Edexcel Chemistry A-level

Topic 2 - Bonding and Structure

Flashcards

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What are ions?

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What are ions?

Charged particles that is formed when an atom loses or gains electrons

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What is the charge of the ion when electrons are gained?

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What is the charge of the ion when electrons are gained?

Negative

N.B - positive charge when electrons are lost

E.g. 3^+ ion has lost 3 electrons

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What are molecular ions?

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What are molecular ions?

Covalently bonded atoms that lose or gain electrons

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Which electrons are lost when an atom becomes a positive ion?

CC BY NC ND

Which electrons are lost when an atom becomes a positive ion?

Electrons in the highest energy levels

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Do metals usually gain or lose electrons?

CC BY NC ND

Do metals usually gain or lose electrons?

Lose electrons

N.B - non-metals generally gain electrons

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Which are the 4 elements that don't tend to form ions and why?

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Which are the 4 elements that don't tend to form ions and why?

The elements are beryllium, boron, carbon and silicon

Requires a lot of energy to transfer outer shell electrons

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What are the 3 main types of chemical bonds?

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What are the 3 main types of chemical bonds?

- Ionic
- Covalent
- Metallic

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Define ionic bonding

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Define ionic bonding

The electrostatic attraction between positive and negative ions

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Give an example of a ionically bonded substance

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Given an example of an ionically bonded substance

NaCl (Sodium Chloride - salt)

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What determines the strength of an ionic bond?

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What determines the strength of an ionic bond?

- Ionic radius and ionic charge
- Ionic bonding is stronger and the melting points higher when the ions are smaller and/ or have higher charges.

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Draw the dot and cross diagram to show ionic bonding in MgO

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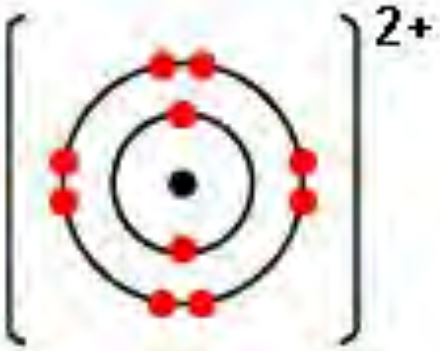
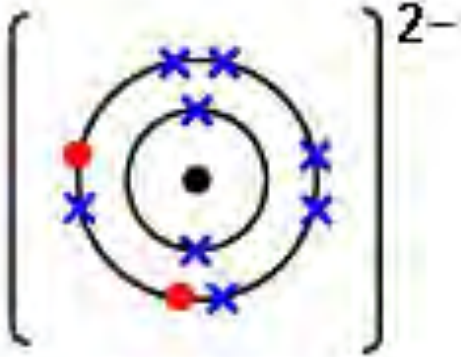
Draw the dot and cross diagram to show ionic bonding in MgO



magnesium ion,
Mg^{2+} $[2,8]^{2+}$



oxide ion,
O^{2-} $[2,8]^{2-}$

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Explain the trend in ionic radius down a group

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Explain the trend in ionic radius down a group

Ionic radii increases going down the group. This is because down the group the ions have more shells of electrons and thus the outermost electron experience less pull from positive nucleus.

