Separate Chemistry Workbook

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Exam Information

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| --- | --- | --- |
| Paper | Duration | Topics Covered |
| 1 | 1 hour and 45 minutes | Topics 1-4 (Book 1 - all of year 10)  Topic 5 (this book) |
| 2 | 1 hour and 45 minutes | Topic 1 (Book 1)  Topics 6-8 (Book 2 – year 11)  Topic 9 (this book) |

5 quick questions

Lesson 1

1) How many moles of iron are present in a 2.8 g iron nail? (Ar Fe = 56)

2) How many atoms of iron are present in a 2.8 g iron nail? (Ar Fe = 56, Avogadro constant = 6.02 x 1023)

3) What is a test for hydrogen?

4) What is meant by the term, electrolysis?

5) What is the formula of calcium nitrate? (nitrate ion – NO3-)

Lesson 2

1) Write a balanced symbol equation, including state symbols, for calcium carbonate (CaCO3) reacting with hydrochloric acid.

2) What is a test for carbon dioxide?

3) Calcium carbonate is steadily added to hydrochloric acid until the reaction is finished. State how you would know the reaction is over (give 2 observations).

4) How would you obtain a pure dry sample of the salt produced when calcium carbonate reacts with hydrochloric acid?

5) Calculate the relative formula mass of calcium carbonate (Ar Ca = 40, C = 12, O = 16).

Lesson 3

1) What is a definition of relative atomic mass?

2) Why do some elements have a relative atomic mass that is not a whole number (e.g. Cl - 35.5)?

3) What is an isotope?

4) Sulfur is made of two naturally occurring isotopes: sulfur-32 (95%) and sulfur-34 (5%). Calculate the relative atomic mass of sulfur.

5) Write a balanced symbol equation for the reaction of iron with bromine to make iron (III) bromide.

Lesson 4

1) Write a balanced symbol equation for lithium reacting with oxygen?

2) How many moles are present if you start with 56 g of lithium? (Ar Li = 7)

3) How many moles of lithium oxide are produced when 56 g of lithium are reacted with excess oxygen?

4) How many grams of lithium oxide are produced when 56 g of lithium are reacted with excess oxygen? (Ar Li = 7, O = 16)

5) How many tonnes of lithium oxide are produced when 2 tonnes of lithium are reacted with excess oxygen? (Ar Li = 7, O = 16)

Lesson 5

1) How could we determine the empirical formula of iron oxide?

2) 0.84 g iron was found to combine with 0.36g of oxygen. What is the empirical formula of this oxide? (Ar Fe = 56, O = 16)

3) What is a test for hydrogen gas?

4) Write a half equation for the formation of hydrogen gas at the cathode in the electrolysis of water.

5) What is a use of hydrogen?

Lesson 6

1) What is the formula of potassium sulfate?

2) What is the concentration of the solution formed, in g dm3, when 43.5 g of potassium sulfate is dissolved in 200 cm3 of water?

3) What is the concentration of the solution formed, in mol dm3, when 43.5 g of potassium sulfate is dissolved in 200 cm3 of water? (Ar K = 39, S = 32, O = 16).

4) What is a test for oxygen gas?

5) Write a half equation for the formation of oxygen gas at the anode in the electrolysis of water.

Lesson 7

1) What would you observe when copper sulfate is added to zinc? (zinc is more reactive than copper).

2) Draw a diagram to show the bonding in carbon dioxide. Show outer electrons only. (Atomic numbers C = 6, O = 8)

3) In chromatography, what is the mobile phase?

4) Calculate the Rf of an ink spot that runs 21mm when the solvent runs 8.8 cm. Give your answer to 2 significant figures.

5) Why is carbon dioxide a gas at room temperature?

Lesson 8

1) What is a covalent bond?

2) What is an ion?

3) What is the mass number and atomic number of potassium?

4) How many protons, neutron and electrons in potassium?

5) Aluminium is made from the electrolysis of Aluminium oxide (Al2O3). How many tonnes of aluminium are made from 51 tonnes of aluminium oxide? (Ar Al = 27, O = 16).

Lesson 9

1) What type of bonding is present in fullerenes?

2) Are fullerenes good conductors of electricity?

3) What type of bonding is present in graphene?

4) Is graphene a good conductor of electricity?

5) A compound contains 39.7% of copper and 20% of sulphur by mass, the rest being oxygen.  
Use this information to show that the empirical formula of the compound is CuSO4 (Ar Cu = 63.5, S = 32, O = 16)

Lesson 10

1) Is calcium sulfate soluble or insoluble in water?

2) How can you turn copper oxide into a pure, dry sample of copper sulfate?

3) What type of reaction is this and what would you observe?

4) Write a balanced symbol equation for this reaction, include state symbols.

5) In a reaction with acid 1 mole of calcium carbonate will produce 1 mole of carbon dioxide. What mass of carbon dioxide is produced from 40 grams of calcium carbonate? (Ar Ca = 40, C = 12, O = 16)

Lesson 11

1) State 2 reasons for electroplating an object.

2) Name a non-metal in period 2.

3) What do all elements in the same period have in common?

4) What do all elements in the same group have in common?

5) 0.115g of element X reacts with 0.04 g of element Y what is the empirical formula of the product? (Ar X = 23, Y = 16)

Lesson 12

1) What is the formula of calcium chloride?

2) Calcium nitrate is made of calcium ions and nitrate ions (NO3-). What is the formula of calcium nitrate?

3) The formula of calcium phosphate is: Ca3(PO4)2 What is the charge on the phosphate ion?

4) Explain whether calcium nitrate added to water is a good or poor conductor of electricity.

5) There are 210.6 g of sodium chloride in a jar. How many moles is this equivalent to? (Ar Na = 23, Cl = 35.5)

Lesson 13

1) Write a half equation for the cathode when molten lead (II) bromide undergoes electrolysis?

2) What are the 3 products when potassium chloride (aq) undergoes electrolysis?

3) Write a half equation for the anode when potassium chloride (aq) undergoes electrolysis.

4) What is a test for chlorine gas?

5) What is the concentration, in g dm-3, of the solution formed when 20 g of potassium chloride is dissolved in 100 cm3 water?

Lesson 14

1) Calculate the relative formula mass of copper carbonate CuCO3. (Ar Cu = 63.5, C = 12, O = 16)

2) What is phytoextraction?

3) Give an advantage of phytoextraction of metals rather than mining for metal ores.

4) What is bioleaching?

5) When 370.5 g copper carbonate is heated it decomposes to form 238.5 g copper oxide and carbon dioxide? What mass, in grams, of carbon dioxide is given off?

Lesson 15

1) Write a balanced symbol equation, including state symbols, for sodium hydroxide reacting with hydrochloric acid.

2) Write a balanced symbol equation, including state symbols, for Indium (III) hydroxide reacting with hydrochloric acid.

3) Potassium chloride reacts with silver nitrate. What are the products of this reaction?

4) How would you prepare a pure dry sample of silver chloride?

5) Calculate the empirical formula of lead chloride when 58.8 g of lead reacts with 40.4 g of chlorine. (Ar Pb = 207, Cl = 35.5)

Lesson 16

1) Does potassium bromide have a high or low melting point?

2) Does hydrogen bromide (HBr) have a high melting point or low melting point?

3) What is the formula of the compound formed when carbon reacts with chlorine?

4) Silicon dioxide has a melting point of 1710 oC. What type of bonding would you expect silicon dioxide to have? Explain.

5) How many atoms are there in 3 moles of carbon dioxide (CO2)? (Avogadro constant: 6.02 x 1023)

Lesson 17

1) What’s the most accurate way of measuring pH of a solution?

2) What’s the most accurate way of measuring 25 cm3 of acid?

3) What is the difference in hydrogen ion concentration between 2 solutions if one has a pH of 3,2 and the other 5.2?

4) How does pH change with hydrogen ion concentration?

5) What mass of chlorine can be formed from 175.5 kg of sodium chloride? (Ar Na = 23, Cl = 35.5) 2NaCl 🡪 2Na + Cl2

Lesson 18

1) A substance has a melting point of -238 oC and a boiling point of -216 oC. What is its physical state at -215 oC?

2) Explain how lithium and oxygen atoms bond together to form lithium oxide (3Li, 8O).

3) Find sodium on the periodic table, use the mass and atomic numbers to calculate the numbers of protons neutrons and electrons present in an atom of sodium.

4) Find sulfur on the periodic table, use the mass and atomic numbers to calculate the numbers of protons, neutrons and electrons in the sulfide ion.

5) How many moles of copper sulfate (CuSO4) are needed to make 1 dm3 of a solution with a concentration of 39.875 g dm-3? (Ar Cu = 63.5, S = 32, O = 16)

Lesson 19

1) What is a test for carbon dioxide?

2) Draw a dot and cross diagram to show the outer electrons in a carbon dioxide molecule. (6C, 8O)

3) What colour is methyl orange in acid and alkali?

4) What colour is litmus in acid and alkali?

5) How many tonnes of iron are produced from the reduction of 80 tonnes of Fe2O3? (Ar Fe = 56, O = 16)

Lesson 20

1) Why is graphite used in electrodes?

2) Why is graphite used as a lubricant?

3) What type of bonding is present in methane (CH4), graphite and fullerenes (C60)?

4) Do fullerenes conduct electricity?

5) 50g of calcium nitrate is dissolved in 400 cm3 of water, what is the concentration in g dm-3?

Lesson 21

1) What is the moles equation when given the mass of a substance?

2) What is the moles equation when given the volume and concentration of a substance?

3) What is the moles equation when given the volume of a gas?

4) What volume of carbon monoxide is made when 100 cm3 of carbon dioxide reacts with excess carbon? CO2 + C 🡪 2CO

5) What volume of carbon monoxide is made when 24 g of carbon reacts with excess carbon dioxide? (Ar C = 12, 1 mole of any gas occupies 24 dm3 at room temp and pressure) CO2 + C 🡪 2CO

Lesson 22

Draw a diagram showing the bonding in: (4Be, 9F, 8O, 1H, 6C)

1) Beryllium fluoride.

2) Methane

3) Oxygen

4) Carbon dioxide

5) What volume of hydrogen is produced when 19.5 g of potassium reacts with excess water? (Ar K = 39, 1 mole of any gas occupies 24 dm3 at room temp and pressure)

2K + 2H2O 🡪 2KOH + H2

Lesson 23

1) What would you see when excess copper oxide is added to sulfuric acid?

2) Write a balanced symbol equation for this reaction, include state symbols.

3) How do you know when the reaction is complete?

4) How do you get a pure dry sample of copper sulfate from this mixture?

5) Calculate the concentration of potassium hydroxide solution formed when 19.5 grams of potassium reacts with 750 cm3 water? (Ar K = 39)

2K + 2H2O 🡪 2KOH + H2

Lesson 24

1) How would you separate a mixture of liquids with similar boiling points?

2) Is the separation of these liquids a chemical reaction?

3) How would you make a sample of river water safe for drinking?

4) Which ion in solution are acids a source of?

5) A sample of copper contains 70% of copper – 63 atoms and 30% of copper – 65 atoms. Use this information to calculate the relative atomic mass of copper in this sample.

Lesson 25

1) How did Mendeleev arrange the elements in his version of the periodic table?

2) Why did Mendeleev leave gaps in his periodic table?

3) How is the modern periodic table different to Mendeleev’s?

4) What is the link between an elements group number and its electronic configuration?

5) A titration was carried out. 25.0 cm3 of 1.50 mol dm–3 sodium hydroxide solution, NaOH, was titrated with hydrochloric acid. The volume of the hydrochloric acid required to neutralise the sodium hydroxide solution was 27.5 cm3. Calculate the concentration of the hydrochloric acid, HCl, in mol dm–3.

HCl + NaOH 🡪NaCl + H2O

Lesson 26

Look at a periodic table.  
1) Name a non-metal in period 2.

2) What element has the electronic configuration 2.8.7?

3) Draw a diagram showing the bonding when 4Be reacts with 9F.

4) What is the name of Al2S3?

5) A titration was carried out. 25.0 cm3 of 1.25 mol dm–3 sodium hydroxide solution, NaOH, was titrated with sulfuric acid. The volume of the sulfuric acid required to neutralise the sodium hydroxide solution was 22.6 cm3. Calculate the concentration of the sulfuric acid, H2SO4, in mol dm–3.

H2SO4 + 2NaOH 🡪Na2SO4 + 2H2O

Lesson 27

1) Which ion in solution are alkalis a source of?

2) Write an ionic equation for neutralisation.

3) An acid has a hydrogen ion concentration of 0.01 mol dm-3 and a pH of 2. The acid is diluted until it has a pH of 5, what is the concentration of hydrogen ions?

4) What are the effects of acids and alkalis on litmus, methyl orange and phenolphthalein?

5) What is the concentration, in g dm-3, of sodium hydroxide when 46 g is dissolved in 150 cm3 of water? Give your answer to 2 significant figures.

Lesson 28

1) What is electrolysis?

2) Draw and label the apparatus needed for the electrolysis of aqueous copper sulphate.

3) What type of substances undergo electrolysis? Explain why.

4) Write a half equation for the formation of copper from copper ions (Cu2+).

5) Calculate the number of atoms in 3 moles of H2O.(Avogadro constant = 6.02 x 1023)

Lesson 29

1) What is the difference between NaCl (l) and NaCl (aq)?

2) What are the products of the electrolysis of NaCl (l)?

3) What are the products of NaCl (aq)?

4) Write a half equation for the formation of chlorine from the chloride ion.

5) What volume of chlorine can be formed from 175.5 g of sodium chloride? (Ar Na = 23, Cl = 35.5, 1 mole of any gas occupies 24 dm3 at room temp and pressure) 2NaCl 🡪 2Na + Cl2

Lesson 30

1) What are the products of the electrolysis of aqueous copper sulfate?

2) Write a half equation for the formation of hydrogen from hydrogen ions.

3) What is the electronic configuration of the oxide ion? (8O)

4) What is an isotope?

5) What volume of chlorine can be formed by electrolysis of 250 cm3 of 2 mol dm-3 sodium chloride solution? (1 mole of any gas occupies 24 dm3 at room temp and pressure) 2NaCl 🡪 2Na + Cl2

Lesson 31

1) Write a balanced symbol equation for the Haber process?

2) What is a, ‘dynamic equilibrium’?

3) The forward reaction in the Haber process is exothermic, explain the effect of increasing the temperature on equilibrium.

4) Where are the nitrogen and hydrogen for the Haber process obtained from?

5) 266 g of nitrogen reacts with 57 g of hydrogen, use this information to prove the formula of ammonia is NH3 (Ar N = 14, H = 1)

Lesson 32

1) Why is the Haber process carried out at 200 atm of pressure?

2) What is a covalent bond?

3) What is the effect of adding a catalyst to the equilibrium position?

4) Ammonia has the formula NH3, calculate the percentage by mass of hydrogen in ammonia. (Ar N = 14, H = 1).

5) Under certain industrial conditions 1400 kg of ammonia are produced. If all the nitrogen and hydrogen were converted 8848 kg of ammonia could be formed. What is the percentage yield of these conditions? Give your answer to 2 significant figures.

Lesson 33

1) What are the products of the displacement reaction between copper sulfate and zinc (zinc is more reactive than copper?

2) What would you observe when copper sulfate reacts with zinc?

3) Is the zinc oxidised or reduced in this reaction?

4) Is the copper oxidised or reduced in this reaction?

5) What is the concentration, in mol dm-3, of copper sulfate solution formed when 39.875 g copper sulfate is dissolved in 250 cm3 distilled water? (Ar Cu -63.5, O = 16, S = 32)

Lesson 34

1) How is iron extracted from its ore?

2) How is aluminium extracted from its ore?

3) Why are different methods used to extract iron and aluminium from their ores?

4) What is phytoextraction of metals?

5) 4 g of copper are extracted from 958 g of plant material. What is the percentage yield of copper from this process? Give your answer to 3 significant figures.

Lesson 35

1) What is bioleaching?

2) Why is diamond used for cutting tools?

3) How can metals be prevented from corroding?

4) Would you expect calcium bromide to have a high or low melting point and why?

5) A titration was carried out. 25.0 cm3 of unknown concentration potassium hydroxide solution, KOH, was titrated with sulfuric acid. The volume of the sulfuric acid, 0.75 mol dm–3, required to neutralise the potassium hydroxide solution was 24.1 cm3. Calculate the concentration of the potassium hydroxide solution, KOH, in mol dm–3.

H2SO4 + 2KOH 🡪K2SO4 + 2H2O

Lesson 36

1) Draw a diagram to show the bonding in carbon tetrafluoride (CF4). Show outer electrons only. (Atomic number C = 6, F = 9).

2) Explain whether carbon tetrafluoride would be a good or poor electrical conductor.

3) Would carbon tetrafluoride have a high or low melting point?

4) Carbon tetrafluoride (CF4) can be produced in the lab by the reaction of SiC with fluorine to produce carbon tetrafluoride and Silicon tetrafluoride (SiF4). Write a balanced symbol equation for this reaction.

5) What is the name of SiC?

Lesson 37

1) What is the empirical formula of a compound comprised of 80% carbon and 20% hydrogen? Ar C = 12, H = 1)

2) The compound has a relative formula mass of 30. What is its molecular formula?

3) Describe the structure of magnesium?

4) Why does magnesium bend and not break?

5) How can magnesium be made stronger?

Lesson 38

1) How does a fuel cell work?

2) Give advantages and disadvantages of using fuel cells to power cars.

3) Write a balanced symbol equation for the reaction that takes place in a fuel cell.

