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IDENTIFIERS *Mole Concept; *Periodic Table

ABSTRACT

This student booklet is one of a set of eight designed to be used in a self-paced introductory chemistry course in conjunction with specified textbooks and computer-assisted instruction (CAI) modules. Each topic is introduced with a textbook reading assignment and additional materials are provided in the booklet. Also included are self-tests (and answers), CAI module assignments, and suggested breakpoints for student-teacher consultations. Each booklet contains specific cognitive objectives to be met by completion. This booklet covers three major topics concerning chemical structure: atomic theory and structure, the mole concept, and the periodic chart. (MH)

ILS CHEM PAC No. **3**

STRUCTURE

by

William Torop

West Chester State College
West Chester, Pennsylvania

Student No. & Name ....

Date Started ....

Date Completed ....

PERIODIC TABLE

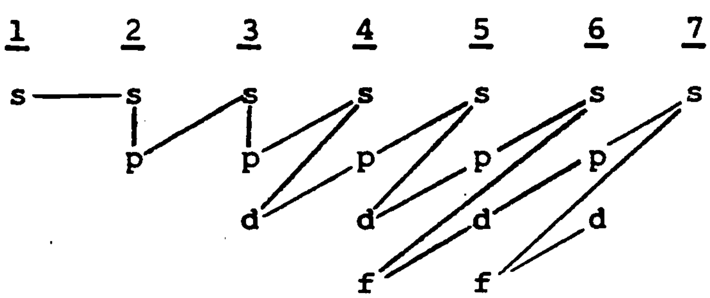
(Based on C^{12}=12.0000; 1961 Atomic Weights)
The atomic number is shown above the symbol; the atomic weight below.

IA	IIA											IIIA	IVA	VA	VIA	VIIA	Rare gases
1 H 1.01																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (99)	44 Ru 101.0	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.0	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)															

Lanthanum series														
58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0	

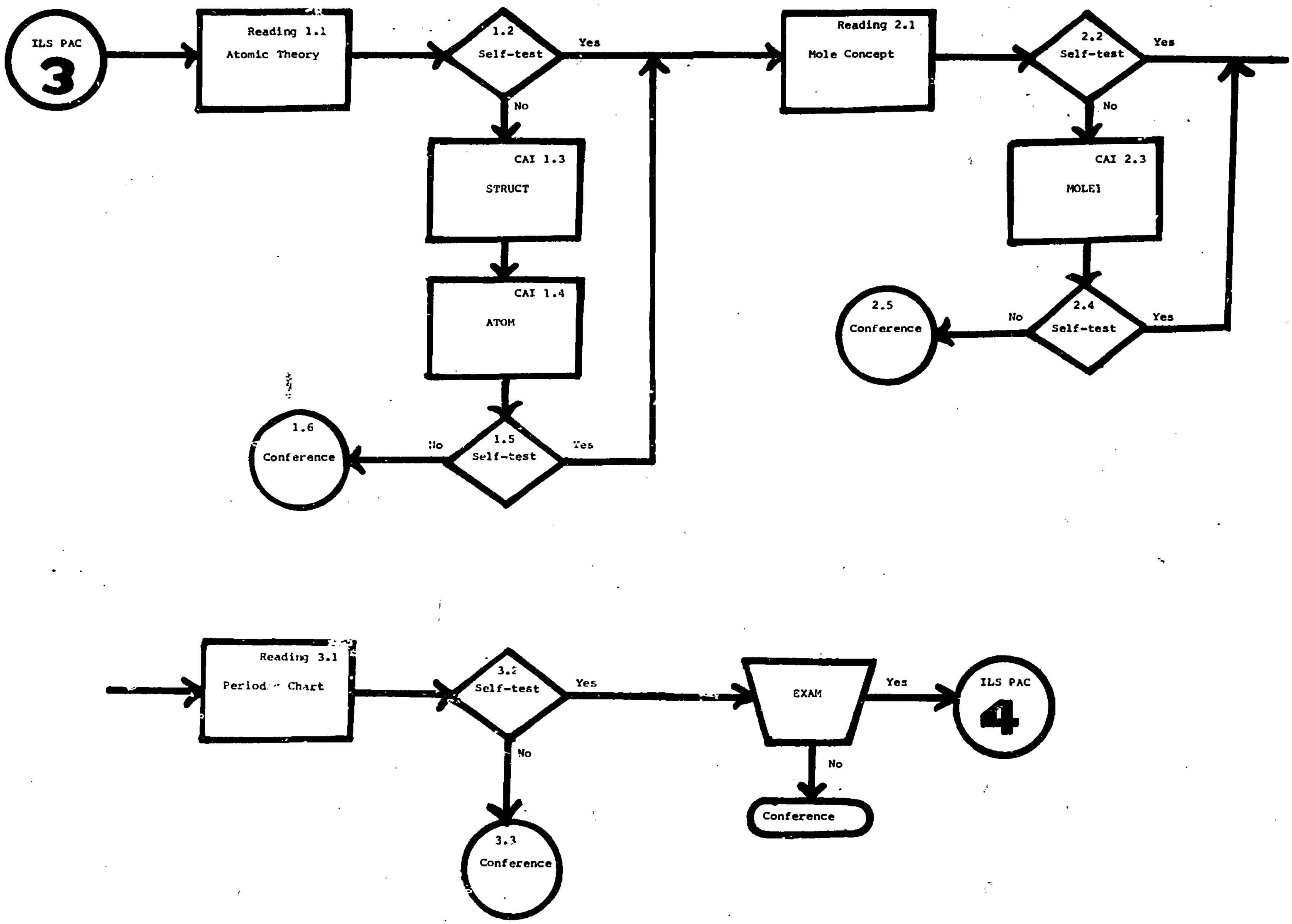
Actinium series													
90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (253)	103 Lw (257)

ORDER OF FILLING OF ELECTRON ORBITALS



N.B.: Orbitals 4f and 5d lie very close together and in certain atoms their order is reversed. The same is true of orbitals 5f and 6d.