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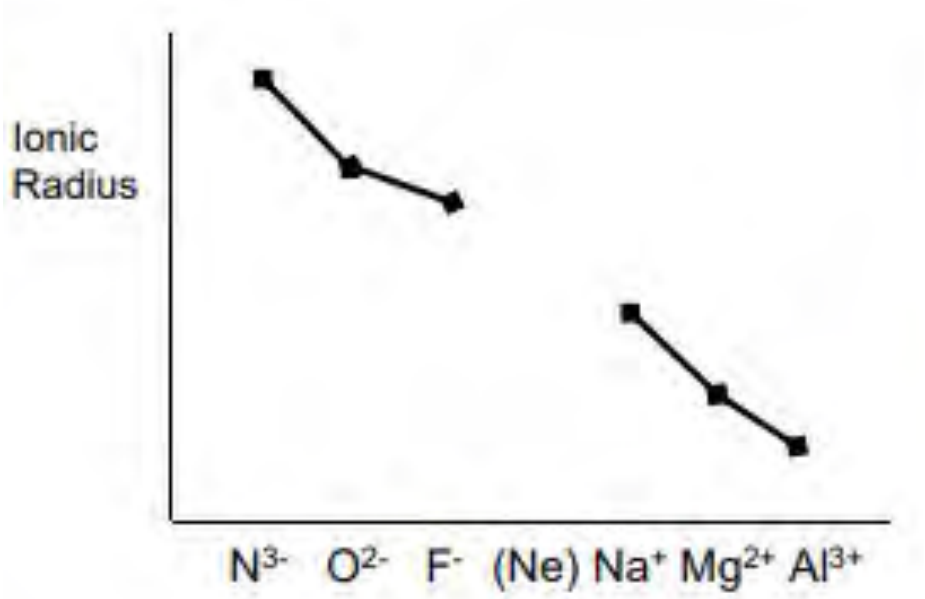
Explain the trend in ionic radius for this set of isoelectronic ions, e.g. N^{3-} to Al^{3+}



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Explain the trend in ionic radius for this set of isoelectronic ions, e.g. N^{3-} to Al^{3+}

There are increasing numbers of protons from N to F and then Na to Al but the same number of electrons. Therefore nuclear attraction between the outermost electrons and nucleus increases and ions get smaller

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What are the physical properties of ionic compounds?

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What are the physical properties of ionic compounds?

- high melting points
- non conductor of electricity when solid
- conductor of electricity when in solution or molten
- brittle /

CC BY NC ND

In a solution of $CuCrO_4$ with connected electrodes which electrode will the 2 ions migrate to?

CC BY NC ND

In a solution of $CuCrO_4$ with connected electrodes which electrode will the 2 ions migrate to?

Cu^{2+} - migrates to negative electrode

CrO_4^{2-} - migrates to positive electrode

CC BY NC ND

Define covalent bonding

CC BY NC ND

Define covalent bonding

Electrostatic attraction between a shared pair of electrons and the nuclei

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Draw a dot and cross diagram for methane - CH_4

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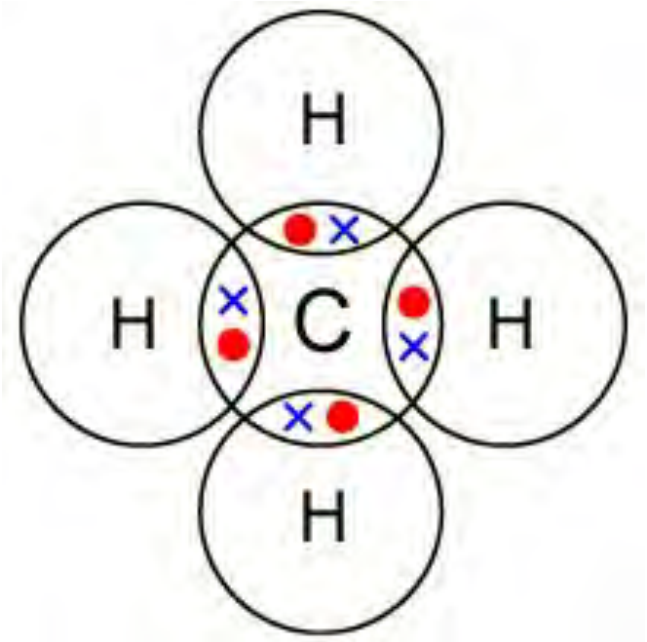
Draw a dot and cross diagram for methane



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Draw a dot and cross diagram for carbon dioxide - CO_2

