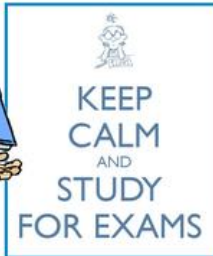


# CHEMISTRY 11 UNIT REVIEW: ATOMIC THEORY & PERIODIC TRENDS

Don't let this be you...



## Atoms

Atoms have protons and neutrons located in the nucleus of the atom. Electrons orbit around the nucleus in well-defined paths. Protons have positive charge, electrons have negative charge, and neutrons are neutral.

## Greek Philosophers (Democritus and Aristotle 400-500 BC)

Democritus, develop the idea of atoms. Democritus thought that if you break matter it will reach the smallest possible particle of matter. He called these basic matter particles, **atomos**.

Unfortunately, the atomic ideas of Democritus had no lasting effects on other Greek philosophers, including Aristotle. In fact, Aristotle dismissed the atomic idea as worthless. People considered Aristotle's opinions very important and if Aristotle thought the atomic idea had no merit, then most other people thought the same also. (Primates have great mimicking ability.)

Not until the early 1800's did people begin again to question the structure of matter.

## John Dalton (1766 – 1844):

John Dalton was an English chemist. His ideas form the atomic theory of matter. Here are his ideas.

- All elements are composed (made up) of atoms. It is impossible to divide or destroy an atom.
- All atoms of the same elements are alike. (One atom of oxygen is like another atom of oxygen.)
- Atoms of different elements are different. (An atom of oxygen is different from an atom of hydrogen.)
- Atoms of different elements combine to form a compound. These atoms have to be in definite whole number ratios. For example, water is a compound made up of 2 atoms of hydrogen and 1 atom of oxygen (a ratio of 2:1). Three atoms of hydrogen and 2 atoms of oxygen cannot combine to make water.

1. What is the name of John Dalton's theory? \_\_\_\_\_
2. What are elements made of? \_\_\_\_\_
3. An atom of hydrogen and an atom of carbon are \_\_\_\_\_.
4. What are compounds made of? \_\_\_\_\_
5. The ratio of atoms in HCl is:     a) 1:3           b) 2:1           c) 1:1

## J. J. Thompson (Late 1800s):

J. J. Thompson was an English scientist. He discovered the electron when he was experimenting with electron gun or gas discharge tubes. He noticed a movement in a tube. He called the movement cathode rays. The rays moved from the negative end of the tube to the positive end. He realized that the rays were made of negatively charged particles – electrons.

Thomson suggested a model of the atom called the Plum Pudding model. Its name is supposed to make you think of a lump of stuff with little pieces floating inside it. This model of the atom is that small negatively charged electrons are floating around inside a evenly spaced positively charged material.

1. What did J.J. Thompson discover? \_\_\_\_\_
2. What is the charge of an electron? \_\_\_\_\_
3. What are cathode rays made of? \_\_\_\_\_
4. Why do electrons move from the negative end of the tube to the positive end?  
\_\_\_\_\_

5. What was Thompson working with when he discovered the cathode rays?

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**Lord Ernest Rutherford (1871 – 1937):**

J.J. Thompson asked Rutherford to conduct further experiments to prove Plum Pudding model. Ernest Rutherford conducted a famous experiment called the gold foil experiment. He used a thin sheet of gold foil. He also used special equipment to shoot alpha particles (positively charged particles) at the gold foil. Most particles passed straight through the foil like the foil was not there. Some particles went straight back or were deflected (went in another direction) as if they had hit something. The experiment shows:

- Protons are concentrated in dense nucleus; based on the observation that positive nucleus repels (pushes away) positive alpha particles
- Atoms are mostly empty space

1. If the plum pudding model was correct depiction of the structure of atom what would have Rutherford found when he performed the Gold Foil experiment.

2. What is the charge of an alpha particle? \_\_\_\_\_

3. Why is Rutherford's experiment called the gold foil experiment?

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4. How did he know that an atom was mostly empty space?

