# Bonding

## The nature of chemical bonds

## Covalent dot and cross

Draw dot and cross diagrams to illustrate the bonding in the following covalent compounds. If you wish you need only draw the outer shell electrons;

(2 marks for each correct diagram)

**1.** Water, H2O

**2.** Carbon dioxide, CO2

**3.** Ethyne, C2H2

**4.** Phosphoryl chloride, POCl3

**5.** Sulfuric acid, H2SO4

Draw dot and cross diagrams to illustrate the bonding in the following ionic compounds.

(2 marks for each correct diagram)

**1.** Lithium fluoride, LiF

**2.** Magnesium chloride, MgCl2

**3.** Magnesium oxide, MgO

**4.** Lithium hydroxide, LiOH

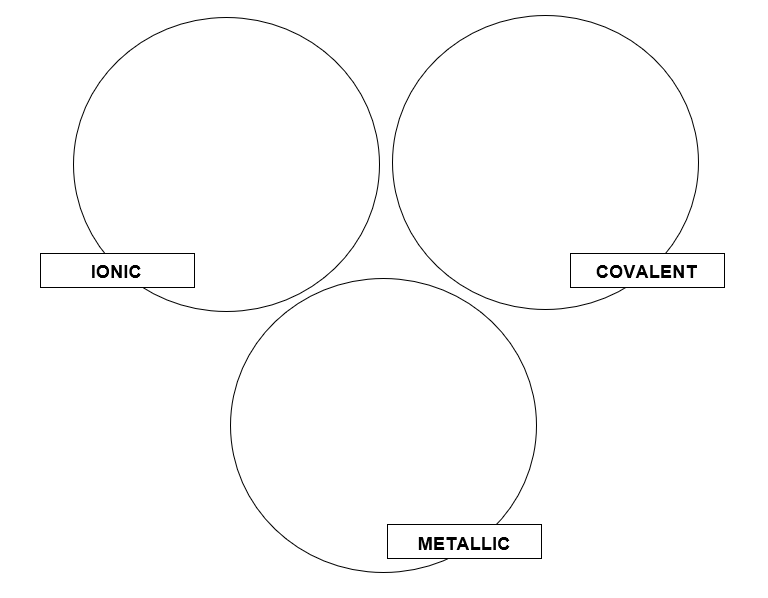
**5.** Sodium cyanide, NaCN

# Which type of chemical bond

There are three types of strong chemical bonds; **ionic**, **covalent** and **metallic**.

1. Sort the compounds below into groups within the circles below according to their chemical bonding;

|  |  |  |
| --- | --- | --- |
| sodium chloride, NaCl | magnesium, Mg | magnesium oxide, MgO |
| methane, CH4 | oxygen, O2 | barium iodide, BaI2 |
| aluminium, Al | ammonia, NH3 | caesium, Cs |



