1 Complete **word** equations for each of the following reactions. Write ***no reaction*** if no reaction takes place.

a) methanol (CH_3OH) + oxygen → **carbon dioxide + water**

b) silane (SiH_4) + oxygen → **silicon (di)oxide + water**

c) hydrochloric acid + calcium oxide → **calcium chloride + water**

d) ammonia + nitric acid → **ammonium nitrate**

e) nitric acid + zinc → **zinc nitrate + hydrogen**

f) lithium + water → **lithium hydroxide + hydrogen**

g) sodium carbonate + sulfuric acid → **sodium sulfate + carbon dioxide + water**

2 Classify each of the following metals as having high / medium / low reactivity.

a) gold **low** b) calcium **high** c) iron **high**

3 Complete the table about the following reactions by ticking the correct boxes.

equation	transfer of	type of reaction		
	protons	electrons	redox	acid-base
$Fe + Cu(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cu$	✓	✓		
$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$	✓	✓		
$Br_2 + 2KI \rightarrow 2KBr + I_2$	✓	✓		

4 a) Complete the table to show the products of the electrolysis of the following compounds.

compound	state	product at positive electrode	product at negative electrode
sodium chloride	molten	**chlorine**	**sodium**
potassium bromide	aqueous	**bromine**	**hydrogen**
silver nitrate	aqueous	**oxygen**	**silver**

b) Write balanced half equations for the following electrolysis conversions.

i) $Al^{3+} \rightarrow Al$ **$Al^{3+} + 3e^- \rightarrow Al$**

ii) $Br^- \rightarrow Br_2$ **$2Br^- - 2e^- \rightarrow Br_2$**

iii) $H^+ \rightarrow H_2$ **$2H^+ + 2e^- \rightarrow H_2$**

iv) $OH^- \rightarrow O_2$ **$4OH^- - 4e^- \rightarrow O_2 + 2H_2O$**

GCSE REVISION 12

Chemical reactions 2

5 When a aqueous solution of chlorine (Cl_2) is added dropwise to an aqueous solution of sodium bromide (NaBr), a displacement reaction takes place to form bromine (Br_2) and sodium chloride ($NaCl$) in the solution.

a) What colour change would you see in this reaction? **colourless to yellow**

b) Explain by reference to electrons why chlorine displaces bromine in this reaction.

- **chlorine is more reactive than bromine**
- **chlorine atoms gain an electron more easily than bromine**
- **as chlorine atoms are smaller and so the electron gained is closer to the nucleus**
- **so there is a stronger attraction from the nucleus to the electron**

c) Write a balanced equation for this reaction. $Cl_2 + 2NaBr \rightarrow Br_2 + 2NaCl$

d) Write the simplest ionic equation for this reaction. $Cl_2 + 2Br^- \rightarrow 2\ Cl^- + Br_2$

e) Write two half equations to show what happens in this reaction. $Cl_2 + 2e^- \rightarrow 2Cl^-$ $2Br^- - 2e^- \rightarrow Br_2$

f) Explain clearly why this is a redox reaction.

Br^- ions loses electrons so are oxidised; Cl_2 gains electrons so is reduced; both oxidation and reduction take place

Area Strength To develop Area Strength To develop Area Strength To develop

Done with care and thoroughness Electron v proton transfer Write half equations for displacement

Good SPG Identify electrolysis products Know halogen reactivity trend

Word equations for reaction with O_2 Write electrolysis half equations Explain halogen reactivity trend

Word equations for metal reactions Write formulae Give observations in halogen displacement

Word equations for acid reactions Write balanced equations Explain redox in terms of electrons