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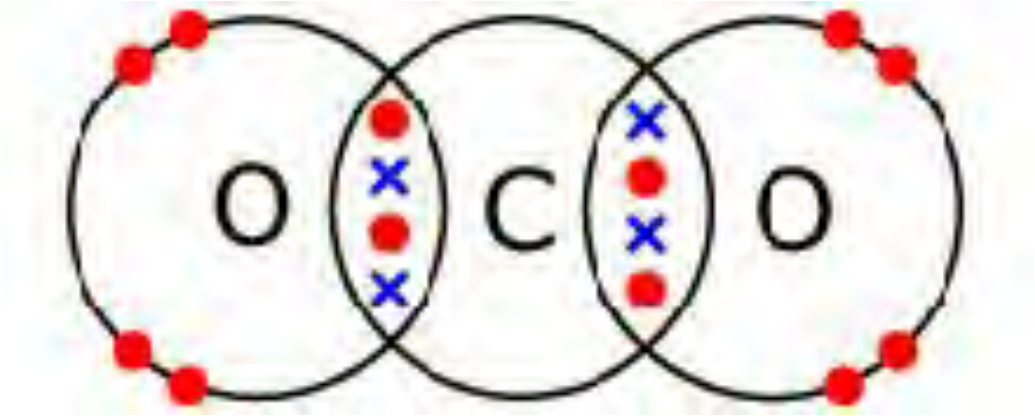
Draw a dot and cross diagram for carbon dioxide



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Draw a dot and cross diagram for nitrogen - N_2

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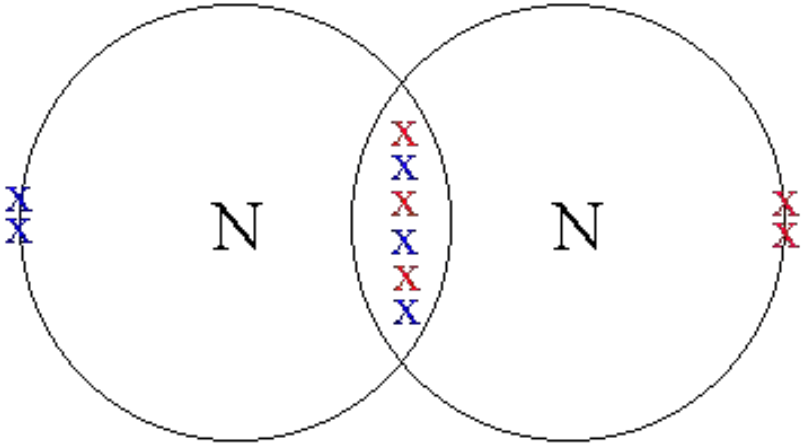
Draw a dot and cross diagram for nitrogen - N_2



CC BY NC ND

Define metallic bonding

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Define metallic bonding

Electrostatic attraction between the positive metal ions and the sea of delocalised electrons

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Electrons in which shell are represented in a dot and cross diagram?

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Electrons in which shell are represented in a dot and cross diagram?

The outer shell

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Why does giant ionic lattices conduct electricity when liquid but not when solid?

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Why does giant ionic lattices conduct electricity when liquid but not when solid?

In solid state the ions are in fixed positions and thus cannot move. When they are in liquid state the ions are mobile and thus can freely carry the charge

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Giant ionic lattices have high or low melting and boiling point? Explain your answer

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Giant ionic lattices have high or low melting and boiling point? Explain your answer

They have high melting and boiling point because a large amount of energy is required to overcome the electrostatic bonds

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In what type of solvents do ionic lattices dissolve?

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In what type of solvents do ionic lattices dissolve?

Polar solvents

E.g water

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Why are ionic compounds soluble in water?

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Why are ionic compounds soluble in water?

Water has a polar bond. Hydrogen atoms have a $\square^{+}$ charge and oxygen atoms have a $\square^{-}$ charge. These charges are able to attract charged ions

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What is it called when atoms are bonded by a single pair of shared electrons?

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What is it called when atoms are bonded by a single pair of shared electrons?

Single bond

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How many covalent bonds does carbon form?

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How many covalent bonds does carbon form?

4

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How many covalent bonds does oxygen form?

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How many covalent bonds does oxygen form?

2

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What is the effect of multiple covalent bonds on bond length and strength?

