Edexcel IAL Chemistry A-Level

Topic 3 - Bonding and Structure

Flashcards

How is an ion formed?

How is an ion formed?

By the addition or removal of at least one electron.

How does electrolysis provide evidence for the existence of ions?

How does electrolysis provide evidence for the existence of ions?

In a mixture of blue Cu^{2+} ions and yellow CrO_4^- ions:

- When an electric current is applied via two electrodes on opposite ends of the container, the positive Cu^{2+} ions will move towards the negative electrode and the negative CrO_4^- ions will move towards the positive electrode.
- Evidence for this is the fact that one end of the container turns blue and slowly fades to yellow at the other end.

How do electron density maps provide evidence for the existence of ions?

How do electron density maps provide evidence for the existence of ions?

Electron density maps show the likelihood of finding an electron in a particular region.

For example, the electron density map of NaCl shows that:

- Ions are arranged in a regular pattern.
- Cl^- ions are larger than Na^+.
- The ions are separate/discrete as the electron density between ions is zero.

What is an ionic bond?

What is an ionic bond?

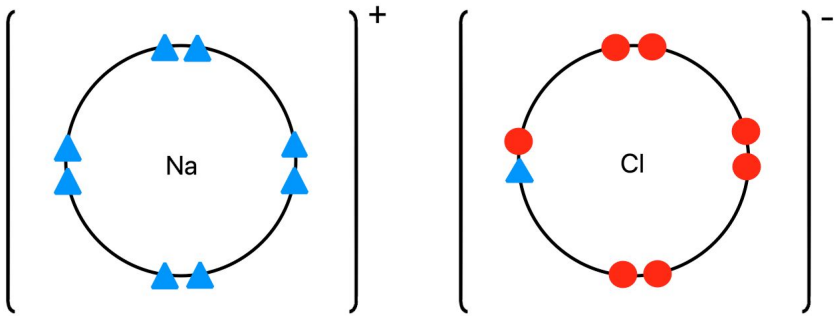
A bond between a positive and negative ion. The ions are held together by strong electrostatic attraction.

Draw a dot-and-cross diagram for the ionic compound NaCl

Draw a dot-and-cross diagram for the ionic compound NaCl

The sodium atom has lost one electron to form a sodium ion, Na^+.

The chlorine atom has gained this electron to form a chloride ion, Cl^-.



What is an ionic crystal?

What is an ionic crystal?

A giant lattice of ions, held together by the electrostatic attraction of oppositely charged ions.

What is the trend in ionic radius down a group and why is this?

What is the trend in ionic radius down a group and why is this?

As you go down the group:

- Nuclear charge increases
- Shielding increases
- Electrostatic attraction decreases

Therefore atomic radius increases as there is less attraction between the nucleus and the electrons.

How does ionic radius and ionic charge affect the strength of ionic bonding?

How does ionic radius and ionic charge affect the strength of ionic bonding?

As the ionic charge increases or the ionic radius decreases, the charge density increases. This increases the strength of the ionic bond.

What is an isoelectronic species?

What is an isoelectronic species?

Species with the same electronic configuration.

What is the trend in ionic radius for a set of isoelectronic species i.e. N^{3-} to Al^{3+}?

What is the trend in ionic radius for a set of isoelectronic species i.e. N^{3-} to Al^{3+}?

As you go from N^{3-} to Al^{3+}:

- The nuclear charge increases.
- Number of electrons remains the same.
- Nuclear attraction increases.
- Ionic radius decreases.

What is polarisation?

What is polarisation?

An attraction between a cation and the outer electrons of an anion can lead to the ionic bond being ‘distorted’.

If distortion is significant, it may lead to a charge cloud developing that is similar to that of a covalent bond.

What does the polarising power of a cation depend upon?

What does the polarising power of a cation depend upon?

It depends upon its charge density (which relies upon charge and ionic radius).

The greater the charge density, the greater the polarising power of the cation.

What does the polarising power of an anion depend upon?

What does the polarising power of an anion depend upon?

It depends on the ionic radius of the anion. This affects how strongly the electrons are held/attracted towards the nucleus.

The larger the anion's ionic radius, the more easily it is polarised.

What is a covalent bond?

What is a covalent bond?

A bond formed that involves the sharing of electron pairs between atoms.

