Edexcel International GCSE Chemistry Specification Questions and Answers.

Any questions in a red box are for Paper 2 only. These topics will not be assessed in Paper 1.

Any questions in an orange box are connected with practical work that is stated in the specification.

Inorganic Chemistry

Group 1 (alkali metals) – lithium, sodium and potassium

How do the similarities in the reactions of Group 1 elements with water provide evidence for their recognition as a family of elements?

The Group 1 elements, also known as alkali metals, share many similar chemical properties. One of these properties is their reaction with water.

When an alkali metal is added to water, it reacts vigorously, producing hydrogen gas and a metal hydroxide. This reaction is exothermic, meaning that it releases heat.

The similarities in the reactions of Group 1 elements with water provide evidence for their recognition as a family of elements because they all have one valence electron in their outermost shell, which makes them highly reactive. As a result, they all react in a similar manner with water, producing hydrogen gas and metal hydroxide.

Additionally, the reactivity of alkali metals with water increases down the group, with the more reactive elements producing more vigorous reactions. This trend is due to the increasing atomic radius and decreasing ionization energy down the group, which makes it easier for the outermost electron to be lost and react with water.

How do the differences between the reactions of Group 1 elements with air and water provide evidence for the trend in reactivity in Group 1?

Although all the alkali metals react with both water and air, the extent and nature of these reactions differ. Alkali metals react with air to form a layer of oxide on their surface, which prevents further reaction with air. However, this oxide layer is not stable in water, leading to a reaction between the metal and water.

The differences in the reactions of Group 1 elements with air and water provide evidence for the trend in reactivity in Group 1. As mentioned earlier, the reactivity of alkali metals increases down the group, which means that the more reactive elements react more vigorously with water. This is evidenced by the fact that cesium, the most reactive alkali metal, reacts explosively with water, whereas lithium, the least reactive alkali metal, reacts slowly and less violently.

Similarly, the extent of reaction with air increases down the group, with the more reactive elements producing a thicker layer of oxide on their surface.

This is due to the increasing ease with which the outermost electron can be lost, allowing for the formation of a more stable oxide layer.

How can knowledge of trends in Group 1 be used to predict the properties of other alkali metals?

Knowledge of trends in Group 1 can be used to predict the properties of other alkali metals. For example, we can predict that the next alkali metal, after cesium, would have a larger atomic radius, lower ionization energy, and be more reactive than cesium. It would also have a lower melting and boiling point and a higher density, as these properties generally increase down the group.

We can also predict that the next alkali metal would have a lower electronegativity and a more positive electron affinity than cesium, as these properties generally decrease down the group. In addition, it would be more likely to form ionic compounds with non-metals, and these compounds would have a higher solubility in water, as the ionic radius increases down the group.

What is the trend in reactivity in Group 1 elements, and how is it related to their electronic configurations?

The trend in reactivity in Group 1 elements is that their reactivity increases as we move down the group, with the lower elements being more reactive than the higher ones. This trend is directly related to the electronic configurations of the elements.

How does the electronic configuration of Group 1 elements affect their reactivity?

All Group 1 elements have a single valence electron in their outermost shell, which is the outermost energy level where electrons can exist. This valence electron is only weakly held to the nucleus, as it is shielded from the positively charged nucleus by the other electrons in the atom.

How does the shielding effect of the inner electrons affect the reactivity of Group 1 elements?

The shielding effect of the inner electrons reduces the attractive force between the positively charged nucleus and the valence electron, making it easier for the valence electron to be removed. This means that the outermost electron of Group 1 elements is very loosely held to the nucleus, making these elements highly reactive.

Group 7 (halogens) – chlorine, bromine and iodine

What are the colors and physical states of the halogens at room temperature?

At room temperature, fluorine (F) is a pale yellow gas, chlorine (Cl) is a greenish-yellow gas, bromine (Br) is a reddish-brown liquid, iodine (I) is a bluish-black solid, and astatine (At) is a dark grey/black solid.

What trend can be observed in the physical properties of the halogens down Group 7?