Metals as high/medium/low reactivity Write ionic equations for displacement

1 Give the formula of the following ionic substances.

a) copper(II) oxide **CuO** c) aluminium nitrate **$Al(NO_3)_3$**

b) calcium hydroxide **$Ca(OH)_2$** d) lithium carbonate **Li_2CO_3**

2 Calculate the relative formula mass of the following substances.

a) nitrogen, N_2 **2(14) = 28**

b) calcium nitrate, $Ca(NO_3)_2$ **40 + 2(14) + 6(16) = 164**

3 What mass of hydrogen reacts with 140 g of nitrogen to make ammonia? $N_2 + 3H_2 \rightarrow 2NH_3$

moles N_2 = $\frac{140}{28}$ **= 5 moles H_2 = 3 x 5 = 15 mass H_2 = 15 x 2 = 30 g**

4 Calcium hydroxide is made by reaction of calcium oxide with water: $CaO + H_2O \rightarrow Ca(OH)_2$

a) Calculate the maximum mass of calcium hydroxide that could be formed from 1.12 kg of calcium oxide.

moles CaO = $\frac{1120}{56}$ **= 20 moles $Ca(OH)_2$ = 20 mass $Ca(OH)_2$ = 20 x 74 = 1480 g**

b) In a reaction, 1440 g of calcium hydroxide was formed from reaction of 1.12 kg of calcium oxide with water. Calculate the percentage yield for this reaction.

% yield = 100 x $\frac{1440}{1480}$ **= 97.3%**

c) Suggest one reason why the yield was less than 100%.

- **reaction is reversible / incomplete**
- **some products lost**
- **other reactions may take place**

5 Calculate the atom economy to make titanium in this reaction: $TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$

% atom economy = 100 x $\frac{190}{12(24)}$ $\frac{48}{}$

= 20.2%

6 What volume of oxygen gas is needed to react with 4 dm^3 of propane with complete combustion, with the volume of all gases measured at the same temperature and pressure?

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

5 x 4 = 20 dm^3

GCSE REVISION 13

Calculations 3

7 Calculate the volume of the following gases at room temperature and pressure.

a) 2.5 moles of carbon dioxide, CO_2 **volume CO_2 = 24 x 2.5 = 60 dm^3**

b) 10 g of argon, Ar **moles Ar =** $\frac{10}{40}$ **= 0.25 volume Ar = 24 x 0.25 = 6 dm_3**

8 5.1 g of the vanadium (a transition metal, symbol = V) reacts with 4.0 g of oxygen (O_2) to make an oxide of vanadium. Calculate the moles of vanadium and oxygen and use this to determine the balanced equation for the

reaction.

moles V = $\frac{5.1}{51}$ = 0.1 moles O_2 = $\frac{4.032}{}$ = 0.125 ratio moles V : moles O_2 = 0.1 : 0.125 = 4 : 5

$4V + 5O_2 \rightarrow 2V_2O_5$

9 25.0 cm^3 of a solution of sodium hydroxide was neutralised by 23.6 cm^3 of 0.400 mol dm^{-3} sulfuric acid in a titration.

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

a) Calculate the concentration of the sodium hydroxide in mol/dm^3. Give your answer to 3 significant figures. **mol H_2SO_4 = 0.400 x $\frac{23.6}{1000}$ = 0.00944mol mol NaOH = 2 x 0.00944 = 0.01888 mol**

conc NaOH = $\frac{0.01888}{25.0\ 1000}$ = 0.755 mol/dm_3

b) Calculate the concentration of the sodium hydroxide in g/dm^3. Give your answer to 3 significant figures.

conc NaOH = 0.755 x 40 = 30.2 g/dm^3

Area Strength To develop Area Strength To develop Area Strength To develop
Done with care and thoroughness Can work out mass from moles Deduce molar reacting ratio from mass
Shows suitable working Can work out % atom economy Work out moles for solutions
Can write ionic formulae Can work out % yield Convert mol/dm^3 to g/dm^3
Can work out M_r Understands why yield < 100% Does not round too much
Work out moles from mass Work out gas volume from mass or mol Can use sig figs
Use equation to find reacting moles Understands reacting gas volumes Gives units

1 **a** Calculate the energy change in the following reaction using the bond energies given.
[C–C = 348, C-H = 412, C=C = 612, H–H = 436 kJ/mol]

HH
H

H

H C CCH + 2 H H

Bonds broken Bonds made Energy change

6 C–H = 6(412) = 2472 2 C=C = 2(612) = 1224 1 C–C = 348 2 H-H = 2(436) = 872

HH
H

H

H C CCH
H H H H

= bonds broken – bonds made = 4916 – 5164 = **–248 kJ /mol**

Total = 4916 Total = 5164

b Explain whether this reaction is exothermic or endothermic by discussing bond breaking and making.

