

2 Atoms, elements and compounds

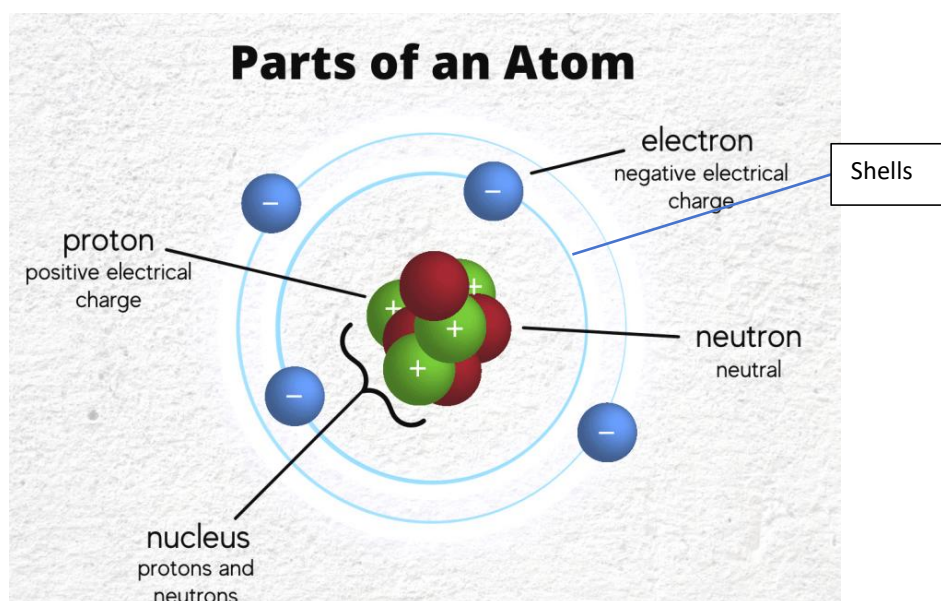
2.1 Elements, compounds and mixtures

1 Describe the differences between elements, compounds and mixtures

- An element is a substance made up of one type of atoms which all have the same proton number.
- A compound is a substance that consists of two or more elements that are chemically combined. Elements in a compound can not be separated by physical means
- A mixture is a combination of two or substances that are not chemically combined. These substances can be separated by physical means.

2.2 Atomic structure and the Periodic Table

1 Describe the structure of the atom as a central nucleus containing neutrons and protons surrounded by electrons in shells



2 State the relative charges and relative masses of a proton, a neutron and an electron

Particle	Relative Mass	Relative Charge
Proton	1	+1
Neutron	1	0
Electron	1/1860	-1

NOTE: When answering questions, you may write the relative mass of electrons as just 0.

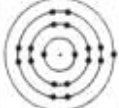
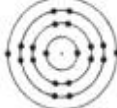
3 Define proton number/atomic number as the number of protons in the nucleus of an atom

4 Define mass number/nucleon number as the total number of protons and neutrons in the nucleus of an atom

5 Determine the electronic configuration of elements and their ions with proton number 1 to 20, e.g. 2,8,3

Element	Atomic Number	Correct Shell Configuration
Hydrogen	1	1
Helium	2	2
Lithium	3	2, 1
Beryllium	4	2, 2
Boron	5	2, 3
Carbon	6	2, 4
Nitrogen	7	2, 5
Oxygen	8	2, 6
Fluorine	9	2, 7
Neon	10	2, 8
Sodium	11	2, 8, 1

Magnesium	12	2, 8, 2
Aluminium	13	2, 8, 3
Silicon	14	2, 8, 4
Phosphorus	15	2, 8, 5
Sulfur	16	2, 8, 6
Chlorine	17	2, 8, 7
Argon	18	2, 8, 8
Potassium	19	2, 8, 8, 1
Calcium	20	2, 8, 8, 2