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5. What happened to the alpha particles as they hit the gold foil? \_\_\_\_\_

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6. How did he know that the nucleus was positively charged? \_\_\_\_\_

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**Niels Bohr (Early 1900s):**

Niels Bohr was a Danish physicist. He proposed a model of the atom that is similar to the model of the solar system. The electrons go around the nucleus like planets orbit around the sun. All electrons have their energy levels – a certain distance from the nucleus. Each energy level can hold a certain number of electrons. Level 1 can hold 2 electrons, Level 2 - 8 electrons, Level 3 - 18 electrons, and level 4 – 32 electrons. The energy of electrons goes up from level 1 to other levels. When electrons release (lose) energy they go down a level. When electrons absorb (gain) energy, they go to a higher level.

1. Why could Bohr's model be called a planetary model of the atom? \_\_\_\_\_

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2. How do electrons in the same atom differ? \_\_\_\_\_

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- How many electrons can the fourth energy level hold? \_\_\_\_\_
- Would an electron have to absorb or release energy to jump from the second energy level to the third energy level? \_\_\_\_\_
- For an electron to fall from the third energy level to the second energy level, it must \_\_\_\_\_ energy.

## General Review– All topics

- Give the number of protons, neutrons and electrons in the following:

<i>Isotope</i>	<i>Protons</i>	<i>Neutrons</i>	<i>Electrons</i>
$^{177}\text{Hf}^{3+}$			
$^{209}\text{Po}^{2+}$			
$^{212}\text{At}^-$			

- Give the nuclear notation of the following:

<i>Isotope</i>	<i>Protons</i>	<i>Neutrons</i>	<i>Electrons</i>
	42	54	39
	32	42	32
	108	157	105

- What is the name of the element, **X**, which has the following mixture of isotopes:

$^{192}\text{X} = 35.5\%$ ,  $^{194}\text{X} = 34.9\%$ ,  $^{198}\text{X} = 20.3\%$ ,  $^{209}\text{X} = 9.3\%$

- Each single orbital can hold a maximum of \_\_\_\_\_ electrons.
- An "s" subshell (1 orbital) can hold a maximum of \_\_\_\_ electrons  
 A "p" subshell (3 orbitals) can hold a maximum of \_\_\_\_ electrons  
 A "d" subshell (5 orbitals) can hold a maximum of \_\_\_\_ electrons  
 An "f" subshell (7 orbitals) can hold a maximum of \_\_\_\_ electrons

When electrons in an atom are filling energy levels, they fill the \_\_\_\_\_ possible energy levels first.

- Give the electron configuration for each of the following atoms and ions: (You may use core notation )

Si	Cr
Br	Sr

K	Fe
Ge	P
Na <sup>+</sup>	Mg <sup>+2</sup>
Br <sup>-</sup>	As <sup>-2</sup>
O <sup>-2</sup>	Te <sup>-2</sup>

7. Write the configuration and then find the number of valence electrons for the following atoms:

N (configuration) \_\_\_\_\_ (# of valence e<sup>-</sup>s) \_\_\_\_\_

Si (configuration) \_\_\_\_\_ (# of valence e<sup>-</sup>s) \_\_\_\_\_

Ca (configuration) \_\_\_\_\_ (# of valence e<sup>-</sup>s) \_\_\_\_\_

P (configuration) \_\_\_\_\_ (# of valence e<sup>-</sup>s) \_\_\_\_\_

Al (configuration) \_\_\_\_\_ (# of valence e<sup>-</sup>s) \_\_\_\_\_

**On the following diagram of the Periodic Table, list the number of valence electrons and the most common ion charge in Groups 1, 2 & 13-18**

# of Valence e<sup>-</sup>s  
Ion Charge

H																				He	
Li	Be											B	C	N	O	F	Ne				
Na	Mg											Al	Si	P	S	Cl	Ar				
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr				
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe				
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn				
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub										
			La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu				
			Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr				