Exothermic – more energy released making bonds than is needed to break bonds

c Complete the energy profile for this reaction. Draw arrows to show the overall energy chance (label "OEC") and the activation energy (label "AE")

2 Tick the correct box to show whether each of the following relates to an exothermic or an endothermic reaction.

10 C–H = 10(412) = 4120 3 C–C = 3(348) = 1044

exothermic endothermic

energy change is +72 kJ ✓

products have more energy than reactants ✓

neutralisation of hydrochloric acid by sodium hydroxide ✓

thermal decomposition of copper carbonate ✓

Energy

GCSE REVISION 14

Energy changes 1

HC CH
C
H

C H H + 2 H H
H

AE

OEC

HC CH
C
H
C H H
H H H H

progress of reaction

3 Fuel cells have a number of advantages over non-rechargeable and rechargeable cells. The hydrogen fuel cell is the most common fuel cell.

a Give one advantage and one disadvantage of hydrogen fuel cells compared to rechargeable cells.

advantage **no need to recharge / only waste product is water**

disadvantage **fuel cells are expensive / hard to store/transport hydrogen**

b Give the half equations for the reactions that take place at the electrodes in hydrogen fuel cells.

anode $2H_2 \rightarrow 4H^+ + 4e^-$ cathode $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

4 A simple cell can be made by placing two different metals (as electrodes) in a salt solution (as electrolyte). A student made some cells in this way and measured the voltage (potential difference) in each case. The table shows which electrode was connected to which terminal of the voltmeter.

positive electrode
negative electrode

voltage (V) nickel iron +0.19

iron zinc +0.32

iron cobalt +0.16

a What is an electrolyte? **liquid that conducts electricity**

b Place the four metals in order of reactivity, with the most reactive first.

most **Zn Co Fe Ni** least

c What would the voltage be if a cell was made using cobalt and iron, with cobalt connected to the negative terminal of the voltmeter. **+0.16 V**

a To create the cell the greatest voltage with a positive voltage when connected to a voltmeter:

i) which two metals would you use? **zinc & nickel**

ii) what would the voltage be? **+0.51 V**

iii) which metal would be the positive electrode? **nickel**

Area Strength To develop Area Strength To develop Area Strength To develop
Done with care and thoroughness Can draw energy profiles Use voltage to order metal reactivity
Shows suitable working Can label activation / energy change Work out voltage in cells
Calculate energy change using bonds Pros and cons of fuel cells Use voltage data to solve problems
Deduce if exo/endothermic Fuel cell electrode equations
Explain if exo/endothermic using bonds Knows what an electrolyte is

1 An experiment was carried out to see how the rate of a reaction changes during the reaction. A piece of magnesium was reacted with hydrochloric acid and the volume of hydrogen gas collected recorded. A graph was plotted of the results.

a Draw a tangent to the line to find the rate at 40 seconds.

rate = 60!10

94!0 = 50 94 = 0.53 cm3/s

b Explain why the reaction slows down.

as the reaction proceeds, there are less reactant particles and so successful collisions between reactant particles are less frequent

2 Hydrochloric acid reacts with sodium thiosulfate in a flask to form a precipitate that increases the turbidity of the mixture. The time taken for the mixture to become too cloudy to see a cross on a piece under the flask can be used to investigate factors that affect the reaction rate.