1 HYDROGEN  H 1								0 2 HELIUM  He 2
Group number →	I	II	III	IV	V	VI	VII	
	3 LITHIUM  Li 2.1	4 BERYLLIUM  Be 2.2	5 BORON  B 2.3	6 CARBON  C 2.4	7 NITROGEN  N 2.5	8 OXYGEN  O 2.6	9 FLUORINE  F 2.7	10 NEON  Ne 2.8
Proton number →	11 SODIUM  Na 2.8.1	12 MAGNESIUM  Mg 2.8.2	13 ALUMINIUM  Al 2.8.3	14 SILICON  Si 2.8.4	15 PHOSPHORUS  P 2.8.5	16 SULPHUR  S 2.8.6	17 CHLORINE  Cl 2.8.7	18 ARGON  Ar 2.8.8
Full electronic structure →								
Symbol of element →								
Simplified electronic structure →	19 POTASSIUM  K 2.8.8.1	20 CALCIUM  Ca 2.8.8.2						

6 State that:

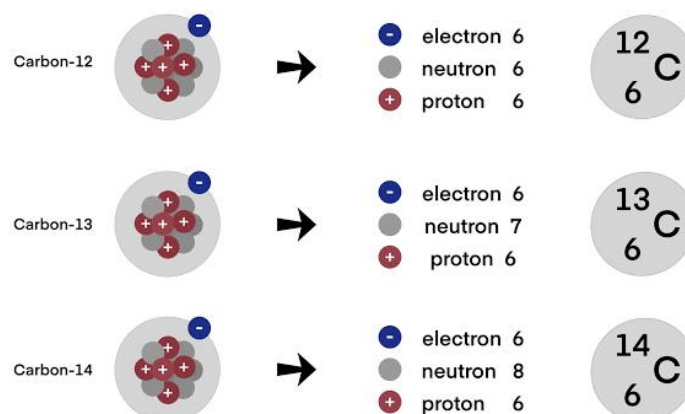
(a) Group VIII noble gases have a full outer electron shell

(b) the number of outer shell electrons is equal to the group number in Groups I to VII

(c) the number of occupied electron shells is equal to the period number

2.3 Isotopes

1 Define isotopes as different atoms of the same element that have the same number of protons but different numbers of neutrons



NOTE: A change in the number of electrons leads to ions forming. A change in the number of protons leads to completely different elements. A change in the neutron number leads to isotopes.

2 Interpret and use symbols for atoms, e.g. $^{12}_6\text{C}$, and ions, e.g. $^{35}_{17}\text{Cl}^-$

- C is the symbol for carbon, 12 is the mass number(6 neutrons and 6 protons). 5 is the proton number.
- Ions(charged atoms) have a (-) or (+) symbol.

3 State that isotopes of the same element have the same chemical properties because they have the same number of electrons and therefore the same electronic configuration

4 Calculate the relative atomic mass of an element from the relative masses and abundances of its isotopes

- Formula; relative atomic mass = $(m_1 \times a_1) + (m_2 \times a_2) \dots$ (if more present isotopes) / 100
- m is the atomic mass of each isotope and a is the abundance of each isotope. Divide by 100 because the abundance is a % value.
- Example: The 3 isotopes of magnesium have atomic masses of 24, 25 and 26

3. Practice Question

Magnesium has three isotopes:

- Mg-24 (79% abundance)
- Mg-25 (10% abundance)
- Mg-26 (11% abundance)

$$A_r = \frac{(24 \times 79) + (25 \times 10) + (26 \times 11)}{100}$$

$$A_r = \frac{1896 + 250 + 286}{100} = \frac{2432}{100} = 24.3$$

So, the relative atomic mass of magnesium is 24.3.