**2.** For each of the types of compound, indicate if you would expect them to;

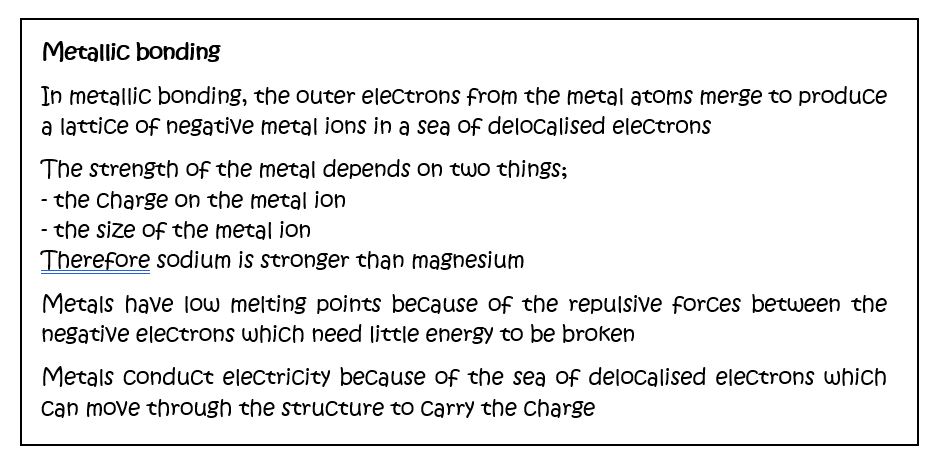
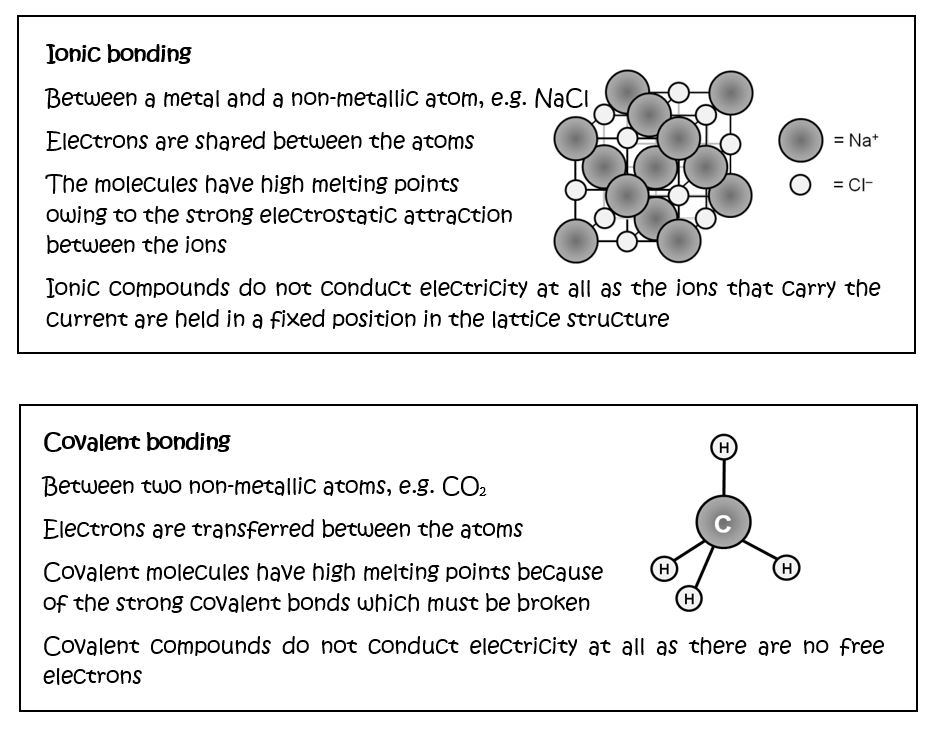
(a)have a high or a low melting point

(b)conduct electricity

# Bonding summary

A student has written the revision cards below to help her prepare for the exam. However she has made a number of mistakes. Can you correct her cards to make sure she has accurate information to revise from;

(1 mark for each correct correction made)



# Co-ordinate bonding

By drawing dot and cross diagrams, decide which of the species below contain a co-ordinate or dative covalent bond in which both electrons in one of the covalent bonds is provided by a single atom.

1. H2S (2 marks)

2. NH4+ (2 marks)

3. H3NBF3 (2 marks)

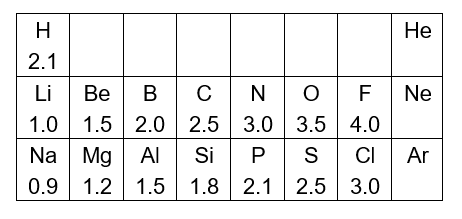
4. CO (2 marks)

5. PF3 (2 marks)

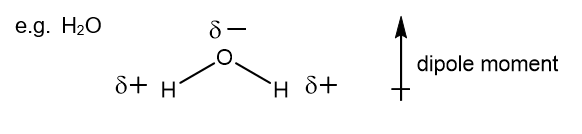
# Electronegativity and polarity

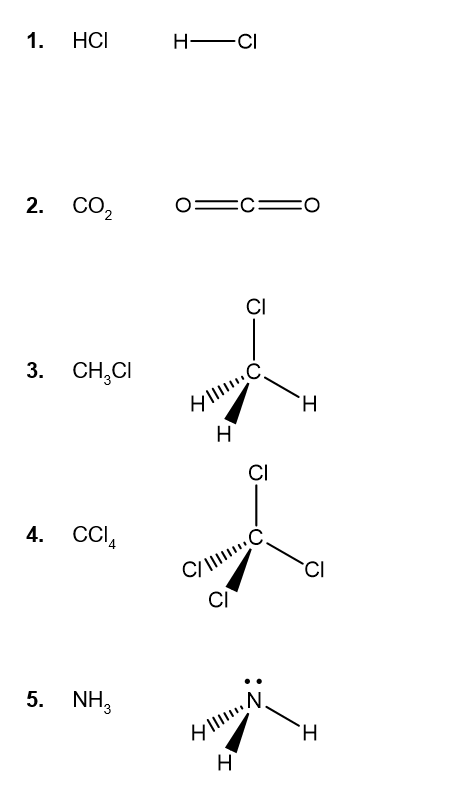
A **polar bond** is a bond in which the electrons between the atoms that are bonded together covalently are shared unequally. The unequal share of electrons is usually shown by a δ+ and a δ– sign. If a molecule contains more than one polar bond, the effect of the polarity of all the bonds in the molecule may result in the molecule having a **dipole moment**.