STRUCTURE


ILS PAC 3
Reading 1.1
Atomic Theory
1.2 Self-test
Yes
No
CAI 1.3
STRUCT
CAI 1.4
ATOM
1.5 Self-test
No
Yes
1.6 Conference
Reading 2.1
Mole Concept
2.2 Self-test
Yes
No
CAI 2.3
MOLE1
2.4 Self-test
No
Yes
2.5 Conference
Reading 3.1
Periodic Chart
3.2 Self-test
Yes
No
3.3 Conference
EXAM
Yes
No
Conference
ILS PAC 4

OBJECTIVES

Upon completion of the ILS Chem Pac on Atomic Structure and Periodicity the student should be able to

1. Atomic Theory & Structure

A. Given a list of various statements, identify postulates of the modern atomic theory and identify characteristics of the various atomic particles.

B. Given the symbol of an element with its atomic number and mass number, determine how many neutrons, protons, and electrons there are in one atom of the element and the arrangement of the electrons for 5 out of 6 such elements.

2. Mole Concept

Given the name or formula of a substance, with the aid of a Periodic Chart, calculate the molecular weight of the substance--or given the mass or volume of the substance under these conditions, calculate the number of moles of the substance or vice versa--correctly calculating 9 out of 10 such problems.

3. Periodic Chart

With the aid of a Periodic Chart, distinquish between pairs, such as the following, and name at least one example to substantiate this distinction:

a. mass number and atomic number
b. proton and neutron
c. metal and non-metal
d. group and period of the Periodic Chart
e. representative element and transition element

answering 9 out of 10 questions about the Periodic Chart.

ILS Chem Pac 3 - Atomic Structure and Periodicity

[or "What's It Made Of?"]

Reading 1.1 - Read pages 18-34 in Medeiros, pages 24-32 in Sackheim & Schultz, and pages 22-34 in Holum.
Notes:

According to the atomic theory, the nucleus of an atom contains the protons and neutrons while the electrons are located outside the nucleus. To determine the number of these particles present in any given atom, the following rules are observed:

1. The number of protons in the nucleus, by definition, is always equal to the atomic number of the element.
2. The number of electrons is always equal to the number of protons since atoms are electrically neutral.
3. The number of neutrons is equal to the difference between the atomic number (protons) and the atomic weight or mass number (protons plus neutrons).

For example, take hydrogen, symbol H, atomic number 1, atomic weight 1. The atomic number is 1, so there must be one proton (rule 1) and one electron (rule 2). To determine the number of neutrons, we take the difference between the atomic number [1] and the atomic weight [1] which is zero (rule 3). Ordinary hydrogen is the only element without any neutrons.

Now let's take Helium, symbol He, atomic number 2, atomic weight 4. Since the atomic number is 2, there must be ...... (1) protons in the nucleus and ...... (2) electrons outside the nucleus. The difference between the atomic number [2] and the atomic weight [4] is 2 so there must be ...... (3) neutrons in the nucleus.

A more complicated example is sodium, symbol Na, with an atomic number of 11 and an atomic weight of 23. There must be ...... (4) protons in the nucleus and ...... (5) electrons outside the nucleus and ...... (6) neutrons in the nucleus.

In looking at your Periodic Chart you have probably noticed that while most of the atomic weights are nearly whole numbers, some of them are not. This is due to the presence of isotopes. By definition, <u>isotopes</u> are atoms of an element with the same atomic number but different atomic weights. Since the atomic numbers are the same, the elements must have the same number of protons and electrons. Since the atomic weights are different, the number of neutrons must be different in each case. For example, chlorine, symbol Cl, atomic number 17, and atomic weights 35 and 37. Each isotope must have ...... (7) protons and ...... (8) electrons since the atomic number is 17. Since one isotope has an atomic weight of 35, it must have ...... (9) neutrons while the isotope of atomic weight 37 must have ...... (10) neutrons.

This brings us to the arrangement of the electrons. The electrons occur in energy levels around the nucleus. Each energy level can contain a maximum number of electrons and no more. The first level can hold a maximum of 2 electrons. It can contain 1 electron or 2 electrons but never more than 2. The second energy level can hold any number of electrons up to 8 but never more than 8. The third energy level can hold up to 18 electrons. See your textbook for a detailed description of the orbitals found in the various energy levels (spdf notation). A few examples follow. Hydrogen, atomic number 1, has only 1 electron which must go into the first energy level. Helium, symbol He, has an atomic number of 2, so it has ...... (11) electrons in the first level.

Lithium, symbol Li, atomic number 3, has 3 electrons. The first energy level can hold only 2 electrons so the third must go into the second energy level which is indicated by 2,1. Fluorine, symbol F, atomic number 9, has ...... (12) electrons outside the nucleus. ...... (13) of these go in the first level and the remaining ...... (14) go in the next energy level. Magnesium, symbol Mg, atomic number 12, has the electron arrangement ...... (15).