4) Hydrogen can be obtained from the electrolysis of water. Write half equations for the anode and cathode.

5) What is the mass, in grams of 1 carbon dioxide molecule? (Avogadro constant = 6.02 x 1023, Ar C = 12, O = 16)

Lesson 39

1) What are the names of group 1, 7 and 0 of the periodic table?

2) Why is potassium more reactive than lithium?

3) Why is fluorine more reactive than chlorine?

4) Why is sodium iodide reacting with chlorine a redox reaction?

5) What volume of hydrogen is produced when 19.5 g of potassium react with excess water? 1 mole of any gas occupies 24 dm3. Ar K = 39

2K + 2H2O 🡪 2KOH + H2

Lesson 40

1) Write a balanced symbol equation for the reaction for calcium carbonate with hydrochloric acid.

2) What type of reaction is this?

3) Include state symbols.

4) How could you monitor the rate of this reaction?

5) What volume of, 0.5 mol dm-3, hydrochloric acid would be required to produce 300 cm3 of carbon dioxide gas in this reaction? (1 mole of any gas occupies 24 dm3, calcium carbonate is present in excess).

Lesson 41

1) What would you observe if 50 cm3 of 1 mol dm-3 sulfuric acid were added to excess magnesium?

2) Write a balanced symbol equation for this reaction.

3) What would you observe is the reaction were repeated with 2 mol dm-3 sulfuric acid. Everything else remained the same.

4) How could a pure dry sample of magnesium sulfate be produced from the reaction above?

5) What volume of hydrogen will be produced when 50 cm3 of 1 mol dm-3 sulfuric acid were added to excess magnesium?

Lesson 42

1) In the reversible reaction: A + B ⇌ C + H2O. The forward reaction is exothermic. What would be the effect of increasing the temperature on the equilibrium position.

2) How could the equilibrium be pushed to the A + B side?

3) How would a catalyst alter the equilibrium position?

4) How does increasing the pressure of the reaction vessel alter the yield of ammonia in the Haber process?

5) A fuel cell bus has 5000 dm3 of hydrogen stored. How many grams of water are produced by the time the tank is empty? 1 mole of any gas occupies 24 dm3 at room temperature and pressure.

2H2 + O2 🡪 2H2O

Lesson 43

1) What has to happen to chemical bonds in every reaction?

2) Why are some reactions exothermic?

3) Sketch an energy level diagram to show the profile for an endothermic reaction.

4) Label the bond making and bond breaking parts of this diagram.

5) What is the percentage by mass of copper in copper sulfate? Ar Cu = 63.5, S = 32, O = 16

Lesson 44

1) How is crude oil separated?

2) What is bitumen used for?

3) What fraction of crude oil is used as jet engine fuel?

4) How does a bitumen and kerosene molecule differ?

5) Under certain conditions the Haber process converts 50% of its reactants to ammonia at dynamic equilibrium.

What volume of ammonia gas would be produced if the reaction started with 12 dm3 of hydrogen under these conditions?

N2 + 3H2 ⇌ 2NH3

Lesson 45

1) What is an unsaturated hydrocarbon?

2) What are the products of complete combustion of ethane?

3) Draw a propene molecule

4) What is a test for propene?

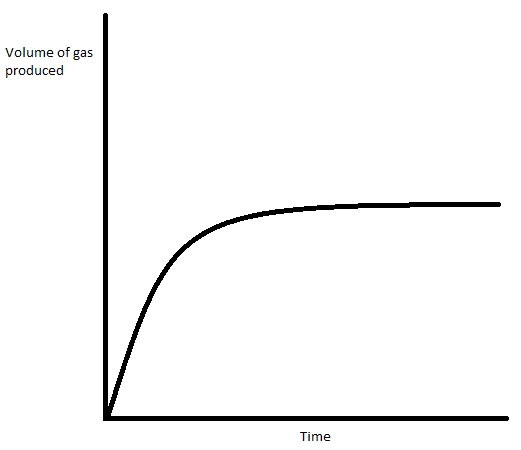
5) Use the table of bond energies to calculate the energy change when 1 mole of ethane is burnt in excess oxygen.

|  |  |
| --- | --- |
| Covalent bond | Bond energy (kj mol-1) |
| C-H | 413 |
| O=O | 498 |
| C=O | 805 |
| O-H | 464 |

2C2H6 + 7O2 🡪 4CO2 + 6H2O

Lesson 46

The graph shows the volume of carbon dioxide produced against time for the reaction of excess calcium carbonate chips and 50 cm3 HCl (aq) 1 mol dm-3. Sketch additional curves to estimate the curves produced in q 1-4.



1) Same reaction with 1 lump of the same mass of calcium carbonate instead of small chips.

2) Same reaction but with double the concentration of acid.

3) Same reaction but 10 oC hotter.

4) What apparatus could be used to collect the gas?

5) Predict how much gas would be produced from 50 cm3 of 1 mol dm3 hydrochloric acid?

CaCO3 + 2HCl 🡪 CaCl2 + H2O + CO2

1 mole of any gas occupies 24 dm3

Lesson 47

1) Sketch an energy level diagram for an exothermic reaction?

2) Does bond making give out or take in energy?

3) Is the energy value for bond making bigger or smaller than bond making in an endothermic reaction?

4) Does an exothermic reaction get hot or cold?

5) Titanium can be produced by reaction of titanium (IV) chloride with magnesium. What is the atom economy for the production of titanium? Ar Ti = 48, Mg = 24, Cl = 35.5

TiCl4 + 2Mg 🡪 Ti + 2MgCl2

Lesson 48

1) Why is carbon monoxide toxic?

2) What were the first gases present in the earth’s atmosphere?

3) How is carbon dioxide removed from the atmosphere?

4) How is acid rain formed?

5) How many tonnes of iron are required to produce 10 tonnes of copper? Give your answer to 3 significant figures. (Ar Fe = 56, Cu = 63.5)

Fe + CuSO4 🡪 FeSO4 + Cu

Lesson 49

1) How is acid rain formed?

2) What gases were found in the earth’s first atmosphere?

3) What natural processes lead to a reduction in carbon dioxide in the atmosphere?

4) How does burning fossil fuels lead to global warming?

5) What volume of carbon dioxide is produced from the complete combustion of 342 g of octane?

2C8H18 + 25O2 🡪 16CO2 + 18H2O

Ar C = 12, H = 1. One mole of any gas occupies 24 dm3 at room temperature and pressure.

Lesson 50

Part of the manufacture of sulfuric acid involves turning sulfur dioxide into sulfur trioxide in the presence of vanadium (V) oxide catalyst. This is a reversible reaction and the forward reaction has a net energy transfer of -196 kj mol-1

2SO2 (g) + O2 (g) ⇌ 2SO3 (g)

1) What is the formula of vanadium (V) oxide?

2) Is the forward reaction exothermic or endothermic?

3) What temperature would be ideal for this process?

4) What pressure would be ideal for this process?

5) What volume of hydrogen is produced when 100 cm3 of 0.125 mol dm-3 nitric acid reacts with excess magnesium?

Mg + 2HNO3 🡪 Mg(NO3)2 + H2

1 mole of any gas at room temperature and pressure occupies a volume of 24 dm3

Lesson 51

Part of the manufacture of sulfuric acid involves turning sulfur dioxide into sulfur trioxide in the presence of vanadium (v) oxide catalyst. This is a reversible reaction and the forward reaction has a net energy transfer of -196 Kj mol-1

2SO2 (g) + O2 (g) ⇌ 2SO3 (g)

1) Why in industry are equal proportions of sulfur dioxide and oxygen added to the reaction vessel?

2) Although a high pressure would definitely increase the yield and rate of production of sulfur trioxide this reaction is actually carried out at around atmospheric pressure. Ca you suggest a reason why this is the case?

3) How will the catalyst change the dynamic equilibrium of this reaction?

4) What is the atom economy of the forward reaction?

5) The electrolysis of water produces hydrogen and oxygen. If 12 dm3 of hydrogen is produced what volume of oxygen is also produced?

2H2O (l) 🡪 2H2 + O2

Lesson 52

1) What is needed for iron to rust?

2) How would you prevent rusting of a bike chain?

3) How would you prevent rusting of a steel bike frame?

4) Stainless steel is an alloy of chromium and iron. What is an alloy?

5) Chromium can be extracted by displacement with aluminium. How many tonnes of chromium oxide are needed to produce 13 tonnes of chromium? Ar Cr = 52, O = 16)

Cr2O3 + 2Al 🡪 2Cr + Al2O3

Lesson 53

1) Iron can be protected from corrosion by galvanising with zinc. One method is Electrogalvanisation. What will the electrodes be made from in this process?

2) Suggest a suitable electrolyte?

3) Zinc ions have the formula Zn2+. Write a half equation for the anode.

4) Write a half equation for the cathode.

5) Zinc can be obtained from zinc sulfide. In this process Zinc sulfide is first roasted and turned into zinc oxide. What is the atom economy of this reaction? (Ar Zn = 65.5, S = 32, O = 16)

2ZnS + 3O2 🡪 2ZnO + 2SO2

Lesson 54

1) What do members of the same homologous series have in common?

2) What is the functional group of an alkene?

3) What is the functional group of an alcohol?

4) What is the functional group of a carboxylic acid?

5) The percentage yield for the roasting of zinc sulfide to zinc oxide is 75%. How much zinc oxide is produced from 390 g of zinc sulfide? (Ar Zn = 65.5, S = 32, O = 16)

2ZnS + 3O2 🡪 2ZnO + 2SO2

Lesson 55

1) What is the formula of propene?

2) What is the formula of but-2-ene?

3) What would you observe if bromine water is added to but-2-ene?

4) Write a symbol equation for the reaction in q3 showing the formulae of all the molecules.

5) A titration was carried out. 25.0 cm3 of unknown concentration lithium hydroxide solution, LiOH, was titrated with sulfuric acid. The volume of the sulfuric acid, 0.5 mol dm–3, required to neutralise the lithium hydroxide solution was 23.8 cm3. Calculate the concentration of the lithium hydroxide solution, LiOH, in mol dm–3.

H2SO4 + 2LiOH 🡪Li2SO4 + 2H2O

Lesson 56

1) What pieces of equipment would you use for a titration?

2) Name the indicators and associated colour changes for all indicators on the specification.

3) What is a covalent bond?

4) Do simple molecular substances have high or low boiling points? Explain.

5) A sodium hydroxide solution was made up by dissolving 60.0 g of sodium hydroxide in water and making the volume of the solution up to 0.25 dm3. Calculate the concentration (in mol dm–3) of sodium hydroxide, NaOH, in this solution.

(relative atomic masses: H = 1.00, O = 16.0, Na = 23.0)

Lesson 57

1) Give 3 reasons why you wouldn’t expect 100% yield from a chemical reaction.

2) Assuming the methane is present in excess what volume of carbon dioxide is made from 5 dm3 of oxygen?

CH4 (g) + 2O2 (g) 🡪 CO2 (g) + 2H2O (g)

3) How do you carry out a flame test?

4) What colours to the common metals turn a Bunsen flame?

5) A titration was carried out. 25.0 cm3 of 0.75 mol dm–3 sodium hydroxide solution, NaOH, was titrated with sulfuric acid. The volume of the sulfuric acid required to neutralise the sodium hydroxide solution was 27.6 cm3. Calculate the concentration of the sulphuric acid, H2SO4 , in mol dm–3.

H2SO4 + 2NaOH 🡪Na2SO4 + 2H2O

Lesson 58

1) Give the test results when the common cations are added to sodium hydroxide solution.

2) Define: dynamic equilibrium.

3) In the reaction below, how would you shift the position of the dynamic equilibrium to the left?

[Co(H2O)6]2+ (aq) + 4Cl- (aq) ⇌ [CoCl4]2- + 6H2O (l)

4) Explain the conditions used in the Haber process.

5) What volume of hydrogen is created when 19.5 g of potassium is reacted with excess water?

2K + 2H2O 🡪 2KOH + H2

Ar K = 39. One mole of any gas occupies 24 dm3 at room temperature and pressure

Lesson 59

1) How are sulfate, carbonate, and halide ions tested for?

2) What do fertilisers add to the soil?

3) Why is diamond used for cutting tools and graphite used as a lubricant?

4) What are advantages and disadvantages of a fuel cell?

5) Calculate the atom economy for making sodium hydroxide (Ar Na = 23, H = 1, O = 16, Cl = 35.5).

2NaCl + 2H2O 🡪 2NaOH + Cl2 + H2

Lesson 60

1) What is an isotope?

2) How many protons neutrons and electrons in the Al3+ ion? (mass number 27, atomic number 13)

3) What do all atoms of group 2 have in common?

4) Do ionic substances conduct electricity?

5) Iron is made from iron oxide (Fe2O3). How many grams of iron are made from 16 g of iron oxide? (Ar Fe = 56, O = 16).

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Calculation Licence.

You must answer each of these questions correctly before sitting your GCSE

**Calculate the relative atomic mass.**

A sample of silicon contains

92.2% of silicon-28 atoms

4.7% of silicon-29 atoms

3.1% of silicon-30 atoms.

Use this information to calculate the relative atomic mass of this sample of silicon.

****

**Counting the number of atoms.**

Count the number of atoms in Aluminium nitrate Al(NO3)3.



**Calculate relative formula mass.**

Calculate the relative formula mass of ammonium nitrate, NH4NO3.

(relative atomic masses: H = 1, N = 14, O = 16).

**Calculating percentage**

1 kg of spring water contains 66.2 mg of calcium ions. What is the percentage by mass of calcium ions in the water. Give your answer to 2 significant figures.

**Empirical Formulae**

A 46.4 g sample of iron oxide contains 33.6 g of iron. Calculate the empirical formulae of this oxide.

**Empirical formulae and relative formula mass**

A hydrocarbon contains 3 g of carbon and 0.5 g of hydrogen. The relative formula mass of this molecule is 56. Calculate the molecular formula of this hydrocarbon.

(relative atomic masses: H = 1, C = 12).



**Calculating Quantities**

The equation for the electrolysis of aluminium oxide is

2Al2O3 🡪 4Al + O2

Calculate the maximum mass of aluminium that can be obtained from 510 tonnes of aluminium oxide.

(relative atomic masses: O = 16, Al = 27).

**Concentration (g dm-3)**

Sodium chloride solution was prepared by dissolving 9.11 g of solid in water and making the volume up to 200 cm3.

Calculate the concentration of sodium chloride in g dm-3. Give your answer to 3 significant figures.

**Using the Avogadro constant.**

Calculate the number of molecules in 5 moles of glucose, C6H12O6.

(Avogadro constant = 6.02 x 1023)

A beaker of water contains 4.214 x 1024 molecules. How many moles of water are present?

(Avogadro constant = 6.02 x 1023)

**Calculating Moles**

How many moles of ammonia, NH3 are present in a 51 g sample?

(relative atomic masses: H = 1, N = 14).

**Avogadro constant and moles**

How many molecules are present in a 23 g sample of ethanol, C2H5OH? (Avogadro constant = 6.02 x 1023)Ar C = 12, H = 1, O = 16

**Stoichiometry**

The equation for the production of ammonia is:

N2 (g) + 3H2 (g) ⇌ 2NH3 (g)

How many moles of nitrogen would react with 12 moles of hydrogen?

Assuming a 100% yield, how many moles of ammonia would be produced from 12 moles of hydrogen?

**Calculating Rf**

In a chromatography experiment a coloured substance in a food dye moved 2.1 cm when the solvent front moved 2.6 cm.

Calculate the Rf value for this substance, giving your answer to 2 significant figures.

**Law of Conservation of Mass**

Copper oxide thermally decomposes on heating to form copper oxide and carbon dioxide.

CuCO3 (s) 🡪 CuO (s) + CO2 (g)

61.75 g of copper carbonate was heated. 39.75 g of solid remained, calculate the mass of carbon dioxide produced.

**Concentration (mol dm-3)**

Copper sulfate, CuSO4 solution was prepared by dissolving 39.875 g of solid in water and making the volume up to 100 cm3.

Calculate the concentration of copper sulfate in mol dm-3. (relative atomic masses: Cu = 63.5, S = 32, O = 16).

**Titrations**

Sodium hydroxide solution was titrated with dilute hydrochloric acid. The results of the experiment were:

Volume of sodium hydroxide solution = 25.0 cm3

Volume of 0.25 mol dm–3 hydrochloric acid used:

|  |  |
| --- | --- |
| 1st titration | 22.4 cm3 |
| 2nd titration | 23.7 cm3 |
| 3rd titration | 22.6 cm3 |

(i) State the volume of hydrochloric acid that must be used to calculate the concentration of sodium hydroxide solution.

Volume of hydrochloric acid = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cm3

(ii) Use your answer to part (i) to calculate the concentration of sodium hydroxide solution, NaOH, in mol dm–3.

NaOH + HCl → NaCl + H2O

**Percentage yield**

It is possible to turn ethene into ethanol by reacting it with steam. This is done in factories on an industrial scale, one such factory takes 2 tonnes of ethene and produces 2.97 tonnes of ethanol. Chemists at the factory have calculated that 2 tonnes of ethene should produce 3.28 tonnes of ethanol. What is the percentage yield of this reaction? Answer to 2 significant figures.

****

**Atom economy**

Copper (II) oxide is reduced by smelting with carbon to produce copper. Calculate the atom economy of the production of copper.

2CuO + C 🡪 2Cu + CO2

(relative atomic masses: Cu = 63.5, C = 12, O = 16).

**Calculating the volume of gas produced.**

The hydrogen used in the Haber process is produced by reacting methane with steam.