Use the table of the Pauling electronegativity of different elements to identify any polar bonds in the molecules below. Then use these polar bonds to decide if the molecule has a dipole moment (this can be shown by an arrow with a line through it ; the head of the arrow points towards the negative end.)



(2 marks per molecule)





# Intermolecular forces

Molecules are attracted to each other by weak intermolecular forces. There are three types of intermolecular force;

* Van der Waal’s forces
* Dipole-dipole forces
* Hydrogen bonding

For each group of molecules below, identify the strongest type of intermolecular force present in each molecule (1 mark) and then use this information to order the molecules according to their boiling point, from lowest to highest (1 mark).

**1.** CH4 SiH4 SnH4

**2.** NH3 PH3 AsH3

**3.** HF HCl HBr

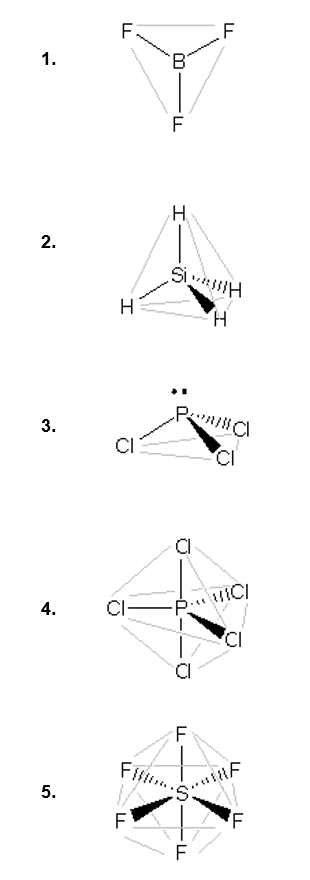
**4.** CH3F CH3Cl CH4

**5.** HF H2O NH3

# Shapes of molecules

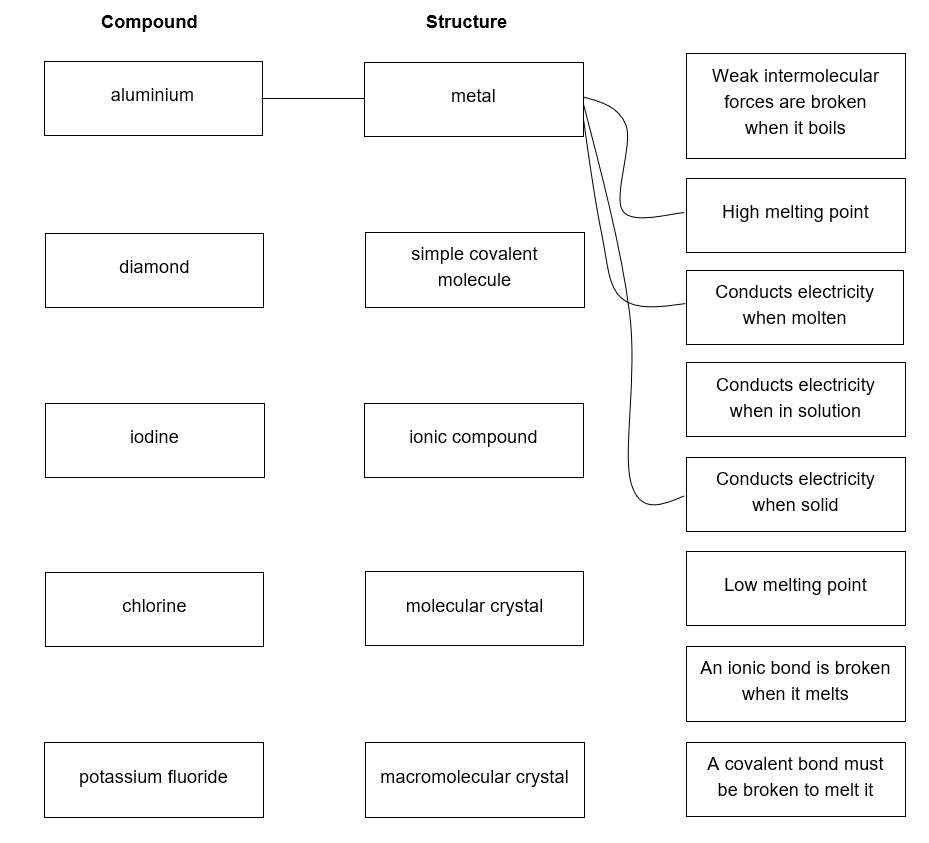
For this activity you need to work with a partner. The diagrams below show the 3 dimensional shapes of some different molecules. Your job is to describe the diagrams to your partner such that they can draw exact copies without seeing the original diagram. Good luck!

