WJEC (Eduqas) Chemistry A-level

Physical and Inorganic 2.1 - Chemistry of the p-Block

Flashcards

Why are they called the p-block elements?

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Each of the p-block elements have their outer electron in the p orbital.

What is meant by amphoteric behaviour?

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An amphoteric species can act as both an acid and a base.

Which two p-block elements have amphoteric behaviour?

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Al/Al^{3+}

Pb/Pb^{2+}

What is the chemical equation for the reaction between aluminium oxide and sulfuric acid?

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$$Al_2O_3 + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2O$$

What is the chemical equation for the reaction between aluminium oxide and sodium hydroxide?

What is the chemical equation for the reaction between aluminium oxide and sodium hydroxide?

$$Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$$

What is the chemical equation for the reaction between lead oxide and hydrochloric acid?

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$$PbO + 2HCl \rightarrow PbCl_2 + H_2O$$

What is the chemical equation for the reaction between lead oxide and sodium hydroxide?

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$$PbO + NaOH + H_2O \rightarrow NaPb(OH)_3$$

What is the inert pair effect?

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The tendency of electrons in the outer s orbital to remain unionised and unshared. It is used to explain the increasing stability of the oxidation states that are two less than the group valency for Groups 3, 4, and 5 (also known as Groups 13, 14 and 15).

Describe how the stability of oxidation states changes down Group 3

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In Group 3 (Group 13) the stability of the +1 oxidation state increases down the group.

The Tl^{+} ion is much more common than the Tl^{3+} ion, whereas at the top of the group the Al^{+} ion is very rare due to its instability and hence the Al^{3+} ion is more common.

Describe how the stability of oxidation states changes down Group 4

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In Group 4 (Group 14), stability of the +4 oxidation state reduces down the group, whilst stability of the +2 oxidation state increases down the group.

Describe how the stability of oxidation states changes down Group 5

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In Group 5 (Group 15), stability of the +5 oxidation state reduces down the group, whilst stability of the +3 oxidation state increases down the group.

Describe the structure and bonding in Al_2Cl_6

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Aluminium Hexachloride (Al_2Cl_6) is a donor-acceptor dimer. It is made up of two separate, identical molecules which are linked together by two dative bonds. Two atoms of chlorine share their lone pair of electrons with two atoms of aluminium to form the dative bonds.

Draw the structure of Al_2Cl_6

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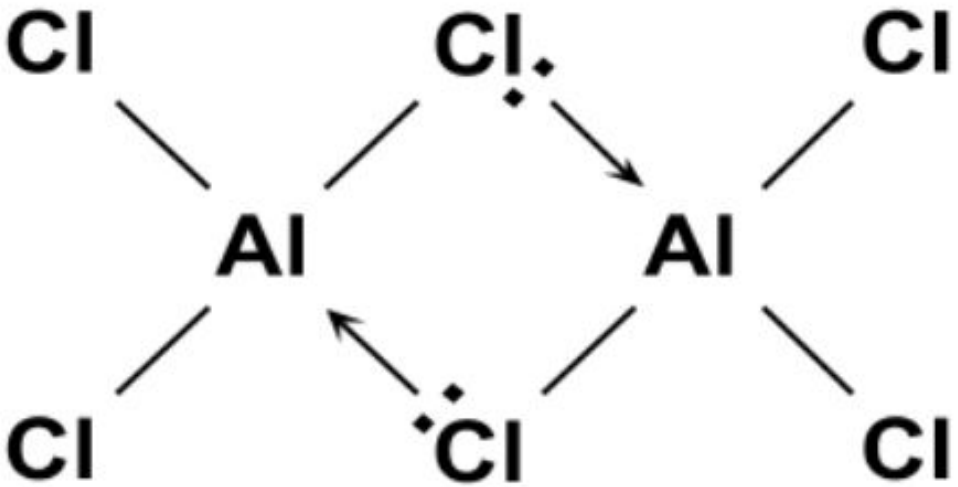

Describe the structure and bonding in NH_3BF_3

Describe the structure and bonding in NH_3BF_3

NH_3BF_3 is a donor-acceptor compound.

There is a dative coordinate bond formed between nitrogen and boron atom, where nitrogen supplies both the electrons for the covalent bond.

Describe the structure of cubic boron nitride

Describe the structure of cubic boron nitride

The cubic form of boron nitride consists of alternately linked boron and nitrogen atoms. The structure is a tetrahedral bond network which is similar to that of the carbon atoms in diamond. The lone pair of electrons on nitrogen are accepted by boron to give this giant 3D covalent lattice.

Describe the structure of hexagonal boron nitride

Describe the structure of hexagonal boron nitride

Hexagonal boron nitride has a layered structure which is similar to graphite. The layers form a 2D giant covalent network. The alternate boron and nitrogen atoms link together and form hexagonal rings in thin layers which are held together by weak intermolecular forces.

Explain which boron nitride structure is suitable to be used as a lubricant

Explain which boron nitride structure is suitable to be used as a lubricant

The hexagonal boron nitride structure has weak intermolecular forces between the layers and so these layers can slide, making it suitable to be used as a lubricant.

Identify the reducing agent in the following reaction

$$CuO + CO \rightarrow Cu + CO_2$$

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$CuO + CO \rightarrow Cu + CO_2$

Cu: $2+ \rightarrow 0$ (reduced)

C: $2+ \rightarrow 4+$ (oxidised)

The reducing agent is carbon monoxide.

What is the chemical equation for the reaction between PbO_2 and hydrochloric acid?