The answers to Reading 1.1 are:

1. 2	6. 12	11. 2
2. 2	7. 17	12. 9
3. 2	8. 17	13. 2
4. 11	9. 35 - 17 = 18	14. 7
5. 11	10. [illegible] - 17 = 20	15. 2, 8, 2

Self-test 1.2

Sackheim & Schultz: p. 35, #1

If you missed more than one answer in Self-test 1.2, take the NO route (CAI 1.3).

CAI 1.3 - STRUC - Elementary Atomic Structure

This module provides drill in identifying the atomic structure of selected neutral atoms. Given two of the following parameters: symbol of the element, mass number, number of protons (or atomic number), electrons and/or neutrons--you identify the other parameters of the given element. A total of 15 such questions are presented.

Date Completed:

CAI 1.4 - ATOM - Atomic Structure

Nine initial questions based on atomic structure, electron distributions, use of the periodic chart, Lewis electron-dot diagrams and electronegativity of which six or more must be answered correctly. Otherwise seven more similar questions are presented.

Figures 1-10 and 26-34 (following pages) will be needed to answer some questions in this module.

Ten initial questions...of which seven or more must be answered correctly.

You should have a Periodic Chart available when you take this module. In responding with the spdf notation for a given element, separate each orbital with a dash (-). Example: Beryllium (Be) is 1s2-2s2.

Date Completed:

Self-test 1.5

CAI 1.3 and/or CAI 1.4 will also count as Self-test 1.5. In CAI 1.3 you should correctly answer 13 out of 15 questions and in CAI 1.4 you should correctly answer 6 out of 9 questions.

Conference 1.6

If you are still having difficulty with atomic theory and structure, please see your instructor.

Date:

Notes:

Figure 1

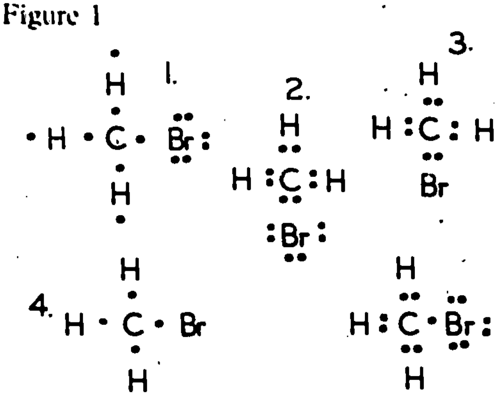


Figure 2

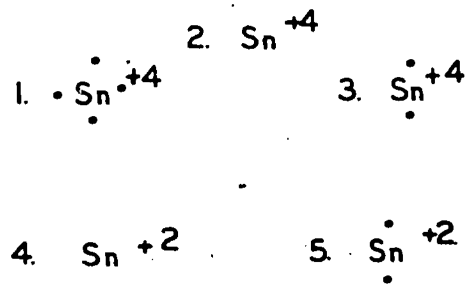


Figure 3

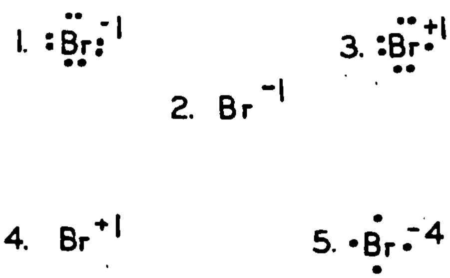


Figure 4

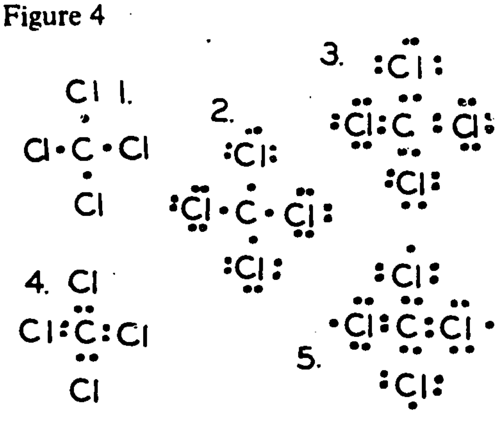


Figure 5

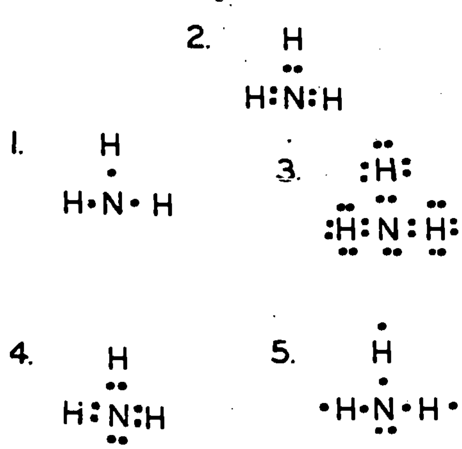


Figure 6

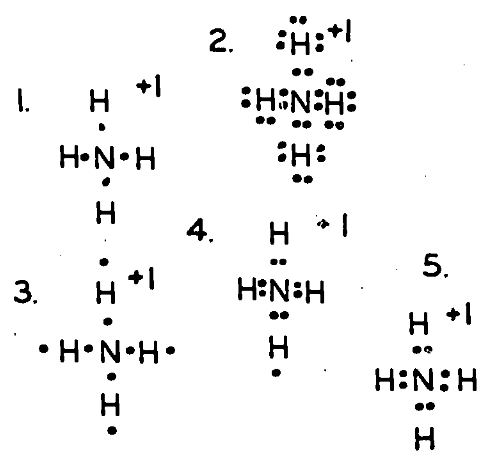


Figure 7

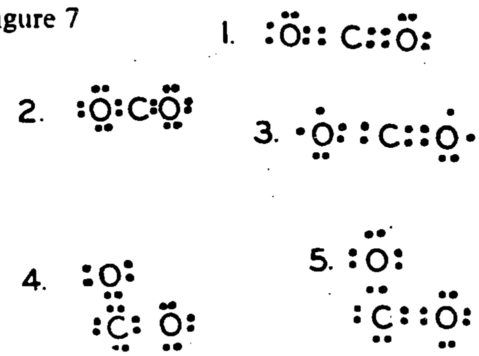


Figure 8

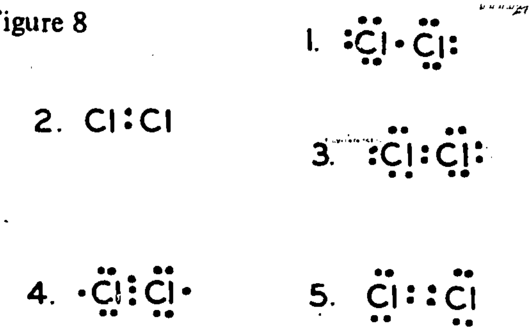


Figure 9

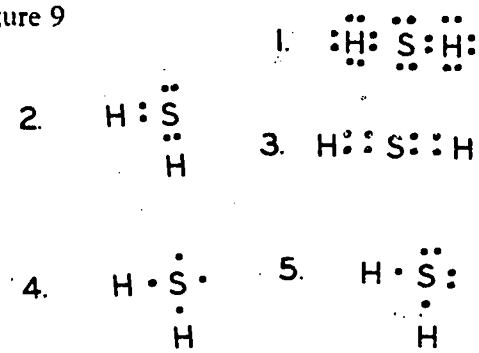


Figure 10

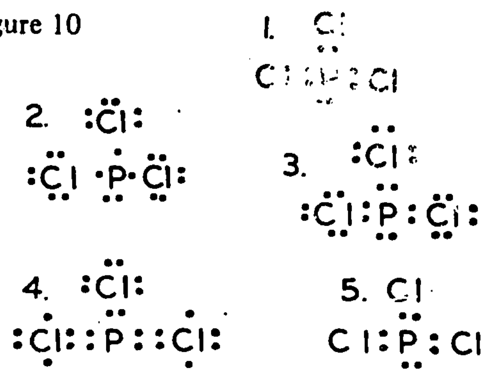


Figure 26

1. [Ar] $3d_x$↑↓ $3d_y$↑↓ $3d_z$↑↓ 4S↑↓

2. [Ar] $3d_x$↑↓ $3d_y$↑ $3d_z$↑ $3d_{xy}$↑ $3d_{yz}$↑ 4S↑↓

3. [Ar] $3d_x$↑↓ $3d_y$↑↓ $3d_z$↑↓ $3d_{xy}$ $3d_{yz}$ 4S↑↓

4. [Ar] $3d_x$↑↓ $3d_y$↑↓ $3d_z$↑↓ $3d_{xy}$ $3d_{yz}$ 4S↑↓

Figure 27

1. [Ar] $3d_x$↑↓ $3d_y$↑↓ $3d_z$↑↓ $3d_{xz}$↑ $3d_{yz}$ 4S↑↓

2. [Ar] $3d_x$↑↓ $3d_y$↑↓ $3d_z$↑ $3d_{xz}$↑ $3d_{yz}$↑ 4S ↑↓

3. [Ar] $3d_x$↑↓ $3d_y$↑↓ $3d_z$↑↓ $3d_{xz}$↑↓ $3d_{yz}$ 4S↑

4. [Ar] $3d_x$↑↓ $3d_y$↑↓ $3d_z$↑↓ $3d_{xz}$↑ $3d_{yz}$ 4S↑↓

Figure 28

1. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\uparrow\downarrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow}$ $3d_{yz}^{\uparrow}$ $4S^{\uparrow\downarrow}$

2. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\uparrow\downarrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow\downarrow}$ $3d_{yz}$ $4S^{\uparrow\downarrow}$

3. [Ar] $3d_x^{\uparrow\uparrow}$ $3d_y^{\uparrow\uparrow}$ $3d_z^{\uparrow\uparrow}$ $3d_{xy}^{\uparrow\uparrow}$ $3d_{yz}$ $4S^{\uparrow\uparrow}$

4. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\downarrow\uparrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow\downarrow}$ $3d_{yz}^{\uparrow\downarrow}$ $4S^{\downarrow\uparrow}$

Figure 29

1. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\uparrow\downarrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow\downarrow}$ $3d_{yz}^{\uparrow}$ $4S^{\uparrow\downarrow}$

2. [Ar] $3d_x^{\uparrow\uparrow}$ $3d_y^{\uparrow\uparrow}$ $3d_z^{\uparrow\uparrow}$ $3d_{xy}^{\uparrow\uparrow}$ $3d_{yz}^{\uparrow\uparrow}$ $4S^{\uparrow}$

3. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\uparrow\downarrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow\downarrow}$ $3d_{yz}^{\uparrow\downarrow}$ $4S^{\uparrow}$

4. [Ar] $3d_x^{\uparrow\uparrow}$ $3d_y^{\uparrow\uparrow}$ $3d_z^{\uparrow\uparrow}$ $3d_{xy}^{\uparrow\uparrow}$ $3d_{yz}^{\uparrow}$ $4S^{\uparrow\uparrow}$

Figure 30

1. [Ar] $3d_x^{\uparrow\uparrow}$ $3d_y^{\uparrow\uparrow}$ $3d_z^{\uparrow\uparrow}$ $3d_{xy}^{\uparrow\uparrow}$ $3d_{yz}^{\uparrow\uparrow}$ $4S^{\uparrow\uparrow}$

2. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\uparrow\downarrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow\downarrow}$ $3d_{yz}^{\uparrow\downarrow}$ $4S^{\uparrow}$

3. [Ar] $3d_x^{\uparrow\uparrow}$ $3d_y^{\uparrow\uparrow}$ $3d_z^{\uparrow\uparrow}$ $3d_{xy}^{\uparrow\uparrow}$ $3d_{yz}^{\uparrow\uparrow}$ $4S^{\uparrow}$

4. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\uparrow\downarrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow\downarrow}$ $3d_{yz}^{\uparrow\downarrow}$ $4S^{\uparrow\downarrow}$

Figure 31

1. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\uparrow\downarrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow\downarrow}$ $3d_{yz}^{\uparrow\downarrow}$ $4S^{\uparrow\downarrow}$ $4P^{\uparrow\downarrow}$

2. [Ar] $3d_x^{\uparrow\uparrow}$ $3d_y^{\uparrow\uparrow}$ $3d_z^{\uparrow\uparrow}$ $3d_{xy}^{\uparrow\uparrow}$ $3d_{yz}^{\uparrow\uparrow}$ $4S^{\uparrow\uparrow}$ $4P^{\uparrow}$

3. [Ar] $3d_x^{\uparrow\uparrow}$ $3d_y^{\uparrow\uparrow}$ $3d_z^{\uparrow\uparrow}$ $3d_{xy}^{\uparrow\uparrow}$ $3d_{yz}^{\uparrow\uparrow}$ $4S^{\uparrow\uparrow}$ $3f^{\uparrow}$

4. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\uparrow\downarrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow\downarrow}$ $3d_{yz}^{\uparrow\downarrow}$ $4S^{\downarrow\uparrow}$ $3f^{\uparrow}$

5. [Ar] $3d_x^{\uparrow\downarrow}$ $3d_y^{\uparrow\downarrow}$ $3d_z^{\uparrow\downarrow}$ $3d_{xy}^{\uparrow\downarrow}$ $3d_{yz}^{\uparrow\downarrow}$ $4S^{\uparrow\downarrow}$ $4P^{\uparrow}$

Figure 32

1. [Ar] $3d_x\uparrow\downarrow$ $3d_y\uparrow\downarrow$ $3d_z\uparrow\downarrow$ $3d_{xy}\uparrow\downarrow$ $3d_{yz}\uparrow\downarrow$ $4S\uparrow\downarrow$ $4P_x\uparrow$ $4P_y\uparrow$

2. [Ar] $3d_x\uparrow\downarrow$ $3d_y\uparrow\downarrow$ $3d_z\uparrow\downarrow$ $3d_{xy}\uparrow\downarrow$ $3d_{yz}\uparrow\downarrow$ $4S\uparrow\downarrow$ $4P_x\uparrow\downarrow$

3. [Ar] $3d_x\uparrow\uparrow$ $3d_y\uparrow\uparrow$ $3d_z\uparrow\uparrow$ $3d_{xy}\uparrow\uparrow$ $3d_{yz}\uparrow\uparrow$ $4S\uparrow\uparrow$ $4P_x\uparrow\uparrow$

4. [Ar] $3d_x\uparrow\downarrow$ $3d_y\uparrow\downarrow$ $3d_z\uparrow\downarrow$ $3d_{xy}\uparrow\downarrow$ $3d_{yz}\uparrow\downarrow$ $4S\uparrow$ $4P_x\uparrow$ $4P_y\uparrow$ $4P_z\uparrow$

Figure 33

1. [Ar] $3d_x\uparrow\downarrow$ $3d_y\uparrow\downarrow$ $3d_z\uparrow\downarrow$ $3d_{xy}\uparrow\downarrow$ $3d_{yz}\uparrow\downarrow$ $4S\uparrow\downarrow$ $4P_x\uparrow\downarrow$ $4P_y\uparrow$

2. [Ar] $3d_x\uparrow\uparrow$ $3d_y\uparrow\uparrow$ $3d_z\uparrow\uparrow$ $3d_{xy}\uparrow\uparrow$ $3d_{yz}\uparrow\uparrow$ $4S\uparrow\uparrow$ $4P_x\uparrow\uparrow$ $4P_y\uparrow$

3. [Ar] $3d_x\uparrow\downarrow$ $3d_y\uparrow\downarrow$ $3d_z\uparrow\downarrow$ $3d_{xy}\uparrow\downarrow$ $3d_{yz}\uparrow\downarrow$ $4S\uparrow\downarrow$ $4P_x\uparrow$ $4P_y\uparrow$ $4P_z\uparrow$