(2 marks awarded for each diagram your partner draws)



# Properties and bonding

Match the compound on the left to its correct structure from the middle bank of statements and one or more statements from the column on the right. Aluminium has been done for you.

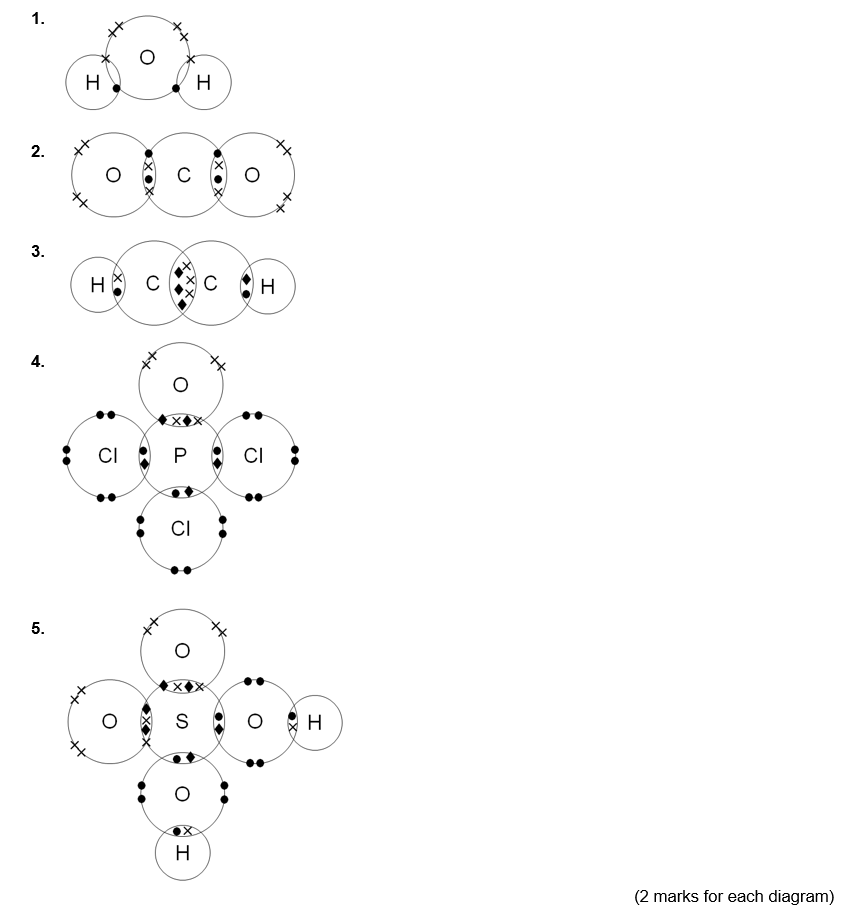


**BONUS MARK** Sketch the arrangement of molecules in a crystal of iodine

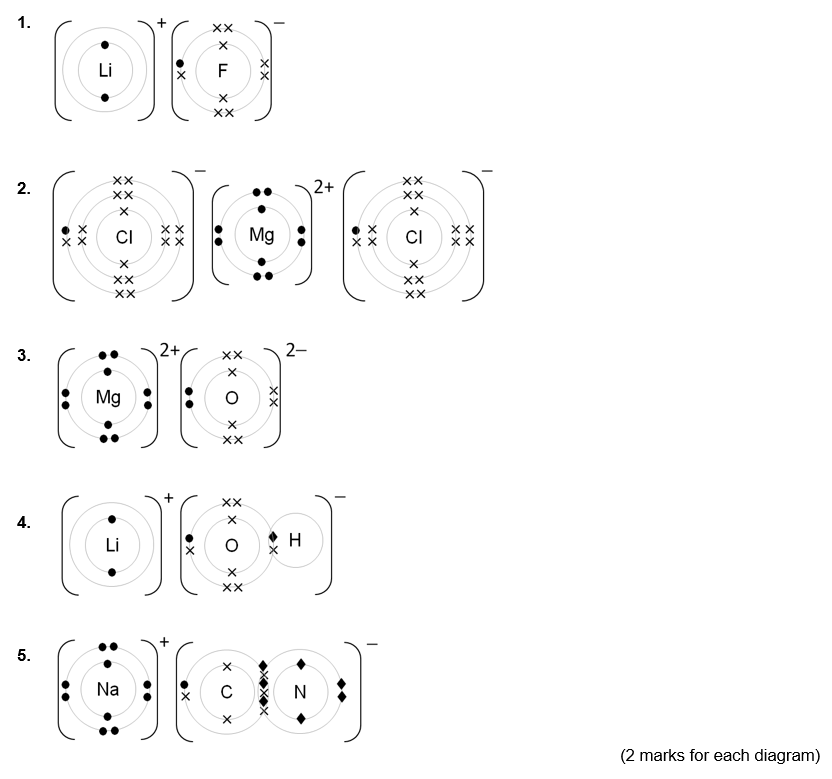
# Bonding – Answers

## The nature of chemical bonds

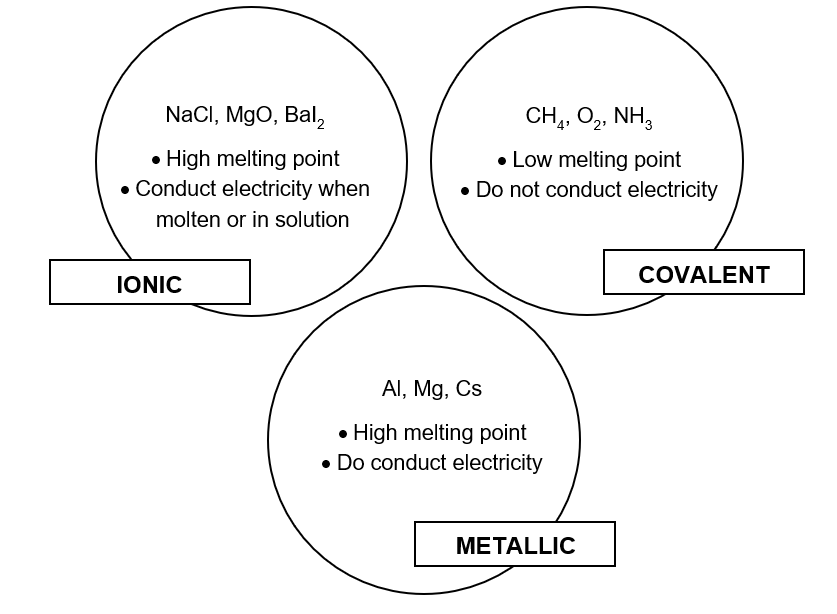
