**Chemistry 20 – Lesson 2**

**Atoms, ions, compounds**

**/100**

Part 1

Group 1

Group IA

2

IIA

14

IVA

15

VA

16

VIA

18

VIIIA

17

VIIA

13

IIIA

13

11

2

12

3

1

7

6

5

8

9

10

4

14

15

16

17

18

helium

He

2p+

 2e~~­–~~

hydrogen

H

1p+

 1e~~­–~~

neon

Ne

10p+

 2e~~­–~~

 8e~~­–~~

fluorine

F

9p+

 2e~~­–~~

 7e~~­–~~

oxygen

O

8p+

 2e~~­–~~

 6e~~­–~~

nitrogen

N

7p+

 2e~~­–~~

 5e~~­–~~

carbon

C

6p+

 2e~~­–~~

 4e~~­–~~

boron

B

5p+

 2e~~­–~~

 3e~~­–~~

beryllium

Be

4p+

 2e~~­–~~

 2e~~­–~~

lithium

Li

3p+

 2e~~­–~~

 1e~~­–~~

argon

Ar

18p+

 2e~~­–~~

 8e~~­–~~

 8e~~­–~~

sodium

Na

11p+

 2e~~­–~~

 8e~~­–~~

 1e~~­–~~

aluminum

Al

13p+

 2e~~­–~~

 8e~~­–~~

 3e~~­–~~

silicon

Si

14p+

 2e~~­–~~

 8e~~­–~~

 4e~~­–~~

phosphorous

P

15p+

 2e~~­–~~

 8e~~­–~~

 5e~~­–~~

sulfur

S

16p+

 2e~~­–~~

 8e~~­–~~

 6e~~­–~~

chlorine

Cl

17p+

 2e~~­–~~

 8e~~­–~~

 7e~~­–~~

magnesium

Mg

12p+

 2e~~­–~~

 8e~~­–~~

 2e~~­–~~

Questions:

1. What is the relationship between the old American system group number and the number of valence electrons?

 **The roman numeral matches the number of valence electrons**.

2. What is the relationship between the period number and the number of energy levels in which electrons are accommodated?

 **The period number is the same as the number of electron energy levels for the atoms in the period**.

3. What is the relationship between the maximum number of electrons in each energy level and the number of atoms in each period of the periodic table?

 **The number of atoms in a period equals the maximum number of electrons that can exist at that energy level.**

4. According to the above abbreviated periodic table, how many electrons can be accommodated before a new energy level is started in each of the first three energy levels?

1st energy level **2** 2nd energy level **8** 3rd energy level **8**

5. Do the diagrams drawn above represent what the electron is actually doing? Explain.

**While the actual motions of the electrons are essentially unknown, the energies of the electrons can be measured. Thus, the energy level diagrams indicate energy only.**

**25 marks**

Part 2

Group 1

Group IA

2

IIA

14

IVA

15

VA

16

VIA

18

VIIIA

17

VIIA

13

IIIA

13

11

12

3

1

7

8

9

4

15

16

17

hydrogen

H+

1p+

fluoride

F–

9p+

 2e~~­–~~

 8e~~­–~~

oxide

O2–

8p+

 2e~~­–~~

 8e~~­–~~

nitride

N3–

7p+

 2e~~­–~~

 8e~~­–~~

berylium

Be2+

4p+

 2e~~­–~~

lithium

Li+

3p+

 2e~~­–~~

chloride

Cl–

17p+

 2e~~­–~~

 8e~~­–~~

 8e~~­–~~

sulfide

S2–

16p+

 2e~~­–~~

 8e~~­–~~

 8e~~­–~~

phosphide

P3–

15p+

 2e~~­–~~

 8e~~­–~~

 8e~~­–~~

aluminum

Al3+

13p+

 2e~~­–~~

 8e~~­–~~

 8e~~­–~~

sodium

Na+

11p+

 2e~~­–~~

 8e~~­–~~

 2e~~­–~~

12p+

magnesium

Mg2+

Questions:

1. What relationship exists between the electron structure of a Group A ion and the electron structure of the nearest noble gas?

 **They have the same electron structure.**

2. Why do boron, carbon and silicon not form simple ions? How do they satisfy their electron requirements?

 **Boron, carbon and silicon prefer sharing electrons with other atoms to form molecular bonds rather than exchanging electrons to form ionic bonds.**

3. What charge do the ions from the following groups assume?

Group 1(IA) Group (IIA) Group (IIIA) Group (VA) Group (VIA) Group (VIIA)

 **1+ 2+ 3+ 3– 2– 1–**

4. What evidence is there that a noble-gas-like electron structure is stable?

 **When atoms form ions their electron structure becomes that of the nearest noble gas.**

5. What are the differences in the chemical properties of a sodium atom and a sodium ion?

**A sodium atom has one valence electron. In order to lose the electron to have the electron structure of a noble gas (neon) it reacts with a non-metal and loses its electron to the non-metal. Thus a sodium atom will readily react with other atoms. A sodium ion already has a stable electron structure and therefore it does not have to react with something else.**