As we go down Group 7, the halogens have increasing atomic size, mass, and boiling points. Their reactivity with other elements also decreases down the group.

How can knowledge of trends in Group 7 be used to predict the properties of other halogens?

The trend in physical properties down Group 7 can be used to predict the physical properties of other halogens that are not commonly studied. For example, we can predict that a hypothetical halogen below astatine (At) in the periodic table would have a higher atomic mass, boiling point, and melting point than astatine.

How do displacement reactions involving halogens and halides provide evidence for the trend in reactivity in Group 7?

Displacement reactions involving halogens and halides demonstrate the trend in reactivity down Group 7. For example, when a more reactive halogen (such as chlorine) is added to a solution containing a less reactive halide (such as iodide), the more reactive halogen will displace the less reactive halide from its compound, forming a new compound with the more reactive halogen. This is evidence that the more reactive halogens are more likely to displace the less reactive halogens in a chemical reaction.

How can the trend in reactivity in Group 7 be explained in terms of electronic configurations?

The trend in reactivity down Group 7 can be explained in terms of electronic configurations. As we go down the group, the halogens have more occupied energy levels, which means they have a higher electron shielding effect and less attraction to the nucleus. This makes it easier for the halogens to gain an electron and form a negative ion. Therefore, the trend in reactivity down the group is that the halogens become more reactive as they have a greater tendency to gain an electron to form a more stable, negative ion.

Gases in the atmosphere

What are the approximate percentages by volume of the four most abundant gasses in dry air?

The four most abundant gasses in dry air are nitrogen (78%), oxygen (21%), argon (0.9%), and carbon dioxide (0.04%).

How can the percentage by volume of oxygen in air be determined using experiments involving the reactions of metals and non-metals with air?

The percentage by volume of oxygen in air can be determined using experiments involving the reactions of metals and non-metals with air. For example, when a piece of iron is heated in air, it reacts with oxygen to form iron oxide. By measuring the mass of the iron before and after the reaction, the mass of oxygen that reacted with the iron can be calculated. From this, the percentage by volume of oxygen in air can be calculated. Similar experiments can be performed using other metals and non-metals, such as phosphorus.

Can you describe the combustion of elements in oxygen, including magnesium, hydrogen, and sulfur?

When magnesium metal is heated in oxygen, it burns brightly with a white light, forming magnesium oxide. Hydrogen gas also burns in oxygen, producing water vapor. Sulfur burns in oxygen with a blue flame, forming sulfur dioxide gas.

Can you describe the formation of carbon dioxide from the thermal decomposition of metal carbonates, including copper(II) carbonate?

When copper(II) carbonate is heated, it undergoes thermal decomposition to form copper(II) oxide and carbon dioxide gas. This reaction can be represented by the equation: $CuCO3(s) \rightarrow CuO(s) + CO2(g)$.

Carbon dioxide is a greenhouse gas. Can you explain how increasing amounts in the atmosphere may contribute to climate change?

Carbon dioxide is a greenhouse gas because it absorbs and re-emits infrared radiation, which causes heat to be trapped in the atmosphere. Increasing amounts of carbon dioxide in the atmosphere can lead to increased global temperatures, which can cause climate change. This can lead to a range of impacts, including rising sea levels, more frequent and severe weather events, and changes in ecosystems.

How can the percentage by volume of a gas in a mixture be determined using practical methods?

One practical method to determine the percentage by volume of a gas in a mixture is by gas chromatography. In this method, the gas mixture is passed through a column containing a stationary phase that separates the individual gases based on their physical and chemical properties.

The gases are then detected and quantified using a detector.

Another method involves using a gas syringe to measure the volume of a gas before and after it is added to a known volume of the gas mixture. The difference in volumes can be used to calculate the percentage by volume of the gas in the mixture.

Reactivity series

How can metals be arranged in a reactivity series based on their reactions with water and dilute acids?

Metals can be arranged in a reactivity series based on their reactions with water and dilute acids by observing the rate of the reaction. The more reactive the metal, the faster the reaction. For example, alkali metals such as potassium and sodium react vigorously with water to produce hydrogen gas and metal hydroxides, while less reactive metals such as copper and silver do not react with water. Similarly, metals react with dilute acids to produce metal salts and hydrogen gas, and the reactivity series can be determined by observing the rate of hydrogen gas production.