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What is the effect of multiple covalent bonds on bond length and strength?

Double/triple bonds exert greater electron density therefore the attraction between nucleus and electron is greater resulting in a shorter and stronger bond.

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What is a lone pair?

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What is a lone pair?

Electrons in the outer shell that are not involved in the bonding

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What is formed when atoms share two pairs of electrons?

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What is formed when atoms share two pairs of electrons?

Double bond

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What is formed when atoms share three pairs of electrons?

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What is formed when atoms share three pairs of electrons?

Triple bond

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What is a dative covalent bond?

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What is a dative covalent bond?

A bond where both of the shared electrons are supplied by one atom

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How are oxonium ions formed?

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How are oxonium ions formed?

Formed when acid is added to water, H_3O^+

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Draw a dot and cross diagram to show bonding of Al_2Cl_6

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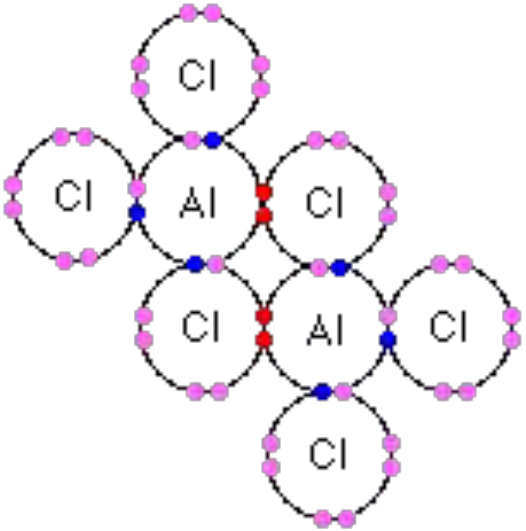
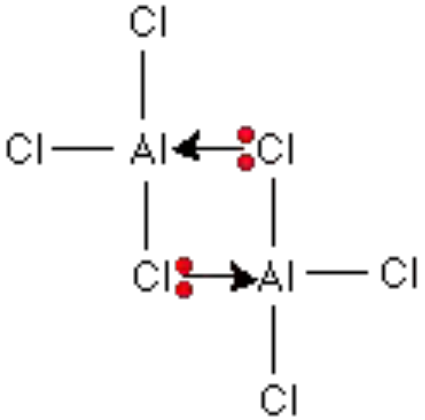
Draw a dot and cross diagram to show bonding of Al_2Cl_6





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What does expansion of the octet mean?

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What does expansion of the octet mean?

When a bonded atom has more than 8 electrons in the outer shell

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What are the types of covalent structure?

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What are the types of covalent structure?

- Simple molecular lattice
- Giant covalent lattice

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Describe the bonding in simple molecular structures

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Describe the bonding in simple molecular structures?

Atoms within the same molecule are held by strong covalent bonds and different molecules are held by weak intermolecular forces

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Why do simple molecular structures have low melting and boiling point?

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Why do simple molecular structures have low melting and boiling point?

Small amount of energy is enough to overcome the intermolecular forces

CC BY NC ND

Can simple molecular structures conduct electricity?

CC BY NC ND

Can simple molecular structures conduct electricity?

No, they are non conductors.

CC BY NC ND

Why do simple molecular structures not conduct electricity?

CC BY NC ND

Why do simple molecular structures not conduct electricity?

The have no free charged particles to move around

CC BY NC ND

Simple molecular structures dissolve in what type of solvent?

CC BY NC ND

Simple molecular structures dissolve in what type of solvent?

Non polar solvents

CC BY NC ND

Give examples of giant covalent structures

CC BY NC ND

Give examples of giant covalent structures

- Diamond
- Graphite
- Silicon dioxide, SiO_2

CC BY NC ND

List some properties of giant covalent structures? (3)

CC BY NC ND

List some properties of giant covalent structures

- High melting and boiling point
- Non conductors of electricity, except graphite
- Insoluble in polar and non polar solvents

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How does graphite conduct electricity?

CC BY NC ND

How does graphite conduct electricity?