## Covalent dot and cross



# Ionic dot and cross



# Types of chemical bond

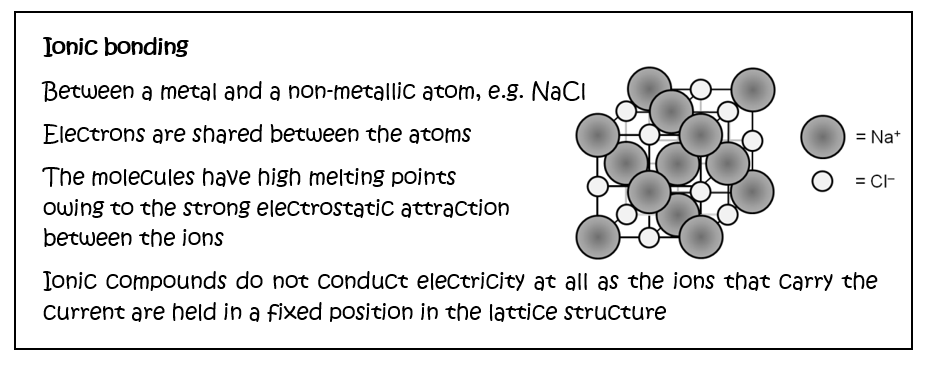


(1 mark for all three of each type correctly identified;

1 mark for each of the six comments relating to melting point / conductivity;

1 bonus mark for clarifying that ionic compounds only conduct when molten or in solution)

## Bonding summary



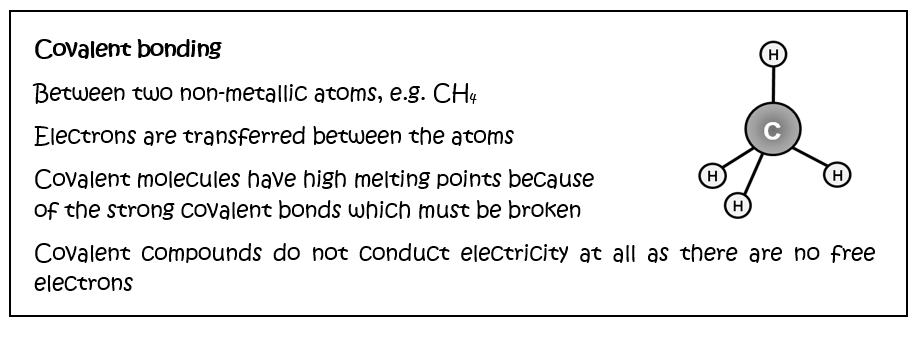
Corrections;