How can metals be arranged in a reactivity series based on their displacement reactions?

Metals can be arranged in a reactivity series based on their displacement reactions by observing whether a metal can displace another metal from a compound. For example, if a more reactive metal is added to a solution of a less reactive metal salt, the more reactive metal will displace the less reactive metal from the salt, forming a new metal salt and the less reactive metal. The order of reactivity can be determined by observing which metals are capable of displacing other metals from their compounds.

What is the order of reactivity of the following metals: potassium, sodium, lithium, calcium, magnesium, aluminum, zinc, iron, copper, silver, gold?

The order of reactivity of the metals is: potassium, sodium, lithium, calcium, magnesium, aluminum, zinc, iron, copper, silver, gold. This means that potassium is the most reactive and gold is the least reactive metal.

Under what conditions does iron rust?

Iron rusts in the presence of oxygen and water. The presence of an electrolyte such as salt can accelerate the rusting process.

How can the rusting of iron be prevented by barrier methods?

The rusting of iron can be prevented by barrier methods such as painting or coating the iron with a layer of a non-reactive material that prevents oxygen and water from coming into contact with the iron.

How can the rusting of iron be prevented by galvanising?

The rusting of iron can be prevented by galvanising, which involves coating the iron with a layer of zinc. Zinc is more reactive than iron and will corrode instead of the iron. The zinc layer acts as a sacrificial protection, preventing the iron from coming into contact with water and oxygen.

What is oxidation and reduction in terms of gain or loss of oxygen and loss or gain of electrons?

Oxidation is the process of losing electrons or gaining oxygen, while reduction is the process of gaining electrons or losing oxygen. In a redox reaction, one substance is oxidized while another is reduced. An oxidizing agent is a substance that causes another substance to be oxidized, while a reducing agent is a substance that causes another substance to be reduced.

What are the expected observations when investigating reactions between dilute hydrochloric and sulfuric acids and metals such as magnesium, zinc, and iron?

When investigating reactions between dilute hydrochloric and sulfuric acids and metals, the following observations can be expected:

Magnesium: When magnesium is added to dilute hydrochloric or sulfuric acid, hydrogen gas is produced, and the magnesium dissolves to form a colorless solution of magnesium chloride or magnesium sulfate. The solution becomes slightly warm.

Zinc: When zinc is added to dilute hydrochloric or sulfuric acid, hydrogen gas is produced, and the zinc dissolves to form a colorless solution of zinc chloride or zinc sulfate. The solution becomes slightly warm.

Iron: When iron is added to dilute hydrochloric or sulfuric acid, hydrogen gas is produced, and the iron dissolves to form a yellowish-green solution of iron(II) chloride or iron(II) sulfate. The solution becomes slightly warm.

The observations above demonstrate that the reactivity of the metals with dilute hydrochloric and sulfuric acid increases in the order of magnesium, zinc, and iron. Magnesium reacts most vigorously with the acids, while iron reacts least vigorously. These observations allow us to arrange the metals in a reactivity series based on their reaction with dilute hydrochloric and sulfuric acid.

Extraction and uses of metals

What is the source of most metals and how are unreactive metals found in nature?

Most metals are extracted from ores that are found in the Earth's crust. Ores are rocks or minerals that contain a high enough concentration of a particular metal to make it economically viable to extract. Unreactive metals, on the other hand, are often found as the uncombined element, such as gold and platinum, and can be found in their native form in certain rocks and river beds.

How is the method of extraction of a metal related to its position in the reactivity series?

The method of extraction of a metal is related to its position in the reactivity series because metals that are more reactive than carbon, such as magnesium and aluminum, are extracted using electrolysis. This involves passing an electric current through a molten compound of the metal to break it down into its pure form. Metals that are less reactive than carbon, such as iron, are extracted using the blast furnace, where carbon is used as a reducing agent to remove the oxygen from the metal oxide. This is because carbon is more reactive than these metals and can displace them from their oxide.

