Name: _____ Date: _____

Honors Physical Science

Bohr Model: Calculations

1. Calculate the energy of an electron in the following energy levels (E_n=13.6eV/n^2).
   a. n=1 -13.6eV
   b. n=5 $\frac{-13.6}{25}$ -0.544eV
   c. n=4 $\frac{-13.6}{16}$ -0.85eV
   d. n=3 $\frac{-13.6}{9}$ -1.51eV
   e. n=7 $\frac{-13.6}{49}$ -0.278eV

2. How much energy is required in Joules to extract an electron from the following energy levels (1ev = 1.60 x 10^{-19}J)?
   a. n=1 $\frac{-13.6}{1}\left|\frac{1.6E^{-19}}{1}\right.$ -2.176×10^{-18}J
   b. n=5 -8.70×10^{-20} J
   c. n=4 1.36×10^{-19} J
   d. n=3 -2.416×10^{-19} J
   e. n=7 -4.448×10^{-20} J

3. Calculate the energy in Joules of a photon when an electron falls from: n=2: -5.44×10^{-19}J
   a. n=3 to n=1 1.93×10^{-18}J
      $-2.416\times10^{-19}-(-2.176\times10^{-18})$
   b. n=5 to n=3 1.546×10^{-19}J
   c. n=4 to n=2 4.08×10^{-19}J
   d. n=3 to n=2 2.98×10^{-19} J
   e. n=7 to n=2 4.992×10^{-19} J

4. Use your answers from question 3 to calculate the wavelength of those photons and predict where in the electron magnetic spectrum (color if possible) the photon should fall.

   1st calc frequency, then λ

   $\lambda=\frac{c}{f}$

   a. n=3 to n=1
      $f=2.91\times10^{15}$ Hz
      $\lambda=1.03\times10\times10^{-7}$m
   b. n=5 to n=3
      $f=2.33\times10^{14}$ Hz
      $\lambda=1.29\times10^{-7}$ m
   c. n=4 to n=2
      $f=6.15\times10^{14}$ Hz
      $\lambda=4.88\times10^{-7}$m
   d. n=3 to n=2
      $f=4.49\times10^{14}$
      $\lambda=6.67\times10^{-7}$m
   e. n=7 to n=2
      $f=7.53\times10^{14}$
      $\lambda=3.98\times10^{-7}$m

Name:

Period:

Electron Configuration

Symbol	Atomic Number	Electron Configuration Notation	Number of electrons in each Energy Level				
			1	2	3	4	5
H	1	$1s^1$	1				
He	2	$1s^2$	2				
Li	3	$1s^2 2s^1$	2	1			
Be	4	$1s^2 2s^2$	2	2			
B	5	$1s^2 2s^2 2p^1$	2	3			
C	6	$1s^2 2s^2 2p^2$	2	4			
N	7	$1s^2 2s^2 2p^3$	2	5			
O	8	$1s^2 2s^2 2p^4$	2	6			
F	9	$1s^2 2s^2 2p^5$	2	7			
Ne	10	$1s^2 2s^2 2p^6$	2	8			
Na	11	$1s^2 2s^2 2p^6 3s^1$	2	8	1		
Mg	12	$1s^2 2s^2 2p^6 3s^2$	2	8	2		
Al	13	$1s^2 2s^2 2p^6 3s^2 3p^1$	2	8	3		
Si	14	$1s^2 2s^2 2p^6 3s^2 3p^2$	2	8	4		
P	15	$1s^2 2s^2 2p^6 3s^2 3p^3$	2	8	5		
S	16	$1s^2 2s^2 2p^6 3s^2 3p^4$	2	8	6		
Cl	17	$1s^2 2s^2 2p^6 3s^2 3p^5$	2	8	7		
Ar	18	$1s^2 2s^2 2p^6 3s^2 3p^6$	2	8	8		
K	19	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$	2	8	8	1	
Ca	20	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$	2	8	8	2	
Sc	21	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$	2	8	9	2	
Ti	22	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$	2	8	10	2	
Fe	23	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$	2	8	14	2	
As	24	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$	2	8	18	5	
Br	25	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$	2	8	18	7	

WRITE THE ELECTRON CONFIGURATION OF THE FOLLOWING ATOMS AND IONS.