(1 mark) In the diagram the Na+ ion should be smaller than the Cl− ion

(1 mark) Electrons are not shared but transferred between the atoms

(1 mark) Ionic compounds are NOT molecules

(1 mark) Ionic compounds can conduct electricity when molten or in solution

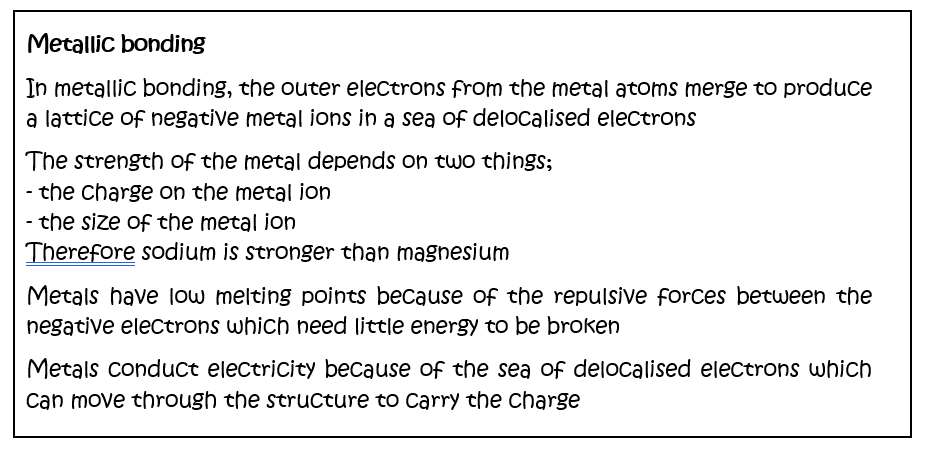


Corrections;

(1 mark) Electrons are shared between atoms not transferred

(1 mark) Covalent molecules have low melting points because……

(1 mark)Only weak intermolecular forces need to be broken (clarification of correction above)



Corrections;

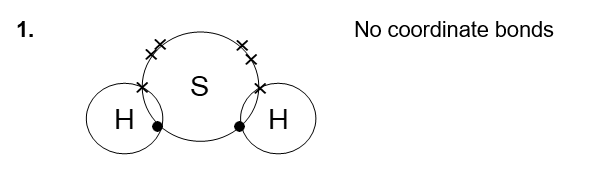
*(*1 mark) The metal ions are positive not negative

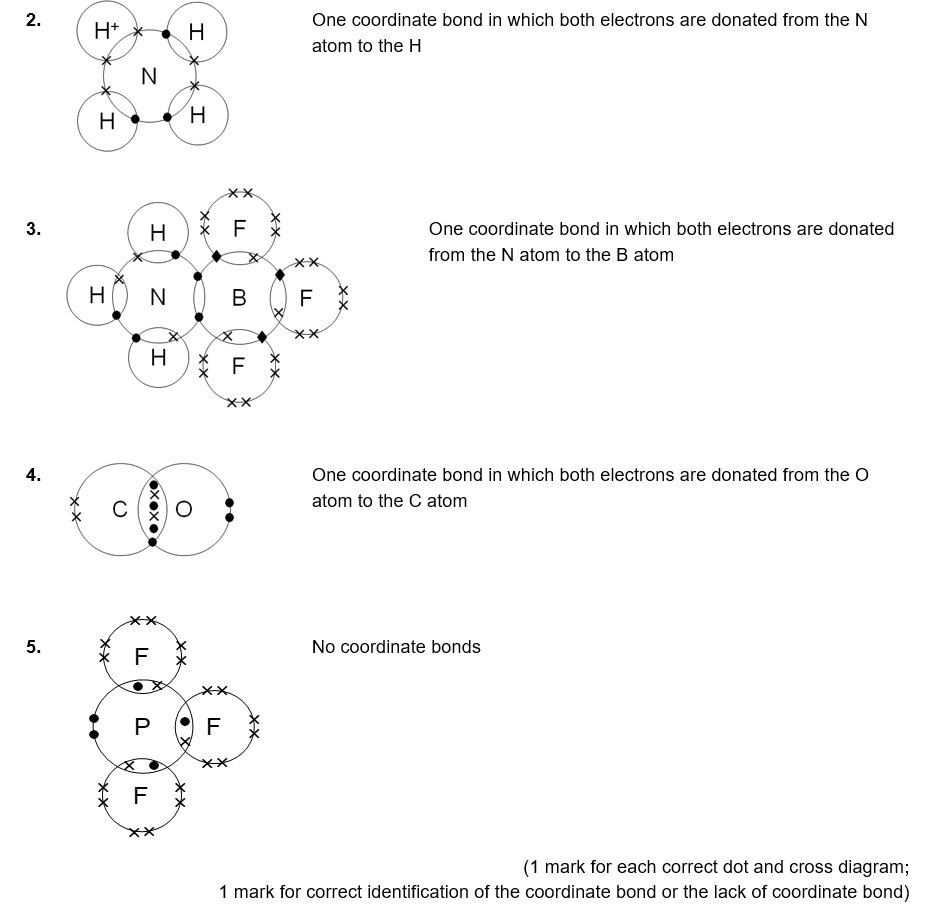
(1 mark) Sodium is weaker than magnesium (following on from the points raised)

(1 mark)Metals have high melting points because of the attractive forces between the positive metal ions and the delocalised sea of electrons.