What are some uses of aluminum, copper, iron, and steel, and how are these materials selected for these applications?

Aluminum is lightweight and has a high strength-to-weight ratio, making it useful in the construction of aircraft and cars. Copper is an excellent conductor of electricity and is used in wiring and electrical components. Iron is used in the production of steel, which is used in construction, machinery, and many other applications. Steel is selected for these applications because it is strong, durable, and can be made to have a wide range of properties by varying the amount of carbon and other alloying elements. The types of steel used in construction are typically low-carbon (mild) or high-carbon steel, while stainless steel is used in applications where corrosion resistance is important.

What is an alloy, and why are alloys harder than pure metals?

An alloy is a mixture of a metal and one or more other elements, usually other metals or carbon. Alloys are often harder than pure metals because the other elements in the alloy disrupt the orderly arrangement of atoms in the pure metal, making it more difficult for them to move and deform when a force is applied. This makes the metal stronger and more resistant to deformation. Additionally, the other elements in the alloy can form intermetallic compounds with the metal, which can also contribute to the hardness and strength of the material.

Acids, alkalis and titrations

What is the use of litmus, phenolphthalein and methyl orange in distinguishing between acidic and alkaline solutions?

Litmus, phenolphthalein, and methyl orange are indicators used to distinguish between acidic and alkaline solutions.

Litmus is a dye extracted from lichens and is available as a paper strip or solution. In an acidic solution, the litmus paper turns red, and in an alkaline solution, it turns blue.

Phenolphthalein is a synthetic compound available as a colourless solution. It turns pink or magenta in an alkaline solution and remains colourless in acidic solutions.

Methyl orange is also a synthetic compound and is available as a yellow-orange powder or solution. It turns red in an acidic solution and yellow in an alkaline solution.

How can the pH scale be used to classify solutions?

The pH scale is a measure of the acidity or alkalinity of a solution. The scale ranges from 0 to 14, with 7 being neutral. A pH of less than 7 indicates an acidic solution, while a pH greater than 7 indicates an alkaline solution. Solutions with a pH of 0-3 are considered strongly acidic, 4-6 weakly acidic, 8-10 weakly alkaline, and 11-14 strongly alkaline.

How can universal indicator be used to measure the approximate pH value of an aqueous solution?

Universal indicator is a solution containing a mixture of several indicators that change colour at different pH values. When added to an aqueous solution, it changes colour to indicate the pH of the solution. The resulting colour is then compared to a colour chart to determine the approximate pH value of the solution.

What are hydrogen ions and hydroxide ions in aqueous solutions?

In aqueous solutions, an acid is a source of hydrogen ions (H^+), and an alkali is a source of hydroxide ions (OH^-). In other words, when an acid dissolves in water, it donates hydrogen ions, which increase the concentration of H^+ ions in the solution. When an alkali dissolves in water, it donates hydroxide ions, which increase the concentration of OH- ions in the solution.

How can an acid-alkali titration be carried out?

An acid-alkali titration is a technique used to determine the concentration of an acid or an alkali. In this titration, a measured volume of an acid is added to an alkali or vice versa until the reaction is complete.

The endpoint of the reaction is determined by using an indicator such as phenolphthalein or methyl orange. The indicator is added to the solution and changes colour when the reaction is complete, indicating that the acid and alkali have reacted completely. From the volume of acid or alkali used, the concentration of the unknown solution can be calculated.

Acids, bases and salt preparations

What are the general rules for predicting the solubility of ionic compounds in water?

The general rules for predicting the solubility of ionic compounds in water are as follows:

1. Common sodium, potassium, and ammonium compounds are soluble in water.
2. All nitrates are soluble in water.
3. Common chlorides are soluble in water, except those of silver and lead(II).
4. Common sulfates are soluble in water, except for those of barium, calcium, and lead(II).
5. Common carbonates are insoluble in water, except for those of sodium, potassium, and ammonium.
6. Common hydroxides are insoluble in water, except for those of sodium, potassium, and calcium (calcium hydroxide is slightly soluble).