4. [Ar] $3d_x\uparrow\downarrow$ $3d_y\uparrow\downarrow$ $3d_z\uparrow\downarrow$ $3d_{xy}\uparrow\downarrow$ $3d_{yz}\uparrow\downarrow$ $4S\uparrow\downarrow$ $4P_x\uparrow\downarrow$ $4P_y\uparrow$ $4P_z\uparrow$

Figure 34

1. [Ar] $3d_x\uparrow\downarrow$ $3d_y\uparrow\downarrow$ $3d_z\uparrow\downarrow$ $3d_{xy}\uparrow\downarrow$ $3d_{yz}\uparrow\downarrow$ $4S\uparrow\downarrow$ $4P_x\uparrow\downarrow$ $4P_y\uparrow\downarrow$

2. [Ar] $3d_x\uparrow\downarrow$ $3d_y\uparrow\downarrow$ $3d_z\uparrow\downarrow$ $3d_{xy}\uparrow\downarrow$ $3d_{yz}\uparrow\downarrow$ $4S\uparrow\downarrow$ $4P_x\uparrow\downarrow$ $4P_y\uparrow$ $4P_z\uparrow$

3. [Ar] $3d_x\uparrow\uparrow$ $3d_y\uparrow\uparrow$ $3d_z\uparrow\uparrow$ $3d_{xy}\uparrow\uparrow$ $3d_{yz}\uparrow\uparrow$ $4S\uparrow\uparrow$ $4P_x\uparrow\uparrow$ $4P_y\uparrow\uparrow$

4. [Ar] $3d_x\uparrow\uparrow$ $3d_y\downarrow\downarrow$ $3d_z\uparrow\uparrow$ $3d_{xy}\downarrow\downarrow$ $3d_{yz}\uparrow\uparrow$ $4S\downarrow\downarrow$ $4P_x\uparrow\uparrow$ $4P_y\downarrow\downarrow$

Reading 2.1 - Read pages 34-36 in Medeiros and pages **79 & 80 in Holum.**

Notes:

The concept of a mole is a very useful convenience in chemistry. It is not practical to work with the weight of a single atom or molecule because it is so small. Consequently, chemists have defined a mole of a substance to be that quantity of a substance which contains approximately 6×10^{23} particles of the substance. This number is called Avogadro's number. The weight of an element in grams that corresponds to its atomic weight is often called a gram-atom, although the term mole may also be used in this context. One gram-atom of oxygen therefore weighs 16 grams and contains 6×10^{23} atoms of oxygen. The weight of a substance in grams which is equal to its molecular weight or formula weight is referred to as a mole of the substance. One mole of oxygen weighs 32 grams because the molecular or formula weight of oxygen (O_2) is 32.

To apply these concepts in a more general setting, consider the problem of finding the weight of one mole of professors. How many professors would there be in one mole? __________ Yes, this would be 6×10^{23} professors, which is a lot of people, even with a population explosion. If the average weight per professor was 60 kg, what would be the mole weight (weight of one mole) of professors? __________ You should have rounded your answer off to two significant figures (the average weight per professor is given to only two figures). In scientific notation the answer is 3.6×10^{25} kg/mole. This is a mass of professors equal to approximately six times the total mass of the earth.

Now let us turn the problem around. Assume the total weight of professors in the United States to be 1.3×10^{10} kg and that the mole weight of a professor is 3.6×10^{25} kg/mole and that the average weight per professor is 60 kg. Calculate the population of the United States in professors and moles.

Write out your answers before reading the next paragraph.

__________ professors and __________ moles of professors

If you found there were 2.2×10^{8} professors and 3.6×10^{-16} moles you are right. How did we get these numbers? First we divided 1.3×10^{10} kg of professors by 60 kg per professor and found the population in professors. Next we divided the weight of professors (1.3×10^{10} kg) by the weight of one mole of professors to get the number of moles of professors (3.6×10^{-16}). It is obvious that moles is not a convenient unit to use when working with professors. But, how about atoms and molecules in chemistry?

A container of liquid water weighs 180 g. Calculate the number of moles of water (H_2O) in this container. The answer to this problem is 10 moles -- based on the molecular weight of water which is 18 g/mole.

Self-test (2.2)

Calculate the number of moles in

1. 30 g of calcium
2. 12 g of helium
3. 6 g of carbon

How many atoms are there in

4. 40 g of calcium
5. 12 g of helium
6. 6 g of carbon

How many grams of each of the following elements are needed to obtain 3×10^{23} atoms of the respective element?

7. hydrogen
8. sulfur
9. oxygen
10. magnesium

If you missed more than one problem in Self-test 2.2, follow the NO route (CAI 2.3).

CAI 2.3 - MOLE1 - The Mole Concept

Introductory module on the mole concept in which the following non-chemical reaction type problems are presented:

1. What is the mole weight of x?
2. How many moles of x are in y grams of x?
3. How many grams of x are in y moles of x?
4. What is the volume of y moles of a gas at STP?
5. How many moles of a gas are in z liters (at STP) of the gas?
6. How many grams are in z liters of x gas at STP?
7. How many liters (at STP) are occupied by y grams of x?
8. What is the mole weight of a gas if y grams occupy z liters at STP?
9. A gas has a density of y grams per liter at STP; what is its mole weight?

Since the computer cannot type subscripts or lower case letters, the formulas of compounds are written in all capital letters and subscripts are written on line. Example: $AlCl_3$ would appear as ALCL3.