CH4 + 2H2O 🡪 CO2 + 4H2

What volume of hydrogen is produced from 10 dm3 of methane?

**Calculations involving solutions and gases**

What volume of hydrogen is produced when 50 cm3 of 0.25 mol dm-3 nitric acid reacts with excess magnesium?

Mg + 2HNO3 🡪 Mg(NO3)2 + H2

1 mole of any gas at room temperature and pressure occupies a volume of 24 dm3

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Bonding Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Ionic | Covalent | | | Metallic |
| Description |  |  | | |  |
| Atoms Involved |  |  | | |  |
| Example |  |  | | |  |
| Charges |  |
| Formula |  |
| Name |  |
| Structure |  | Simple Molecular | Giant Molecular | |  |
|  | Diamond | Graphite |  |
| Melting Point |  |  |  |  |  |
| Electrical Conductivity |  |  |  |  |  |
| Solubility in water |  |  |  |  |  |

Writing Ionic Equations

Ionic equations only show the ions that change their physical state (solid or dissolved) or their oxidation state (their charge) and ignores ions that keep the same charge and remain in solution. Ions that keep the same charge and remain in solution are known as spectator ions. **Ionic equations do not include spectator ions.**

Half equations in electrolysis are examples of ionic equations.

Write a half equation for the cathode and anode when molten lead bromide is electrolysed.

|  |  |
| --- | --- |
| Cathode |  |
| Anode |  |

Write a half equation for the cathode and anode when water is electrolysed.

|  |  |
| --- | --- |
| Cathode |  |
| Anode |  |

Write a half equation for the cathode and anode when copper chloride (aq) is electrolysed.

|  |  |
| --- | --- |
| Cathode |  |
| Anode |  |

We also need to be able to write ionic equations for full reactions. So far, in paper 1 we have come across neutralisation and precipitation reactions in the acids module as well as displacement reactions with metals in the metals module. Similarly, in paper 2 we covered displacement reactions of halogens.

It is important to remember the atoms are not charged in covalent substances but they are in ionic.

How can you identify whether the bonding is ionic or covalent?

|  |  |
| --- | --- |
| Ionic |  |
| Covalent |  |

You are also going to have to be able to work out the charges on ions in ionic compounds.

Remember the periodic table helps you with the charges, but you will need to learn the charges of the common more complex ions below:

|  |  |
| --- | --- |
| Hydroxide | OH- |
| Nitrate | NO3- |
| Sulfate | SO42- |

Give the charges of the following ions in the compounds below.

1. Magnesium oxide, MgO

Type of bonding \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
|  | Charge (if ionic) |
| Magnesium |  |
| Oxygen |  |

1. Carbon dioxide, CO2
2. Type of bonding \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
|  | Charge (if ionic) |
| Carbon |  |
| Oxygen |  |

1. Calcium nitrate, Ca(NO3)2

Type of bonding \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
|  | Charge (if ionic) |
| Calcium |  |
| Nitrate |  |

1. Aluminium sulfate, (Al2(SO4)3

Type of bonding \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
|  | Charge (if ionic) |
| Aluminium |  |
| Sulfate |  |

1. Iron (III) hydroxide, Fe(OH)3

Type of bonding \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
|  | Charge (if ionic) |
| Iron |  |
| Hydroxide |  |

1. Carbon tetrachloride, CCl4

Type of bonding \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
|  | Charge (if ionic) |
| Carbon |  |
| Chlorine |  |

Neutralisation reactions

**Metal oxide + Acid**

For each reaction, use the symbol equation to construct an ionic equation.

|  |  |
| --- | --- |
| Symbol equation | MgO (s) + 2HCl (aq) 🡪 MgCl2 (aq) + H2O (l) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | CuO (s) + H2SO4 (aq) 🡪 CuSO4 (aq) + H2O (l) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | Li2O (s) + 2HNO3 (aq) 🡪 2LiNO3 (aq) + H2O (l) |
| Ionic equation |  |

**Metal hydroxide + Acid**

|  |  |
| --- | --- |
| Symbol equation | LiOH (aq) + HNO3 (aq) 🡪 LiNO3 (aq) + H2O (l) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | Ca(OH)2 (aq) + 2HCl (aq) 🡪 CaCl2 (aq) + 2H2O (l) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | 2KOH (aq) + H2SO4 (aq) 🡪 K2SO4 (aq) + 2H2O (l) |
| Ionic equation |  |

**Metal carbonate + Acid**

|  |  |
| --- | --- |
| Symbol equation | CaCO3 (s) + 2HNO3 (aq) 🡪 Ca(NO3)2 (aq) + H2O (l) + CO2 (g) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | MgCO3 (s) + H2SO4 (aq) 🡪 MgSO4 (aq) + H2O (l) + CO2 (g) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | Li2CO3 (s) + 2HNO3 (aq) 🡪 2LiNO3 (aq) + H2O (l) + CO2 (g) |
| Ionic equation |  |

**Metal + Acid**

|  |  |
| --- | --- |
| Symbol equation | Ca (s) + 2HNO3 (aq) 🡪 Ca(NO3)2 (aq) + H2 (g) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | Mg (s) + H2SO4 (aq) 🡪 MgSO4 (aq) + H2 (g) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | 2Al (s) + 6HNO3 (aq) 🡪 2Al(NO3)3 (aq) + 3H2 (g) |
| Ionic equation |  |

Precipitation Reactions

|  |  |
| --- | --- |
| Symbol equation | AgNO3 (aq) + NaCl (aq) 🡪 NaNO3 (aq) + AgCl (s) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | 3Ca(OH)2 (aq) + Fe2(SO4)3 (aq) 🡪 2Fe(OH)3 (s) + 3CaSO4 (aq) |
| Ionic equation |  |

|  |  |
| --- | --- |
| Symbol equation | 3NaOH (aq) + Al(NO3)3 (aq) 🡪 Al(OH)3 (s) + 3NaNO3 (aq) |
| Ionic equation |  |

Displacement reactions of halogens

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Word equation | Sodium chloride | + | Fluorine | 🡪 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | + | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Symbol equation |  | + |  | 🡪 |  | + |  |
| Ionic equation |  | + |  | 🡪 |  | + |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Word equation | Sodium bromide | + | chlorine | 🡪 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | + | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Symbol equation |  | + |  | 🡪 |  | + |  |
| Ionic equation |  | + |  | 🡪 |  | + |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Word equation | Lithium chloride | + | fluorine | 🡪 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | + | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| Symbol equation |  | + |  | 🡪 |  | + |  |
| Ionic equation |  | + |  | 🡪 |  | + |  |

**Topic 5 - Content and Checklist: Transition metals, alloys and corrosion**

For each content point put a tick next to it firstly when you understand it and secondly when you have learnt it. If you don’t understand a content point you must ask your teacher.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Content | Understand it | Learnt it |
| 1 | Most metals are transition metals and they have a number of properties in common, these are:   * High melting points * High densities * Formation of coloured compounds * Catalytic activity of the metals and their compounds e.g. iron. |  |  |
| 2 | Learn that the reaction of metals with oxygen (oxidation) results in corrosion. |  |  |
| 3 | Explain how the rusting of iron can be prevented by:   * Exclusion of oxygen * Exclusion of water * Sacrificial protection |  |  |
| 4 | Understand that electroplating can be used to improve the appearance and/or the resistance to corrosion of something made from metal. |  |  |
| 5 | Be able to draw and use a diagram to explain why alloys are stronger than pure metals. |  |  |
| 6 | Learn why iron is alloyed with other metals to make steel. |  |  |
| 7 | Explain how the uses of metals are related to their properties. Be able to do this for aluminium, copper and gold as well as the alloys magnalium and brass. |  |  |

Label the periodic table below by:

* Shading the alkali metals purple.
* Shading the halogens red.
* Shading the noble gases grey.
* Shading the transition metals yellow

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Label each metal in the table with its method of extraction, properties and uses.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Method of Extraction | Properties | Use |
| Aluminium |  |  |  |
| Iron (steel) |  |  |  |
| Copper |  |  |  |
| Gold |  |  |  |

Think of 4 different objects made from metal, draw them then explain why the properties of the metal make it suitable for that use. For example, copper saucepans are made from this metal because they have a high melting point, are strong and are good conductors of heat. Be able to do this for aluminium, copper and gold as well as the alloys magnalium and brass.

|  |  |
| --- | --- |
| Use | Reason why the metal is chosen. |
| Aluminium |  |
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|  |
| Copper |  |
|  |
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| Gold |  |
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| Magnalium |  |
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| Brass |  |
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Explain why magnalium and brass are not found on the periodic table.

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What are the common properties of the transition metals?

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What is the difference between rusting and corrosion?

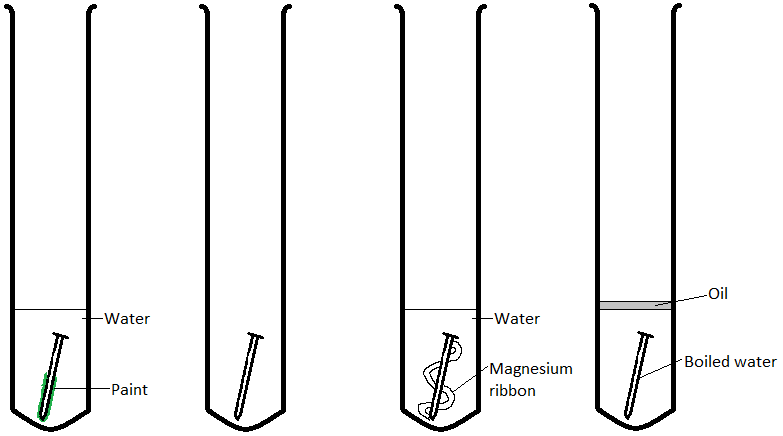
|  |  |
| --- | --- |
| rusting |  |
|  |
| corrosion |  |
|  |

Write a balanced word and symbol equation for the corrosion of iron. The formula of iron oxide is: Fe2O3.

|  |  |
| --- | --- |
| Word |  |
| symbol |  |

The corrosion of iron weakens the metal and quickly makes objects redundant. Prevention of rusting is a very desirable thing to accomplish.

Set up the experiment below, it is designed to deprive the iron nail of either oxygen or water.



For each test tube state what the nail does not have oxygen or water.

|  |  |
| --- | --- |
| Experiment | Missing oxygen or water |
| Painted nail |  |
| Dry nail |  |
| Nail wrapped with magnesium ribbon |  |
| Nail in boiled water |  |

Results – What rusting occurs in each test tube?

|  |  |
| --- | --- |
| Experiment | Rusting |
| Painted nail |  |
| Dry nail |  |
| Nail wrapped with magnesium ribbon |  |
| Nail in boiled water |  |

Conclusion – What conditions are necessary for iron to rust?

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It is also possible to prevent iron from rusting by electroplating it with another metal. Year 10 revision:- can you draw an electrolytic cell that would electroplate the iron metal with silver. Also, write half equations for the reaction that takes place at each electrode.

|  |  |
| --- | --- |
| Labelled apparatus | |
| Anode half equation |  |
| Cathode half equation |  |

Year 10 Revision

When magnesium corrodes, it forms magnesium oxide.

Use your knowledge from year 10 to draw diagrams to show the bonding in each substance.

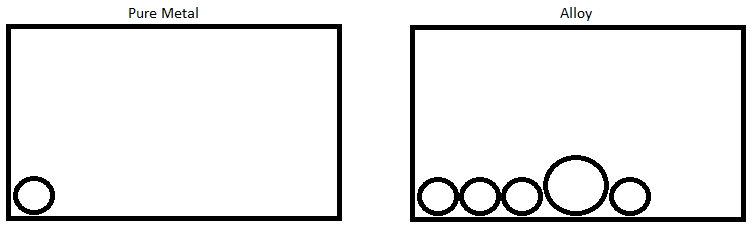
|  |  |  |  |
| --- | --- | --- | --- |
|  | Magnesium | Oxygen | Magnesium oxide |
| Type of bonding |  |  |  |
| Formula |  |  |  |
| Diagram |  |  |  |
| Melting Point |  |  |  |

Alloys

What is an alloy?

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Complete the following boxes. The first one shows the structure of a pure metal, complete this box with metal ions that are the same size. The second box shows an alloy, complete this structure but use metal ions of 2 different sizes.



In which box above would the metal ions find it easier to slide over one another and why?

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Which is stronger the pure metal or the alloy?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is steel and why do we turn iron into it to use it?

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**Topic 5 – Quantitative Analysis**

For each content point put a tick next to it firstly when you understand it and secondly when you have learnt it. If you don’t understand a content point you must ask your teacher.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Content | Understand it | Learnt it |
| 1 | Be able to calculate the concentration of solutions in moles per dm3 (mol dm-3) and convert into grams per dm3 (g dm-3) and vice versa. |  |  |
| 2 | Write a method naming all the apparatus used in order to perform an acid-alkali titration. |  |  |
| 3 | Use the results of an acid base calculation to calculate the concentration of an unknown reactant or an unknown volume of solution. |  |  |
| 4 | Calculate the percentage yield of a reaction. Do this using actual yield and theoretical yield. |  |  |
| 5 | Understand and learn that the theoretical yield is usually less than the actual yield for a reaction because:   1. The reaction is incomplete 2. Reactant or product is lost during the reaction. This is called practical losses. 3. Competing, unwanted reactions. |  |  |
| 6 | Learn that atom economy is a measure of the amount of starting materials that become useful products. This can be expressed as a percentage by calculating the formula mass of all the products and the desired product. |  |  |
| 7 | Calculate atom economy of a reaction. |  |  |
| 8 | Look at different reaction pathways and by looking at data such as atom economy, yield, rate, equilibrium position and usefulness of by-products explain why a particular pathway is chosen. |  |  |
| 9 | Learn that the definition of the molar volume of a gas at room temperature and pressure is: the volume occupied by one mole of molecules of any gas at room temperature and pressure. (This volume will be provided in the exam as 24 dm3 (or 24000 cm3) |  |  |
| 10 | Use the molar volume of a gas in mole calculations involving masses of solids and volumes of gases. |  |  |
| 11 | Use avogadro’s law to calculate the volumes of gases involved in a gaseous reaction. |  |  |

**The dm3**

What is a decimetre (dm)? \_\_\_\_\_\_\_\_\_\_\_

How many cm3 would you fit in a dm3? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Example**

What is the concentration (in g dm-3) of sodium hydroxide solution made from 25 g of NaOH and 250 cm3 of distilled water.

Step 1 – convert the cm3 into dm3 by dividing by 1000.



Step 2 – divide the mass of NaOH by the volume of water



Questions

Work out the concentration of each of the following solutions in g dm-3.

1. 50 g of sodium chloride in 0.5 dm3 of distilled water.
2. 2564 g of calcium hydroxide in 2.6 dm3 of distilled water.
3. 20 g of barium chloride in 50 cm3 of distilled water.
4. 250 g of silver nitrate in 5000 cm3 of distilled water.
5. 2.75 kg of sodium hydroxide in 3000 cm3 of distilled water.

You should now know all the formulae of the above salts, can you write them down next to your answers.

Calculations:

What is the equation (and formula triangle) for converting mass into moles?

|  |  |
| --- | --- |
| Equation | Formula triangle |
|  |  |

Questions:

1. 2.54 g of copper were produced in an experiment. Calculate the number of moles of copper, Cu, produced in this experiment. (Relative atomic mass: Cu = 63.5)
2. 156 g of Magnesium were produced in an experiment. Calculate the number of moles of Magnesium, Mg, produced in this experiment. (Relative atomic mass: Mg = 24)
3. 2.5 g of iron were produced in an experiment. Calculate the number of moles of iron, Fe, produced in this experiment. (Relative atomic mass: Fe = 56)

Example

If 80 g of sodium hydroxide (NaOH) are dissolved in 1 dm3 of water, what is the concentration of the solution in moles dm-3? Ar Na = 23, Ar O = 16, Ar H = 1.





Questions

1. If 53 g of sodium carbonate (Na2CO3) are dissolved in 1 dm3 of water, what is the concentration of the solution in moles dm-3? Ar Na = 23, Ar O = 16, Ar C = 12.
2. A sodium hydroxide solution was made up by dissolving 20.0 g of sodium hydroxide in water and making the volume of the solution up to 1.00 dm3. Calculate the concentration (in mol dm–3) of sodium hydroxide, NaOH, in this solution.

(relative atomic masses: H = 1.00, O = 16.0, Na = 23.0)

1. A calcium chloride solution was made up by dissolving 444.0 g of calcium chloride in water and making the volume of the solution up to 1.00 dm3. Calculate the concentration (in mol dm–3) of calcium chloride, CaCl2, in this solution.

(relative atomic masses: Cl = 35.5, Ca = 40.0)

1. A sodium hydroxide solution was made up by dissolving 100.0 g of sodium hydroxide in water and making the volume of the solution up to 0.50 dm3. Calculate the concentration (in mol dm–3) of sodium hydroxide, NaOH, in this solution.

(relative atomic masses: H = 1.00, O = 16.0, Na = 23.0)

Go back to the calculations on p**23**, instead of calculating the concentration of each solution in g dm-3, recalculate the concentration of each solution in mol dm-3.

1. NaCl (Ar: Na = 23, Cl = 35.5)
2. Ca(OH)2 (Ar: Ca = 40, O = 16, H = 1)
3. BaCl2 (Ar: Ba = 137, Cl = 35.5)
4. AgNO3 (Ar: Ag = 108, N = 14, O = 16)
5. NaOH (Ar: Na = 23, O = 16, H = 1)

**Preparing a pure sample of a soluble salt.**

Why is it essential that neither reactant is present in excess if you want to produce

a pure sample of a soluble salt?