How can acids and bases be described in terms of proton transfer?

Acids and bases can be described in terms of proton transfer. An acid is a substance that donates a proton (H^+) and a base is a substance that accepts a proton. When an acid and a base react, the acid donates a proton to the base. The acid is then called a conjugate base, and the base is called a conjugate acid. The transfer of protons between acids and bases is called a proton transfer or a protonation reaction.

What are the reactions of hydrochloric acid, sulfuric acid, and nitric acid with metals, bases, and metal carbonates (excluding the reactions between nitric acid and metals) to form salts?

Hydrochloric acid, sulfuric acid, and nitric acid can react with metals, bases, and metal carbonates to form salts. When these acids react with metals, they produce hydrogen gas and a metal salt. When they react with bases, they produce water and a salt.

When they react with metal carbonates, they produce carbon dioxide gas, water, and a metal salt. The specific reactions are as follows:

1. Hydrochloric acid + metal → hydrogen gas + metal chloride
2. Sulfuric acid + metal → hydrogen gas + metal sulfate
3. Nitric acid + metal → no reaction (excluding some specific metals)
4. Hydrochloric acid + base → water + salt
5. Sulfuric acid + base → water + salt
6. Nitric acid + base → water + salt
7. Hydrochloric acid + metal carbonate → carbon dioxide gas + water + metal chloride
8. Sulfuric acid + metal carbonate → carbon dioxide gas + water + metal sulfate
9. Nitric acid + metal carbonate → carbon dioxide gas + water + metal nitrate

What is an experiment to prepare a pure, dry sample of a soluble salt, starting from an insoluble reactant?

One experiment to prepare a pure, dry sample of a soluble salt, starting from an insoluble reactant, involves the following steps:

1. Mix the insoluble reactant with an excess of a soluble reactant that will form a soluble salt with the insoluble reactant. The excess of the soluble reactant ensures that all of the insoluble reactant will react.
2. Add water to the mixture and heat it to dissolve the soluble salt. The insoluble reactant will remain undissolved.

3. Filter the mixture to separate the undissolved insoluble reactant from the solution of the soluble salt.
4. Evaporate the water from the solution to obtain a solid sample of the salt.
5. Dry the solid sample to remove any remaining water and obtain a pure, dry sample of the soluble salt.

Describe an experiment to prepare a pure, dry sample of a soluble salt, starting from an acid and alkali.

Materials required:

Dilute hydrochloric acid
Sodium hydroxide solution
Two beakers
A stirring rod
Filter paper
Bunsen burner
Tripod stand
Heatproof mat
Evaporating dish
Glass rod

Procedure:

1. Add dilute hydrochloric acid to one of the beakers.
2. Add sodium hydroxide solution to the other beaker until it becomes slightly excess.
3. Slowly pour the sodium hydroxide solution into the hydrochloric acid while stirring continuously with the glass rod until the mixture becomes neutral. This can be tested using universal indicator paper or a pH meter. The resulting mixture will be a salt and water.
4. Heat the mixture gently using a Bunsen burner until some of the water evaporates.

5. Once the salt starts to crystallize, remove the heat and leave the mixture to cool down.
6. Filter the crystals using filter paper to separate the salt from the remaining water.
7. Wash the salt crystals with a small amount of cold distilled water to remove any impurities and then leave to dry on the filter paper.
8. Once the salt crystals are dry, transfer them onto an evaporating dish and heat the dish gently using a Bunsen burner until the salt crystals are completely dry.

The final product will be a pure, dry sample of a soluble salt.

Describe an experiment to prepare a pure, dry sample of an insoluble salt, starting from two soluble reactants

One possible experiment to prepare a pure, dry sample of an insoluble salt starting from two soluble reactants involves the reaction between sodium chloride and silver nitrate to form silver chloride, which is insoluble in water.