It forms due to the electrostatic attraction between the positive nuclei of the bonded atoms and the negative electrons which are between the two nuclei.

What are some properties of giant covalent structures?

What are some properties of giant covalent structures?

- High melting and boiling points. This is due to a network of millions of strong covalent bonds which require a lot of energy to break.
- Cannot conduct electricity. This is because there are no free charge carriers.

What are some properties of simple molecular covalent structures?

What are some properties of simple molecular covalent structures?

- Low melting and boiling points due to the weak intermolecular forces (van der Waals between molecules).
- Cannot conduct electricity as there are no free charge carriers.

What is a dative covalent bond?

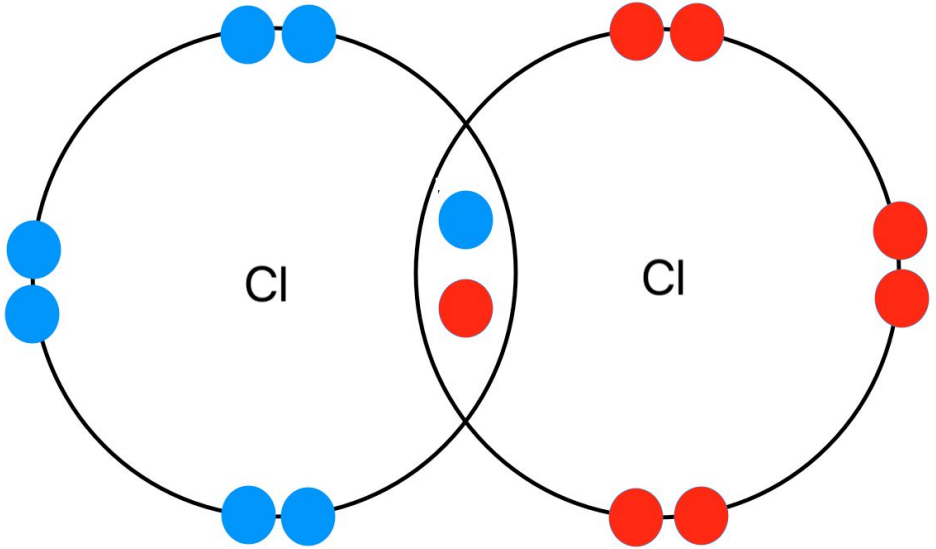
What is a dative covalent bond?

A covalent bond whereby both electrons in the shared pair are donated by one of the bonding atoms only.

How do you draw a dot and cross diagram for Cl_2?

How do you draw a dot-and-cross diagram for Cl_2?

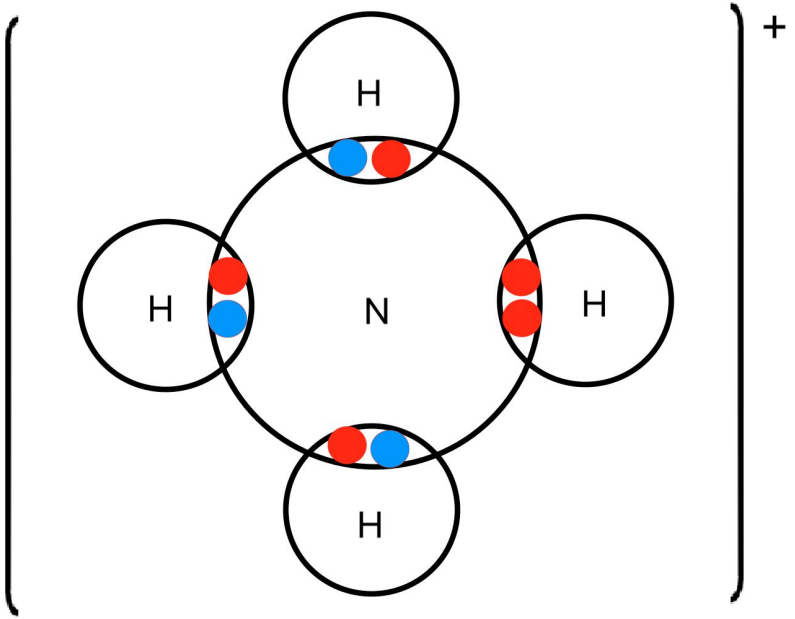
(Showing outer shells only)



How do you draw a dot-and-cross diagram for NH_4^+?