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Write a method and draw diagrams to fully explain how to carry out an acid base titration to determine the concentration of a solution of sodium hydroxide.

The following apparatus and chemicals must be used:

* Burette
* Pipette
* White tile
* Conical flask
* Funnel
* Phenolphthalein
* Sodium hydroxide
* Hydrochloric acid

|  |
| --- |
| Diagram |
| Method |
|  |
|  |
|  |
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|  |
|  |
| Equation |

**Practical**

We have a bottle of sodium hydroxide of unknown concentration. Your task is to titrate a known volume of sodium hydroxide, 25 cm3, with hydrochloric acid, 0.1 mol dm3. You are then to use the volume of hydrochloric acid required to neutralise the sodium hydroxide to calculate its concentration.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Rough titration | Titration 1 | Titration 2 | Titration 3 | Average |
| Initial burette reading (cm3) |  |  |  |  |  |
| Final burette reading (cm3) |  |  |  |  |  |
| Difference (Titre) |  |  |  |  |  |

**Calculation**

Step 1 – calculate the number of moles of hydrochloric acid used in the titration





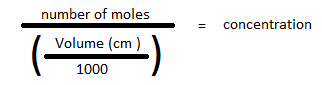
Step 2 – Use reaction equation

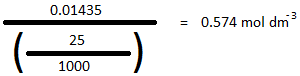
NaOH + HCl = NaCl + H2O

1 mole of NaOH reacts with 1 mole of HCl, therefore

0.01435 moles hydrochloric acid reacts with 0.1435 moles sodium hydroxide.

Step 3 – rearrange the equation





Now use your experimental data to calculate the concentration of sodium hydroxide that you were given.

HCl + NaOH *=* NaCl + H2O

|  |
| --- |
| Stage 1 |
| Stage 2 |
| Stage 3 |

**Questions**:

1. A titration was carried out. 25.0 cm3 of 1.50 mol dm–3 sodium hydroxide solution, NaOH, was titrated with hydrochloric acid. The volume of the hydrochloric acid required to neutralise the sodium hydroxide solution was 30.0 cm3. Calculate the concentration of the hydrochloric acid, HCl, in mol dm–3.

HCl + NaOH *=* NaCl + H2O

|  |
| --- |
| Stage 1 |
| Stage 2 |
| Stage 3 |

1. Sodium hydroxide solution was titrated with dilute hydrochloric acid. The results of the experiment were

Volume of sodium hydroxide solution = 25.0 cm3

Volume of 0.100 mol dm–3 hydrochloric acid used:

|  |  |
| --- | --- |
| rough titration | 23.3 cm3 |
| 1st titration | 22.4 cm3 |
| 2nd titration | 22.6 cm3 |

(i) State the volume of hydrochloric acid that must be used to calculate the concentration of sodium hydroxide solution.

Volume of hydrochloric acid = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cm3

(ii) Use your answer to part (i) to calculate the concentration of sodium hydroxide solution, NaOH, in mol dm–3.

NaOH + HCl → NaCl + H2O

concentration of sodium hydroxide solution = .................................................... mol dm–3

1. Some titration results that will be used to calculate the concentration of sodium hydroxide in drain cleaner are show:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Volume (cm3) | | |
| Experiment 1 | Experiment 2 | Experiment 3 |
| Final burette reading | 26.50 | 24.90 | 25.10 |
| Initial burette reading | 0.15 | 0.10 | 0.20 |
| Volume of hydrochloric acid added | 26.35 |  |  |

What volume of hydrochloric acid should be used in the calculation?

The concentration of the hydrochloric acid, HCl, was 0.5 mol dm-3. Calculate the concentration of sodium hydroxide, NaOH, in the diluted drain cleaner in mol dm–3 **when 25cm3 is used**.

NaOH + HCl = NaCl + H2O

1. A titration was carried out. 25.0 cm3 of 1.25 mol dm–3 sodium hydroxide solution, NaOH, was titrated with sulfuric acid. The volume of the sulfuric acid required to neutralise the sodium hydroxide solution was 22.6 cm3. Calculate the concentration of the sulphuric acid, H2SO4 , in mol dm–3.

H2SO4 + 2NaOH *=* Na2SO4 + 2H2O

1. A titration was carried out. 25.0 cm3 of 1.1 mol dm–3 sodium hydroxide solution, NaOH, was titrated with hydrochloric acid. The concentration of the hydrochloric acid was 0.95 mol dm-3, what volume of acid will be required to completely neutralise **the sodium hydroxide**?

HCl + NaOH *=* NaCl + H2O

Other Questions

1. A different sodium hydroxide solution, NaOH, has a concentration of 0.080 mol dm–3. Calculate the concentration of this solution in g dm–3.

(Relative formula mass of sodium hydroxide, NaOH = 40.0)

1. Ammonia is reacted with excess nitric acid, HNO3, to make ammonium nitrate, NH4NO3.

NH3 + HNO3 → NH4NO3

Calculate the mass of ammonium nitrate produced by the complete reaction of 34 g of ammonia.

(Relative atomic masses H = 1.0, N = 14, O = 16)

1. Enzo decided to find the concentration of sodium carbonate (Na2CO3) in a solution. To do this he decided to take a 250 cm3 sample and heat it over a Bunsen until only the sodium carbonate remained?
2. Where did the water go? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The results are below:

|  |  |
| --- | --- |
|  | Mass (g) |
| Flask | 212.38 |
| Flask filled with sodium carbonate (aq) | 470.57 |
| Flask and residue | 220.57 |

1. Use these results to calculate the concentration of sodium carbonate in g dm-3
2. Use these results to calculate the concentration of sodium carbonate in mol dm-3

(relative atomic masses Na = 23, C = 12, O = 16)

**Percentage Yield**

What is the yield?

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In reactions it is very rare to have 100% of the reactants turn into the expected products.

Give 3 reasons for this.

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| 3 |  |
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Example:

If in a reaction the expected yield is 10 g and the actual yield is 5 g. What is the expected yield?





Question:

1. In a reaction the expected yield is 20 g and the actual yield is 15 g. What is the % yield?
2. When decane is cracked the theoretical yield of ethene is 28 g. the actual yield in one experiment is 25.2 g, what is the % yield?
3. Adding water to 10 g of calcium oxide should produce 13.2 g of calcium hydroxide. In an experiment it actually produces 12.8 g of calcium hydroxide. What is the percentage yield?

Ca + H2O = Ca(OH)2

1. The equation below is for the reaction of zinc reacts with dilute sulphuric acid:

Zn + H2SO4 = ZnSO4 + H2

The equation can be used to calculate that 6.46 g of zinc will produce 16 g of zinc sulphate. In an experiment 3.23 g of zinc produced 4 g of zinc sulphate. What is the percentage yield in this experiment?

1. It is possible to turn ethene into ethanol by reacting it with steam. This is done in factories on an industrial scale, one such factory takes 2 tonnes of ethene and produces 2.96 tonnes of ethanol. Chemists at the factory have calculated that 2 tonnes of ethene should produce 3.28 tonnes of ethanol. What is the percentage yield of this reaction?

**Waste products**

Why does the chemical industry dislike waste products?

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The equations for 3 industrial processes are shown below:

1. reduction of iron oxide by carbon monoxide

Fe2O3 + 3CO 🡪 2Fe + 3CO2

1. electrolysis of brine (salt water))

NaCl (aq) 🡪 NaOH (aq) + Cl2 (g) + H2 (g)

1. Production of ammonia

N2 (g) + 3H2 (g) ⇌ 2NH3 (g)

Explain which of these processes has no waste products.

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What are the problems associated with waste disposal?

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What does the chemical industry try to do to minimise waste?

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Explain how chemists work to make processes as economically as viable as possible

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Atom Economy

Atom economy is a measure of the atoms wasted in a chemical reaction. For example, the hydrogen required for the Haber process is made by reacting methane with steam.

CH4 + 2H2O 🡪 CO2 + 4H2

Calculate the atom economy for making hydrogen in this process (Ar C = 12, H = 1, O = 16).



* Mr H2 = 1 + 1 = 2
* Mr CO2 = 12 + 16 + 16 = 44
* In the equation there are 4 moles of H2, so the total mass from the equation is 4 x 2 = 8



**Questions**

Calculate the atom economy for making calcium oxide (Ar C = 12, Ca = 40, O = 16).

CaCO3 🡪 CaO + CO2

Calculate the atom economy for making lithium hydroxide (Ar Li = 7, H = 1, O = 16).

2Li + 2H2O 🡪 2LiOH + H2

Calculate the atom economy for making ammonia (Ar N = 14, H = 1).

N2 + 3H2 ⇌ 2NH3

* When looking at this reaction the atom economy is high, why is the yield in this case no way near the atom economy?

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Calculate the atom economy for making aluminium (Ar Al = 27, O = 16).

Al2O3 🡪 4Al + 3O2

Calculate the atom economy for making copper nitrate (Ar C = 12, Cu = 63.5, O = 16, H = 1).

CuCO3 + 2HNO3 🡪 Cu(NO3)2 + H2O + CO2

Calculate the atom economy for making sodium hydroxide (Ar Na = 23, H = 1, O = 16, Cl = 35.5).

NaCl(aq) 🡪 NaOH + Cl2 + H2

* The atom economy in this reaction is nothing better than average yet to the chemical industry in is in practice much higher. Can you explain why?

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Atom economy is one way of judging the economic viability of a reaction, can you name others:

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Gases

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| --- |
| **One mole of any gas always occupies 24 dm3 at room temperature and pressure.** |

1. What volume does 1 mole of Helium occupy at room, temperature and pressure?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What volume does 1 mole of carbon dioxide occupy at room, temperature and pressure?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What volume does 1 mole of nitrogen occupy at room, temperature and pressure?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |
| --- |
| Number of moles x 24 dm3 = Volume dm3 |

1. What volume does 3 moles of methane occupy at room, temperature and pressure?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What volume does 0.25 moles of chlorine occupy at room, temperature and pressure?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Now answer these examiners favorites using the reaction equation….

1. Assuming the sulfur is present in excess what volume of sulfur dioxide is made from 5 dm3 of oxygen?

S (s) + O2 (g) 🡪 SO2 (g)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

1. Assuming the methane is present in excess what volume of carbon dioxide is made from 5 dm3 of oxygen?

CH4 (g) + 2O2 (g) 🡪 CO2 (g) + 2H2O (g)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

1. In the production of SO3 what volume of SO2 would be required to react with 500 cm3 of O2?

2SO2 (g) + O2 (g) ⇌ 2SO3 (g)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

1. In the production of ammonia what volume of Nitrogen would be required to react with 5 dm3 of hydrogen?

N2 (g) + 3H2 (g) ⇌ 2NH3 (g)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

Now can you convert a mass to moles and use a reaction equation?

1. What volume of hydrogen is produced when 28 g of lithium is reacted with excess water?

2Li (s) + 2H2O (l) 🡪 2LiOH (aq) + H2 (g)

1. What volume of oxygen is produced when 51 g of aluminium oxide is electrolysed?

2Al2O3 (l) 🡪 4Al (l) + 3O2 (g)

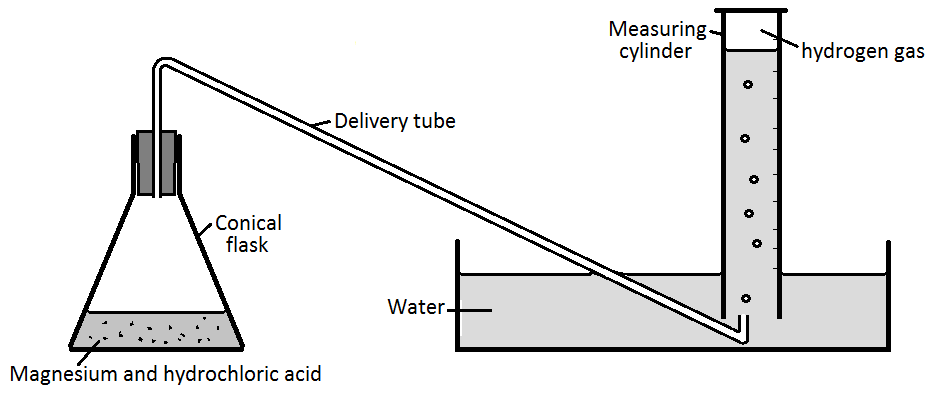
You will react 50 cm3 0.5 mol dm-3 hydrochloric acid with 1 g of magnesium turnings. In this experiment the magnesium is present in excess, what does in excess mean?

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The gas will be collected using the apparatus below, use the information above and the reaction equation to calculate the volume of hydrogen gas that you would expect to collect. (1 mole of any gas at room temperature and pressure occupies 24000 cm3)

Mg + 2HCl (aq) 🡪 MgCl2 + H2 (g)

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In reality only 200 cm3 of gas was collected, what is the percentage yield for this reaction?

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What reasons could you give for not getting closer to 100% yield?

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**Topic 5 – Dynamic Equilibria**

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| --- | --- | --- | --- |
|  | Content | Understand it | Learnt it |
| 1 | Remember the Haber process from year 10 as a reversible reaction between nitrogen and hydrogen to form ammonia. |  |  |
| 2 | Learn how the rate of attainment of equilibrium is affected by changes in temperature, pressure, concentration and catalyst. |  |  |
| 3 | Explain how, in industrial reactions, including the Haber process, conditions used are related to:   1. Availability and cost of raw materials and energy supplies 2. Controlling reaction conditions like temperature, pressure and catalyst so a compromise can be used to produce an acceptable yield in an acceptable time. |  |  |
| 4 | Learn that fertilisers contain nitrogen, phosphorus and potassium compounds and that these are essential for plant growth. |  |  |
| 5 | Learn that ammonia is reacted with nitric acid to produce the salt ammonium nitrate and that this salt is used as a fertiliser. |  |  |
| 6 | Understand that ammonium sulfate can also be used as a fertiliser and that the lab based preparation method and the industrial production are different. You need to be able to explain each and state the differences between the small scale lab production and the several stage large scale production method used in industry. |  |  |



The Haber Process

What is the chemical formula of ammonia? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Write a balanced word and symbol equation for the production of ammonia.

|  |  |
| --- | --- |
| Word |  |
| Symbol |  |

Where are the raw materials for the production of ammonia sourced?

|  |  |
| --- | --- |
| Raw Material | Source |
|  |  |
|  |  |

What does this symbol mean ⇌ ?

|  |
| --- |
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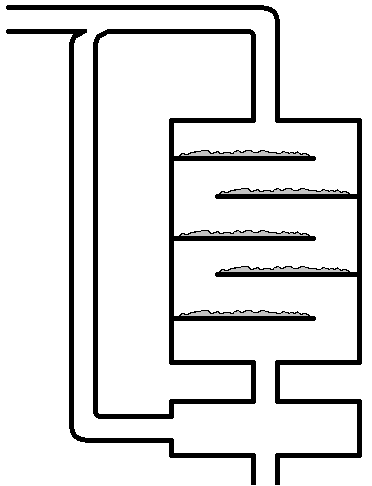
What is a dynamic equilibrium?

|  |
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Explain how each of the following conditions affects the rate of attainment of equilibrium.

|  |  |
| --- | --- |
| Condition | Effect on rate |
| Temperature |  |
|  |
|  |
| Pressure |  |
|  |
|  |
| Concentration |  |
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| Catalyst |  |
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Apparatus - Label the diagram of the Haber process



Temperature and pressure also affect the dynamic equilibrium and cause it to shift.

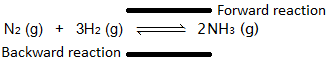
**Temperature**

In equilibrium reactions, one reaction is exothermic and one reaction is endothermic.

Define exothermic and endothermic and state which gives off and which takes in heat.

|  |  |  |
| --- | --- | --- |
|  | Definition | Hot or cold |
| Exothermic |  |  |
|  |
| Endothermic |  |  |
|  |

In the Haber process the forward reaction is exothermic and the reverse reaction is endothermic. Label the equation accordingly:



Dynamic equilibrium reactions move to oppose the change in conditions i.e. if you heat it up it will move in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_direction. Does increasing the temperature increase or decrease the yield of ammonia? Give the reason for this.

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| Increase or decrease? | Reason |
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**Pressure**

If you increase the pressure on an equilibrium reaction the equilibrium will shift to reduce the pressure. Count the gas molecules on each side of the arrow to find the degree of shift.

N2 (g) + 3H2 (g) ⇌ 2NH3 (g)

How many gas molecules are there on the left of the Haber process? \_\_\_\_\_\_\_\_\_\_\_

How many gas molecules are there on the right of the Haber process? \_\_\_\_\_\_\_\_\_\_\_

Which side has the least molecules? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If you increase the pressure does the equilibrium shift to the N2 + 3H2 or the 2NH3? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

Does increasing the pressure increase or decrease the yield of ammonia? Give the reason for this.

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| --- | --- |
| Increase or decrease? | Reason |
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In reality a medium temperature of ~450 oC and a high pressure of 200 atm is used. Can you explain these conditions?

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If the reactants were solutions, then concentration would also affect the dynamic equilibrium. How would increasing the concentration of a reactant effect the position of the equilibrium?

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What factors would affect the siting of an industrial complex producing ammonia?

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The ammonia that is produced from the Haber process can be used to produce fertilisers. What is a fertiliser?

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What do fertilisers add to the soil?

