

The Periodic Table

A. Structure of the Periodic Table

The modern periodic table is a listing of elements in a gridlike chart arrangement. The elements are placed in order of atomic number, and fall into certain positions in the table that reveal many of their properties and their relationships to each other.

Period #1	Group #1												Group #14		Group #16		Group #18															
Period #2	Group #2												Group #13		Group #15		Group #17		Group #18													
Period #3	Group #3		Group #4		Group #5		Group #6		Group #7		Group #8		Group #9		Group #10		Group #11		Group #12		Group #13		Group #14		Group #15		Group #16		Group #17		Group #18	
Period #4	Group #3		Group #4		Group #5		Group #6		Group #7		Group #8		Group #9		Group #10		Group #11		Group #12		Group #13		Group #14		Group #15		Group #16		Group #17		Group #18	
Period #5	Group #3		Group #4		Group #5		Group #6		Group #7		Group #8		Group #9		Group #10		Group #11		Group #12		Group #13		Group #14		Group #15		Group #16		Group #17		Group #18	
Period #6	Group #3		Group #4		Group #5		Group #6		Group #7		Group #8		Group #9		Group #10		Group #11		Group #12		Group #13		Group #14		Group #15		Group #16		Group #17		Group #18	
Period #7	Group #3		Group #4		Group #5		Group #6		Group #7		Group #8		Group #9		Group #10		Group #11		Group #12		Group #13		Group #14		Group #15		Group #16		Group #17		Group #18	
	Group #3		Group #4		Group #5		Group #6		Group #7		Group #8		Group #9		Group #10		Group #11		Group #12		Group #13		Group #14		Group #15		Group #16		Group #17		Group #18	
	Group #3		Group #4		Group #5		Group #6		Group #7		Group #8		Group #9		Group #10		Group #11		Group #12		Group #13		Group #14		Group #15		Group #16		Group #17		Group #18	

1. The figure above represents a blank periodic table. Fill in the atomic numbers 1-109, one in each box, completing each row before moving to the next row. The elements in the two separate rows at the bottom are to be numbered as if they fit into the positions indicated by the arrows.

2. Now fill in the group numbers for each of the 18 columns, moving from left to right.

3. By what other name are elements in Group 1 known?

Alkali metals

4. By what other name are elements in Group 2 known?

Alkaline earth metals

5. By what other name are elements in Groups 3-12 known?

Transition metals

6. By what other name are elements in Group 17 known?

Halogens

7. By what other name are elements in Group 18 known?

Noble / Inert gases

8. What is true of the elements within any group?

Tend to have similar properties

9. Fill in the period numbers for each of the seven rows of the table, moving from top to bottom.

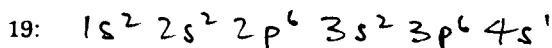
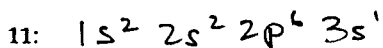
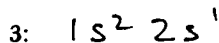
10. How many elements are in each period? Per. 1 : 2 Per. 2 : 8 Per. 3 : 8

Per. 4 : 18 Per. 5 : 18 Per. 6 : 32 Per. 7 : 23 so far, potentially 32.
65

B. Relating Electron Configurations to the Periodic Table

The electron configuration of an atom ($1s^2$, etc.) reveals the placement of electrons within the orbitals of the atom and is a key to chemical behavior. The filling order of these orbitals is: $1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p$.

1. Write electron configurations for atoms that have the following atomic numbers.



What, if anything, do these electron configurations have in common?

All represent atoms that have $1e^-$ in the outermost s orbital.

What would you expect about the relative properties of these elements?

They would be similar.

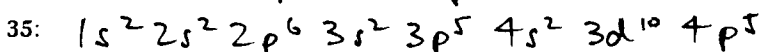
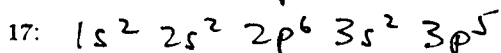
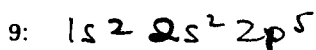
Where are these atoms located in the periodic table? (Refer to a complete periodic table.)

Group 1: Alkali metals.

What are the names and symbols of these atoms?

3: lithium, Li 11: sodium, Na 19: potassium, K

2. Write electron configurations for atoms that have the following atomic numbers:



What, if anything do these electron configurations have in common?

All represent atoms that have $5e^-$ in their outermost p orbitals.

What would you expect about the relative properties of these elements? They would be similar.

Where are these atoms located in the periodic table? Group 17: Halogens

What are the names and symbols of these atoms? 9: fluorine, F

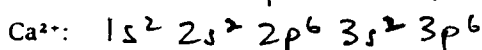
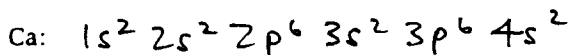
17: chlorine, Cl

35: bromine, Br

C. Ionic Charge and the Periodic Table

Atoms become electrically charged by gaining or losing electrons. The typical number of electrons gained or lost is related to electron configuration and to position in the periodic table.