2.4 Ions and ionic bonds

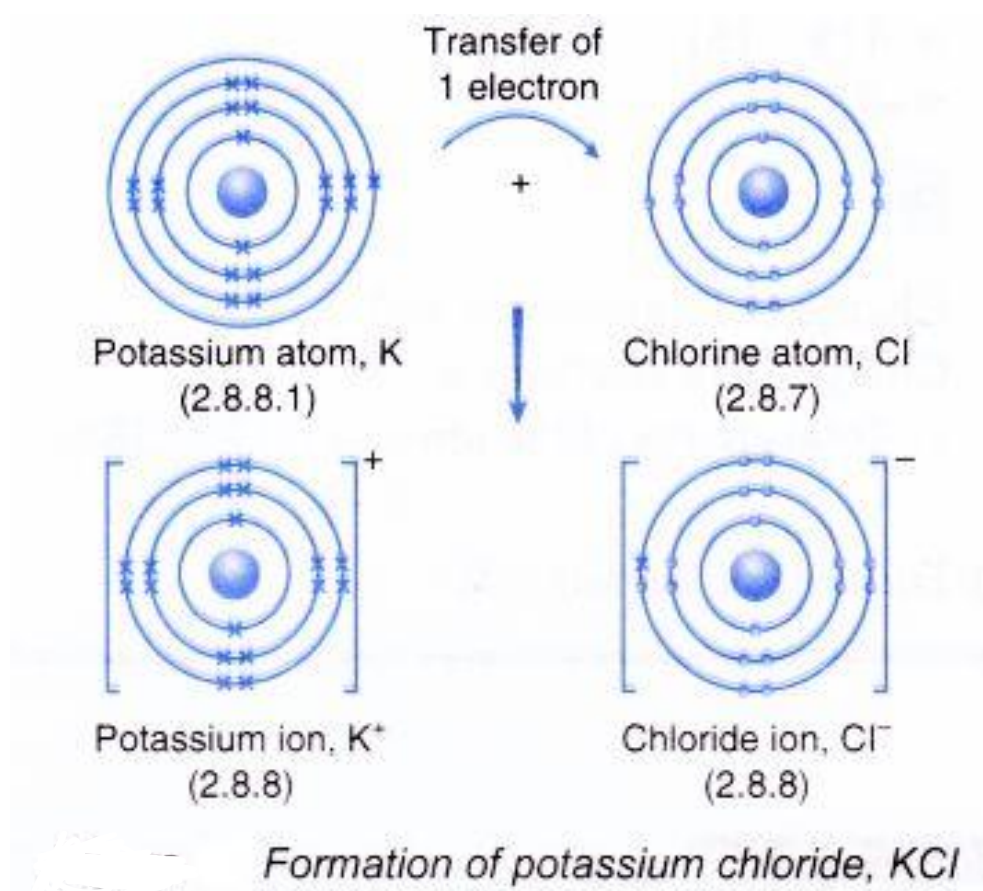
1 Describe the formation of positive ions, known as cations, and negative ions, known as anions

- Cations form when an atom loses electrons. It will have an overall positive charge as there will be more protons than electrons (the positive charge "overpowers" the negative charge)
- Anions form when an atom gains electrons. It will have an overall negative charge as there will be more electrons than protons (the negative charge "overpowers" the positive charge).

2 State that an ionic bond is a strong electrostatic attraction between oppositely charged ions

3 Describe the formation of ionic bonds between elements from Group I and Group VII, including the use of dot-and-cross diagrams AND 6 Describe the formation of ionic bonds between ions of metallic and non-metallic elements, including the use of dot-and-cross diagrams

● **EXAMPLE:** potassium chloride.



- The electron that was transferred in this example is represented by a cross to indicate that it came from the potassium.
- The positive chloride ion and the negative potassium ion attract each other, forming an ionic bond. Many potassium and chloride ions held by ionic bonds lead to formation of a giant ionic lattice of potassium chloride.

4 Describe the properties of ionic compounds AND 7 Explain in terms of structure and bonding the properties of ionic compounds:

(a) high melting points and boiling points

- A lot of heat energy is required to overcome the many ionic bonds and break the lattice.

(b) good electrical conductivity when aqueous or molten and poor when solid

- When solid, the ions can not move. They can only move when in molten or dissolved in water(aqueous). once the ions are able to move they can conduct electricity.

5 Describe the giant lattice structure of ionic compounds as a regular arrangement of alternating positive and negative ions

