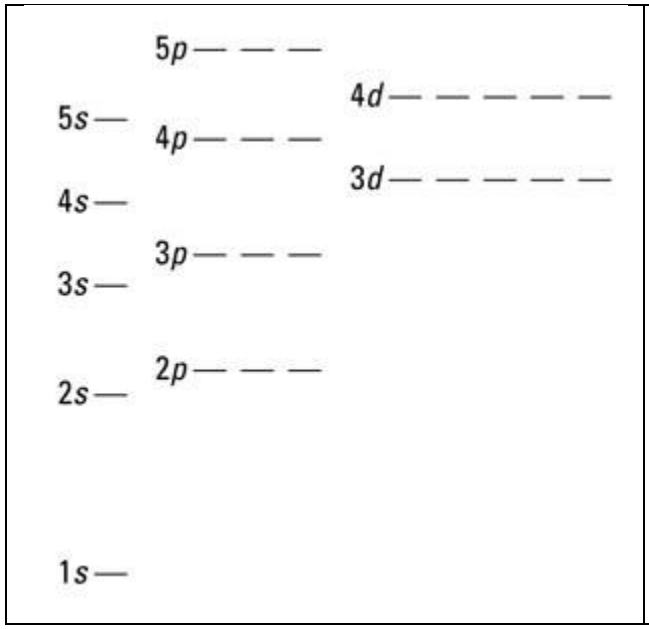
Chlorine

1s	2s	2p	2p	2p	3s	3p	3p	3p	4s

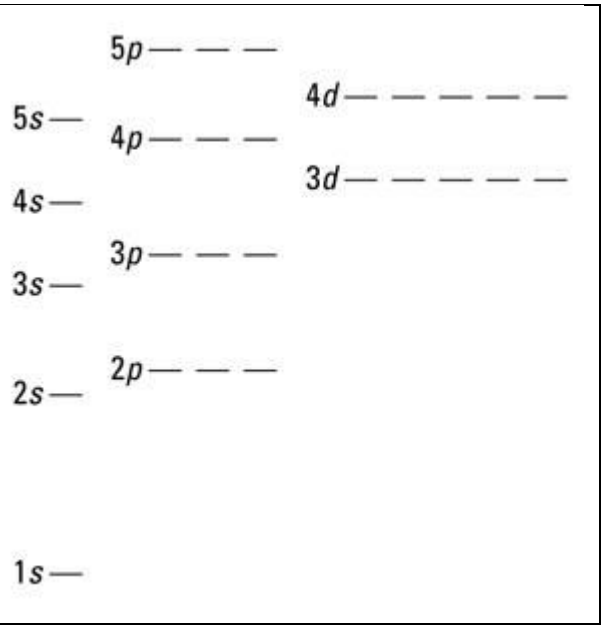
Silicon

1s	2s	2p	2p	2p	3s	3p	3p	3p	4s

Titanium



Iron



Write the full electron configuration for

Oxygen:_____

Sodium:_____

Aluminum:_____

Electron Configuration Practice Worksheet

1. How many electrons are present in: a) Helium (He) _____ b) Carbon (C) _____
   c) Neon (Ne) _____ d) Sodium (Na) _____ e) Zinc (Zn) _____

2. How many ***valence*** electrons are present in: a) Helium (He) _____ b) Carbon (C) _____
   c) Neon (Ne) _____ d) Sodium (Na) _____ e) Potassium (K) _____

3. Draw Lewis Dot Structures for the following elements: a) Helium (He) _____
   b) Carbon (C) _____ c) Neon (Ne) _____ d) Sodium (Na) _____
   e) Indium (In) _____ f) Oxygen (O) _____ g) Strontium (Sr) _____

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

1. sodium _____
2. iron _____
3. bromine _____
4. barium _____
5. Np _____
6. Mg _____
7. P _____
8. V _____
9. Ge _____
10. cobalt _____
11. silver _____
12. tellurium _____
13. radium _____
14. Lr _____
15. Cl^{1-} _____
16. Mg^{2+} _____
17. N^{3-} _____
18. O^{2-} _____

Determine what elements are denoted by the following electron configurations:

19. $1s^2 2s^2 2p^6 3s^2 3p^4$ _____

20. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$ _____

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

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

23. [Rn] $7s^2 5f^{11}$ _____

Determine which of the following electron configurations are not valid:

24. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^{10} 4p^5$ _____

25. $1s^2 2s^2 2p^6 3s^3 3d^5$ _____

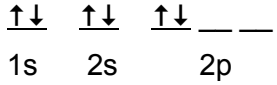
26. [Ra] $7s^2 5f^8$ _____

27. [Kr] $5s^2 4d^{10} 5p^5$ _____

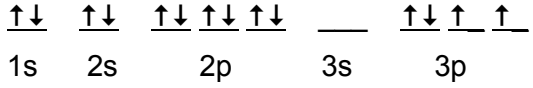
28. [Xe] _____

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

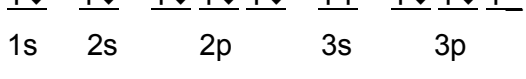
29.



30.



31.



32.

Chapter 13 WS 2: Valance Electrons

Element	Bohr Model	Principle Energy level of Valence electrons	Group #	Period #	Valence elcctron Configuration	# of valence electrons	Lewis Structure
H							
Li							
Na							
K							
F							
Cl							
Br							
O							
S							

Chapter 15 WS 1 Ion Electron Configurations

1. Define the term “valence electrons.”

2. Name the first four halogens. What group are they in, and how many valence electrons does each of them have?

3. Fill in the table for each of the following elements

element	# electrons	electron configuration	group #	# valence electrons
nitrogen				
lithium				
phosphorus				
barium				

4. Write electron dot structures for each of the following elements:

   Chlorine sulfur

   Aluminum lithium

5. How many electrons must be lost by each of these to attain a noble gas configuration?

   Calcium _____ aluminum_____

   Potassium_____ barium_____

6. Write complete electron configurations for the following atoms and ions.

   a. Ar

   b. K^{+}

   c. Ca^{2+}

7. How many electrons must be gained by each of these to attain a noble gas configuration?

   Nitrogen_____ sulfur_____

   Chlorine_____ phosphorus_____

8. Write complete electron configurations for the following atoms and ions.

   a. N^{3-}

   b. O^{2-}

   c. F^{-}

   d. Ne

Name: _____ Date: _____ Pd: ___

Ch 15 WS 3 Atoms and Ions

Directions: Complete the chart below. You will need a periodic table. Recall that protons have a positive charge and electrons have a negative charge. Neutral atoms have the same number of protons and electrons. Ions are atoms that have either gained or lost electrons. An atom that gains an electron has a negative charge and is called an **anion** (usually a nonmetal.) An atom that loses electrons has a positive charge and is called a **cation** (usually a metal.)

ELEMENT	ATOMIC NUMBER	MASS NUMBER	PROTONS	ELECTRONS	NEUTRONS	CHARGE	ATOM OR ION	SYMBOL
Na	11	23	11	11	12	0	Atom	$^{23}_{11}Na$
Na^{+}	11	23	11	10	12	+1	Cation	$^{23}_{11}Na^{+}$
		15	7	7				
	16			18	16			
	12				12		Atom	
Co^{+2}		59						
			35		34	0		
		42		20			Atom	
	29	65		28			Cation	
			14		14	+4		
								$^{16}_{8}O$
								$^{16}_{8}O^{-2}$
		56		26			Atom	
	35	80				-1		

Ch 15 WS 4 Mixed Naming Practice

Name the following compounds

1. $NaNO_3$_____
2. $FeSO_4$_____
3. CaO_____
4. $NiSO_4$_____
5. SO_3_____
6. Li_3PO_4_____
7. NH_4Cl_____
8. $Cr(CO_3)_3$_____
9. $Mg(OH)_2$_____
10. K_2S_____

Write formulas for the following compounds

1. Zinc hydroxide_____
2. Ammonium nitrate_____
3. Diphosphorus tetroxide_____
4. Iron(II) hydroxide_____
5. Lithium nitrate_____
6. Copper(I) oxide_____
7. Cobalt(II) sulfate_____
8. Manganese(III) acetate_____
9. Calcium nitride_____
10. Sodium hydrogen carbonate_____
11. Magnesium phosphate_____