Here are the steps for this experiment:

Materials:

Sodium chloride
Silver nitrate
Distilled water
Filter paper
Funnel
Bunsen burner
Tripod
Wire gauze
Evaporating dish
Procedure:

1. Measure 5g of sodium chloride and 5g of silver nitrate separately and place them in two different beakers.
2. Add 50 ml of distilled water to each beaker and stir with a glass rod to dissolve the solids completely.
3. Pour the silver nitrate solution into the sodium chloride solution, stirring continuously with the glass rod. A white precipitate of silver chloride will form immediately.
4. Filter the mixture through a filter paper placed in a funnel to collect the solid.
5. Wash the solid several times with distilled water to remove any impurities.
6. Dry the solid by pressing it gently between two filter papers.
7. Transfer the solid to an evaporating dish and heat it gently over a Bunsen burner to evaporate the water and obtain a pure, dry sample of silver chloride.

Note: It is important to handle silver nitrate and silver chloride with care, as they can be toxic and can cause staining on skin and clothing. It is also important to use distilled water to avoid contamination of the sample.

How do you prepare a sample of pure, dry hydrated copper(II) sulfate crystals starting from copper(II) oxide

To prepare a sample of pure, dry hydrated copper(II) sulfate crystals starting from copper(II) oxide, you can follow these steps:

Materials:

Copper(II) oxide
Sulfuric acid (dilute)
Beaker
Glass rod
Funnel
Filter paper

Tripod
Bunsen burner
Heat-resistant mat
Gauze
Electronic balance
Desiccator

Procedure:

1. Weigh 5g of copper(II) oxide and place it in a beaker.
2. Add 25ml of dilute sulfuric acid to the beaker. Stir the mixture with a glass rod.
3. Heat the mixture using a Bunsen burner on a low flame. Continue heating until all the copper(II) oxide has reacted with the acid to form copper(II) sulfate. The solution should turn blue in color.
4. Filter the blue solution into another beaker using a funnel and filter paper to remove any unreacted copper(II) oxide.
5. Heat the blue solution gently until it becomes concentrated and almost all the water has evaporated. You should see small blue crystals starting to form.
6. Allow the solution to cool to room temperature, then place the beaker in a desiccator to dry for a day or until no more water is evaporated.
7. Once the crystals are dry, weigh them and record the mass.
8. The crystals obtained are hydrated copper(II) sulfate. To obtain pure, dry anhydrous copper(II) sulfate, heat the hydrated crystals in a crucible until they turn white.
9. Note: Copper(II) sulfate is harmful if ingested or inhaled. Always wear appropriate personal protective equipment when handling chemicals.

How do you prepare a sample of pure, dry lead(II) sulfate?

To prepare a sample of pure, dry lead(II) sulfate, you can follow these steps:

Materials:

Lead(II) nitrate ($Pb(NO_3)_2$)
Sodium sulfate (Na_2SO_4)
Distilled water
Bunsen burner or hot plate
Beaker
Funnel
Filter paper
Drying oven or desiccator

Procedure:

1. Weigh out 5g of lead(II) nitrate and dissolve it in 50 mL of distilled water in a beaker.
2. Weigh out 4g of sodium sulfate and dissolve it in 50 mL of distilled water in a separate beaker.
3. Slowly pour the sodium sulfate solution into the lead(II) nitrate solution while stirring constantly. A white precipitate of lead(II) sulfate will form.
4. Allow the mixture to settle for a few minutes, then filter the precipitate using a funnel and filter paper. Wash the precipitate several times with distilled water to remove any impurities.
5. Transfer the wet precipitate to a drying oven or desiccator and leave it to dry completely. This may take several hours or overnight.
6. Weigh the dry lead(II) sulfate and record the mass. The lead(II) sulfate is now a pure, dry sample.

Note: Lead compounds are toxic and should be handled with care. It is important to wear appropriate personal protective equipment, such as gloves and a lab coat, when working with lead compounds.

Chemical tests

Describe tests for these gasses:

Hydrogen:

The pop test: A lighted splint is inserted into the gas to be tested. If hydrogen is present, a "pop" sound will be heard due to the ignition of the gas.

The burning splint test: A burning splint is held at the mouth of the container. Hydrogen will ignite with a pop sound.

Oxygen:

The glowing splint test: A glowing splint is inserted into the gas. If oxygen is present, the splint will reignite.