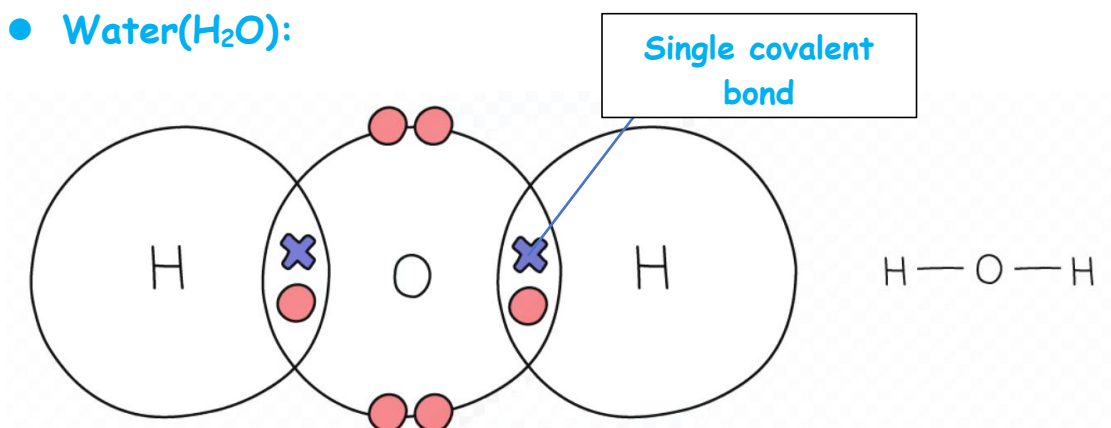
2.5 Simple molecules and covalent bonds

1 State that a covalent bond is formed when a pair of electrons is shared between two atoms leading to noble gas electronic configurations

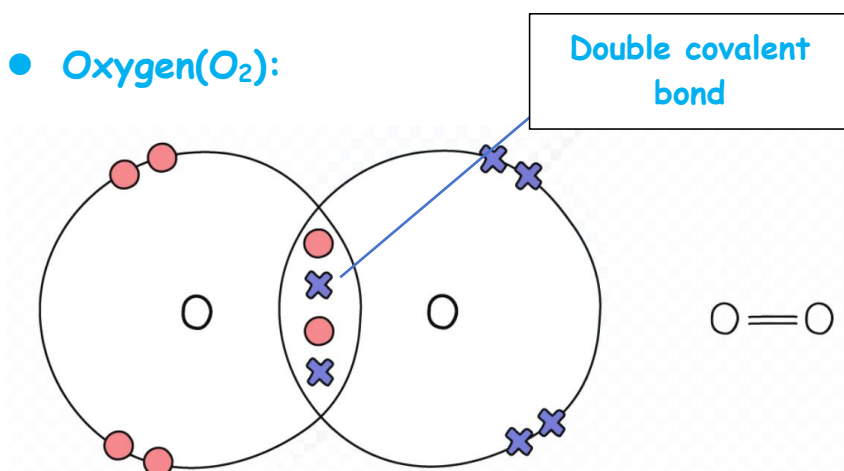
2 Describe the formation of covalent bonds in simple molecules, including H_2 , Cl_2 , H_2O , CH_4 , NH_3 and HCl . Use dot-and-cross diagrams to show the electronic configurations in these and similar molecules AND 4 Describe the formation of covalent bonds in simple molecules, including CH_3OH , C_2H_4 , O_2 , CO_2 and N_2 . Use dot-and-cross diagrams to show the electronic configurations in these and similar molecules

NOTE: only the outer shell electrons will be shown.