a A student carried out an experiment to see how changing the concentration of the acid affects the reaction rate. List four key control variables in this experiment.

temperature, concentration of sodium thiosulfate, volume of sodium thiosulfate, cross

b Explain why increasing the concentration of the acid would increase the rate of reaction.

higher the concentration, the closer the particles and so successful collisions are more frequent

3 Catalysts increase the rate of chemical reactions. Explain, in simple terms, how they work.

different route with lower activation energy

0 60) 50 **mc(n egordyhf oe mulo**V40 30 20 10 0 20 40 60 80 100 120 140 160 **Time (s)**

GCSE REVISION 15

Rates & equilibria 1

4 Sulfur dioxide reacts with oxygen to form sulfur trioxide in a reaction that reaches a state of dynamic equilibrium in a closed system. The forward reaction is exothermic.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

a What is happening when a reaction is in dynamic equilibrium?

both reactions take place simultaneously at the same rate

b What would happen to the yield of sulfur trioxide if the temperature was increased? Explain your answer.

yield decreases equilibrium position moves left to lower temperature in direction of endothermic reaction

c What would happen to the yield of sulfur trioxide if the pressure was increased? Explain your answer.

yield increases equilibrium position moves right to lower pressure to side with less gas particles

Area Strength To develop Area Strength To develop Area Strength To develop

Done with care and thoroughness Calculate gradient How T affects equilibrium position

Shows suitable working Explain why reactions slow down Why T affects equilibrium position

Can draw tangents to curves Explain how catalysts work How P affects equilibrium position

Choose points for gradient Explain dynamic equilibrium Why P affects equilibrium position

1 Complete **word** equations for each of the following reactions. Write ***no reaction*** if no reaction takes place.

a) nitric acid + zinc → **zinc nitrate + hydrogen**

b) potassium hydroxide + sulfuric acid → **potassium sulfate + water**

c) water + potassium → **potassium hydroxide + hydrogen**

d) iron (Fe) + oxygen → **iron oxide**

e) thiol (C_2H_5SH) + oxygen → **water + carbon dioxide + sulfur dioxide**

f) ethanol (C_2H_5OH) + oxygen → **water + carbon dioxide**

g) hydrochloric acid + lead oxide → **lead chloride + water**

h) copper carbonate + nitric acid → **copper nitrate + carbon dioxide + water**

2 Complete the table about the following reactions by ticking the correct boxes.

equation	transfer of		type of reaction	
	protons	electrons	redox	acid-base
$Cl_2 + 2KBr \rightarrow 2KCl + Br_2$	✓	✓		
$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$	✓	✓		
$MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$	✓	✓		

3 Classify each of the following metals as having high / medium / low reactivity.

a) potassium **high** b) copper **low** c) iron **medium**

4 a) Complete the table to show the products of the electrolysis of the following compounds.

compound	state	product at positive electrode	product at negative electrode
sodium bromide	molten	**bromine**	**sodium**
copper nitrate	aqueous	**oxygen**	**copper**
potassium iodide	aqueous	**iodine**	**hydrogen**

b) Write balanced half equations for the following electrolysis conversions.

i) $I^- \rightarrow I_2$ **$2I^- - 2e^- \rightarrow I_2$ or $2I^- \rightarrow I_2 + 2e^-$**

ii) $Na^+ \rightarrow Na$ **$Na^+ + e^- \rightarrow Na$**

iii) $OH^- \rightarrow O_2$ **$4OH^- - 4e^- \rightarrow O_2 + 2H_2O$ or $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$**

iv) $H^+ \rightarrow H_2$ **$2H^+ + 2e^- \rightarrow H_2$**

GCSE REVISION 16

Chemical reactions 3

5 When copper metal is placed in aqueous solution of silver(I) nitrate, a reaction takes place to form silver metal and copper(II) nitrate.

a) Write a balanced equation for this reaction.

$Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$

b) Write the simplest ionic equation for this reaction.

$Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$

c) Write two half equations to show what happens in this reaction.