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| 1) |  | 2) |  | 3) |  |

To produce a fertiliser from ammonia you have to react it with an acid. Write a word and symbol equation for the production of ammonium nitrate.

|  |  |
| --- | --- |
| Word |  |
| Symbol |  |

Ammonia has a pH of 12, what pH will ammonia nitrate have and what family of compounds will it belong to?

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| --- | --- |
| Ammonium nitrate pH |  |
| Ammonium nitrate family |  |

Write a word and symbol equation for the production of ammonium sulfate.

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| --- | --- |
| Word |  |
| Symbol |  |

Write a method explaining how you would go about preparing a pure dry sample of ammonium sulfate in the lab.

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What is the difference between a batch process and a continuous process?

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| Batch process |  |
|  |
| Continuous process |  |
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Is the production of ammonium sulfate in the lab a batch or continuous process? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How is the industrial production of ammonium sulfate different?

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Other reversible reaction questions.

**Remember!**

1. **Increasing the temperature on a reversible reaction always favours the endothermic reaction.**
2. **Increasing the pressure on a reversible reaction with reactants and products that are gases favours the side of the reaction with the fewer gas molecules.**
3. **Increasing the concentration of a solution moves the equilibrium to the other side.**
4. Iodine monochloride reacts reversibly with chlorine to form iodine trichloride. The forward reaction is exothermic.

ICl + Cl2 ⇌ ICl3

If this reaction is left it reaches a state of dynamic equilibrium. What does this mean?

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Iodine monochloride is brown and iodine trichloride is yellow. A mixture that has reached dynamic equilibrium is heated, would you expect the mixture to become darker or lighter.

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**\*Delete** as appropriate.

Increasing the heat favours the **exothermic\*/endothermic\*** reaction

1. In another reversible reaction a mixture of nitrogen dioxide (NO2) and dinitrogen tetroxide (N2O4) is left in a sealed container.

2NO2 ⇌ N2O4

Nitrogen dioxide (NO2) is brown and dinitrogen tetroxide (N2O4) is colourless.

A container left at a constant room temperature filled with these gases will reach a dynamic equilibrium and the colour is light brown.

The container is put in the fridge and the colour lightens from light brown to yellow. (Assume the pressure remains unchanged.) Is the forward reaction exothermic or endothermic?

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Why do you think this? (Use the **remember** bullet points on the previous page)

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The pressure on this dynamic equilibrium is then increased. Would you expect the colour to become darker or lighter?

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Why would it change this colour? (Use the **remember** bullet points on the previous page)

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1. In the production of sulfuric acid, sulfur dioxide gas can react with oxygen gas to make sulfur trioxide gas and the reaction is reversible.

2SO2 (g) + O2 (g) ⇌ 2SO3 (g)

How would you increase the quantity of sulfur trioxide produced.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Why have you chosen these conditions? (Use the **remember** bullet points on the previous page)

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1. The following reaction is reversible.

[Co(H2O)6]2+ (aq) + 4Cl- (aq) ⇌ [CoCl4]2- (aq) + 6H2O (l)

[Co(H2O)6]2+ (aq) is pink solution

[CoCl4]2- (aq) is blue a blue solution

Cl- (aq) is hydrochloric acid and is colourless.

If left to reach dynamic equilibrium the solution is violet.

Starting with three tubes of violet-coloured solution, keep one tube as a control, and place another tube in the hot water, you will observe It will turn blue. Put the third tube in the ice/water mixture and you will see it will turn pink. Following this, the tubes in the hot and cold water are swapped over and the pink and blue colours reverse to show the reaction is reversible.

Is the forward reaction exothermic or endothermic? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Why do you think this? (Use the **remember** bullet points on the previous page)

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Devise a different experiment to show that this is a reversible reaction.

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1. In the production of nitric acid ammonia is first reacted with oxygen to form nitrogen oxide. The reaction is reversible.

4NH3(g) + 5O2(g) ⇌ 4NO(g) + 6H2O(g)

The energy change of the forward reaction is -904 kJ mol-1

Is the forward reaction exothermic or endothermic? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If you were to maximise the yield of nitrogen oxide in this reversible reaction what conditions would you choose and why?

|  |  |
| --- | --- |
| Condition | Reason |
| Excess oxygen or 5 times amount ammonia |  |
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| Temperature of 900 oC or room temperature. |  |
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| 7 atm pressure or atmospheric pressure. |  |
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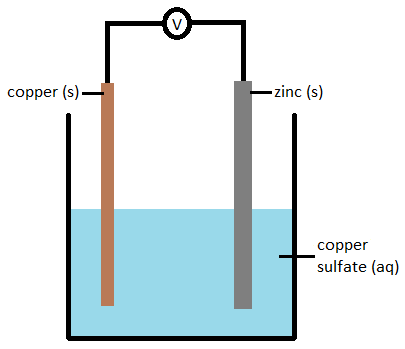
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**Topic 5 – Chemical cells and fuel cells**

For each content point put a tick next to it when firstly you understand it and secondly when you have learnt it. If you don’t understand a content point you must ask your teacher.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Content | Understand it | Learnt it |
| 1 | Learn that chemical reactions can be set up to produce electricity and the voltage will last until one of the reactants is used up. |  |  |
| 2 | Remember from the hydrocarbon unit that hydrogen-oxygen fuel cells are a potential alternative form of power for cars. Learn that they use hydrogen and oxygen to produce a voltage and that water is the only product. |  |  |
| 3 | Be able to write in detail about the strengths and weaknesses of hydrogen fuel cells for a range of uses. |  |  |

You can set up displacement reactions so that the energy released is in the form of electrical energy.



Set up the following apparatus and record the voltage of each cell.

|  |  |  |
| --- | --- | --- |
| Electrode 1 | Electrode 2 | Voltage (V) |
| Copper | Zinc |  |
| Copper | Iron |  |
| Copper | Magnesium |  |
| Copper | Copper |  |

Why do you think lithium batteries are very popular for electric cars?

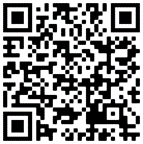
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When will the cell stop producing electricity?

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Explain how a fuel cell works, include in your answer how the reactants are found, why the fuel cell is different to burning the hydrogen, why fuel cells are an exciting alternative to petrol cars.

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Complete the table showing the advantages and disadvantages of fuel cells.

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| Advantages | Disadvantages |
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Why are fuel cells used for buses in some parts of London and yet nobody owns a fuel cell car?

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**Topic 9 – Qualitative analysis: tests for ions**

For each content point put a tick next to it when firstly you understand it and secondly when you have learnt it. If you don’t understand a content point you must ask your teacher.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Content | Understand it | Learnt it |
| 1 | Explain why the test for any ion must be unique. |  |  |
| 2 | Know how to do a flame test and learn the results to identify the following cations:   1. Lithium ion (Li+) – red. 2. Sodium ion (Na+) – yellow. 3. Potassium ion (K+) – lilac. 4. Calcium ion (Ca2+) – orange-red. 5. Copper (II) ion (Cu2+) – blue-green. |  |  |
| 3 | Know that you can test for cations in solids or solutions by using sodium hydroxide solution. Learn the following results:   1. Aluminium ion (Al3+) – white precipitate that dissolves in excess sodium hydroxide. 2. Calcium ion (Ca2+) – white precipitate 3. Copper (II) ion (Cu2+) – blue precipitate 4. Iron (II) ion (Fe2+) – green precipitate 5. Iron (III) ion (Fe3+) – brown precipitate 6. Ammonium ion (NH4+) - Gently warm test tube and test gas with moist red litmus and it goes blue. |  |  |
| 4 | Learn the test for ammonia. |  |  |
| 5 | Learn the tests and results for the following anions:   1. Carbonate ion (CO32-) – use dilute acid and test the gas given off with limewater. The CO2 produced will turn the limewater milky. 2. Sulfate ion (SO42-) – add dilute hydrochloric acid and barium chloride solution. The presence of the sulfate ion is indicated with a white precipitate. 3. Halide ions – add dilute nitric acid and silver nitrate solution. The presence of the chloride ion (Cl-) is indicated with a white precipitate. The presence of the bromide ion (Br-) is indicated with a cream precipitate. The presence of the iodide ion (I-) is indicated with a yellow precipitate. |  |  |
| 6 | Learn that instrumental methods of analysis like flame photometry can be used to the accuracy, speed and sensitivity of the tests outlined above. |  |  |
| 7 | Be able to evaluate data from a flame photometer. You should be able to use this data to:   1. Work out the concentration of ions in dilute solution using a calibration curve. 2. Identify metal ions by comparing the data with reference data. |  |  |

What is the difference between a qualitative test and a quantitative test?

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| Qualitative |  |
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| Quantitative |  |
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How can you remember the difference?

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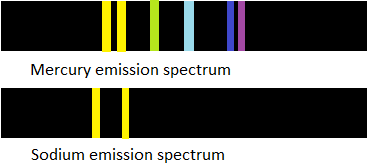
Why is it important that a test must be unique?

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Give advantages of using instrumental methods of analysis over the tests you have performed.

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Instrumental methods can be used to analyse the light given off in flame tests, from this emission sprectra can be produced and these are unique to each element. The emission spectra of sodium and mercury are below. Each line is light being given off at a particular wavelength.



Identifying an unknown element would just involve comparing the emission spectrum to the reference one for each element until a match was made. Much like the police matching fingerprints from crime scenes.

Flame Photometers

Flame photometers can give the wavelength of the light emitted from a flame test and these could be compared to data tables. The table below gives the wavelength and colours of light emitted by some alkali and alkali earth elements.

|  |  |  |
| --- | --- | --- |
| Element | Emission wavelength | Flame colour |
| Barium | 554 | Lime green |
| Caesium | 852 | Outside visible spectrum |
| Calcium | 622 | Orange-red |
| Lithium | 670 | Red |
| Magnesium | 285 | Outside visible spectrum |
| Potassium | 766 | Lilac |
| Rubidium | 780 | Violet |
| Sodium | 589 | Yellow |
| Strontium | 461 | Scarlet |

If you add an unknown element to a flame photometer you can record the wavelength of the light emitted, then quickly and accurately compare it to a table like this.

Flame photometers also perform a quantitative analysis by recording the brightness or intensity of the flame colour. This allows us to record the concentration of the ion in solution by comparing the unknown against a calibration curve.

The graph below is a calibration curve for sodium ions in solution.

Two different solutions of sodium of unknown concentration are tesed in a flame photometer. Use the calibration curve above to deduce the concentration of each solution. (Hint – if you’re not now reaching for a sharp pencil and a ruler you will get it WRONG!)

|  |  |  |
| --- | --- | --- |
| Solution of sodium | Light intensity | Concentration |
| A | 2.8 |  |
| B | 6.9 |  |

In your own words explain how a flame photometer can be used to both identify and give the concentration of a metal ion in an unknown solution.

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Qualitative tests

**LEARN EVERYTHING ON THIS SHEET**

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| --- | --- | --- |
| Indicator **(Paper 1)** | Result | Used For |
| Phenolphthalein | Pink when a base is added otherwise colourless | Titrations with strong acids and bases or a weak acid and strong base. |
| Methyl Orange | Yellow in alkali, red in acid. | Titrations with a strong acid and weak base |
| Blue Litmus | Goes Red | Test for acids |
| Red Litmus | Goes Blue | Test for Bases |

**All other learning is for paper 2**

|  |  |
| --- | --- |
| Flame Test | Colour of Flame |
| Lithium (Li+) | Red |
| Sodium (Na+) | Yellow |
| Potassium (K+) | Lilac |
| Calcium (Ca2+) | Orange-Red |
| Copper (Cu2+) | Blue-Green |

|  |  |  |
| --- | --- | --- |
| Add NaOH (sodium hydroxide) | Observation | Equation |
| Aluminium (Al3+) | White precipitate that dissolves in excess NaOH | Al3+ + 3OH- = Al(OH)3 |
| Calcium (Ca2+) | White suspension | Ca2+ + 2OH- = Ca(OH)2 |
| Copper (Cu2+) | Light blue precipitate | Cu2+ + 2OH- = Cu(OH)2 |
| Iron (Fe2+) | Dark green precipitate | Fe2+ + 2OH- = Fe(OH)2 |
| Iron (Fe3+) | Brown precipitate | Fe3+ + 3OH- = Fe(OH)3 |
| Ammonium (NH4+) | Gently warm test tube and test ammonia gas with moist red litmus and it goes blue |  |

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| Add acid (dil) | Observation | Equation |
| Carbonate (CO32-) | Test carbon dioxide gas given off with limewater. The limewater goes cloudy. | CO32- + 2H+ = CO2 + H2O |

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| Add dil HCl and Barium Chloride | Observation | Equation |
| Sulphate (SO42-) | White precipitate | Ba2+ + SO42- = BaSO4 |

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| Add dil HNO3 (nitric acid) then silver nitrate (AgNO3) | Observation | Equation |
| Chloride (Cl-) | White precipitate | Ag+ + Cl- = AgCl |
| Bromide (Br-) | Cream precipitate | Ag+ + Br- = AgBr |
| Iodide (I-) | Yellow precipitate | Ag+ + I- = AgI |

4 blank templates follow – use these to test whether you have successfully learnt all the qualitative tests. More blanks can be provided.

Qualitative tests

LEARN EVERYTHING ON THIS SHEET

|  |  |  |
| --- | --- | --- |
| Indicator **(Paper 1)** | Result | Used For |
| Phenolphthalein |  |  |
| Methyl Orange |  |  |
| Blue Litmus |  |  |
| Red Litmus |  |  |

**All other learning is for paper 2**

|  |  |
| --- | --- |
| Flame Test | Colour of Flame |
| Lithium (Li+) |  |
| Sodium (Na+) |  |
| Potassium (K+) |  |
| Calcium (Ca2+) |  |
| Copper (Cu2+) |  |

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| --- | --- | --- |
| Add NaOH (sodium hydroxide) | Observation | Equation |
| Aluminium (Al3+) |  |  |
| Calcium (Ca2+) |  |  |
| Copper (Cu2+) |  |  |
| Iron (Fe2+) |  |  |
| Iron (Fe3+) |  |  |
| Ammonium (NH4+) |  |  |

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| Add \_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Carbonate (CO32-) |  |  |

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| Add \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Sulphate (SO42-) |  |  |

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| Add \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Chloride (Cl-) |  |  |
| Bromide (Br-) |  |  |
| Iodide (I-) |  |  |

Qualitative tests

LEARN EVERYTHING ON THIS SHEET

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| --- | --- | --- |
| Indicator **(Paper 1)** | Result | Used For |
| Phenolphthalein |  |  |
| Methyl Orange |  |  |
| Blue Litmus |  |  |
| Red Litmus |  |  |

**All other learning is for paper 2**

|  |  |
| --- | --- |
| Flame Test | Colour of Flame |
| Lithium (Li+) |  |
| Sodium (Na+) |  |
| Potassium (K+) |  |
| Calcium (Ca2+) |  |
| Copper (Cu2+) |  |

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| Add NaOH (sodium hydroxide) | Observation | Equation |
| Aluminium (Al3+) |  |  |
| Calcium (Ca2+) |  |  |
| Copper (Cu2+) |  |  |
| Iron (Fe2+) |  |  |
| Iron (Fe3+) |  |  |
| Ammonium (NH4+) |  |  |

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| Add \_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Carbonate (CO32-) |  |  |

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| Add \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Sulphate (SO42-) |  |  |

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| Add \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Chloride (Cl-) |  |  |
| Bromide (Br-) |  |  |
| Iodide (I-) |  |  |

Qualitative tests

LEARN EVERYTHING ON THIS SHEET

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| --- | --- | --- |
| Indicator **(Paper 1)** | Result | Used For |
| Phenolphthalein |  |  |
| Methyl Orange |  |  |
| Blue Litmus |  |  |
| Red Litmus |  |  |

**All other learning is for paper 2**

|  |  |
| --- | --- |
| Flame Test | Colour of Flame |
| Lithium (Li+) |  |
| Sodium (Na+) |  |
| Potassium (K+) |  |
| Calcium (Ca2+) |  |
| Copper (Cu2+) |  |

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| --- | --- | --- |
| Add NaOH (sodium hydroxide) | Observation | Equation |
| Aluminium (Al3+) |  |  |
| Calcium (Ca2+) |  |  |
| Copper (Cu2+) |  |  |
| Iron (Fe2+) |  |  |
| Iron (Fe3+) |  |  |
| Ammonium (NH4+) |  |  |

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| Add \_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Carbonate (CO32-) |  |  |

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| Add \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Sulphate (SO42-) |  |  |

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| Add \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Chloride (Cl-) |  |  |
| Bromide (Br-) |  |  |
| Iodide (I-) |  |  |

Qualitative tests

LEARN EVERYTHING ON THIS SHEET

|  |  |  |
| --- | --- | --- |
| Indicator **(Paper 1)** | Result | Used For |
| Phenolphthalein |  |  |
| Methyl Orange |  |  |
| Blue Litmus |  |  |
| Red Litmus |  |  |

**All other learning is for paper 2**

|  |  |
| --- | --- |
| Flame Test | Colour of Flame |
| Lithium (Li+) |  |
| Sodium (Na+) |  |
| Potassium (K+) |  |
| Calcium (Ca2+) |  |
| Copper (Cu2+) |  |

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| --- | --- | --- |
| Add NaOH (sodium hydroxide) | Observation | Equation |
| Aluminium (Al3+) |  |  |
| Calcium (Ca2+) |  |  |
| Copper (Cu2+) |  |  |
| Iron (Fe2+) |  |  |
| Iron (Fe3+) |  |  |
| Ammonium (NH4+) |  |  |