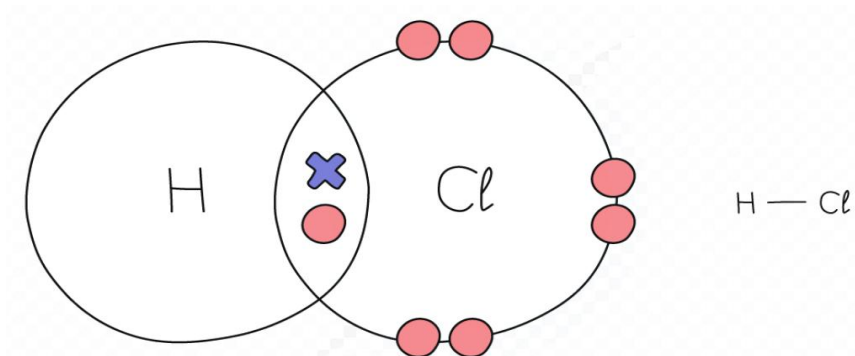
- **Water(H_2O):**



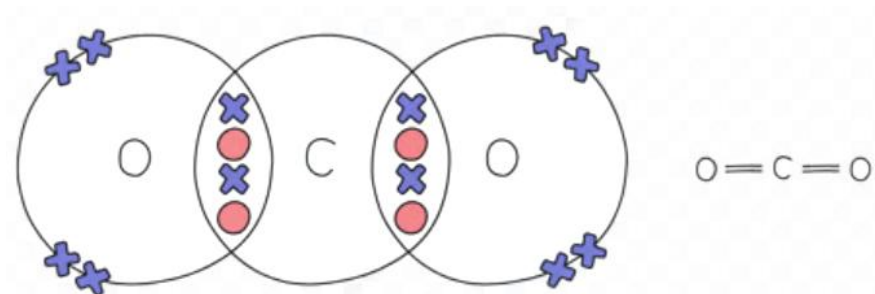
- **Oxygen(O_2):**



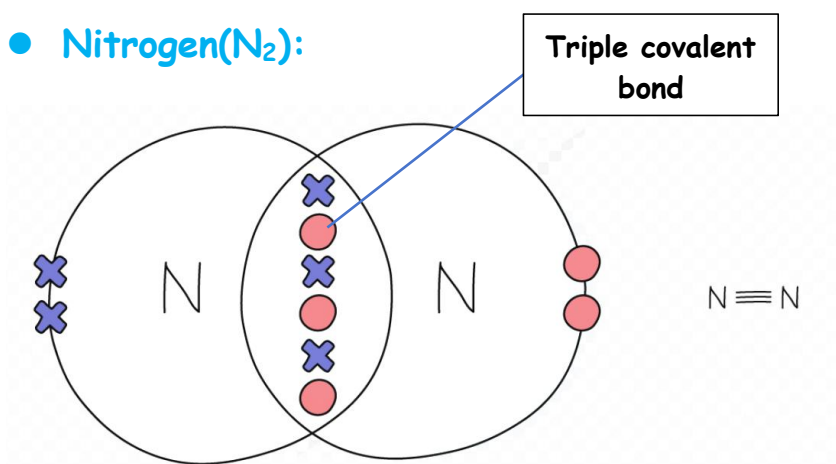
- **Hydrogen chloride(HCl):**



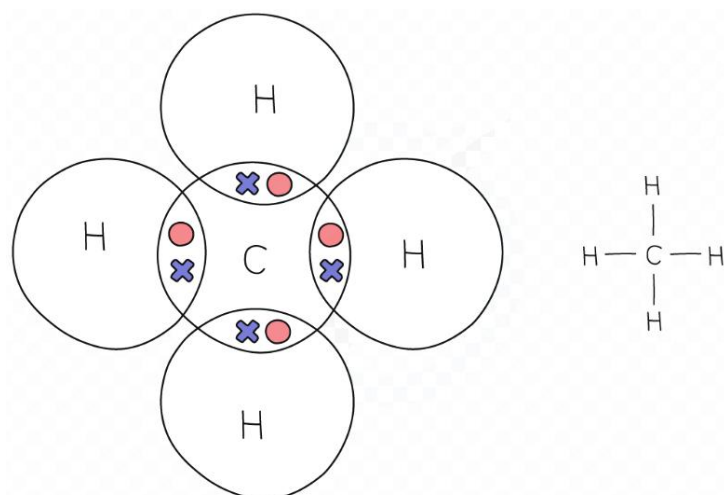
- **Carbon dioxide(CO_2):**



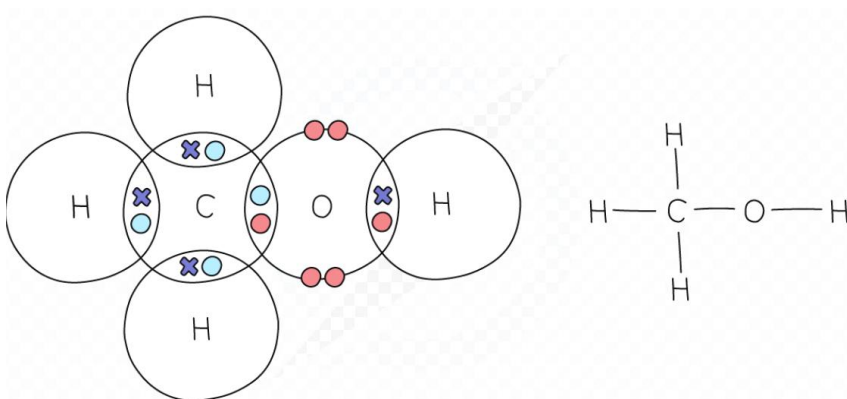
- Nitrogen(N_2):