1. Calcium, Ca, element 20, tends to form a $2+$ ion. Write the electron configuration of neutral Ca and of the Ca^{2+} ion.



Explain why the $2+$ ion is the one that tends typically to form.

The $2+$ ion is formed by loss of the $2e^-$ present in the outermost orbital. This loss leaves the ion with an e^- configuration like that of Ar, a noble gas. Atoms tend to

In what group of the periodic table is Ca located? Group 2 become isoelectronic with noble gases.

What ions would the other elements in this group tend to form? Why? They would all tend to form 2+ ions because their e⁻ configurations are similar to that of Ca, and they would thus become isoelectronic with noble gases by losing 2e⁻.

2. Sulfur, S, element 16, tends to form a 2- ion. Write the electron configuration of neutral S and of this ion.

S: $1s^2 2s^2 2p^6 3s^2 3p^4$

S²⁻: $1s^2 2s^2 2p^6 3s^2 3p^6$

Explain why the 2- ion is the one that tends typically to form. The 2- ion is formed by a gain of 2e⁻, which enter outermost p orbitals. This gain leaves the ion with an e⁻ configuration like that of Ar, a noble gas. Atoms tend to become isoelectronic with noble gases.

In what group of the periodic table is S located? Group 16

What ions would the other elements in this group tend to form? Why?

They would tend to form 2- ions because their e⁻ configurations are similar to that of S, and they would become isoelectronic with noble gases by gaining 2e⁻.

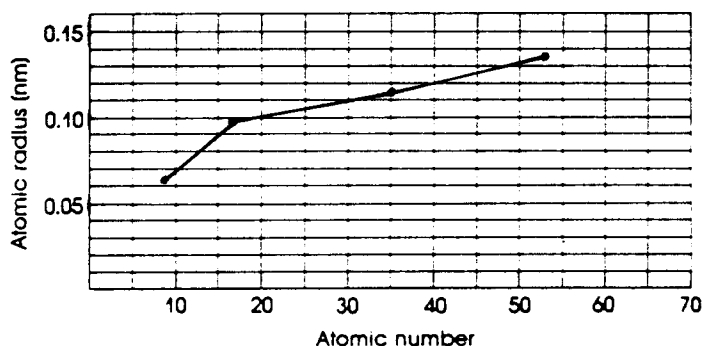
D. Atomic Radius, Ionization Energy, and the Periodic Table

The size of atoms is measured in terms of atomic radius, in units such as nanometers (1 nm = 1×10^{-9} m) or angstroms (Å) (1 Å = 1×10^{-8} cm). The ionization energy, or energy needed to remove an electron from a gaseous atom, is typically measured in kilojoules per mole of atoms. These quantities are related to position in the periodic table.

1. The radius of the first few atoms in Group 17 have been estimated to have the following values:

F (element 9):	0.064 nm
Cl (17):	0.099 nm
Br (35):	0.114 nm
I (53):	0.133 nm

Graph these values versus atomic number in the grid.



What do you notice about the relationship?

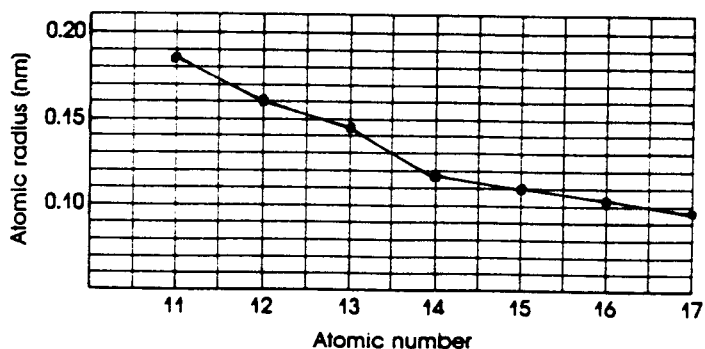
As atomic number increases down the group, the atomic radius increases.

Account for this relationship in terms of atomic forces and structure.

Negatively charged e⁻ are attracted by the positively charged nucleus. Although more e⁻ are present in the elements w. higher atomic number, the attractive force on the outer e⁻ is weakened by the shielding effect brought about by the inner e⁻. The like-charged inner and outer e⁻ also repel each other. These factors tend to make for a larger atomic radius.

2. The radii of the first seven elements in Period 3 have been estimated to have the following values:

Na (11):	0.186 nm
Mg (12):	0.160 nm
Al (13):	0.143 nm
Si (14):	0.117 nm
P (15):	0.110 nm
S (16):	0.104 nm
Cl (17):	0.099 nm



Graph these values versus atomic number in the grid.

What do you notice about the relationship?