(11) Na $1s^2 2s^2 2p^6 3s^1$

(14) Si $1s^2 2s^2 2p^6 3s^2 3p^2$

(17) Cl $1s^2 2s^2 2p^6 3s^2 3p^5$

(18) Ar $1s^2 2s^2 2p^6 3s^2 3p^6$

(20) Ca $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

(8) O $1s^2 2s^2 2p^4$

(5) B $1s^2 2s^2 2p^1$

(3) Li $1s^2 2s^1$

(1) H $1s^1$

(12) Mg $1s^2 2s^2 2p^6 3s^2$

(16) S $1s^2 2s^2 2p^6 3s^2 3p^4$

(15) P $1s^2 2s^2 2p^6 3s^2 3p^3$

(18) Cl^- $1s^2 2s^2 2p^6 3s^2 3p^6$

(10) Na^+ $1s^2 2s^2 2p^6$

(10) O^{2-} $1s^2 2s^2 2p^6$

(10) C^{4+} $1s^2 2s^2 2p^6$

(18) P^{3-} $1s^2 2s^2 2p^6 3s^2 3p^6$

(10) Al^{3+} $1s^2 2s^2 2p^6$

(18) K^+ $1s^2 2s^2 2p^6 3s^2 3p^6$

(10) Mg^{2+} $1s^2 2s^2 2p^6$

(18) Ca^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6$

(10) N^{3-} $1s^2 2s^2 2p^6$

(2) Li^+ $1s^2$

(10) F^- $1s^2 2s^2 2p^6$

	Protons	Neutrons	Electrons
$^{13}_{6}C$	6	7	6
$^{10}_{4}Be$	4	6	4
$^{20}_{10}Ne$	10	10	10
$^{11}_{5}B$	5	6	5
$^{33}_{16}S$	16	17	16

Explain how the atoms of one element differ from those of another element.
Explain how the atoms of one isotope differ from those of other isotopes of the same element.

# of protons

# of neutrons

A. Matching

Match each description in Column B with the correct term in Column A. Write the letter of the correct description in the blank provided.

	Column A	Column B
J	1. proton	a. the total number of protons and neutrons in the nucleus of an atom
G	2. atom	b. the weighted average mass of the atoms in a naturally occurring sample of an element
A	3. mass number	c. $\frac{1}{12}$ the mass of a carbon-12 atom
C	4. atomic mass unit	d. the number of protons in the nucleus of an element
F	5. electron	e. atoms with the same number of protons but different numbers of neutrons
E	6. isotopes	f. negatively charged subatomic particle
D	7. atomic number	g. the smallest particle of an element that retains the properties of that element
B	8. atomic mass	h. elements that are nonlustrous and that are generally poor conductors of electricity
H	9. nonmetals	i. subatomic particle with no charge
I	10. neutron	j. positively charged subatomic particle

Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
9	19	9	10	9
7	14	7	7	7
20	41	20	21	20
13	27	13	14	13
26	56	26	30	26

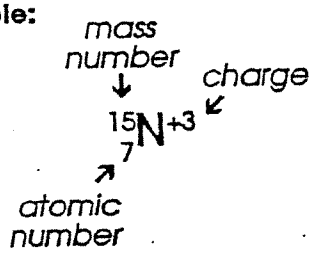
ATOMIC STRUCTURE

Name _____

An atom is made up of protons and neutrons (both found in the nucleus) and electrons (in the surrounding electron cloud). The atomic number is equal to the number of protons. The mass number is equal to the number of protons plus neutrons. In a neutral atom, the number of protons equals the number of electrons. The charge on an ion indicates an imbalance between protons and electrons. Too many electrons produces a negative charge, too few, a positive charge.

This structure can be written as part of a chemical symbol.

Example:



7 protons
8 neutrons (15 - 7)
4 electrons

Complete the following chart.

Element/ Ion	Atomic Number	Atomic Mass	Mass Number	Protons	Neutrons	Electrons
$^{1}_{1}H$	1	1.01	1	1	0	1
$^{1}_{1}H^{+}$	1	1.01	1	1	0	0
$^{12}_{6}C$	6	12.01	12	6	6	6
$^{7}_{3}Li^{+}$	3	6.94	7	3	4	2
$^{35}_{17}Cl^{-}$	17	35.45	35	17	18	18
$^{39}_{19}K$	19	39.10	39	19	20	19
$^{24}_{12}Mg^{2+}$	12	24.31	24	12	12	10
$^{75}_{33}As^{3-}$	33	74.92	75	33	42	36
$^{108}_{47}Ag$	47	107.87	108	47	61	47
$^{108}_{47}Ag^{+1}$	47	107.87	108	47	61	46
$^{32}_{16}S^{-2}$	16	32.07	32	16	16	18
$^{238}_{92}U$	92	238.03	238	92	146	92