How do you draw a dot-and-cross diagram for NH_4^+?

Each hydrogen atom is covalently bonded to the nitrogen, one of which is a dative covalent bond.



Describe the structure of graphite

Describe the structure and properties relating to graphite

- Each carbon atom bonded to 3 other carbon atoms.
- Layers of hexagonal rings of carbon atoms.
- Weak intermolecular forces between layers.
- One delocalised electron per carbon atom.

Describe and explain the properties of graphite

Describe and explain the properties of graphite

- Soft/slippery because there are only weak intermolecular forces between layers which allow the layers to slide over one another.
- Electrical conductor because there is one delocalised electron per carbon atom. The delocalised electrons are mobile charges.

Describe the structure of diamond

Describe the structure of diamond

All carbon atom are covalently bonded to four other carbon atoms in a rigid, repeating structure.

No delocalised electrons.

Describe the properties of diamond

Describe the properties of diamond

- Very hard due to strong covalent bonding.
- Very high melting point due to covalent bonding.
- Doesn't conduct electricity as there are no charged particles.

What are the uses of graphite? Why?

What are the uses of graphite? Why?

- Electrodes - because graphite conducts electricity and has a high melting point.
- Lubricant - because it's slippery (the layers can slide over each other).

Why is diamond used in cutting tools?

Why is diamond used in cutting tools?

Diamond is very hard

What are the properties of graphene?

What are the properties of graphene?

- High melting point due to covalent bonding between carbon atoms.
- Conducts electricity because it has delocalised electrons.

Why is graphene useful in electronics?

Why is graphene useful in electronics?

It is extremely strong and has delocalised electrons which are free to move and carry charge.

It is only one atom thick as it is a single layer of graphite.

Define electronegativity

Define electronegativity

The power of an atom to attract the electron density in a covalent bond towards itself.

How does the difference in electronegativity between two atoms affect the type of bonding the atoms undergo with one another?

How does the difference in electronegativity between two atoms affect the type of bonding the atoms undergo with one another?

Ionic and covalent bonding are the extremes of a continuum bonding type.

- The greater the difference in electronegativity, the greater the ionic character of the bond.
- The more similar the two electronegativities are, the greater the covalent character of the bond.

How can the electron pair repulsion theory be used to predict the shapes of simple molecules and ions?

How can the electron pair repulsion theory be used to predict the shapes of simple molecules and ions?

The shape of a molecule is determined by the arrangement of electron pairs around the central atom. The electron pairs repel each other which leads to specific shapes depending on how many electron pairs are present. There is greater repulsion between lone pairs compared with bonding pairs.

Repulsion decreases:

Lone pair-lone pair > lone pair-bonding pair > bonding pair-bonding pair

Define bond length

Define bond length

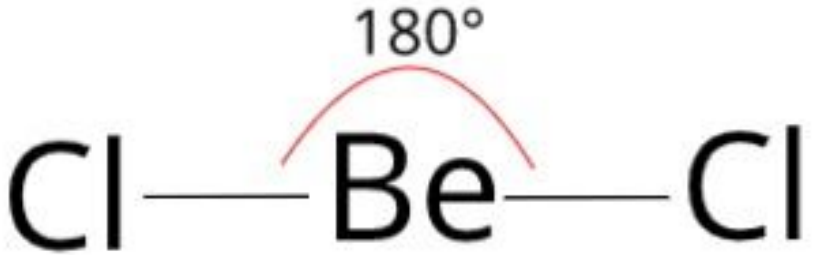
The distance between the nuclei of two bonded atoms in a molecule.

Name the shape of $BeCl_2$.
What is the bond angle?

Name the shape of $BeCl_2$. What is the bond angle?

Linear

Angle = 180°

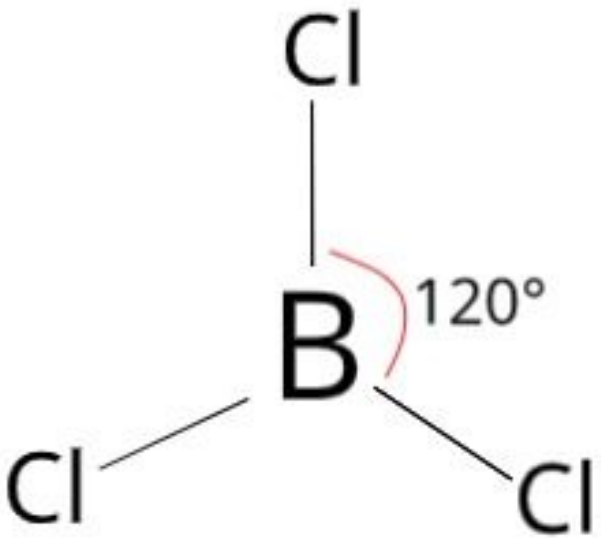


Name the shape of BCl_3.
What is the bond angle?