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| --- | --- | --- |
| Add \_\_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Carbonate (CO32-) |  |  |

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| --- | --- | --- |
| Add \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Sulphate (SO42-) |  |  |

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| --- | --- | --- |
| Add \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ then \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Observation | Equation |
| Chloride (Cl-) |  |  |
| Bromide (Br-) |  |  |
| Iodide (I-) |  |  |

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**Topic 9 - Hydrocarbons, polymers, alcohols and carboxylic acids**

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| --- | --- | --- | --- |
|  | Content | Understand it | Learnt it |
| 1 | Learn the formulae of the first 4 members of the alkane homologous series (methane, ethane, propane and butane). Also, be able to draw diagrams showing their structure. |  |  |
| 2 | Learn the definition of a saturated hydrocarbon. E.g. alkanes |  |  |
| 3 | Learn the formulae of the first 4 members of the alkene homologous series (ethene, propene, but-1-ene and but-2-ene). Also, be able to draw diagrams showing their structure. |  |  |
| 4 | Explain why alkenes are unsaturated hydrocarbons. Learn the functional group within the alkene homologous series is C=C. |  |  |
| 5 | Learn what happens when bromine is added to an alkene (e.g. ethene). Be able to draw the structure of the reactants and products of the reaction. |  |  |
| 6 | Learn that bromine water is used as a test to distinguish between alkanes and alkenes. Know what happens when bromine water is added to each. |  |  |
| 7 | Know about the complete combustion of alkanes and alkenes. Learn that oxidation of either homologous series produces carbon dioxide and water. |  |  |
| 8 | Learn that a polymer is a substance of high average relative molecular mass made up of small repeating units. |  |  |
| 9 | Be able to write about how ethene molecules join together to form the poly(ethene). |  |  |
| 10 | Write equations for the following addition polymerisation reactions:   1. Chloroethene to poly(chloroethene) (PVC) 2. Propene to poly(propene) 3. Tetrafluroethene to poly(tetreafluoroethene (PTFE) |  |  |
| 11 | Predict the structure of the reactant monomer when looking at the structure of an addition polymer. Also, predict the structure of a polymer when given a monomer structure. |  |  |
| 12 | Learn the properties of the following polymers. For each of them give a use based upon its property.   1. Poly(ethene) 2. Poly(propene) 3. Poly(chloroethene) 4. Poly(tetreafluoroethene) |  |  |
| 13 | Learn about condensation polymerisation and explain:   1. Why polyesters are condensation polymers 2. How polyester is formed when a monomer molecule containing 2 carboxylic acid groups is reacted with a monomer molecule containing 2 alcohol groups. 3. How a water molecule is also formed each time an ester link is formed. |  |  |
| 14 | Be able to write about some of the problems associated with polymers, these must include:   1. Availability of starting materials 2. They do not rot (biodegrade) in landfill sites. (Polymers are non-biodegradable). 3. Toxic gases can be produced when certain plastics are burnt. 4. When plastics are recycled they have to be sorted according to type and this is difficult/time consuming before they can be melted down to make new products. |  |  |
| 15 | Evaluate the advantages and disadvantages of recycling polymers, this must include:   1. Economic implications 2. Availability of starting materials 3. Environmental impact. |  |  |
| 16 | Learn that:   1. DNA is a polymer made from 4 different monomers called nucleotides. 2. Starch is a polymer based on sugars 3. Proteins are polymers based on amino acids. |  |  |
| 17 | Learn the formulae and draw the structures of each of the following alcohols:   1. Methanol 2. Ethanol 3. Propanol 4. Butanol |  |  |
| 18 | Learn that:   1. The functional group of the alcohol homologous series is -OH. 2. Alcohols can be dehydrated to form alkenes. |  |  |
| 19 | Know the method of the experiment to measure the temperature rise produced in a known mass of water by the combustion of the alcohols ethanol, propanol, butanol and pentanol. |  |  |
| 20 | Learn the formulae and draw the structures of each of the following carboxylic acids:   1. Methanoic 2. Ethanoic 3. Propanoic 4. Butanoic |  |  |
| 21 | Learn that:   1. The functional group of the carboxylic acid group homologous series is -COOH. 2. Carboxylic acids have typical acidic properties. |  |  |
| 22 | Learn that alcohols can be oxidised to form carboxylic acids. Example, ethanol oxidises to from ethanoic acid. |  |  |
| 23 | Understand that members of the same homologous series will have similar reactions because their molecules contain the same functional group. This can be used to predict the products of reactions of other members of the series. |  |  |
| 24 | Know that ethanol can be produced by the fermentation of carbohydrates in aqueous solution, using yeast to provide enzymes. |  |  |
|  | Learn that to obtain a concentrated solution of ethanol then the fermentation mixture will have to be fractionally distilled. |  |  |



**Alkanes**

Crude oil is a mixture of different length hydrocarbon compounds. These only contain \_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_ atoms bonded together. The table below shows the first four hydrocarbons, these are alkanes. You will need to complete the formula for each alkane and draw a diagram to show how the structure including all covalent bonds

.

How many bonds does a carbon atom form? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How many bonds does a hydrogen atom form? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |
| --- | --- | --- |
| **Hydrocarbon** | **Formula** | **Diagram** |
| Methane |  |  |
| Ethane |  |  |
| Propane |  |  |
| Butane |  |  |

Are these compounds ionic or covalent?

Type of bonding? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Year 10 Revision.

How is the bonding in diamond and graphite different to the bonding in methane?

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Explain the difference in melting point between diamond and methane.

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Explain the difference in electrical conductivity between graphite and methane.

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When long chain hydrocarbons are cracked shorter chain alkanes and alkenes are produced. Complete the following equations showing examples of different cracking reactions.

1. C14H30 🡪 C12H26 + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. C15H32 🡪 C12H26 + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. C16H34 🡪 C11H24 + C3H6 + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 🡪 C10H22 + C3H6

Alkanes and Alkenes

Fill in the blanks:

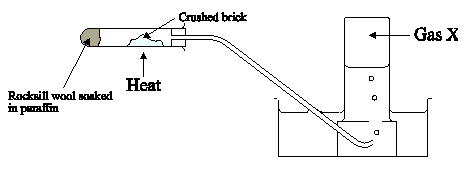
Alkanes and alkenes are 2 different homologous series that are both \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. A hydrocarbon is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ made of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ only. Alkanes are found in \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_ and alkenes are produced when \_\_\_\_\_\_\_\_ chain alkanes are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Alkanes have carbon to carbon \_\_\_\_\_\_\_\_\_\_\_\_ bonds and are known as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Whereas alkenes have a carbon to carbon \_\_\_\_\_\_\_\_\_\_\_\_\_ bond and are known as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The double bond is a reactive site, alkenes are therefore \_\_\_\_\_\_\_\_\_\_\_ reactive than the corresponding member of the alkane family.

**Alkenes**

|  |  |  |
| --- | --- | --- |
| **Hydrocarbon** | **Formula** | **Diagram** |
| Ethene |  |  |
| Propene |  |  |
| But-1-ene |  |  |
| But-2-ene |  |  |

What is the functional group of the alkene homologous series? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The following apparatus can be used to crack long chain hydrocarbons in a science lab.



Explain the purpose of each of the following:

|  |
| --- |
| Paraffin |
| Heat |
| Crushed Brick |

What is Gas X?

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| --- |
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What is a test for Gas X and what is the positive result?

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Complete the equation below by drawing the structures of the molecules involved in the reaction of ethene with bromine.

|  |
| --- |
| + 🡪 |

Complete the equation below by drawing the structures of the molecules involved in the reaction of propene with bromine.

|  |
| --- |
| + 🡪 |

Complete the equation below by drawing the structures of the molecules involved in the reaction of but-1-ene with bromine.

|  |
| --- |
| + 🡪 |

Complete the equation below by drawing the structures of the molecules involved in the reaction of but-2-ene with bromine.

|  |
| --- |
| + 🡪 |

Explain how bromine water is used to distinguish between alkanes and alkenes.

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Most hydrocarbons will be burnt as fuels, assuming complete combustion write balanced symbol equations for the following reactions.

1. Ethane burning.

|  |
| --- |
|  |

1. Ethene burning.

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| --- |
|  |

1. Propane burning.

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| --- |
|  |

1. Propene burning.

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| --- |
|  |

1. Butane burning.

|  |
| --- |
|  |

1. But-1-ene burning.

|  |
| --- |
|  |

1. But-2-ene burning.

|  |
| --- |
|  |

If in any of these reactions there were incomplete combustion, give 2 different products that might be produced.

|  |  |  |  |
| --- | --- | --- | --- |
| 1) |  | 2) |  |

Addition Polymerisation

Polymerisation is the process of making plastic. The word poly derives from the Greek

word polus meaning much/many. Polymerisation requires many unsaturated molecules.

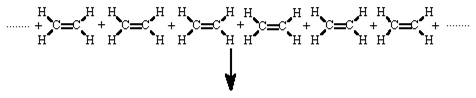
Q: What is an unsaturated molecule?

|  |
| --- |
|  |

In addition polymerisation the unsaturated molecule is called the monomer. The monomers are heated and pressurised, when this happens the carbon carbon double bond in the monomers springs open and each monomer joins to one nearby it forming the polymer. The polymers name is made by taking the monomer name and putting the word ‘poly’ before it.

Complete the equation below and label it with the following words:

1) Polymer 2) Ethene 3) Monomer 4) unsaturated 5) saturated 6) poly(ethene)

****

What is the name of the polymer formed, what is it used for and what environmental problems are associated with it?

|  |
| --- |
| Name |
| Uses |
| Environmental problems |

Do polymers have a high or a low relative molecular mass? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

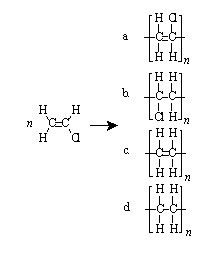
Shorthand equation

It would take too long to write an equation like the one above because the polymer chains often contain 30 000 to 40 000 carbon atoms so instead we use the letter ‘*n’* which means, ‘lots’ to help create a shorthand version.

Have a go at completing the 2 shorthand equations below, in the first I would like you to show 1 repeating unit of the polymer and in the second I would like you to show 2 repeating units of the polymer; your teacher will need to help you:

|  |  |
| --- | --- |
| 1. 1 Repeating Unit   \\srv-007\StaffDocuments$\pbrockington\My Documents\Year 10 Revision CD ROM\October\Publish destination\assets\images\4polyq.GIF | 1. 2 Repeating Units   \\srv-007\StaffDocuments$\pbrockington\My Documents\Year 10 Revision CD ROM\October\Publish destination\assets\images\4polyq.GIF |

Look at the following multiple choice question and firstly identify the right answer but then say why each of the other 3 responses is wrong.



|  |  |  |
| --- | --- | --- |
| **Option** | **Correct/incorrect** | **If incorrect state why** |
| **A** |  |  |
| **B** |  |  |
| **C** |  |  |
| **D** |  |  |

**Complete the table below, it shows all the polymers you are expected to know, you may have to research on the internet to find the properties and use of the polymers.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Monomer name** | **Monomer structure** | **Polymer name** | **Polymer structure (1 repeat unit)** | **Polymer structure (2 repeat unit)** | **Polymer properties and use.** |
| **Ethene** |  |  |  |  |  |
|  |  |  |  |  |  |
| **Vinyl Chloride**  **Or**  **Chloroethene** |  | **Or** |  |  |  |
| **TFE**  **(tetrafluroethene)** |  |  |  |  |  |

Condensation Polymerisation

Two other homologous series include alcohols and carboxylic acids. They can react

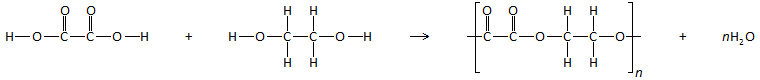
together in a condensation polymerisation reaction. Give the functional group of both alcohols and carboxylic acids and draw the structures of the first members.

|  |  |  |  |
| --- | --- | --- | --- |
| Homologous series | Functional group | Name | Structure |
| Alcohols |  | 1. Methanol |  |
|  | 2) |  |
|  | 1. Propan-1-ol |  |
|  | 1. Butan-1-ol |  |
| Carboxylic acids |  | 1) |  |
|  | 2) |  |
|  | 3) |  |
|  | 4) |  |

Polyester – Condensation Polymerisation

Polyesters are formed when molecules containing 2 carboxylic acid groups are reacted with molecules containing 2 alcohol groups. It is called condensation polymerisation because a water molecule is also produced.

The equation shows the formation of a polyester. Circle the atoms within the reactant molecules that form the water produced as a result of the polymerisation.



What would a section of this polymer look like if it were showing 2 repeating units.

|  |
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What is the ester functional group? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Complete the following condensation polymerisation reaction equations, show it first with 1 repeating unit, then with 2 repeating units.

|  |  |
| --- | --- |
|  | |
| 1 repeating unit |  |
| 2 repeating units |  |

|  |  |
| --- | --- |
|  | |
| 1 repeating unit |  |
| 2 repeating units |  |

|  |  |
| --- | --- |
|  | |
| 1 repeating unit |  |
| 2 repeating units |  |

What are the problems associated with the use of polymers and how can they be overcome?

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| --- | --- |
| Problem | Possible solution |
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There are naturally occurring polymers as well as the synthetic ones that humans manufacture.

Link with lines the correct monomer and polymer pair. **Learn this**

|  |  |  |
| --- | --- | --- |
| Monomer |  | Polymer |
| Glucose |  | DNA |
|  |  |  |
| Nucleotides x 4 |  | Protein |
|  |  |  |
| Amino acids |  | Starch |

Alcohols and Carboxylic Acids

What are the alcohol and carboxylic acid functional groups?

|  |  |
| --- | --- |
| Alcohol | Carboxylic acid |
|  |  |

Write a balanced symbol equation for the fermentation of glucose solution (C6H12O6) solution with a yeast catalyst. The products are ethanol and carbon dioxide. Include state symbols.

|  |
| --- |
| Balanced symbol equation |
|  |

Complete the equation below by drawing the structures of the molecules involved in the dehydration of propan-1-ol.

|  |
| --- |
| 🡪 + |

Complete the equation below by drawing the structures of the molecules involved in the dehydration of butan-1-ol.

|  |
| --- |
| 🡪 + |

Give 2 uses of alcohols

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Draw the apparatus used for the fermentation of grape juice.

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What is the purpose of the trap at the top of the flask?

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Name the technique, draw a diagram and explain how the ethanol solution produced from fermentation can be turned into a much more concentrated solution.

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| Technique |
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Ethanol can be oxidised with an oxidising agent like potassium manganite (VII), in this case the corresponding carboxylic acid can be formed.

Write an equation showing this reaction.

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What would be produced when propan-1-ol is oxidised with potassium managanate (VII)?

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|  |

Which is the best fuel – ethanol, propanol, butanol or petanol?

Starter

1. List as many renewable and non-renewable fuels as you can.

|  |  |
| --- | --- |
| Renewable | Non-renewable |
|  |  |

What are the characteristics of a good fuel? Think of as many as you can.

|  |  |  |
| --- | --- | --- |
| 1) | 2) | 3) |
| 4) | 5) | 6) |
| 7) | 8) | 9) |
| 10) | 11) | etc |

You will be given alcohol burners. Plan how you will see which gives off the most heat energy per gram of fuel burnt. Draw a diagram showing the apparatus that you will use.

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What variables are you going to need to control, how will you control them and explain your reasoning.

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What measurements are you going to take?

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| Construct a results table for your results |

Work out the temperature rise per gram of fuel burnt.

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Conclusion – Which was the best fuel?

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Evaluate your method, what were the strengths and weaknesses and how would you improve it to better answer which is the best fuel?

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Carboxylic acids

What is the functional group for a carboxylic acid? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If wine is left open to the air what does the ethanol turn into?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Is this oxidation or reduction? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What effect would a carboxylic acid have on blue litmus paper? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Year 10 Revision:

Complete these equations

* Acid + metal oxide 🡪

Hydrochloric acid + iron oxide 🡪

* Acid + metal hydroxide 🡪

Nitric acid + lithium hydroxide 🡪

* Acid + Metal carbonate 🡪

Sulphuric acid + calcium carbonate 🡪

Extension Chemistry

Ethanoic acid will react just as any other acid will react and will produce a salt called an ‘ethanoate’.

Complete the following:

* Ethanoic acid + copper oxide 🡪
* Ethanoic acid + sodium hydroxide 🡪
* Ethanoic acid + magnesium carbonate 🡪
* Ethanoic acid + magnesium 🡪
* Propanoic acid + calcium hydroxide 🡪
* Butanoic acid + sodium carbonate 🡪

Topic 9 - Bulk and surface properties of matter including nanaoparticles

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| --- | --- | --- | --- |
|  | Content | Understand it | Learnt it |
| 1 | Be able to compare the size of nanoparticles with the sizes of atoms and molecules. |  |  |
| 2 | Learn that the properties of nanoparticulate materials are related to their uses including surface area to volume ratio of the particles they contain. Learn how this applies to sunscreen. |  |  |
| 3 | Explain what risks are possibly associated with some nanoparticulate material. |  |  |
| 4 | Use data to compare the physical properties of glass and clay ceramics, polymers, composites and metals. |  |  |
| 5 | Explain why the properties of a material make it suitable for a given use and use data to select materials appropriate for specific uses. |  |  |

Properties of matter including nanoparticles.