Delocalised electrons present between the layers are able to move freely carrying the charge

CC BY NC ND

Why do giant covalent structures have high melting and boiling point?

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Why do giant covalent structures have high melting and boiling point?

Strong covalent bonds within the molecules need to be broken which requires a lot of energy

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Draw and describe the structure of a diamond

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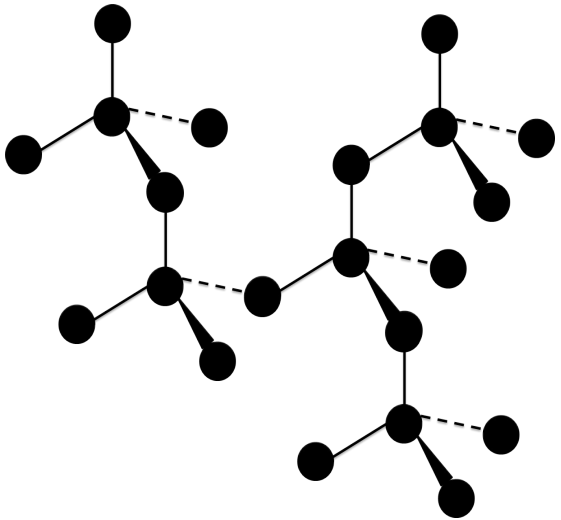
Draw and describe the structure of a diamond

3D tetrahedral structure of C atoms, with each C atom bonded to four others



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What does the shape of a molecule depend on?

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What does the shape of a molecule depend on?

Number of electron pairs in the outer shell

Number of these electrons which are bonded and lone pairs

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What is the shape, diagram and bond angle for $BeCl_2$

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What is the shape, diagram and bond angle in a shape with 2 bonded pairs and 0 lone pairs?

Linear

180°

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What is the shape, diagram and bond angle for BCl_3?

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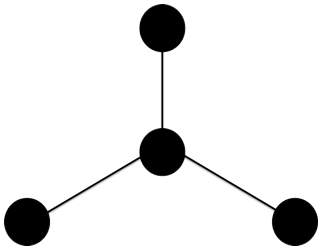
What is the shape, diagram and bond angle in a shape with 3 bonding pairs and 0 lone pairs?

Trigonal planar

120°



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What is the shape, diagram and bond angle for CH_4?

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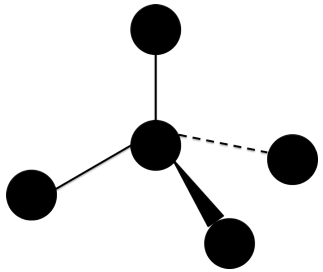
What is the shape, diagram and bond angle in a shape with 4 bonded pairs and 0 lone pairs?

Tetrahedral

109.5°



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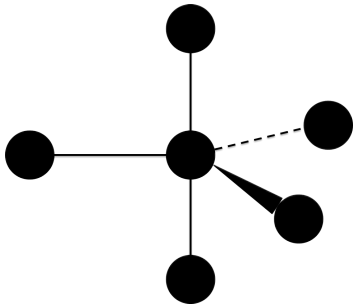
What is the shape,diagram and bond angle for PCl_5?

CC BY NC ND

What is the shape, diagram and bond angle in a shape with 5 bonded pairs and 0 lone pairs?

Trigonal bipyramid

90° and 120°



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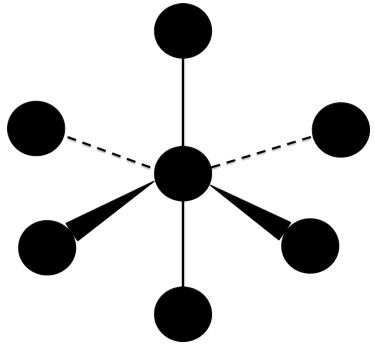
What is the shape, diagram and bond angle for SF_6?

CC BY NC ND

What is the shape, diagram and bond angle in a shape with 6 bonded pairs and 0 lone pairs?