Name the shape of BCl_3. What is the bond angle?

Trigonal planar

Angle = 120°

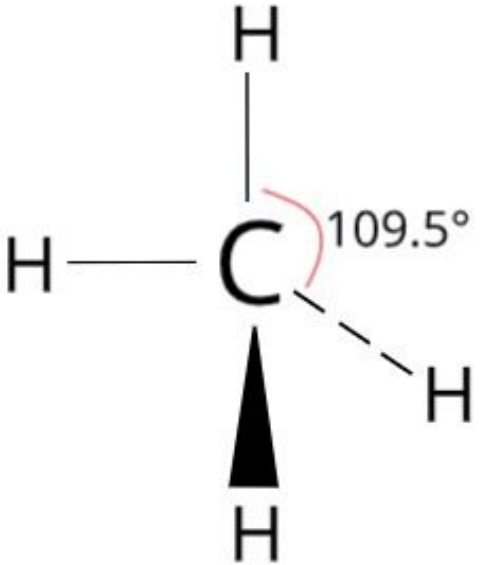


Name the shape of CH_4.
What is the bond angle?

Name the shape of CH_4. What is the bond angle?

Tetrahedral

Angle = 109.5°

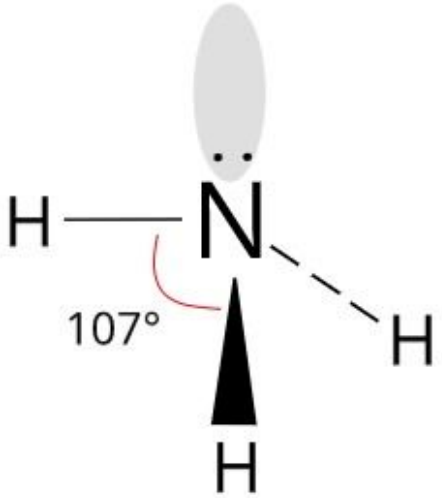


Name the shape of NH_3.
What is the bond angle?

Name the shape of NH_3. What is the bond angle?

Trigonal pyramidal

Bond angle = 107°

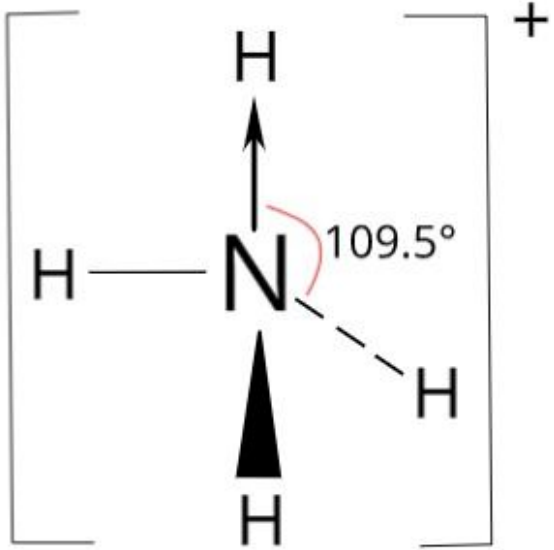


Name the shape of NH_4^+.
What is the bond angle?

Name the shape of NH_4^+. What is the bond angle?

Tetrahedral

Bond angle = 109.5°

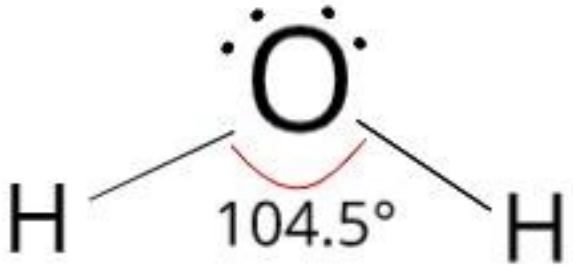


Name the shape of H_2O.
What is the bond angle?