What are the definitions of:

1. Bulk matter

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1. Nanoparticulate matter

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Put the following in order of size:

* bacteria
* helium atom
* gold atom
* gold nanoparticle
* carbon dioxide molecule

|  |  |
| --- | --- |
| Smallest |  |
|  |  |
|  |  |
|  |  |
|  |  |
| Largest |  |

What size are nanoparticles? From \_\_\_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_\_\_

How many meters is 1 nanometer? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Questions

|  |  |  |
| --- | --- | --- |
| 1 | A carbon atom has a diameter of 134 x10-12 m, what is its diameter in nanometers? |  |
| 2 | A sodium atom has a diameter of 380 x10-12 m, what is its diameter in nanometers? |  |
| 3 | A carbon atom has a diameter of 142 x10-12 m, what is its diameter in meters? |  |
| 4 | A oxygen molecule has a diameter of 293 x10-12 m, what is its diameter in nanometers? |  |
| 5 | A carbon dioxide molecule has a diameter of 324 x10-12 m, what is its diameter in meters? |  |
| 6 | A gold atom has a diameter of 348 x10-12 m, what is its diameter in nanometers? |  |
| 7 | A gold nanoparticle has a diameter of 0.00000003 m, what is its diameter in nanometers? |  |
| 8 | A titanium dioxide nanoparticle has a diameter of 50 nm, what is its diameter in meters? |  |

Some of the properties of nanoparticles depend on their large surface area to volume ratio.

Use cubes that have sides of 2 nm and 12 nm to show that the smaller cube has a larger surface area to volume ratio.

Remember: when calculating surface area a cube has 6 surfaces.

|  |  |  |  |
| --- | --- | --- | --- |
| Cube side length | Surface area | Volume | Surface area : volume ratio |
| 2 nm |  |  |  |
| 12 nm |  |  |  |

Nanoparticles – Uses and possible dangers.

Read the following passage taken from Wikipedia and answer the questions below

Nanoparticles are of great scientific interest as they are, in effect, a bridge between bulk materials and [atomic](https://en.wikipedia.org/wiki/Atom) or [molecular](https://en.wikipedia.org/wiki/Molecular) structures. A bulk material should have constant physical properties regardless of its size, but at the nano-scale size-dependent properties are often observed. Thus, the properties of materials change as their size approaches the nanoscale and as the percentage of the surface in relation to the percentage of the volume of a material becomes significant. For bulk materials larger than one micrometer (or micron), the percentage of the surface is insignificant in relation to the volume in the bulk of the material. The interesting and sometimes unexpected properties of nanoparticles are therefore largely due to the large surface area of the material, which dominates the contributions made by the small bulk of the material.

Nanoparticles often possess unexpected optical properties as they are small enough to confine their electrons and produce quantum effects. For example, [gold](https://en.wikipedia.org/wiki/Gold) nanoparticles appear deep-red to black in solution. Nanoparticles of yellow gold and grey silicon are red in color. Absorption of solar radiation is much higher in materials composed of nanoparticles than it is in thin films of continuous sheets of material. In both solar PV and solar thermal applications, controlling the size, shape, and material of the particles, it is possible to control solar absorption.

Nanoparticles present possible dangers, both medically and environmentally. Most of these are due to the high surface to volume ratio, which can make the particles very reactive or [catalytic](https://en.wikipedia.org/wiki/Catalytic). They could therefore speed up harmful reactions or carry toxic substances on their surface. They are also able to pass through [cell membranes](https://en.wikipedia.org/wiki/Cell_membrane) in organisms, and their interactions with biological systems are relatively unknown.

* [Carbon Nanotubes](https://en.wikipedia.org/wiki/Carbon_Nanotubes): Carbon materials have a wide range of uses, ranging from composites for use in vehicles and sports equipment to integrated circuits for electronic components. In past research, carbon nanotubes exhibited some toxicological impacts that will be evaluated in various environmental settings in current EPA chemical safety research. EPA research will provide data, models, test methods, and best practices to discover the acute health effects of carbon nanotubes and identify methods to predict them.
* [Cerium oxide](https://en.wikipedia.org/wiki/Cerium(IV)_oxide): Nanoscale cerium oxide is used in electronics, biomedical supplies, energy, and fuel additives. Many applications of engineered cerium oxide nanoparticles naturally disperse themselves into the environment, which increases the risk of exposure. There is ongoing exposure to new diesel emissions using fuel additives containing CeO2 nanoparticles, and the environmental and public health impacts of this new technology are unknown.
* [Titanium dioxide](https://en.wikipedia.org/wiki/Titanium_dioxide): Nano titanium dioxide is currently used in many products. Depending on the type of particle, it may be found in sunscreens, cosmetics, and paints and coatings. It is also being investigated for use in removing contaminants from drinking water.
* [Nano Silver](https://en.wikipedia.org/wiki/Nano_Silver): Nano silver is being incorporated into textiles, clothing, food packaging, and other materials to eliminate bacteria. EPA and the [U.S. Consumer Product Safety Commission](https://en.wikipedia.org/wiki/U.S._Consumer_Product_Safety_Commission) are studying certain products to see whether they transfer nano-size silver particles in real-world scenarios. EPA is researching this topic to better understand how much nano-silver children come in contact with in their environments.
* Iron: While [nano-scale iron](https://en.wikipedia.org/wiki/Nano-scale_iron) is being investigated for many uses, including “smart fluids” for uses such as [optics polishing](https://en.wikipedia.org/wiki/Optics_polishing) and as a better-absorbed [iron nutrient supplement](https://en.wikipedia.org/wiki/Iron_nutrient_supplement), one of its more prominent current uses is to remove contamination from groundwater. This use, supported by EPA research, is being piloted at a number of sites across the country.

Why do nanoparticles have different properties to bulk materials?

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How might a nanoparticles appear differently to a bulk material?

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Why might nanoparticles be dangerous?

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Which nanoparticles might you have come across in your life?

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Why might people that come across nanoparticles be concerned if they read the passage above?

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Why would titanium dioxide nanoparticles be suitable for a sunscreen?

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Properties of Different Materials

What is a composite material?

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Look at the table below, it contains several different materials and information about their physical properties.

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| --- | --- | --- | --- | --- |
| Material | Tensile strength (Mpa) | Density (g/cm3) | Melting point | Brittle |
| Steel reinforced concrete | 102 | 2.4 |  | No |
| Steel | 365 | 7.87 | 1510 | No |
| Concrete | 4 | 2.3 |  | No |
| Aluminium | 90 | 2.7 | 660 | No |
| Aluminium alloy | 510 | 2.81 | 670 | No |
| Carbon fibre | 4300 | 1.75 |  | Yes |
| Glass | 33 | 2.7 | 1538 | Yes |
| Clay Ceramics | 1138 | 4 | Can withstand temps of between 1000-1600 oC | Yes |
| Polypropene | 40 | 0.895 | 171 | Yes |

Use data from the table to explain why concrete is often reinforced with steel in construction projects.

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Name materials from the table that you would consider making aeroplanes from. Explain your answer.

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| Material | Reason |
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Explain using data from the table why polypropene is used to make plastic bowls.

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Bikes can be made from either steel, aluminium or carbon fibre. Explain the pros and cons of each material choice.

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Give uses for glass and clay ceramics and relate their use to a property of the material. (You may think of properties that are not in the table).

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| Material | Use | Property |
| Glass |  |  |
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| Clay Ceramics |  |  |
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THE END! – Time to revise.

Blank Pages for Notes

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**Glossary**

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| acid | a family of chemicals that can give off hydrogen ions in solution. |
| acid rain | rain water that is acidic because sulfur dioxide given off from coal burning power stations has dissolved in the moisture in clouds to form sulfuric acid. |
| activation energy | the amount of energy needed to break the bonds of reacting particles so as to start a chemical reaction. |
| alcohol | A carbon based compound with the functional group -OH. |
| alkali | a family of chemicals that can give off hydroxide ions in solution. |
| alkali metals | group 1 of the periodic table, these are reactive metals that form alkaline solutions. They have 1 electron in their outer shells. |
| alkane | a hydrocarbon family where the carbon atoms are joined together with carbon to carbon single bonds only. Alkanes are known as saturated hydrocarbons. |
| alkene | a hydrocarbon family where 2 carbon atoms are joined together with a carbon to carbon double bond. Alkenes are known as unsaturated hydrocarbons. |
| alloy | a mixture of 2 or more metals. |
| anion | a negatively charged ion. |
| aqueous | the name given to the state when a substance is dissolved in water. |
| atmosphere | the gases that surround a planet. |
| atom | the smallest particles of an element. Atoms are made from protons, neutrons and electrons. |
| atom economy | a measure of the number of atoms that are turned into a useful product during a reaction. |
| atomic number | the number of protons in an element, this is unique for every element. |
| Avogadro constant | 6.02 x 1023 particles. Also see the definition of the mole. |
| basalt | an intrusive igneous rock, formed when lava cools quickly outside of the earth’s crust, it has small crystals. |
| base | a substance that will react with an acid to make a salt and water. |
| biofuel | a fuel that is created from growing plants, once the plant is harvested more are planted leading to a renewable fuel. |
| bitumen | a long chain alkane found in crude oil used to surface roads and roofs. |
| boiling | changing from a liquid to a gas, this occurs at the substances' boiling point. |
| boiling point | the temperature needed to turn a substance from the liquid state to the gaseous state, this is different for all substances and if the substance is pure it happens at a very clear temperature. |
| brass | an alloy of copper and zinc. |
| bromine water | used as a test for unsaturation; bromine water is decolourised by alkenes. |
| bulk material | a material in the form of lumps or powders. |
| carat | a scale used to indicate the purity of a sample of gold. |
| carbon monoxide | formula: CO - a colourless and odourless toxic gas formed from the incomplete combustion of fuels. |
| carboxylic acid | A carbon based compound with the functional group -COOH. |
| catalyst | a substance that speeds up a chemical reaction without being changed itself and without altering the products and without changing mass. It does this by providing an alternative route for the reaction that requires less energy. |
| cation | a positively charged ion. |
| chalk | a sedimentary rock made of calcium carbonate. |
| chemical change | a permanent change brought about by a chemical reaction. |
| chlorination | adding small quantities of chlorine to drinking water to kill bacteria. |
| chromatography | a separating technique used to separate and identify a mixture of liquids e.g. different ink colours that make up a felt tip pen. |
| complete combustion | where a fuel burns with plenty of oxygen and the products are carbon dioxide and water. |
| compound | a substance made up of 2 or more different atoms chemically joined together. |
| concentration | a measure of how much of a substance is dissolved in the solvent. |
| condensation | a gas changing back to a liquid. |
| conductor | a substance that allows either electricity or heat to pass through it. Metals are good at both but some other substances like carbon graphite are good electrical conductors but not good thermal conductors. |
| conservation of mass | a basic law of chemistry that states in a chemical reaction matter is neither created or destroyed, therefore the overall mass of the reactants is the same as the mass of the products. |
| corrosion | a metal reacting with oxygen in the atmosphere. |
| covalent bond | the bond formed when non-metals share a pair or pairs of electrons. |
| cracking | an example of thermal decomposition; a long chain alkane is heated and it decomposes into a shorter chain alkane and an alkene. |
| crude oil | a mixture of hydrocarbons belonging to the alkane family. |
| crystallisation | forming a solid by evaporating the liquid from a solution. |
| d.c. supply | a direct current supply is an electrical supply in which the current always flows in the same direction. |
| density | the mass of a substance divided by the volume. |
| displacement | a type of chemical reaction in which a more reactive element displaces a less reactive one from its compound. |
| dissociation | the splitting of a molecule into ions e.g. water dissociating into H+ and OH- ions |
| dissolved | a substance is taken and mixed with a solvent which changes it from the solid state into a solution. |
| dissolving | when a solid or a gas completely mixes with a liquid to make a solution. |
| decimeter cubed (dm3) | a unit of volume equivalent to 1000 cm3. |
| dynamic equilibrium | when the rate of the forward reaction in a reversible change is equal to the rate of the backward reaction. |
| earth's crust | the relatively thin layer of solid rock that surrounds the earth. |
| electrolysis | a reaction which involves electricity and results in the decomposition of the compound undergoing electrolysis. |
| electron | a sub atomic particle found in shells surrounding nucleus, this particle is negatively charged and has a mass of 1/1837 (Almost zero). |
| electronic configuration | the arrangement of electrons in shells around the nucleus. |
| electroplating | covering a substance with a metal coating through electrolysis. |
| electrostatic forces of attraction | the name given to the attractive forces present between oppositely charged ions. |
| element | a substance made up of the same type of atom. |
| empirical formuale | the formula that gives the proportions of the elements that make up a compound, note: it does not give the actual formula. |
| endothermic | a reaction where less heat energy is released in forming bonds in the products than is required in breaking bonds in the reactants. |
| enzymes | a biological catalyst |
| evaporating | changing from a liquid to a gas beneath the liquid's boiling point. |
| excess | when there is too much of one reactant. We use this to ensure all of the other reactant is used up. |
| exothermic | a reaction where more heat energy is released in forming bonds in the products than is required in breaking bonds in the reactants. |
| fertiliser | a chemical containing nitrogen, phosphorus and potassium compounds to promote plant growth. |
| filtration | a separating technique used to separate an insoluble solid and a liquid. |
| flame photometer | a device used to determine the concentration of certain metal ions. |
| flammable | how easily a fuel ignites. |
| fossil | an imprint of an ancient plant or animal left in sedimentary rock. |
| fossil fuel | a carbon based fuel (coal, oil or gas) formed from ancient plants or animals. |
| fractional distillation | a separating technique used to separate a mixture of different liquids e.g. crude oil. |
| freezing | changing from a liquid to a solid. |
| fuel cell | an electrochemical cell that reacts hydrogen and oxygen to produce water and electrical energy. |
| fuel oil | a long chain alkane found in crude oil used as a fuel for ships and some power stations. |
| fullerene | a form of elemental carbon that forms simple molecules that can act as super conductors. |
| functional group | a group of atoms or bonds within a carbon based compound that are responsible for the characteristic chemical properties of that compound. |
| giant molecular structure | a covalent structure where the bonds spread throughout the entire structure e.g. carbon diamond, carbon graphite, silicon dioxide. |
| granite | an intrusive igneous rock, formed when magma cools slowly in the earth’s crust, it has big crystals. |
| group | a vertical column on the periodic table where the elements that comprise it have similar properties. |
| Haber process | the industrial production of ammonia from hydrogen and nitrogen. |
| halide | the ion of a halogen, carrying a single negative charge. |
| halogens | group 7 of the periodic table, these elements react with hydrogen and produce acidic solutions when dissolved in water. These elements all need 1 electron to complete there outer shells. |
| hazard symbols | pictures found on chemical bottles that warn of the dangers of the substance. |
| homologous series | A family of compounds with similar properties and the same general formula E.g. alkanes. Usually they differ by CH2 in molecular formulae from neighbouring compounds. |
| hydrocarbon | a compound containing only hydrogen and carbon. |
| hydrochloric acid | a commonly occurring lab acid with the formula HCl, also found in human stomachs to help digestion and kill bacteria. |
| igneous rock | rock formed when hot magma cools and solidifies. |
| incomplete combustion | where a fuel burns with insufficient oxygen which can lead to products which include carbon monoxide or carbon (soot). |
| inert | unreactive |
| ion | a charged atom or group of atoms. |
| ionic bond | the name given to the type of bond formed when a metal gives an electron(s) to a non-metal. |
| ionic lattice | the name given to the structure that is formed when many oppositely charged ions attract each other. |
| isotope | 2 or more atoms of the same element with the same number of protons but a different number of neutrons. |
| kerosene | an alkane found in crude oil used as a fuel for jet engines. |
| lava | molten rock outside the earth's crust. |
| limestone | a sedimentary rock made of calcium carbonate. |
| limewater | a solution of calcium hydroxide that is used to test for the presence of carbon dioxide gas. |
| litmus | an indicator that turns red in acid and blue in alkali. |
| magma | molten rock inside the earth's crust. |
| magnalium | an alloy of magnesium and aluminium. |
| malleable | a substance that can bend without breaking e.g. metals. |
| mass number | the mass of an atom, this is equal to the number of protons and neutrons in the nucleus. |
| melting | changing from a solid to a liquid. |
| melting point | the temperature needed to turn a substance from the solid state to the liquid state; this is different for all substances and, if the substance is pure, it happens at a very clear temperature. |
| metallic structure | a lattice arrangement of metal cations surrounded by a sea of delocalised electrons. |
| metamorphic rock | rock formed by the heating and pressurising of existing rock. E.g. limestone, when heated and pressurised it forms marble. |
| methyl orange | an indicator that goes red in acid and yellow in alkali. |
| molar volume | the volume that one mole of any gas will occupy. |
| mole | the unit in chemistry that details the amount of a substance. 1 mole of a substance is said to contain the Avogadro constant. 1 mole always contains 6.02 x 1023 particles. |
| molecule | a particle made of non-metals only where the bonding is covalent. We never use the word molecule to refer to anything ionic or metallic. |
| monomer | a molecule that can be bonded to other identical molecules to form a polymer. |
| nanometer | a unit of length equal to 1 x 10-9m. |
| nanoparticle | A particle made of a few hundred atoms that ranges in size from 1 to 100 nanometers (nm). |
| neutralisation | an acid reacting with a base to make a salt and water. |
| neutron | a sub atomic particle found in the nucleus, this particle is neutrally charged and has a mass of 1. |
| nitinol | a shape memory alloy made from nickel and titanium. |
| noble gases | group 0 of the periodic table. These elements are inert (unreactive) because they all have a full outer shell of electrons. |
| non-biodegradable | a material that does not naturally breakdown in the environment e.g. plastics. |
| non-renewable fuels | fuels that when burnt cannot be replaced examples include fossil fuels (coal, oil and gas). |
| nucleus | the area at the centre of the atom that contains all the protons and neutrons |
| ore | a type of rock that contains important elements like metals. These elements can be extracted from the ore. |
| oxidation | the basic definition is: a reaction in which oxygen is added. However a better definition is when a substance loses electrons. |
| particle | a term that is used to describe a small amount of matter. |
| period | a horizontal row on the periodic table. |
| periodic table | a list of all the elements. |
| phenolphthalein | an indicator that turns pink in alkali but is colourless in acid. |
| photosynthesis | the chemical reaction that takes place in plants to enable them to make their own food. The plant takes in carbon dioxide and water and makes glucose and oxygen. |
| physical change | a change of state e.g. a liquid boiling and turning into a gas. These can be undone by changing the conditions. |
| physical state | whether a substance is a solid, liquid or gas. |
| physical property | a characteristic of matter that may be observed and measured without changing the chemical identity of the sample. |
| phytoextraction | a process where plants remove elements or compounds from soil or water. |
| polymerisation (addition) | a reaction involving unsaturated molecules joining together to make extremely long molecules called polymers. |
| polymerisation (condensation) | a reaction involving a molecule with 2 carboxylic acid groups with a molecule with 2 alcohol groups. They join together to form a polymer and water. |
| polymers | very large molecules that have carbon as the backbone of the molecule. |
| precipitate | a solid formed from a solution. |
| precipitation reaction | a reaction that forms a precipitate. |
| pressure | the force applied divided by the area onto which it is applied. When referring to a gas the pressure increases when you have more gas particles present as there are more particles to bumb into the walls of the container. |
| proton | a sub atomic particle found in the nucleus, this particle gives the atom its identity, is positively charged and has a mass of 1. |
| PVC | polyvinylchloride is a polymer used to make window frames. |
| rate of reaction | speed of reaction, they always start quickly and end slowly. |
| reactivity series | a list of elements in order of reactivity, the most reactive is at the top and the least reactive at the bottom. |
| redox | a reaction where a reduction process and an oxidation process can be identified. Reduction involves the gain of electrons and oxidation is the loss of electrons. |
| reduction | the basic definition is: a reaction in which oxygen is lost. However a better definition is when a substance gains electrons. |
| relative atomic mass | the mass of the atom relative to 1/12 mass of a carbon - 12 atom. |
| renewable fuels | fuels that when used can be replaced examples include biofuels. |
| sacrificial protection | Preventing the corrosion of a metal by attaching a more reactive metal that will corrode instead. |
| salt | a family of compounds of neutral pH formed by the reaction of acids with metal oxides, metal hydroxides or metal carbonates. A salt contains a metal and a non-metal. |
| saturated | a hydrocarbon family like the alkanes where the carbon to carbon bonds are all single. |
| sedimentary rock | a rock formed from sediment building up at the bottom of lakes and oceans over a long period of time. |
| sedimentation | leaving a mixture of an insoluble solid and a liquid to settle. This results in the solid falling to the bottom so that the liquid can be poured off. Used as part of the water treatment process for drinking water. |
| shape memory alloy | an alloy that will return to its initial shape after it has been deformed, useful for spectacle frames and stents. |
| simple distillation | a separating technique used to separate a mixture of a solid dissolved in a liquid or two liquids with very different boiling points. |
| simple molecular structure | a covalent structure where the bonds are contained within the molecule e.g. H2O, CO2, O2, C60 |
| solution | a liquid mixture. |
| solvent | a substance that can dissolve others e.g. water. |
| state symbols | symbols that indicate the physical state of the reactants and products in symbol equations (s) = solid, (l) = liquid, (g) = gas, (aq) = aqueous (dissolved in water). |
| stent | a small expandable tube that can be inserted into a blocked blood vessel. |
| stoichiometry | the name given to the big numbers in reaction equations that show the proportions of reactants used and products made. |
| sulfur dioxide | a polluting gas formed when coal burns. Coal naturally contains some sulfur which oxidises on burning. |
| surface area | the area of an outer part or uppermost layer of something. |
| symbol equation | a way of summarising a chemical reaction by writing the chemical formulae of the reactants and products. |
| temperature | a measurement of hot or cold. |
| thermal decomposition | a reaction where you heat the reactant and it breaks down into 2 or more products. |
| titration | a common lab method of quantitative analysis. We use it to measure exactly how much of one reactant is needed to react with a known volume of another. |
| transition metals | the big group of metals between group 2 and 3. |
| unsaturated | a hydrocarbon family like the alkenes where there is a carbon to carbon double bond. |
| viscosity | how thick a liquid is. |
| word equation | a way of summarising a chemical reaction by writing the names of all reactants and products. |
| yield | a measure of how much product is produced in a reaction. |