Octahedral

90°



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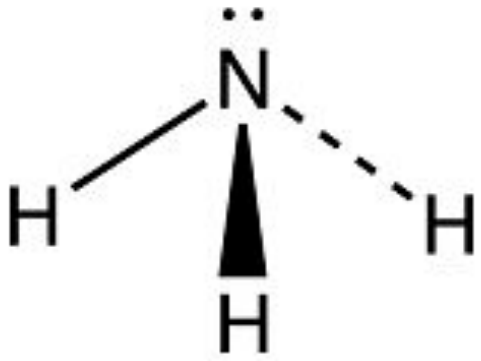
What is the shape, diagram and bond angle for NH_3?

CC BY NC ND

What is the shape, diagram and bond angle in a shape with 3 bonded pairs and 1 lone pairs?

Pyramidal

107°



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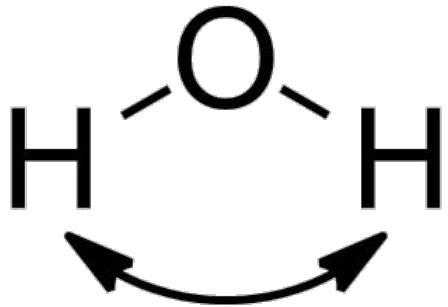
What is the shape, diagram and bond angle for H_2O?

CC BY NC ND

What is the shape, diagram and bond angle in a shape with 2 bonded pairs and 2 lone pairs?

Non linear

104.5°



104.5°

CC BY NC ND

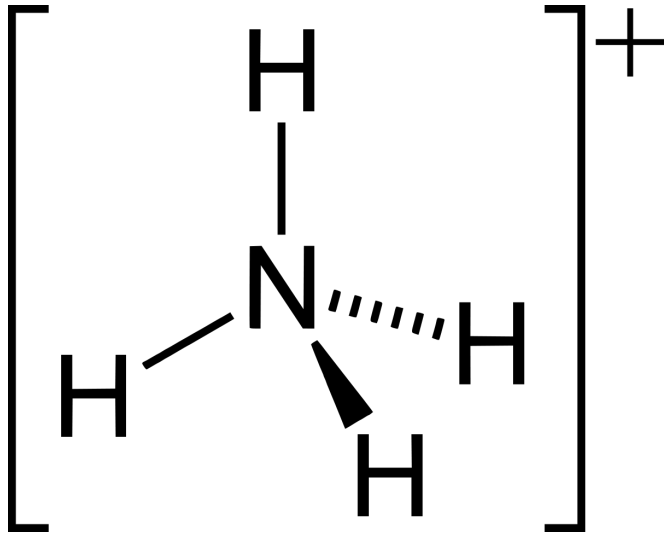
What is the shape, diagram and bond angle for NH_4^+

CC BY NC ND

What is the shape, diagram and bond angle for NH_4^+

Tetrahedral

109.5°



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By how many degrees does each lone pair reduce the bond angle?

CC BY NC ND

By how many degrees does each lone pair reduce the bond angle?

2.5°

CC BY NC ND

Define electronegativity

CC BY NC ND

Define electronegativity

The ability of an atom to attract the pair of electrons (the electron density) in a covalent bond

CC BY NC ND

What scale is electronegativity measured on?

CC BY NC ND

What scale is electronegativity measured on?

Pauling scale

CC BY NC ND

In which direction of the periodic table does electronegativity increase?

CC BY NC ND

In which direction of the periodic table does electronegativity increase?

Top right, towards fluorine

CC BY NC ND

What does it mean when the bond is non-polar?

CC BY NC ND

What does it mean when the bond is non-polar?

The electrons in the bond are evenly distributed

CC BY NC ND

What is the most electronegative element?

CC BY NC ND

What is the most electronegative element?

Fluorine

CC BY NC ND

How is a polar bond formed?

CC BY NC ND

How is a polar bond formed?

Bonding atoms have different electronegativities

CC BY NC ND

Why is H_2O polar, whereas CO_2 is non polar?