Date Completed:

Self-test 2.4

CAI 2.3 will also count as Self-test 2.4. You should answer 4 out of 5 problems presented in serial order.

Conference 2.5

If you are still having difficulty with the mole concept at this point, please see your instructor.

Date:

Notes:

Reading 3.1 - Read pages 74-101 in Medeiros, pages 33-34 in Sackheim & Schultz, and pages 35-38 in Holum.

The Periodic Chart contains a great deal of useful information for the chemist. There is a square on the chart for each element and this square contains information about the element. The atomic number is located in the upper part of the square and the atomic weight is directly below the symbol of the element which is the large letter(s) in the center of the square. On some charts, the color of the symbol designates the state of the element at room temperature--a black symbol means a solid; a blue symbol, a liquid; and an orange symbol, a gas.

Self-test 3.2

At the top of the chart are the Roman numerals I to VIII which designate the group numbers. Group Ia contains the elements H, Li, Na, K, etc. and Group VIIa contains .... (1). The horizontal rows are called periods. The elements in period 2 are Li, Be, B, C, N, O, F, and Ne. The elements in period 3 begin with ...... (2) and ...... (3) and end with ...... (4).

If you write the electron arrangement of the metals in Group Ia (see Reading 1.1) you will note that all of these elements have ...... (5) electron(s) in their outer energy level. This electron can be transferred very easily which gives these elements a valence or oxidation number of +1. In a similar manner, the elements in Group IIa all have a valence or oxidation number of ...... (6). In Group VIIa are the non-metals which all acquire one electron to complete their outer energy levels, so they have a valence or oxidation number of -1. Generally speaking, then, for metals "the group number is the same as the valence or oxidation number" and for non-metals "the group number minus eight gives the valence or oxidation number." In some groups, more than one type of valence is possible. The metals are located on the left side of the heavy line on the chart while the non-metals are located on the right.

The groups are also divided into A's and B's. For example, Group Ib contains the elements Cu, Ag and Au while Group IIb contains the elements .... (7). The "A" group consists of the normal elements while the "B" groups contain the transition elements--elements whose inner energy levels are being filled with electrons. Transition elements have more than one valence because they can lose electrons from an inner energy level as well as from the outer energy level.

The periodic law states that "the properties of the elements are a periodic function of their atomic number." This means that certain elements exhibit similar properties, and that these similarities occur periodically. Thus, Li (atomic number 3) is very similar to Na (atomic number 11) which is similar to K (atomic number 19). Likewise, F [atomic number ...... (8)] is very similar to ......(9) [atomic number 17] which is similar to ...... (10a)[atomic number ......(10b)].

Conference (3.3)

If you are still having difficulty with the use of the Periodic Chart, please see your instructor.

Date:

Notes:

EXAM

ILS Pac 3 will consist of 10 questions.

Objective 1a - Atomic Theory - 2 questions

Objective 2b - Atomic Structure - 8 questions

Objective 3 - Mole Concept - conference and Pacs 4-6

Objective 4 - Periodic Chart - conference and Pacs 4-6

See ILS Pac 0 (Student Directions) for Grading System Equivalents. Please remember that although the EXAM is necessary for a grade it may not be sufficient. You may also be asked to have a final conference with your instructor.

CONFERENCE

Date:

Notes:

SUPPLEMENTARY MATERIAL

Objective 1 - Atomic Theory & Structure

Filmstrip-Tape #851: Electron Configurations and Orbital Diagrams

Objective 2 - Mole Concept

Program-Tape #3: Mole and Molar Weight

Objective 3 - Periodic Chart

Audio-Tape: Mendeleev and The Periodic Table

Filmstrip-Tape #852: Atomic Structure and The Periodic Chart

ANSWERS

Self-test 1.2

element	#protons	# neutrons	#electrons	electron arrangement
N	7	7	7	2, 5
Be	4	5	4	2, 2
F	9	10	9	2, 7
S	16	16	16	2, 8, 6
Ne	10	10	10	2, 8
Si	14	14	14	2, 8, 4

Self-test 2.2

1. 0.75 moles
2. 3 moles
3. 0.5 moles
4. 6×10^{23} atoms
5. $3 \times 6 \times 10^{23} = 1.8 \times 10^{24}$ atoms
6. $\frac{1}{2} \times 6 \times 10^{23} = 3 \times 10^{23}$ atoms
7. 0.5 grams
8. 16 g
9. 8 g
10. 12 g