**25 marks**Part 3

**Part A**:

1. Atoms with the same atomic number but a different atomic mass are called **isotopes**.
2. The results of the gold foil experiment led **Ernest Rutherford** to suggest that atoms are mostly empty space, but do contain a "solid" core which is called the **nucleus**.
3. Elements in group 15 have **five** electron(s) in the outer-most energy level.
4. The number of valence electrons equals the number of electrons in the **outer or valence** energy level.
5. The halogens have **seven** valence electron(s).
6. Noble gases do not react at SATP because they have **a stable electron structure**.
7. An atom that has lost or gained electrons is called a(n) **ion**.
8. If an atom gains electrons, it forms **negative** charged ions called **anions**.
9. When electrons are lost from an atom it forms **positively** charged ions called **cations**.
10. Elements that do not chemically react with other elements are said to be **chemically inert**. An example is **helium, neon, argon, krypton, xenon, or radon**.
11. The alkali metals form ions with a **+1** charge.
12. When elements in group 2 react with other elements, they **lose 2** electrons.
13. When elements in group 16 react with other elements, they **gain 2** electrons.
14. Metals tend to **lose** electrons, whereas non-metals tend to **gain** electrons.
15. When there is a transfer of electrons from one atom to another, a(n) **ionic** bond is formed.
16. When two atoms share electrons a **molecular or covalent** compound forms.
17. **Ionic** compounds are formed when a metal reacts with a non-metal.
18. The subatomic particle that is much smaller than the others is the **electron**.
19. When two non-metals are combined they form a(n) **molecular/covalent** compound.
20. When a metal and a non-metal combine they form a(n) **ionic** compound.
21. The noble gas with electrons only in the first energy level. **helium**
22. The halogen that forms ions containing 18 electrons. **chlorine**
23. The element in period 3 containing 3 valence electrons. **aluminum**

**23 marks**

**Part B**: Complete the chart below.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Atom or ion name** | **Symbol** | **Atomic mass** | **Atomic number** | **# of neutrons** | **# of protons** | **# of electrons** | **# of electrons lost/gained** | **Net charge** |
| iron (III) | Fe3+ | 56 | 26 | 30 | 26 | 23 | lost 3 | 3+ |
| manganese (IV) | Mn4+ | 55 | 25 | 30 | 25 | 21 | lost 4 | 4+ |
| sodium | Na+ | 23 | 11 | 12 | 11 | 10 | lost 1 | 1+ |
| aluminum | Al3+ | 27 | 13 | 14 | 13 | 10 | lost 3 | 3+ |
| argon | Ar | 4040 | 18 | 22 | 18 | 18 | 0 | 0 |
| fluoride | F– | 19 | 9 | 10 | 9 | 10 | gained 1 | 1– |
| hydride | H– | 1 | 1 | 0 | 1 | 2 | gained 1 | 1– |
| sulfide | S2– | 32 | 16 | 16 | 16 | 18 | gained 2 | 2– |
| magnesium | Mg2+ | 24 | 16 | 12 | 12 | 10 | lost 2 | 2+ |
| calcium | Ca2+ | 40 | 20 | 20 | 20 | 18 | lost 2 | 2+ |
| hydrogen | H+ | 1 | 1 | 0 | 1 | 0 | lost 1 | 1+ |
| sulfur | S | 32 | 16 | 16 | 16 | 16 | 0 | 0 |
| cobalt (III) | Co3+ | 59 | 27 | 32 | 27 | 24 | lost 3 | 3+ |

**12 marksPart C**: Complete the following table. Note the name of a *non-metallic* ion ends in *ide* while the name for a *metallic* ion uses the full name of the metal.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Ion name** | **Symbol** | **# of p+** | **# of e–** | **# of electrons lost/gained** | **Same electron structure as what Noble gas?** |
| e.g. fluoride | F– | 9 | 10 | gained 1 | neon |
| 1. iodide | I– | 53 | 54 | gained 1 | xenon |
| 2. sulfide | S2– | 16 | 18 | gained 2 | argon |
| 3. potassium | K+ | 19 | 18 | lost 1 | argon |
| 4. calcium | Ca2+ | 20 | 18 | lost 2 | argon |
| 5. bromide | Br– | 35 | 36 | gained 1 | krypton |
| 6. strontium | Sr2+ | 38 | 36 | lost 2 | krypton |
| 7. hydrogen | H+ | 1 | 0 | lost 1 | (none) |
| 8. oxide | O2– | 8 | 10 | gained 2 | neon |
| 9. magnesium | Mg2+ | 12 | 10 | lost 2 | neon |
| 10. aluminum | Al3+ | 13 | 10 | lost 3 | neon |
| 11. selenide | Se2– | 34 | 36 | gained 2 | krypton |
| 12. hydride | H– | 1 | 2 | gained 1 | helium |
| 13. lithium | Li+ | 3 | 2 | lost 1 | helium |
| 14. rubidium | Rb+ | 37 | 36 | lost 1 | krypton |
| 15. chloride | Cl– | 17 | 18 | gained 1 | argon |

**15 marks**