CC BY NC ND

Why is H_2O polar, whereas CO_2 is non polar?

CO_2 is a symmetrical molecule, so there is no overall dipole

CC BY NC ND

What is meant by intermolecular force?

CC BY NC ND

What is meant by intermolecular force?

Attractive force between neighbouring molecules

CC BY NC ND

What are the 2 types of intermolecular forces?

CC BY NC ND

What are the 3 types of intermolecular forces?

- Hydrogen bonding
- Permanent dipoles
- London forces

CC BY NC ND

Describe permanent dipole-induced dipole interactions

CC BY NC ND

Describe permanent dipole- induced dipole interactions

- When a molecule with a permanent dipole is close to other non polar molecules it causes the non polar molecule to become slightly polar leading to attraction

CC BY NC ND

Describe permanent dipole-permanent dipole interactions

CC BY NC ND

Describe permanent dipole- permanent dipole interactions

Some molecules with polar bonds have permanent dipoles → forces of attraction between those dipoles and those of neighbouring molecules

CC BY NC ND

Describe London forces

CC BY NC ND

Describe London forces

- London forces are caused by random movements of electrons
- This leads to instantaneous dipoles
- Instantaneous dipole induces a dipole in nearby molecules
- Induced dipoles attract one another

CC BY NC ND

Are London forces greater in smaller or larger molecules?

CC BY NC ND

Are London forces greater in smaller or larger molecules?

Larger due to more electrons

CC BY NC ND

Does boiling point increase or decrease down the noble gas group? Why?

CC BY NC ND

Does boiling point increase or decrease down the noble gas group? Why?

Boiling point increases because the number of electrons increases and hence the strength of London forces also increases

CC BY NC ND

What conditions are needed for hydrogen bonding to occur?

CC BY NC ND

What conditions are needed for hydrogen bonding to occur?

O-H, N-H or F-H bond, lone pair of electrons on O, F, N

Because O, N and F are highly electronegative, H nucleus is left exposed

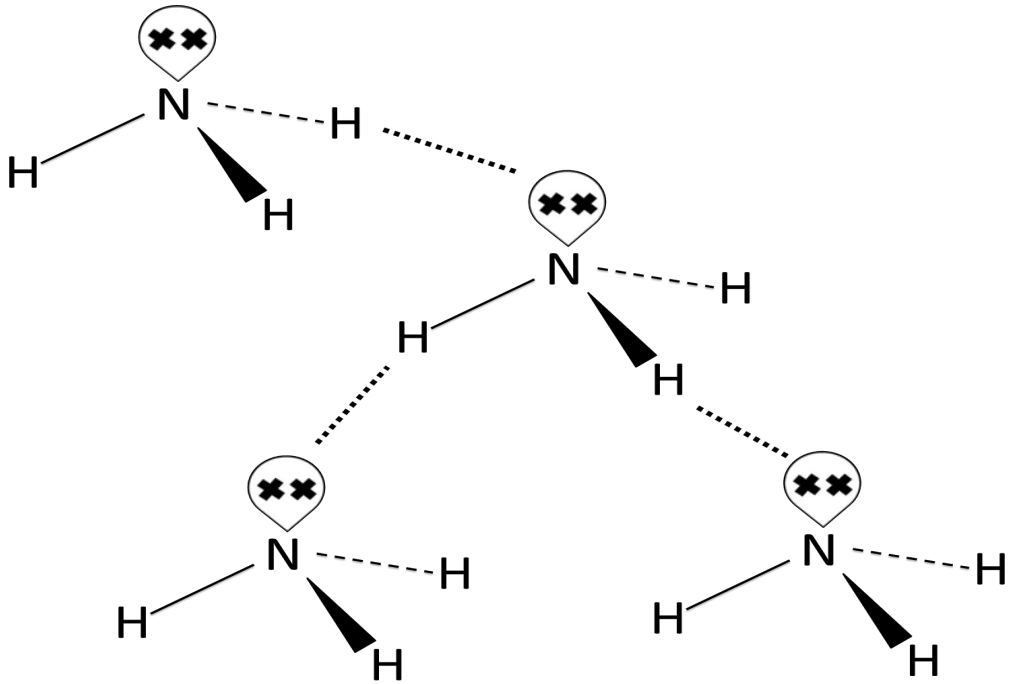
Strong force of attraction between H nucleus and lone pair of electrons on O, N, F

CC BY NC ND

Draw a diagram of hydrogen bonding

CC BY NC ND

Draw a diagram of hydrogen bonding



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Why is ice less dense than liquid water?