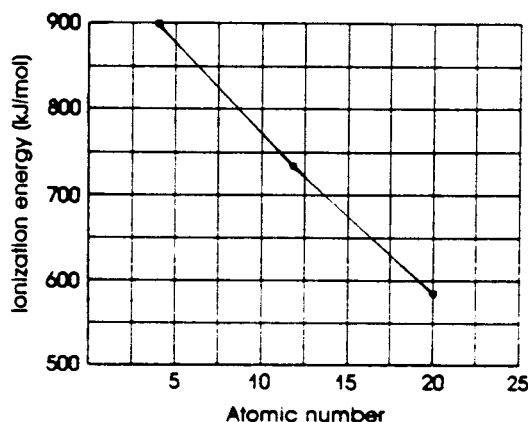
As atomic number increases across the period the atomic radius decreases.

Account for this relationship in terms of atomic forces and structure.

Negatively charged e^- are attracted by the positively charged nucleus. More e^- and p , and thus greater attractive forces, are present in the elements w. higher atomic number, and the e^- are all being added (across a period) to the same principal energy level. These factors tend to make for progressively smaller atomic radii.

3. The ionization energies of the first three atoms in Group 2 are as follows:

Be (4):	900 kJ/mol
Mg (12):	736 kJ/mol
Ca (20):	590 kJ/mol



Graph these values versus atomic number in the grid.

What do you notice about the relationship?

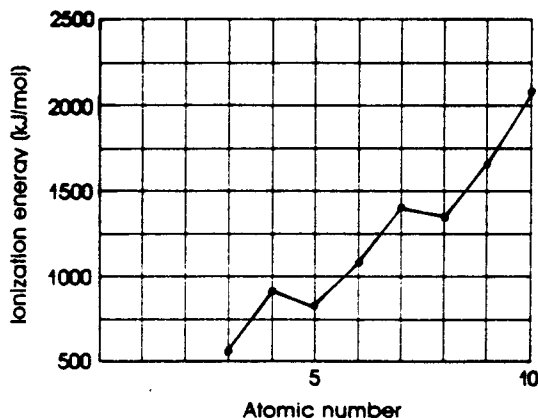
As atomic number increases down the group, the I.E. decreases.

Account for this relationship in terms of atomic forces, structure, and radius.

As one moves down the group, the outermost e^- (one of which is removed during ionization) are further from the positive nucleus, and due to the shielding effect, and ^{are} less strongly attracted to it. Progressively less energy is required to overcome the attractions and remove the e^- .

4. The ionization energies of the elements in Period 2 are as follows:

Li (3):	519 kJ/mol
Be (4):	900 kJ/mol
B (5):	799 kJ/mol
C (6):	1088 kJ/mol
N (7):	1406 kJ/mol
O (8):	1314 kJ/mol
F (9):	1682 kJ/mol
Ne (10):	2080 kJ/mol



Graph these values versus atomic number in the grid.

What general trend do you notice?

As the atomic number increases across the row, the IE generally increases.

Account for this general trend in terms of atomic forces, structure, and radius.

Across the period, the outermost e^- (1 or more of which is removed during ionization) are ^{closer to} further from the positive nucleus, due to the increased numbers of p and increased attractive forces. Progressively more energy is required to overcome the attractions and remove the e^- .

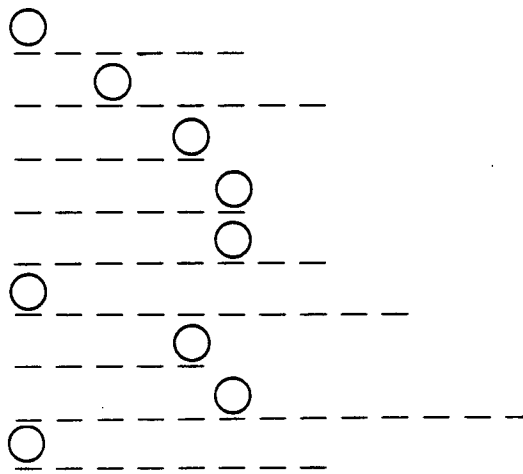
E. Periodic Table Word Scramble

Use the clues provided to help you unscramble the letters below to form words related to Chapter 11. The letters in the circles will then spell out the name of a famous scientist.

CLUES

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|------------------------------------|-------------------------------|
| 1. Na, Mg, Cr, and Fe, for example | 6. A series |
| 2. Charged particle | 7. Like neon |
| 3. An unreactive element | 8. Rb^+ and Kr, for example |
| 4. K to Kr, for example | 9. A transition metal |
| 5. Cl and I, for example | |

1. S A L M T E
2. N C L R E T E O
3. N G O R A
4. E P O D I R
5. N H E L O A G S
6. A L A E N H N D T I
7. O L B E N
8. I N E E T L O S I C C R O
9. N A V I M A U D



Name: _____