Name:_____
Period:_____
Date:_____

1. Give the symbol for the atom that corresponds to each electron configuration
   a. $1s^2 2s^2 2p^6 3s^2 3p^6$ Ar
   b. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4d^7 5s^1$ Sr
   c. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^1 5s^2 5p^6 5d^1 6s^2$ Eu

2. Write the electron configuration for an arsenic atom. Calculate the total number of electrons in each energy level and state which energy levels are not full.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^3$

→ 4th energy level not full

3. An atom of an element has two electrons in the first energy level and five electrons in the second energy level. Write the electron configuration for this atom and name the element. ~~How many unpaired electrons does an atom of this element have?~~

$1s^2\ 2s^2\ 2p^3$ nitrogen

4. Give the symbol and name of the elements that correspond to these configuration of an atom.
   a. $1s^2 2s^2 2p^6 3s^1$ Sodium - Na
   b. $1s^2 2s^2 2p^3$ Nitrogen - N
   c. $1s^2 2s^2 2p^6 3s^2 3p^2$ Silicon - Si
   d. $1s^2 2s^2 2p^4$ Oxygen - O

e. $1s^2 2s^2 3s^2 3p^6 4s^1$ Aluminum - Al

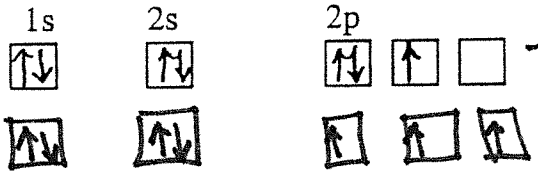
f. ~~$1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^1$~~ incorrect

4. What is the maximum number of electrons that can be found in any orbital of an atom?

5. Which is the ground state configuration of a magnesium atom? _____
   a. $1s^2 2s^2 2p^6 3s^2$
   b. $1s^2 2s^2 2p^6 3s^1$
   c. $1s^2 2s^2 3s^2 2p^6$
   d. $1s^2 2s^2 2p^4 3s^2$

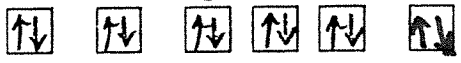
6. Orbital diagrams for the ground states of two elements are shown below. Each diagram shows something that is incorrect. Identify the error in each diagram and then draw the correct diagram.

a. Nitrogen



→ two arrows in a box before 1 in each

b. Magnesium



only 10 electrons not 12

7. Identify the elements whose electrically neutral atoms have the following electron configurations
   a. $1s^2 2s^2 2p^5$ nitrogen
   b. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^2$ germanium
   c. $1s^2 2s^2 2p^6 3s^2 3p^2$ silicon

8. Which of the following is in the ground state of an atom? Which is its excited state? Which is an impossible electron configuration? Identify that elements and briefly explain your choices.

a. $1s^2 2s^2 2p^6 3s^2 3p^6 5p^1$ excited → skipped 4th energy level

b. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ ground state

c. $1s^2 2s^2 2p^6 3s^7$ impossible → s only holds 2e⁻

9. Select the correct electron configuration for silicon, atomic number 14.

a. ~~$1s^2 2s^2 2p^2 3s^2 3p^2 3d^2 4s^2$~~

b. ~~$1s^2 2s^2 2p^4 3s^2 3p^4$~~

c. ~~$1s^2 2s^6 2p^6$~~

d. $1s^2 2s^2 2p^6 3s^2 3p^2$ D

8. Which pair of orbitals has the same shape?

a. 2s and 2p

b. 2s and 3s

c. 3p and 3d

d. More than one is correct. B

9. In the third energy level

a. there are two energy sublevels.

b. the *f* sublevel has 7 orbitals

c. there are three *s* orbitals

d. a maximum of 18 electrons are allowed. A

The lettered choices below refer to Questions 13 – 17. A lettered choice may be used once, more than once, or not at all

a. $s^2 p^6$ b. $s^2 p^2$ c. s^2 d. $s^4 p^1$ e. $s^2 p^4$

Which configurations is the outer shell electron configuration for each of these elements?