The combustion test: A substance that burns is lit in the gas. If oxygen is present, the substance will burn more brightly.
Carbon dioxide:

The limewater test: Carbon dioxide is passed through lime water. If carbon dioxide is present, the limewater will turn milky.

Ammonia:

The damp red litmus paper test: Ammonia is brought near a damp red litmus paper. If ammonia is present, the paper will turn blue.

The "smelling salts" test: Ammonia has a pungent odor that can be detected by smelling the gas.

Chlorine:

The damp blue litmus paper test: Chlorine is brought near a damp blue litmus paper. If chlorine is present, the paper will turn red then bleached.

The bleaching test: Chlorine can bleach colored solutions.

How to carry out a flame test:

A flame test is a method used to identify the presence of certain metal ions in a compound, based on the color of the flame emitted when the compound is heated in a flame.

The steps to carry out a flame test are:Dip a clean, non-flammable wire loop into a sample of the compound to be tested.

1. Heat the wire loop in a Bunsen burner flame to remove any impurities.
2. Dip the wire loop into the Bunsen burner flame, then observe the color of the flame produced.

Compare the color of the flame to a chart of known flame colors for various metal ions.

Know the colors formed in flame tests for these cations:

- Li+ is red
- Na+ is yellow
- K+ is lilac
- Ca2+ is orange-red
- Cu2+ is blue-green.

Tests for these cations:

NH^{4+}: Sodium hydroxide solution is added to the compound. If ammonium ions are present, ammonia gas will be evolved, which can be detected by its pungent odor.

Cu^{2+}, Fe^{2+} and Fe^{3+}: Sodium hydroxide solution is added to the compound.

Copper ions will produce a blue precipitate, while iron (II) ions will produce a green precipitate, and iron (III) ions will produce a brown precipitate.

Tests for these anions:

Cl–, Br– and I–: Acidified silver nitrate solution is added to the compound.

Chloride ions will produce a white precipitate, bromide ions a cream precipitate and iodide ions a yellow precipitate.

SO_4^{2-}: Acidified barium chloride solution is added to the compound. Sulfate ions will produce a white precipitate of barium sulfate.

CO_3^{2-}: Hydrochloric acid is added to the compound. If carbonate ions are present, carbon dioxide gas will be evolved, which can be identified by its effervescence and the production of a white precipitate of calcium carbonate upon addition of lime water.

Describe a test for the presence of water using anhydrous copper(II) sulfate

Anhydrous copper(II) sulfate is a white powder that is used as a drying agent for liquids. It is highly hygroscopic, meaning that it readily absorbs moisture from the air or any other source, including water. Therefore, it is a useful reagent for detecting the presence of water.

To carry out this test, a small amount of anhydrous copper(II) sulfate is taken in a test tube. If the copper sulfate is dry and free of water, it remains white. However, if a small amount of water is added to the tube, the anhydrous copper(II) sulfate turns blue as it reacts with the water molecules to form the blue hydrated form of the compound. The reaction is highly exothermic and generates heat.

The colour change from white to blue is an indication of the presence of water. This reaction can be used to check the purity of a liquid or to see if a substance contains any water. The test is quite sensitive, and even a small amount of water can produce a visible colour change.

Describe a physical test to show whether a sample of water is pure

One physical test to show whether a sample of water is pure is to measure its boiling point. Pure water boils at 100°C at atmospheric pressure (1 atm). If the water sample contains impurities, such as dissolved salts or other substances, the boiling point will be elevated and the boiling temperature will be higher than 100°C.

To perform this test, a thermometer is inserted into the water sample, and the water is heated until it boils. The temperature is then noted when the water begins to boil and as it continues to boil. If the temperature stays constant at 100°C, the water is pure. If the temperature is higher than 100°C, the water is impure and contains dissolved substances.

It's important to note that this test only works for small amounts of impurities. If there are large amounts of impurities, the boiling point elevation may be significant, making it difficult to determine the exact boiling point of the water. In such cases, additional tests, such as chemical tests, may be required to determine the purity of the water sample.