$Cu - 2e^- \rightarrow Cu^{2+}$ $Ag^+ + e^- \rightarrow Ag$ (or $2Ag^+ + 2e^- \rightarrow 2Ag$)

d) Explain clearly why this is a redox reaction.

Cu atoms lose electrons so are oxidised; Ag^+ ions gain electrons so is reduced; both oxidation and reduction take place

6 The soluble salt calcium chloride is formed when calcium oxide, an insoluble base, reacts with an acid.

Describe how crystals of pure calcium chloride could be made in this reaction.

- **react with hydrochloric acid**
- **use excess calcium oxide**
- **filter off excess calcium oxide**
- **boil off some water from calcium chloride solution**
- **leave solution to cool – crystals will form**
- **filter off crystals**
- **wash & dry**

Area Strength To develop Area Strength To develop Area Strength To develop

Done with care and thoroughness Deduce if proton or electron transfer Write ionic equations for displacement

Good SPG Approx. reactivity of common metals Write half equations for displacement

Word equations for metal reactions Predict products of electrolysis Explain displacement in terms of redox

Word equations for acid reactions Write electrolysis half equations Can outline how to make soluble salt

Word equations for reaction with O_2 Write formulae

1 Draw the displayed structure of each of the following molecules in the boxes.

methanol butane

HH

C O H

propene ethyl ethanoate

2 Hexane is an alkane. Hexene is an alkene. They both contain six carbon atoms.

a) What is the molecular formula of hexane? **C_6H_{14}**

b) Alkanes are saturated hydrocarbons. Explain these terms.

hydrocarbon **compound containing H and C only**

saturated **compound containing no double bonds or contains single bonds only**

c) Describe a test what you could use to distinguish hexane from hexene. Give the result for each compound.

test **add bromine water**

hexane result **no reaction / stays yellow-orange**

hexene result **goes colourless**

3 a) Ethanoic acid is a weak acid. Draw it structure.

b) What are weak acids?

in weak acids only a small fraction of the molecules react with water to form $H^+(aq)$ ions

H

H

H

H

H H CCCCH

H H H H HC C

H

H

H

CH

H

H HCH

HCH

O O

HCC H

H

HO

H

C CO H

H

GCSE REVISION 17

Organic Chemistry 1

4 Ethene can be made by cracking of long alkanes. Describe **why** this is done and **one way** in which this is done.

- **there is a surplus of long alkanes which are broken down into high demand, high value shorter alkanes and alkenes on cracking**
- **done by passing vaporised alkanes over a hot catalyst (or mix with steam at high temperature)**

5 Name the monomers that these polymers are made from.
polymer starch proteins poly(ethene) DNA
monomer **glucose amino acids ethene nucleotides**
6 Draw the structure of the polymers formed from these monomers:, and state whether they are addition or condensation polymers.
monomer structure(s) polymer structure polymer type
H F
H F
C C
C C
addition
H F
H F n
H
H O
H HO
H
NC CO H NC C**condensation**
H
H
condensation
Area Strength To develop Area Strength To develop Area Strength To develop
Done with care and thoroughness Test for C=C with $Br_2(aq)$ Draw addition polymers
Good SPG Understands strong and weak acids Draw condensation polymers
Can draw organic molecules Knows how cracking is done Identify addition/condensation polymers
Knows organic definitions Knows why cracking is done
Write molecular formula of alkanes Identify monomers for natural polymers
n
HO
H HO
HO H HO
H
O C O H H O
C
C C C O H
O
C O C C C C H
H
H
H
H H
n

1) a) How many moles in 33.0 kg of ammonium sulfate $(NH_4)_2SO_4$. **M_r = 132 moles =** $\frac{33000}{132}$ **= 250 mol**

b) What is the mass of 0.040 moles of oxygen, O_2? **32 x 0.040 = 1.28 g**

2) a) What maximum mass of methanol that can be made when 12 g of hydrogen reacts with an excess of carbon monoxide? $CO + 2H_2 \rightarrow CH_3OH$

moles H_2 = $\frac{12}{2}$ **= 6 mol**

moles CH_3OH = 3 mol

mass CH_3OH = 32 x 3 = 96 g

b) In a reaction, 60 g of methanol was formed from 12 g of hydrogen. Calculate the percentage yield.