10.sulfur E

11.germanium B

12.beryllium C

13.krypton A

14.strontium C

* for particle conversions use: 6.02×10^{23} particles = 1 mole

Calculations:

1. How many moles are present in 34 grams of $Cu(OH)_2$?

$$34\,g \left| \frac{1\ mol}{97.57\,g} \right. = .348\ mol$$

2. How many moles are present in 2.45×10^{23} molecules of CH_4?

$$2.45 \times 10^{23} \left| \frac{1\ mol}{6.02 \times 10^{23}} \right. = .407\ mol$$

3. How many grams are there in 3.4×10^{24} molecules of NH_3?

$$3.4 \times 10^{24} \left| \frac{1\ mol}{6.02 \times 10^{23}} \right| \frac{17.04\,g}{1\ mol} = 96.24\,g$$

4. How many grams are in 0.500 moles of CuBr?

$$.5\ mol \left| \frac{143.45\,g}{1\ mol} \right. = 71.73\,g$$

5. How many molecules are there in 21.6 grams of CH_4?

$$21.6\,g \left| \frac{1\ mol}{16.05\,g} \right| \frac{6.02 \times 10^{23}}{1\ mol} = 8.10 \times 10^{23}\ molecules$$

6. How many moles are in 25 grams of water?

$$25\,g \left| \frac{1\ mol}{18.02\,g} \right. = 1.39\ mol\ H_2O$$

7. How many grams are in 4.5 moles of Li_2O?

$$4.5\ mol \left| \frac{29.88\,g}{1\ mol} \right. = 134.46\,g$$

8. How many molecules are in 23 moles of oxygen?

$$23\ mol \left| \frac{6.02 \times 10^{23}}{1\ mol} \right. = 1.38 \times 10^{25}\ molecules$$

9. How many moles are in 3.4×10^{23} molecules of H_2SO_4?

$$3.4 \times 10^{23} \left| \frac{1\ mol}{6.02 \times 10^{23}} \right. = .565\ mol$$

10. How many molecules are in 25 grams of NH_3?

$$25\,g \left| \frac{1\ mol}{17.04\,g} \right| \frac{6.02 \times 10^{23}}{1\ mol} = 8.83 \times 10^{23}\ molecules$$

11. How many grams are in 8.2×10^{22} molecules of N_2I_6?

$$8.2 \times 10^{22} \left| \frac{1\ mol}{6.02 \times 10^{23}} \right| \frac{789.42\,g}{1\ mol} = 107.53\,g$$

12. Using your knowledge of mole calculations and unit conversions, determine how many atoms there are in 1 gallon of gasoline. Assume that the molecular formula for gasoline is C_6H_{14} and that the density of gasoline is approximately 0.85 grams/mL.

$1\ gal = 3785.4\ mL$

$m = D \cdot V$

$.85 \cdot 3785.4$

$m = 3217.59\,g$

$$3217.59\,g \left| \frac{1\ mol}{86.2\,g} \right| \frac{6.02 \times 10^{23}}{1\ mol}$$

There are 2.247×10^{25} atoms in 1 gallon of gasoline.

Part IV: Calculating Average Atomic Mass of Isotopes

In this section you will apply the skills you learned from previous parts of the lab to calculate atomic mass of elements on the Periodic Table. Make sure you show all work and answer all questions related to each scenario.

A) Base your answers on the data table, which shows three isotopes of neon.

Isotope	Atomic Mass (atomic mass units)	Percent Natural Abundance
^{20}Ne	19.99	90.9%
^{21}Ne	20.99	0.3%
^{22}Ne	21.99	8.8%

1. Based on the atomic masses and the natural abundances shown in the data table show a correct numerical setup for calculating the average atomic mass of neon.

.909 · 19.99 = 18.17091

.003 · 20.99 = .06297

.088 · 21.99 = 1.93512

2. Based on natural abundances, what is the average atomic mass of neon? 20.169 amu

B) The accepted values for the atomic mass and percent natural abundance of each naturally occurring isotope of silicon are given in the accompanying data table.

Naturally Occurring Isotopes of Silicon

Isotope	Atomic Mass (atomic mass units)	Percent Natural Abundance (%)
Si-28	27.98	92.22
Si-29	28.98	4.69
Si-30	29.97	3.09

1. Based on the atomic masses and the natural abundances shown in the data table show a correct numerical setup for calculating the average atomic mass of silicon.

.9222 · 27.98 = 25.803156

.0469 · 28.98 = 1.359162

.0309 · 29.97 = .926073

2. Based on natural abundances, what is the average atomic mass of silicon? 28.088 amu