Self-test 3.3

1. F, Cl, Br, I, etc.
2. Na
3. Mg
4. Ar
5. 1
6. 2
7. Zn, Cd, Hg
8. 9
9. Cl

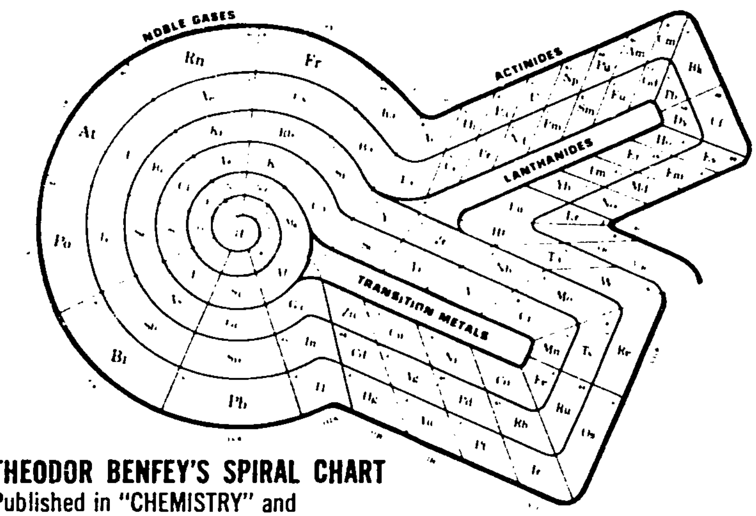
10a. Br

10b. 35

"Fill-in" PERIODIC CHART by I²R

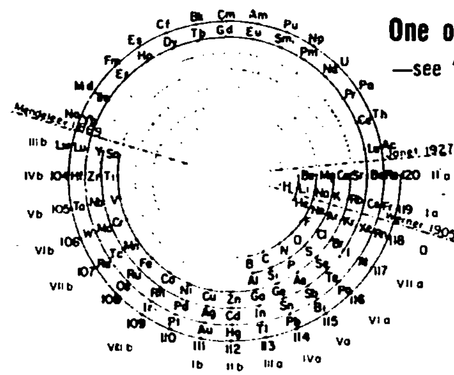
with spaces for notes on each element.

This chart is dedicated to science students, especially those having a need to write in additional data about certain elements. You can fill in (& shade or color) the chart to fit your particular interests. As examples, you can add physical properties: specific gravity, color, etc., or chemical properties: valence, reactivity, etc., or even economic factors . . . whatever is important to you!



THEODOR BENFEY'S SPIRAL CHART
Published in "CHEMISTRY" and reprinted in I²R calendar 1966.

For a discussion of periodic charts, see "The Ups and Downs of the Periodic Table", by E. G. Mazurs; **Chemistry**, Vol. 39, #7, p. 6-12, July, 1966.
As pointed out by Mazurs, various rectangular charts can be obtained from spiral charts by cutting radially and opening up.



One of Janet's Spiral Charts
—see "CHEMISTRY" Vol. 39—#7, p. 10—July, 1966

"NON METALS"

TRANSITION ELEMENTS

																1 1.00797 **H**	2 4.0026 **He**
																3 6.939 **Li**	4 9.0122 **Be**
										5 10.811 **B**	6 12.01115 **C**	7 14.0067 **N**	8 15.9994 **O**	9 18.9984 **F**	10 20.183 **Ne**	11 22.9898 **Na**	12 24.312 **Mg**
										13 26.9815 **Al**	14 28.086 **Si**	15 30.9738 **P**	16 32.064 **S**	17 35.453 **Cl**	18 39.948 **Ar**	19 39.102 **K**	20 40.08 **Ca**
21 44.956 **Sc**	22 47.90 **Ti**	23 50.942 **V**	24 51.996 **Cr**	25 54.938 **Mn**	26 55.847 **Fe**	27 58.9332 **Co**	28 58.71 **Ni**	29 63.546 **Cu**	30 65.37 **Zn**	31 69.72 **Ga**	32 72.59 **Ge**	33 74.9216 **As**	34 78.96 **Se**	35 79.904 **Br**	36 83.80 **Kr**	37 85.47 **Rb**	38 87.62 **Sr**
39 88.905 **Y**	40 91.22 **Zr**	41 92.906 **Nb**	42 95.94 **Mo**	43 (99) **Tc**	44 101.07 **Ru**	45 102.905 **Rh**	46 106.4 **Pd**	47 107.868 **Ag**	48 112.40 **Cd**	49 114.82 **In**	50 118.69 **Sn**	51 121.75 **Sb**	52 127.60 **Te**	53 126.904 **I**	54 131.30 **Xe**	55 132.905 **Cs**	56 137.34 **Ba**
71 174.97 **Lu**	72 178.49 **Hf**	73 180.948 **Ta**	74 183.85 **W**	75 186.2 **Re**	76 190.2 **Os**	77 192.2 **Ir**	78 195.09 **Pt**	79 196.967 **Au**	80 200.59 **Hg**	81 204.37 **Tl**	82 207.19 **Pb**	83 208.980 **Bi**	84 (210) **Po**	85 (210) **At**	86 (222) **Rn**	87 (223) **Fr**	88 (226) **Ra**
103 (257) **Lr**	104																
III b	IV b	V b	VI b	VII b		VIII b		I b	II b	III a	IV a	V a	VI a	VII a	O INERT GASES	I a	II a
d										p						s	

INNER TRANSITION ELEMENTS

57 138.91 **La**	58 140.12 **Ce**	59 140.907 **Pr**	60 144.24 **Nd**	61 (145) **Pm**	62 150.35 **Sm**	63 151.96 **Eu**	64 157.25 **Gd**	65 158.924 **Tb**	66 162.50 **Dy**	67 164.930 **Ho**	68 167.26 **Er**	69 168.934 **Tm**	70 173.04 **Yb**
89 (227) **Ac**	90 232.038 **Th**	91 (231) **Pa**	92 238.03 **U**	93 (237) **Np**	94 (242) **Pu**	95 (243) **Am**	96 (247) **Cm**	97 (247) **Bk**	98 (249) **Cf**	99 (254) **Es**	100 (253) **Fm**	101 (256) **Md**	102 (256) **No**
f													

Thanx to Professor Richard Longini of Carnegie-Mellon University for suggesting the basic rectangular chart above. Credit: Janet, 1927, for the basic form and I²R for expanding it to permit adding notations.