% yield = $\frac{60}{96}$ **x 100 = 62.5%**

3) Calculate the percentage atom economy to make iron from iron(III) oxide by reaction with carbon monoxide. $Fe_2O_3 + 3CO \rightarrow 2Fe + 2CO_2$

$Fe_2O_3 + 3CO \rightarrow 2Fe + 2CO_2$

M_r 160 28 56 Mass 160g 3(28)g 2(56)g

% atom economy = $\frac{160}{3(28)} \frac{2(56)}{}$

x 100 = 45.9%

4) What volume of hydrogen gas is formed, measured at room temperature and pressure, when 0.65 g of zinc reacts with sulfuric acid? $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

moles Zn = $\frac{0.65}{65}$ **= 0.010 mol**

moles H_2 = 0.010 mol

volume H_2 = 24 x 0.010 = 0.24 dm^3

5) What volume of carbon dioxide gas is formed when 100 cm^3 of propane gas burns (both gases are at room temperature and pressure)?

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

volume CO_2 = 3 x 100 = 300 cm^3

GCSE REVISION 18

Calculations 4

6) 0.595 g of tin (Sn) reacts with 0.71 g of chlorine (Cl_2) to form tin chloride. Find the simplest molar ratio in which tin reacts with chlorine and use it to find the formula of the tin chloride. Finally, write a balanced equation for the reaction.

Moles of Sn = $\frac{0.595}{119}$ **= 0.005 mol Moles of Cl_2 =** $\frac{0.71}{71}$ **= 0.010 mol**

Reacting ratio Sn : Cl_2 = 0.005 : 0.010 = 1 : 2

∴ Sn + 2Cl_2 → $SnCl_4$

7) Lead reacts with chlorine to form lead(II) chloride. When 6.21 g of lead reacts with 2.84 g of chlorine, which is the limiting reagent and what mass of lead(II) chloride is formed?

$Pb + Cl_2 \rightarrow PbCl_2$

moles Pb = $\frac{6.21}{207}$ **= 0.030 mol**

moles Cl_2 = $\frac{2.84}{71}$ **= 0.040 mol**

Pb is limiting reagent and so 0.030 mol of $PbCl_2$ is formed

Mass $PbCl_2$ = 278 x 0.030 = 8.34 g

8) Find g/dm^3 the given concentration that 25.0 cmof ^{3} oxalic of this acid solution (H_2Creacts $_2O_4$) in with mol/dm22.8 $_3$ cmand ^{3} 0.100 mol/dm^3 sodium hydroxide solution in a titration.

$H_2C_2O_4 + 2NaOH \rightarrow Na_2 C_2O_4 + 2H_2O$

moles NaOH = 0.100 x 1000 22.8

= 0.00228 mol

moles $H_2C_2O_4$ = 0.00228

2 **= 0.00114 mol**

concentration $H_2C_2O_4$ in mol/dm^3 = 0.00114

25 1000

= 0.0456 mol/dm^3

concentration $H_2C_2O_4$ in g/dm^3 = 0.0456 x 90 = 4.104 g/dm^3

Area Strength To develop Area Strength To develop Area Strength To develop
Done with care and thoroughness Can work out % atom economy Understands limiting reagents
Shows suitable working Can work out % yield Work out moles for solutions
Can work out $\mathcal{M}$ Understands why yield < 100% Convert mol/dm^3 to g/dm^3
Work out moles from mass Work out gas volume from mass or mol Does not round too much
Can work out mass from moles Understands reacting gas volumes Gives units
Use equation to find reacting moles Deduce molar reacting ratio from mass