Name the shape of H_2O. What is the bond angle?

Bent

Bond angle = 104.5°

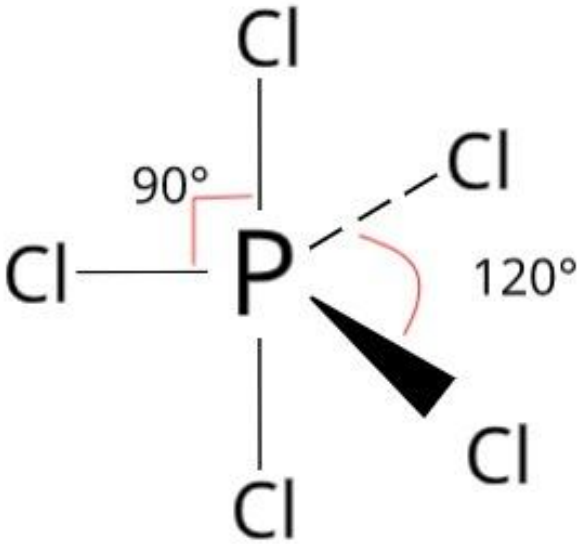


Name the shape of PCl_5.
What are the bond angles?

Name the shape of PCl_5. What are the bond angles?

Trigonal bipyramidal

Bond angles = 90° and 120°

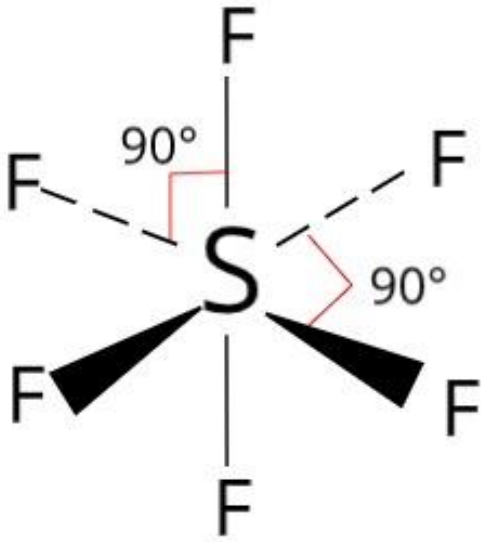


Name the shape of SF_6.
What is the bond angle?

Name the shape of SF_6. What is the bond angle?

Octahedral

Bond angle = 90°



What is metallic bonding?

What is metallic bonding?

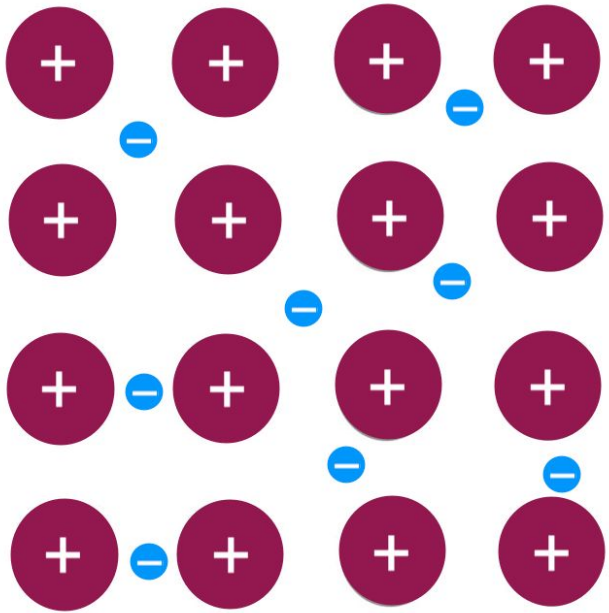
The electrostatic attraction between positive ions (fixed in position) and delocalised (mobile) electrons, to form a giant metallic lattice.

Draw a simplified diagram of metallic bonding

Draw a simplified diagram of metallic bonding

Positive charges = ions

Negative charges = electrons



Why can metals conduct electricity?

Why can metals conduct electricity?

The delocalised electrons are free to move throughout the entire structure and therefore can carry charge.

Why do metals have a high melting point?

Why do metals have a high melting point?

The strong electrostatic attraction between positive ions and delocalised electrons requires a lot of energy to overcome to melt the substance.