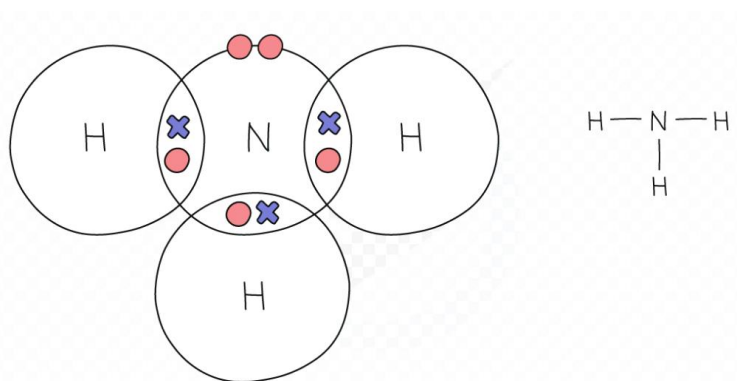
- Methane(CH_4):



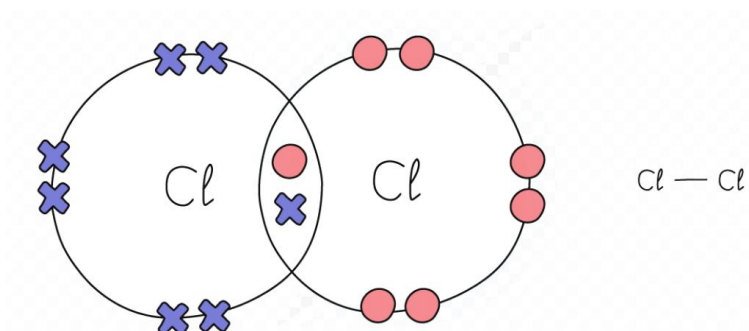
- Methanol(CH_3OH):



- Ammonia(NH_3):



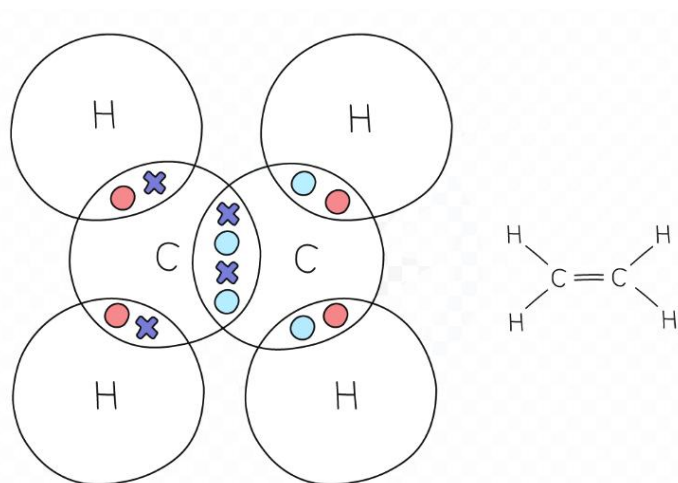
● Chlorine (Cl_2):



● Hydrogen (H_2):



● Ethene (C_2H_4):



3 Describe in terms of structure and bonding the properties of simple molecular compounds AND 5 Explain in terms of structure and bonding the properties of simple molecular compounds:

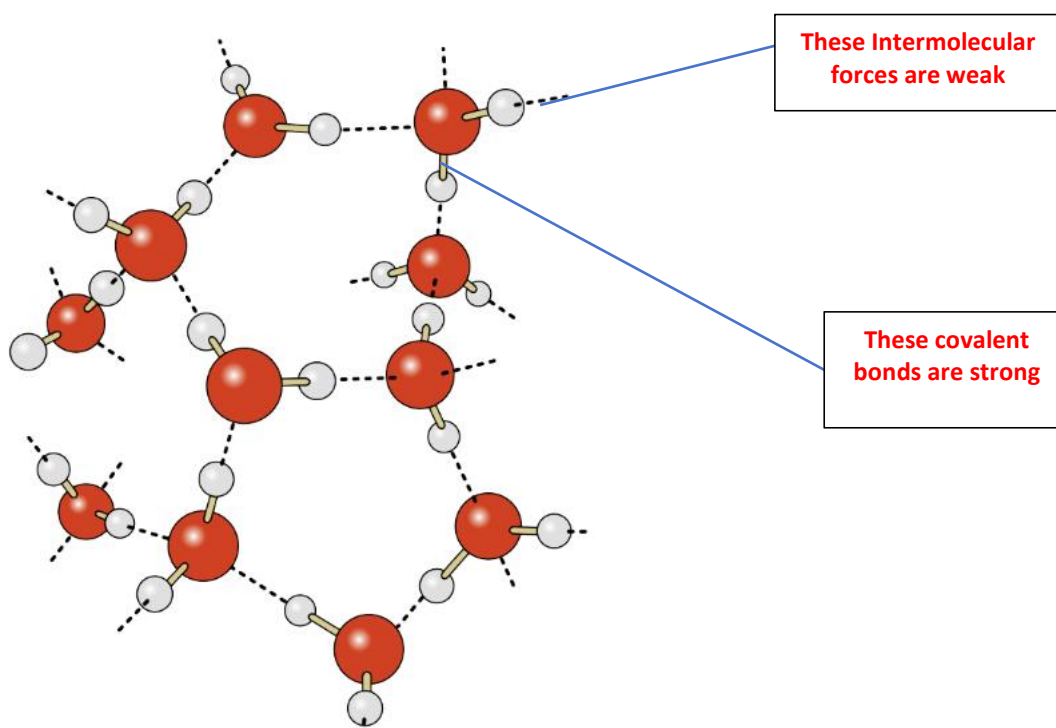
(a) low melting points and boiling points in terms of weak intermolecular forces (specific types of intermolecular forces are not required)

- The weak intermolecular forces between the molecules are very weak so do not require a lot of heat energy to overcome and break. The lattice can be easily broken.

(b) poor electrical conductivity

- They are uncharged(neutral) the electrons are held by covalent bonds. So even if they are molten or dissolved in water(this only breaks the lattice and not the covalent bonds), they still can not conduct electricity (insulators).

NOTE:



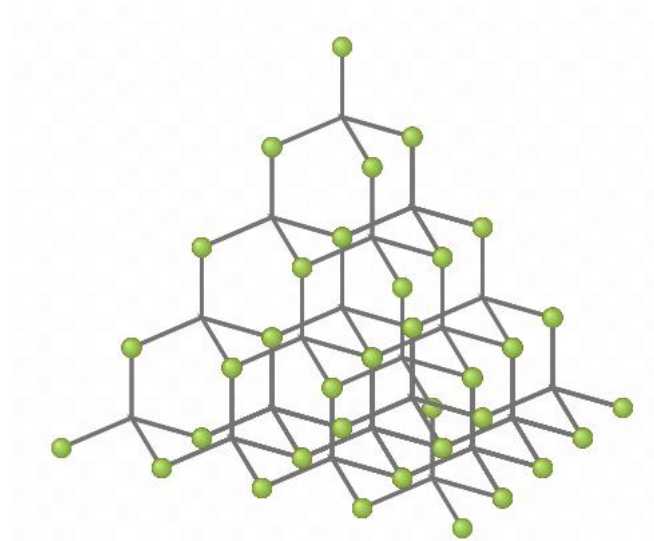
2.6 Giant covalent structures

1 Describe the giant covalent structures of graphite and diamond AND 2 Relate the structures and bonding of graphite and diamond to their uses, limited to:

(a) graphite as a lubricant and as an electrode

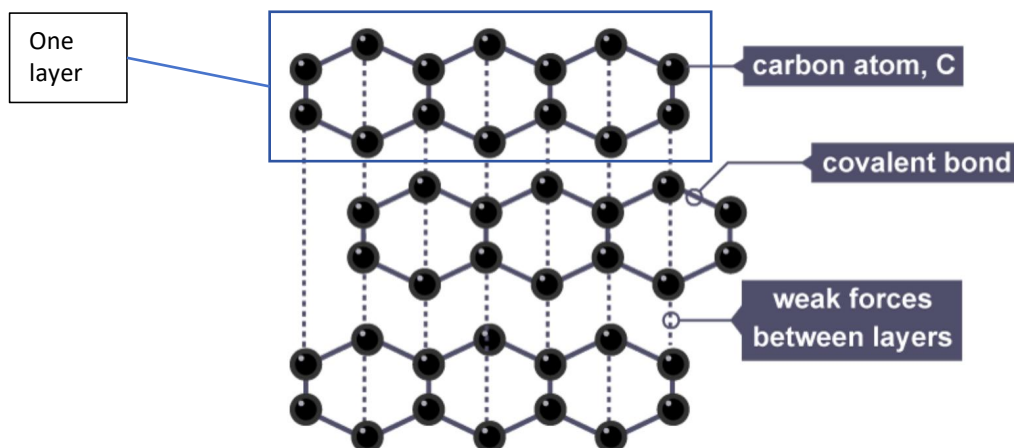
(b) diamond in cutting tools

- Diamond is made up of only carbon atoms. Each carbon atom is covalently bonded to 4 other tightly. This forms a giant covalent lattice (no intermolecular forces present) with no free electrons. Which give it a high melting point and make it very hard (a lot of heat is needed to overcome covalent bonds). Hard substances do not get scratched easily.



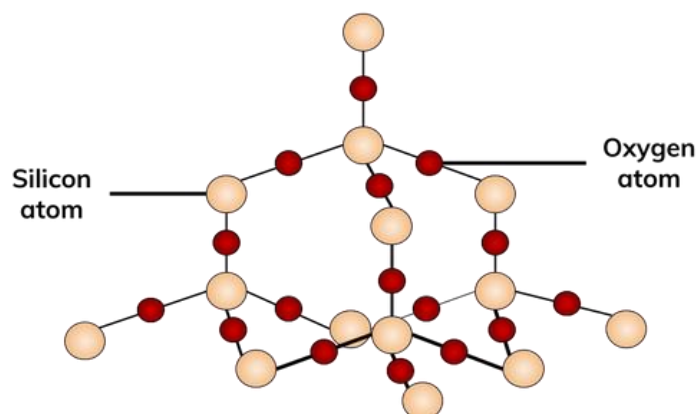
- Graphite consists of carbon arranged in a hexagonal pattern, forming a hexagonal lattice of flat layers. Each carbon forms 3 covalent bonds instead of 4 so there are free electrons and the sheets are held by weak intermolecular forces which allow the layers to slide past each other easily.

- **Electrodes are made of graphite as it is able to conduct electricity and it is used in lubricant and pencils because layers can slide.**



3 Describe the giant covalent structure of silicon(IV) oxide, SiO_2

- **Each silicon atom is covalently bonded to four oxygen atoms, and each oxygen atom is bonded to two silicon atoms.**



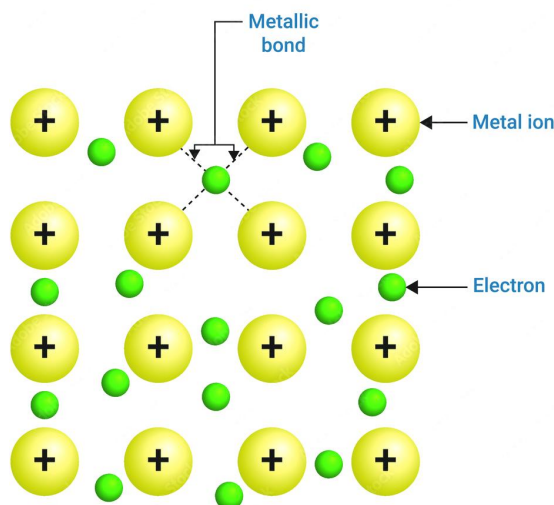
4 Describe the similarity in properties between diamond and silicon(IV) oxide, related to their structures

- **Both do not conduct electricity as they have no free electrons**

- They are both very hard as all the atoms are tightly bonded and there are no intermolecular forces in the lattice(which are tetrahedrons).

2.7 Metallic bonding

1 Describe metallic bonding as the electrostatic attraction between the positive ions in a giant metallic lattice and a 'sea' of delocalised electrons



2 Explain in terms of structure and bonding the properties of metals:

(a) good electrical conductivity

- Electrons are free to move and conduct electricity.

(b) malleability and ductility

- The layers of metal ions can slide past each other and take up different positions without breaking when a force is applied. Metals can be turned into wires easily as a result(ductile)

END OF CHAPTER