**Essential Knowledge Questions**

Qualitative tests

**LEARN EVERYTHING ON THIS SHEET**

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| Indicator (Paper 1) | Result | Used For |
| Phenolphthalein | Pink when a base is added otherwise colourless | Titrations with strong acids and bases or a weak acid and strong base. |
| Methyl Orange | Red in acid, yellow in alkali. | Titrations with a strong acid and weak base |
| Blue Litmus | Goes Red | Test for acids |
| Red Litmus | Goes Blue | Test for Bases |

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| --- | --- |
| Flame Test | Colour of Flame |
| Lithium (Li+) | Red |
| Sodium (Na+) | Yellow |
| Potassium (K+) | Lilac |
| Calcium (Ca2+) | Orange-Red |
| Copper (Cu2+) | Blue-Green |

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| Add NaOH (sodium hydroxide) | Observation | Equation |
| Aluminium (Al3+) | White precipitate that dissolves in excess NaOH | Al3+ + 3OH- = Al(OH)3 |
| Calcium (Ca2+) | White suspension | Ca2+ + 2OH- = Ca(OH)2 |
| Copper (Cu2+) | Light blue precipitate | Cu2+ + 2OH- = Cu(OH)2 |
| Iron (Fe2+) | Dark green precipitate | Fe2+ + 2OH- = Fe(OH)2 |
| Iron (Fe3+) | Brown precipitate | Fe3+ + 3OH- = Fe(OH)3 |
| Ammonium (NH4+) | Gently warm test tube and test ammonia gas with moist red litmus and it goes blue |  |

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| Add acid (dil) | Observation | Equation |
| Carbonate (CO32-) | Test carbon dioxide gas given off with limewater. The limewater goes cloudy. | CO32- + 2H+ = CO2 + H2O |

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| Add dil HCl and Barium Chloride | Observation | Equation |
| Sulphate (SO42-) | White precipitate | Ba2+ + SO42- = BaSO4 |

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| Add dil HNO3 (nitric acid) then silver nitrate (AgNO3) | Observation | Equation |
| Chloride (Cl-) | White precipitate | Ag+ + Cl- = AgCl |
| Bromide (Br-) | Cream precipitate | Ag+ + Br- = AgBr |
| Iodide (I-) | Yellow precipitate | Ag+ + I- = AgI |

**Learn the answers to each of these:**

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|  | **Question** | **Answer** |
| 1 | What are the typical properties of transition metals? | * High melting point * High density * The formation of coloured compounds * Catalytic activity of the metal and their compounds |
| 2 | What does the oxidation of metals in the air result in? | Corrosion |
| 3 | How can the rusting of iron be prevented? | * Exclusion of oxygen * Exclusion of water * Sacrificial protection |
| 4 | Name a method that can be used to improve the appearance of metals and their resistance to corrosion. | Electroplating. |
| 5 | Why does converting a pure metal into an alloy often increase its strength? | In a pure metal all the atoms are the same size. This means that the atoms can roll over each other if a force is applied to the metal, so it is malleable and ductile.  In an alloy, the atoms are not all the same size (because they are not all the same element). This means they cannot roll over each other so easily, and the alloy is stronger than the pure metal if a force is applied. |
| 6 | What are the two advantages of alloy steels over pure iron? | 1. Alloy steels have a greater resistance to corrosion. 2. Alloy steels are stronger. |
| 7 | 1. Why is aluminium used for cooking foil? 2. Why is copper used to make saucepans, water pipes and for electrical wiring? 3. Why is gold used for jewellery and coinage? 4. Why is magnalium (5% magnesium) used for aircraft parts and not pure aluminium? 5. Why is magnalium (50% magnesium) not used for aircraft? 6. Why is brass used for the pins of a plug? | 1. Aluminium has a high resistance to corrosion, low density and is malleable. 2. Copper is a good conductor of heat and electricity, and it does not corrode easily. 3. Gold does not corrode, and it is relatively malleable. 4. Magnalium (5%) is considerably stronger than pure aluminium. 5. Magnalium (50% magnesium) is far more reactive due to the high magnesium content and it is therefore used in pyrotechnics (sparklers). 6. Brass is used because it is stronger than copper but still a good conductor of electricity. |
| 8 | Give 2 units for concentration | 1. g dm-3 2. mol dm-3 |
| 9 | Describe how to carry out a titration between a known concentration of hydrochloric acid and sodium hydroxide of unknown concentration. The aim being to find the concentration of the alkali. | 1. Fill a burette with hydrochloric acid. 2. Measure 25 cm3 of sodium hydroxide using a pipette and place in a conical flask. 3. Add a few drops of phenolphthalein indicator. 4. Place the conical flask on a white tile underneath the burette. 5. Run in hydrochloric acid fairly quickly at first whilst continually stirring. 6. When the neutralisation point is approaching start to add the acid drop wise. 7. Stop adding the acid the moment the indicator goes clear. 8. Repeat the titration 2 further times. |
| 10 | What ions are reacting in an acid base titration? | 1. Hydrogen (H+ ions) from the acid. 2. Hydroxide (OH- ions) from the alkali. |
| 11 | What is the equation needed to calculate the number of moles in solution? |  |
| 12 | What is the formula for calculating the percentage yield of a reaction? |  |
| 13 | Why is the actual yield of a reaction usually less than the theoretical yield? | * Incomplete reactions * Practical losses during the experiment * Competing, unwanted reactions |
| 14 | What is the formula for calculating the atom economy of a reaction? |  |
| 15 | What factors might affect why a particular reaction pathway is chosen? | * Atom economy * Yield * Rate * Equilibrium position * Usefulness of by-products |
| 16 | What is the molar volume of a gas? | The volume occupied by one mole of molecules of any gas at room temperature and pressure. |
| 17 | What is the equation needed to calculate the number of moles of a gas? | Moles = Volume / Gas constant |
| 18 | What is the formula of ammonia and what is it used for? | NH3. Ammonia is the raw material for making fertilizer. |
| 19 | What is the Haber process? | A reversible reaction between nitrogen and hydrogen to form ammonia.  N2 + 3H2 ⇌ 2NH3 |
| 20 | Why in the Haber process is a temperature of 450 OC and a pressure of 200 atm used? | The production of ammonia is exothermic so increasing the temperature reduces the yield. 450 oC is a compromise, the temperature is raised to increase the rate of reaction even though it decreases the yield.  4 molecules of reactants are needed to make 2 molecules of ammonia. If the pressure is raised more ammonia is produced because that would reduce the number of molecules present. |
| 21 | How does adding a catalyst affect the yield of ammonia? | It does not affect the yield it just increases the rate. |
| 22 | What elements might fertilisers contain | * Nitrogen * Phosphorus * Potassium |
| 23 | How is ammonia turned into fertiliser? | It is reacted with nitric acid to make ammonium nitrate.  Ammonia + nitric acid 🡪 ammonium nitrate |
| 24 | What is the difference between the lab preparation of ammonium sulfate and the industrial preparation of ammonium sulfate? | In the lab it is small scale batch process. Ammonia is reacted directly with sulfuric acid.  In industry, it is a large-scale continuous multi stage process that starts with in many cases the individual elements. These are then reacted to make the ammonia and sulfuric acid which is finally reacted to make the ammonium sulfate. |
| 25 | How long will a chemical cell produce a voltage for? | Until one of the reactants is used up? |
| 26 | What is a fuel cell? | A cell that reacts hydrogen and oxygen to produce a voltage and water is the only product. |
| 27 | What are the strengths and weaknesses of fuel cells? | Strengths   * Efficient * No greenhouse gas emissions * No other harmful emissions (e.g. particulates (soot) or acidic gases). * Cells can quickly be refuelled (as long as there is a source of hydrogen).   Weaknesses   * Hydrogen would have to be produced from the electrolysis of water. * There is no hydrogen infrastructure in the country. |
| 28 | What is a qualitative test used for? | To detect the presence of a particular ion. |
| 29 | What is a quantitative test used for? | To detect how much of an ion is present. |
| 30 | What is a precipitate? | A solid formed from solution. |
| 31 | Why is it important that the test for each ion must be unique? | So we can be certain of the presence of a particular ion. |
| 32 | Describe how to carry out a flame test. | 1. Dip a wire hoop in hydrochloric acid. 2. Dip the hoop in the salt. 3. Hold in an intermediate Bunsen flame |
| 33 | Give advantages of using instrumental methods of analysis over the lab tests you carried out. | Instrumental methods may improve:   1. Sensitivity 2. Accuracy 3. Speed |
| 34 | What are the formulae of methane, ethane, propane and butane? | 1. CH4 2. C2H6 3. C3H8 4. C4H10 |
| 35 | Explain whether alkanes are saturated or unsaturated. | Saturated, because every carbon atom is surrounded by single carbon to carbon bonds. |
| 36 | Draw the structures of:   * Ethene * Propene * But-1-ene * But-2-ene |  |
| 37 | Explain whether alkenes are saturated or unsaturated. What is the functional group of the alkene homologous series? | Unsaturated, because they contain a carbon to carbon double bond. This C=C is the functional group of the alkene homologous series. |
| 38 | Write an equation showing the reaction of bromine with ethene. The equation should show the structures of all reactants and products. |  |
| 39 | How does bromine water distinguish between alkenes and alkanes? | Alkenes decolourise bromine water because the bromine reacts with the carbon to carbon double bond and the resulting molecule is colourless. Alkanes have no effect on bromine water leaving it brown because there is no reactive site on the alkane molecule for the bromine to react. |
| 40 | What are the products of complete combustion of any alkane or alkene hydrocarbon? | Carbon dioxide and water. |
| 41 | What is a polymer? | A substance of high relative molecular mass made up of small repeating units. |
| 42 | Describe how poly(ethene) is formed. | When heated and pressurised the carbon to carbon double bond in the ethene molecule opens up. These open bonds then join to the open bonds of a neighboring ethene molecule creating a hugely long chain. |
| 43 | Write an equation for the formation of poly(propene) |  |
| 44 | What is condensation polymerisation? | A reaction involving a molecule with 2 carboxylic acid groups reacting with a molecule with 2 alcohol groups. They join together to form a polymer and water. |
| 45 | What problems are associated with polymers? | * Availability of starting materials. * Persistence in landfill sites, due to non-biodegradability. * Gases produced during disposal by combustion. * Requirement to sort polymers so that they can be melted and reformed into a new product. |
| 46 | What polymers are made from:   1. 4 different nucleotides 2. Sugars 3. Amino acids | 1. DNA 2. Starch 3. Protein |
| 47 | Draw structures of:   * Methanol * Ethanol * Propanol * Butanol |  |
| 48 | What is the functional group of the alcohol family? | R-OH |
| 49 | Draw structures of:   * Methanoic acid * Ethanoic acid * Propanoic acid * Butanoic acid |  |
| 50 | What is the functional group of a carboxylic acid? |  |
| 51 | When ethanol is oxidised what is produced? | Ethanoic acid |
| 52 | How can ethanol be produced? | Fermentation of carbohydrates produces a dilute ethanol solution that can be concentrated through distillation.  C6H12O6 = 2C2H5OH + 2CO2 |
| 53 | What size are nanoparticles? | Particles between 1 and 100 nm in diameter. |
| 54 | What is a nanometer in meters? | 1x10-9 m |
| 55 | Why do nanoparticles have different properties to bulk materails | Nanoparticles have an extremely large surface area to volume ratio. |
| 56 | State some risks that may be associated with nanoparticles. | * Their small size may mean that if breathed in they could pass through cell-surface membranes in the body. * They could carry toxic substances on their surface. * They could catalyse harmful reactions. |

**Homework Scores:**

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| Homework | Score | Knowledge Test | Score |
| 1 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 1 | \_\_\_\_\_\_\_\_\_\_/5 |
| 2 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 2 | \_\_\_\_\_\_\_\_\_\_/5 |
| 3 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 3 | \_\_\_\_\_\_\_\_\_\_/5 |
| 4 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 4 | \_\_\_\_\_\_\_\_\_\_/5 |
| 5 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 5 | \_\_\_\_\_\_\_\_\_\_/5 |
| 6 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 6 | \_\_\_\_\_\_\_\_\_\_/5 |
| 7 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 7 | \_\_\_\_\_\_\_\_\_\_/5 |
| 8 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 8 | \_\_\_\_\_\_\_\_\_\_/5 |
| 9 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 9 | \_\_\_\_\_\_\_\_\_\_/5 |
| 10 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 10 | \_\_\_\_\_\_\_\_\_\_/5 |
| 11 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 11 | \_\_\_\_\_\_\_\_\_\_/5 |
| 12 | \_\_\_\_\_\_\_\_\_\_/\_\_\_ | 12 | \_\_\_\_\_\_\_\_\_\_/5 |