CC BY NC ND

Why is ice less dense than liquid water?

- In ice, the water molecules are arranged in a orderly pattern. It has an open lattice with hydrogen bonds.
- In water, the lattice is collapsed and the molecules are closer together.

CC BY NC ND

Why does water have a melting/ boiling point higher than expected?

CC BY NC ND

Why does water have a melting/ boiling point higher than expected?

Hydrogen bonds are stronger than other intermolecular forces so extra strength is required to overcome the forces

CC BY NC ND

What type of intermolecular forces do alkanes have? Why?

CC BY NC ND

What type of intermolecular forces do alkanes have? Why?

London force → induced dipole-dipole interaction, because the bonds are nonpolar

CC BY NC ND

What happens to the boiling point as alkane chain length increases? Why?

CC BY NC ND

What happens to the boiling point as alkane chain length increases? Why?

The boiling point increases because there is more surface area and so more number of induced dipole- dipole interaction. Therefore more energy required to overcome the attraction

CC BY NC ND

Does a branched molecule have lower or higher boiling point compared to equivalent straight chain? Why?

CC BY NC ND

Does a branched molecule have lower or higher boiling point compared to equivalent straight chain? Why?

The branched molecule has a lower boiling point because they have fewer surface area and hence less induced dipole -dipole interactions.

CC BY NC ND

Are alkanes soluble in water? why?

CC BY NC ND

Are alkanes soluble in water? Explain your answer.

Insoluble because hydrogen bonds in water are stronger than alkanes' London forces of attraction

CC BY NC ND

What kind of intermolecular forces do alcohols have? Why?

CC BY NC ND

What kind of intermolecular forces do alcohols have? Why?

Hydrogen bonding, due to the electronegativity difference in the OH bond

CC BY NC ND

How do alcohols' melting point and boiling point compare to other hydrocarbons' of similar C chain lengths? Why?

CC BY NC ND

How do alcohols' melting point and boiling point compare to other hydrocarbons' of similar C chain lengths? Why?

Higher, because they have hydrogen bonding (strongest type of intermolecular force) → stronger than London forces

CC BY NC ND

Are alcohols soluble in water? Why does solubility depend on chain length?

CC BY NC ND

Are alcohols soluble in water? Why does solubility depend on chain length?

Soluble when short chain - OH hydrogen bonds to hydrogen bond in water

Insoluble when long chain - non-polarity of C-H bond takes precedence

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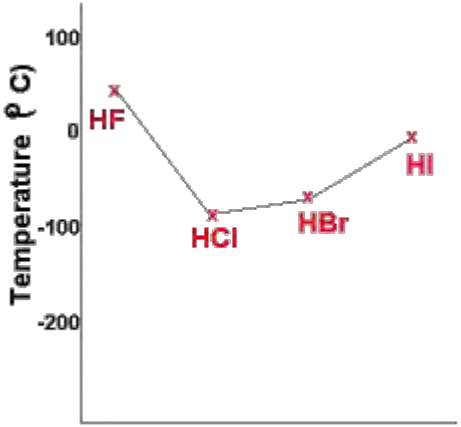
Explain the trend of boiling temperatures of hydrogen halides HF to HI

CC BY NC ND

Explain the trend of boiling temperatures of hydrogen halides HF to HI



There is a general increase of boiling point from HCl to HI which is caused by increasing London forces because of increasing number of electrons. There is a big drop in boiling point from HF to HCl because fluorine is very electronegative therefore the hydrogen bonding is much stronger.