8. In order to become stable,

an atom of Ca will donate 2 electrons and become the ion Ca<sup>2+</sup>

an atom of Se will \_\_\_\_\_ electrons and become the ion \_\_\_\_\_

an atom of K will \_\_\_\_\_ electrons and become the ion \_\_\_\_\_

an atom of Br will \_\_\_\_\_ electrons and become the ion \_\_\_\_\_

an atom of N will \_\_\_\_\_ electrons and become the ion \_\_\_\_\_

an atom of As will \_\_\_\_\_ electrons and become the ion \_\_\_\_\_

an atom of Al will \_\_\_\_\_ electrons and become the ion \_\_\_\_\_

an atom of Te will \_\_\_\_\_ electrons and become the ion \_\_\_\_\_

9. What is the general trend in atomic radius (size of atoms) as you move from left to right across any Period?

(increase/decrease) \_\_\_\_\_

10. As you move from Li to Ne, electrons are filling (*the same/different*) \_\_\_\_\_ energy level(s). This may help explain why atoms don't get bigger as you move to the right within a period.

11. As you move across from Li to Ne, what is happening to the number of *protons* in the nucleus?

\_\_\_\_\_. What do the protons do to the electrons? \_\_\_\_\_. Suggest a reason why the atoms in a period actually get smaller as you move from left to right.

12. What is the general trend in atomic radius (size of atoms) as you move *down* a vertical column (group)?

(increase/decrease) \_\_\_\_\_

13. Suggest a reason for this trend. (*Hint: are electrons filling up the same energy level (orbitals) as you move down a column?*)

14. What is meant by **ionization energy**? \_\_\_\_\_

15. What is the general trend in first ionization energy as you move from left to right across any Period? (eg. from Li→Ne or from Na→Ar) (*increase/decrease*) \_\_\_\_\_

16. Keeping in mind the trend in atomic radius as you move from left to right across a period, suggest a reason for this trend in ionization energies. (*Hint: What happens to the distance and the force of attraction between the nucleus and the outer electron as atoms get smaller?*)

17. What is the trend in ionization energy as you move down a vertical column, like from Li→Na→K or from He→Ne→Ar→Kr? (*increase/decrease*) \_\_\_\_\_

Suggest a reason for this trend based on atomic radius (size) and the distance and force of attraction between the nucleus and the outer electron.

18. Compare the following particles:

sodium ion      oxide      neon      Magnesium atom      Fluorine atom

a. Arrange the particles using **chemical formulas** from **smallest atomic radii** to **largest atomic radii**:

○ ○ ○ ○ ○

—————→

b. On your answer above, using **arrows** show the trend of **electronegativity**, **ionization energy** and **electron affinity**.

### Subatomic Particles in Ions

19. The table below contains information about several ions. Use the information given to fill in the blanks.

Element Name	Ion Symbol	Atomic Number	Mass Number	# of Protons	# of Neutrons	# of Electrons
	Cl <sup>-</sup>				18	
silver			107			46
				8	8	10
	Al <sup>3+</sup>		27			

### Subatomic Particles in Neutral Atoms

The table below contains information about several isotopes. Use the information given to fill in the blanks. Assume all atoms are neutral.

Isotope Name	Nuclear Symbol	Atomic Number	Mass Number	# of Protons	# of Neutrons	# of Electrons
calcium-40						
		26	56			
				8	10	

## Average Atomic Mass

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1. Calculate the average atomic mass for neon if its abundance in nature is 90.5% neon-20, 0.3% neon-21, and 9.2% neon-22.
2. Calculate the average atomic mass of silver if 13 out of 25 atoms are silver-107 and 12 out of 25 atoms are silver-109.
3. Please use the following table to **calculate the average atomic mass of chlorine.**

Isotope	% Abundance	Mass (amu)
$^{35}\text{Cl}$	75.78%	34.969
$^{37}\text{Cl}$	24.22%	36.966

4. Raiderium (Cv) has three naturally occurring isotopes. Raiderium is 74.655%  $^{44}\text{Cv}$ , which has an atomic mass of 43.064 amu, 24.958%  $^{46}\text{Cv}$ , which has a mass of 46.125 amu, and 0.387%  $^{48}\text{Cv}$ , which has an atomic mass of 47.982 amu. **Please calculate the average atomic mass of Raiderium.**