OCR B GCSE Chemistry

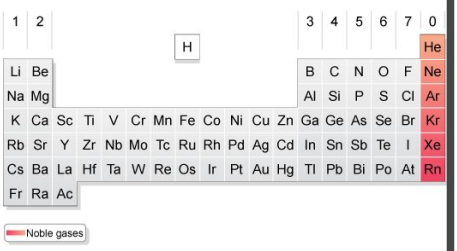
Topic 2: Chemical patterns

How do metals and non-metals combine to form compounds?

Notes

1. Recall the simple properties of Group 0 including their low melting and boiling points, their state at room temperature and pressure and their lack of chemical reactivity

group 0- noble gases:



- They have 8 electrons in their outer shell (except helium, which has 2).
- They are unreactive and do not easily form molecules, because they have a stable arrangement of electrons.
- The boiling points of the noble gases increase with increasing relative atomic mass (going down the group).
    - Low boiling points of all mean they are gases at room temperature and pressure
    - They are monatomic (only one atom in a molecule e.g. He rather than He_2)

2. Explain how observed simple properties of Groups 1, 7 and 0 depend on the outer shell of electrons of the atoms and predict properties from given trends down the groups

- 2, 8, 8 is the typical arrangement of electrons in shells from the first shell (closest to nucleus) outwards to the third shell
    - First shell can have up to 2 electrons
    - Second shell can have up to 8 electrons
    - Third shell can have up to 8 electrons
- All atoms will try to acquire this perfect arrangement of electrons – i.e. having the maximum number of electrons as possible in their outer shell – therefore, all atoms try to have 8 electrons in their outer shell (unless they only have one shell then they will try to have only 2) because this is the most stable arrangement
- this is how elements react- to gain this arrangement

3. Explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number

- Atomic number = number of protons = number of electrons (in ATOMS)
- see above information about how reactions are related to arrangement of electrons

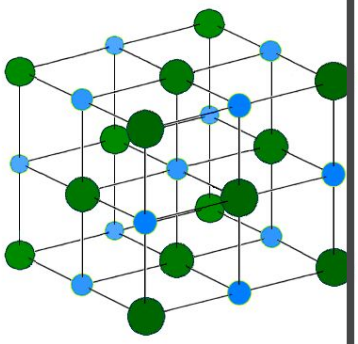
4. Explain how the atomic structure of metals and non-metals relates to their position in the Periodic Table

- Metals react by losing electrons (forming positive metal ions)
- Non-metals react by gaining electrons (forming negative non-metal ions)
- Thus, metals are found to the left and in the middle, and non-metals are found to the right
    - Metals on left
        - Want to lose electrons (to get 8), because they don't have many in their outer most shell of electrons – therefore will empty the outer shell and go into the next shell, which will be full
    - Non-metals on right
        - Want to gain electrons (to get 8) in order to fill the almost-full outer shell of electrons

5. Describe the nature and arrangement of chemical bonds in ionic compounds

- Metals + nonmetals: electrons in the outer shell of the metal atom are transferred
    - Metal atoms lose electrons to become positively charged ions (cation)
    - Nonmetal atoms gain electrons to become negatively charged ions (anion)

- A giant structure of ions = ionic compound
- Held together by strong electrostatic forces of attraction between oppositely charged ions
- The forces act in all directions in the lattice, and this is called ionic bonding.
- The lattice has a regular arrangement of ions



An example is sodium chloride (salt):
Na+ (small blue particles) and Cl- (larger green ones)

properties:

- They have high melting and boiling points, because a lot of energy is required to break the many strong bonds.
- When melted or dissolved in water, ionic compounds conduct electricity because the ions are free to move and carry current.

6. Explain ionic bonding in terms of electrostatic forces and transfer of electrons

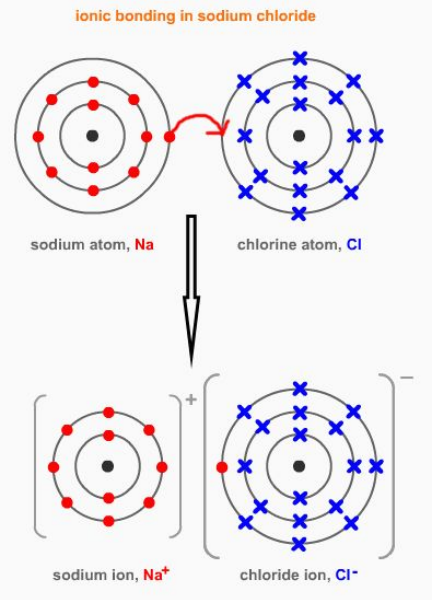
- see above

7. Calculate numbers of protons, neutrons and electrons in atoms and ions, given atomic number and mass number or by using the Periodic Table

- Atomic number = proton number = number of protons
- Mass number = nucleon number = number of protons + neutrons
- In an atom number of protons = number of electrons, but in an ion, there is a different number of electrons to protons. to work out electrons in an ion:
    - work out how many electrons an atom of the element would have (same as proton number)
    - work out how many electrons have been lost or gained (using charge- remember -ve means electrons gained, +ve means electrons lost)
    - calculate number of electrons in atom plus electrons gained or minus electrons lost

8. Construct dot and cross diagrams for simple ionic substances

- Electron transfer during the formation of an ionic compound can be represented by a dot and cross diagram (see eg for NaCl below)



9. Explain how the bulk properties of ionic materials are related to the type of bonds they contain

- Bulk properties
  - High melting and boiling points
  - Conductive when liquid
- Related to the type of bonds they contain – which are ionic bonds, because these have electrostatic forces of attraction that are very strong resulting in these high melting and boiling points. Also, when liquid/molten they are conductive, since the ions are free to carry charge when not solid i.e. in fixed positions

10. Use ideas about energy transfers and the relative strength of attraction between ions to explain the melting points of ionic compounds compared to substances with other types of bonding

- Energy transfer
  - Energy transferred TO a compound – melting, boiling
  - Energy transferred FROM a compound – condensing, freezing
- Relative strength of chemical bonds
  - Covalent bonds are VERY strong
  - Ionic bonds are VERY strong – electrostatic forces of attraction
- Intermolecular forces
  - Simple molecules are melted / boiled easily, because the weak intermolecular forces are overcome and NOT the covalent bonds
  - Ionic compounds have higher melting and boiling points, because the electrostatic forces of attraction are harder to overcome
  - Macromolecular substances do not have intermolecular forces and therefore, are very hard to break down, because the covalent bonds must be overcome to boil or melt these substances
- All of these factors result in different temperatures at which substances change state

11. Describe the limitations of particular representations and models of ions and ionically bonded compounds, including dot and cross diagrams, and 3-D representations

- Main limitation is that it applies really well only to the small class of solids composed of Group 1 and 2 elements with highly electronegative elements such as the halogens
- 2d diagrams don't show the 3d arrangement of atoms, and 3d diagrams don't show the share or transfer of electrons
- Do not include forces of attraction (e.g. electrostatic forces), which are overcome when these ionic compounds are boiled or melted

12. Translate information between diagrammatic and numerical forms and represent three dimensional shapes in two dimensions and vice versa when looking at chemical structures for ionic compounds