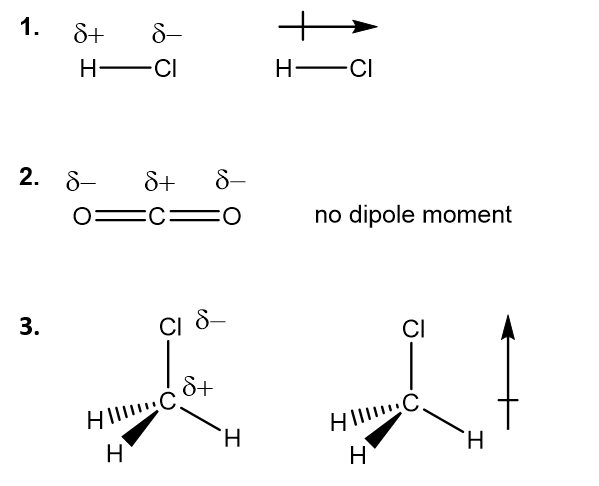
# Covalent bonding

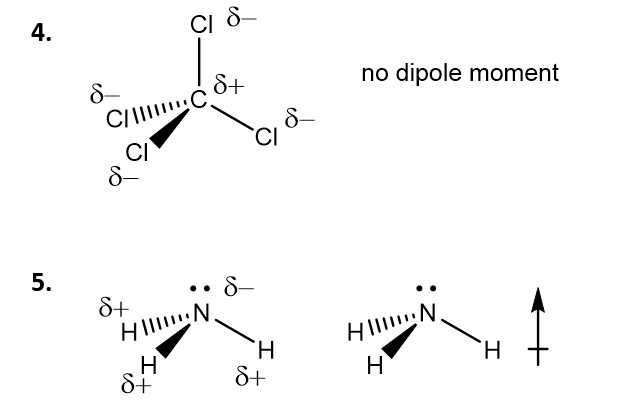
## Coordinate bonding





# Electronegativity and polarity

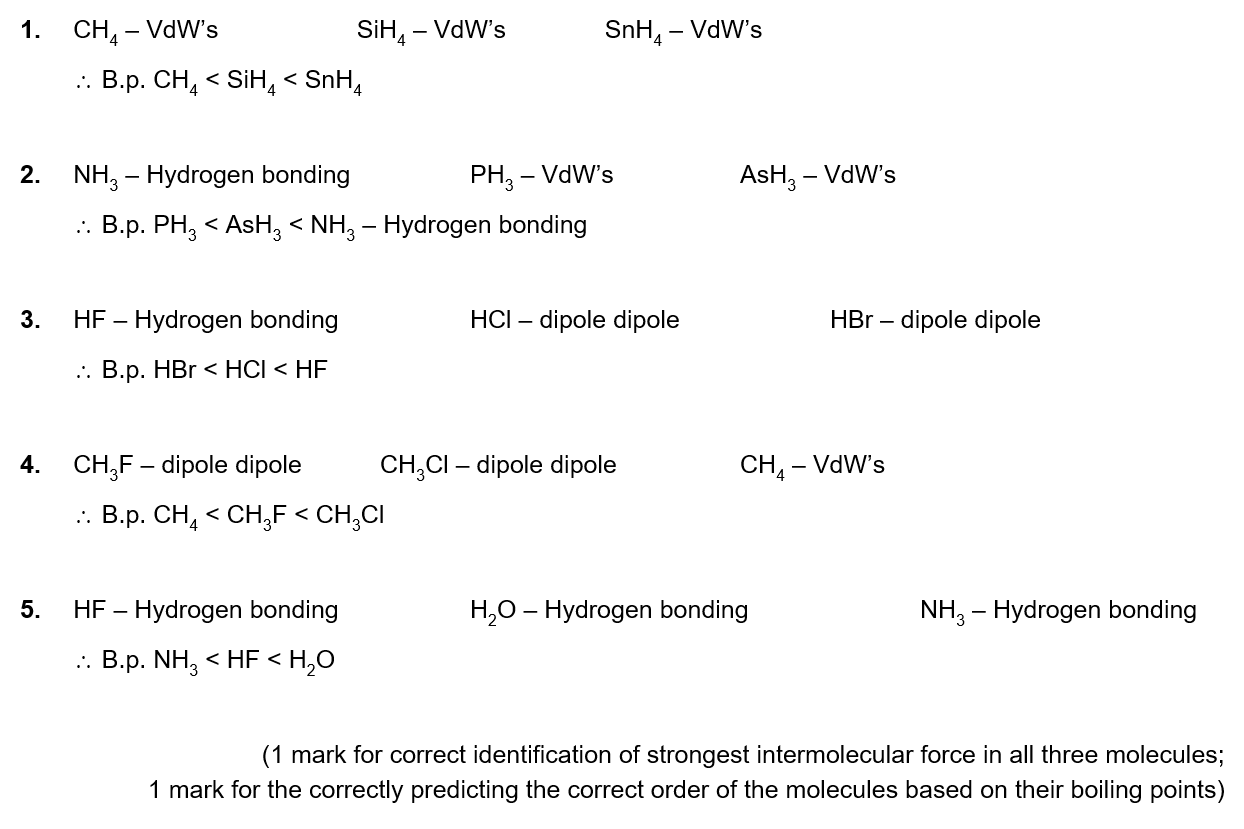




(1 mark for the correct placement of the δ+ and δ−;

1 mark for correct identification of the dipole moment)

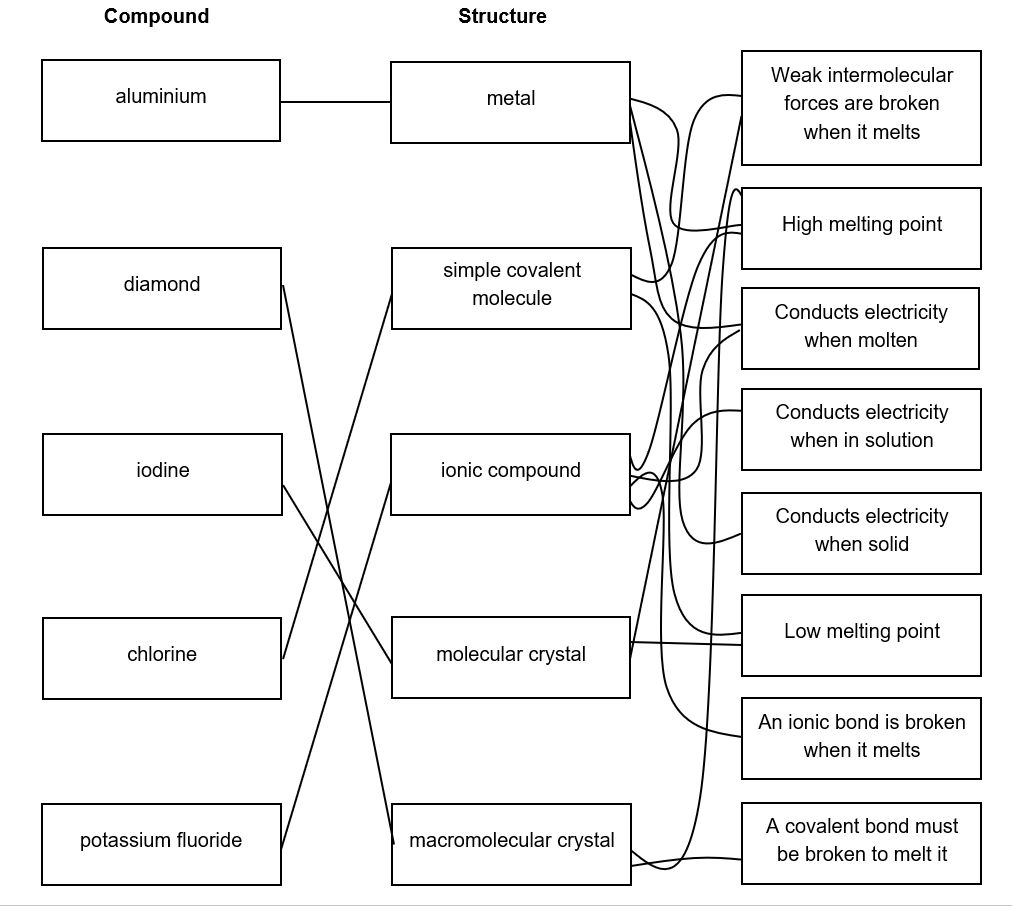
# Intermolecular forces



## Shapes of molecules

2 marks allocated for the drawing of each molecule.

# Properties and bonding



4 marks for the correct identification of the structure of each compound

5 marks for the correct statements (1 mark each for the correct identification of 2 correct statements for diamond, iodine and chlorine, 2 marks for the 4 correct statements for potassium fluoride)

1 Bonus mark;