Identify the oxidising agent

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Identify the oxidising agent

$$PbO_2 + 4HCl \rightarrow PbCl_2 + 2H_2O + Cl_2$$

The oxidising agent is $Pb(IV)/Pb^{4+}$.

Describe the general acid-base behaviour trend of the Group 4 oxides

Describe the general acid-base behaviour trend of the Group 4 oxides

Acidity of the Group 4 oxides decreases as you go down the group. The oxides towards the bottom are more basic, however they don't completely lose their acidic character so they are described as amphoteric.

Explain the acid-base properties of carbon dioxide and lead oxide in relation to their position in Group 4

Explain the acid-base properties of carbon dioxide and lead oxide in relation to their position in Group 4

Carbon is at the top of Group 4 so carbon dioxide is acidic in nature and can react with bases.

Lead is towards the bottom of Group 4 so lead oxide is amphoteric in nature, meaning it can react with acids and bases.

Compare the reactions of CCl_4, $SiCl_4$ and $PbCl_2$ with water

Compare the reactions of CCl_4, $SiCl_4$ and $PbCl_2$ with water

CCl_4 does not react with water.

$SiCl_4$ reacts violently with water.

$PbCl_2$ is partially soluble in cold water but more soluble in hot water.

Why does CCl_4 tend to not react with water?

Why does CCl_4 tend to not react with water?

For the reaction to take place, the oxygen's lone pair from water needs to bond to the carbon atom in CCl_4. the reaction doesn't occur for various reasons:

The chlorine atoms are very bulky and the carbon atom is very small so it is hard for the oxygen to get near the carbon atom. There would also be a lot of repulsion between the various lone pairs as the oxygen atom gets close to the chlorine atoms, which would make this transition state very unstable. Also, there is not a convenient empty orbital for the oxygen to bond to on the carbon atom.

How is $SiCl_4$ able to react with water?

How is $SiCl_4$ able to react with water?

The silicon atom is relatively big so there is space for the oxygen atom on water to attack the silicon atom. Silicon also has empty 3d orbitals which can accept a lone pair of electrons from the oxygen atom.

Explain how $PbCl_2$ reacts with water

Explain how $PbCl_2$ reacts with water

$PbCl_2$ has a lot of ionic character and therefore can be thought of as being ionic in its reaction with water. $PbCl_2$ is slightly soluble in cold water but much more soluble in hot water.

What is the chemical equation for the reaction of $SiCl_4$ with water?

What is the chemical equation for the reaction of $SiCl_4$ with water?

$$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$$

What is the chemical equation for the reaction of Pb^{2+} ions with OH^- ions?

What is the chemical equation for the reaction of Pb^{2+} ions with OH^- ions?

$$Pb^{2+} + 2OH^- \rightarrow Pb(OH)_2$$

$Pb(OH)_2$ dissolves in excess OH^-:

$$Pb(OH)_2 + 2OH^- \rightarrow [Pb(OH)_4]^{2-}$$

What is the chemical equation for the reaction of $Pb^{2+}(aq)$ ions with Cl^- ions?

What is the chemical equation for the reaction of $Pb^{2+}(aq)$ ions with Cl^- ions?

$$Pb^{2+} + 2Cl^- \rightarrow PbCl_2$$

With excess Cl^-:

$$PbCl_2 + 2Cl^- \rightarrow [PbCl_4]^{2-}$$

What is the chemical equation for the reaction of $Pb^{2+}(aq)$ ions with I^- ions?

What is the chemical equation for the reaction of $Pb^{2+}(aq)$ ions with I^- ions?

$$Pb^{2+} + 2I^- \rightarrow PbI_2$$

What is a disproportionation reaction?

What is a disproportionation reaction?

A reaction in which a species simultaneously undergoes oxidation and reduction to form two different products.

What is the chemical equation for the disproportionation reaction that chlorine undergoes with cold sodium hydroxide?

What is the chemical equation for the disproportionation reaction that chlorine undergoes with cold sodium hydroxide?

$$2NaOH + Cl_2 \longrightarrow NaClO + NaCl + H_2O$$

What is the chemical equation for the disproportionation reaction that chlorine undergoes with warm sodium hydroxide?

What is the chemical equation for the disproportionation reaction that chlorine undergoes with warm sodium hydroxide?

$$6NaOH + 3Cl_2 \rightarrow NaClO_3 + 5NaCl + 3H_2O$$

What is the chemical equation for the disproportionation reaction that chlorine undergoes with water?

What is the chemical equation for the disproportionation reaction that chlorine undergoes with water?

$$Cl_2 + H_2O \rightleftharpoons 2H^+ + Cl^- + ClO^-$$

Why are chlorine and chlorate ions used in water treatment?

Why are chlorine and chlorate ions used in water treatment?

They kill bacteria which makes the water safe. This is a result of their oxidising power.

How do chlorine and fluorine react with concentrated sulfuric acid?

How do sodium chloride and sodium fluoride react with concentrated sulfuric acid?

Chlorides and fluorides aren't oxidised by sulfuric acid:

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$$

$$NaF + H_2SO_4 \longrightarrow NaHSO_4 + HF$$

How do bromide ions react with concentrated sulfuric acid?

How do bromide ions react with concentrated sulfuric acid?

Bromide ions can reduce concentrated sulfuric acid:

$$2Br^- + H_2SO_4 + 2H^+ \longrightarrow Br_2 + SO_2 + 2H_2O$$

How do iodide ions react with concentrated sulfuric acid?

How do iodide ions react with concentrated sulfuric acid?

Iodide ions are stronger reducing agents than bromide ions:

$$8I^- + H_2SO_4 + 8H^+ \longrightarrow 4I_2 + H_2S + 4H_2O$$