GCSE REVISION 12
Chemical reactions 2

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

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

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

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

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. $\mathbf{Cl_2 + 2NaBr \rightarrow Br_2 + 2NaCl}$

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

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

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**

b) calcium hydroxide **$Ca(OH)_2$**

c) aluminium nitrate **$Al(NO_3)_3$**

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 $\frac{48}{190+2(24)}$ = 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

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 = $\frac{4.0}{32}$ = 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 = $\frac{0.01888}{\frac{25.0}{1000}}$ = 0.755 mol/dm^3

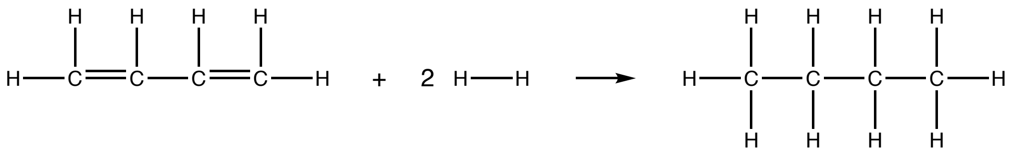
b) Calculate the concentration of the sodium hydroxide in g/dm^3. Give your answer to 3 significant figures.

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		

GCSE REVISION 14
Energy changes 1

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]



Bonds broken

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

Total = 4916

Bonds made

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

Total = 5164

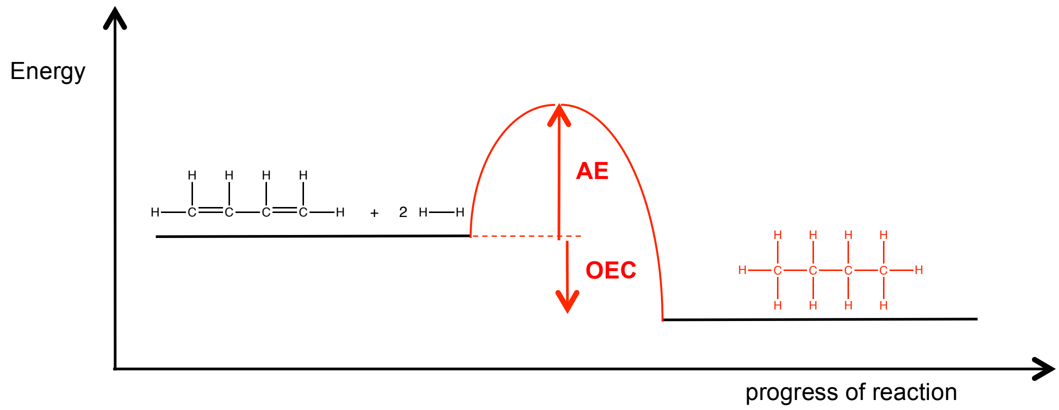
Energy change

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

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.

	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		✓

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:

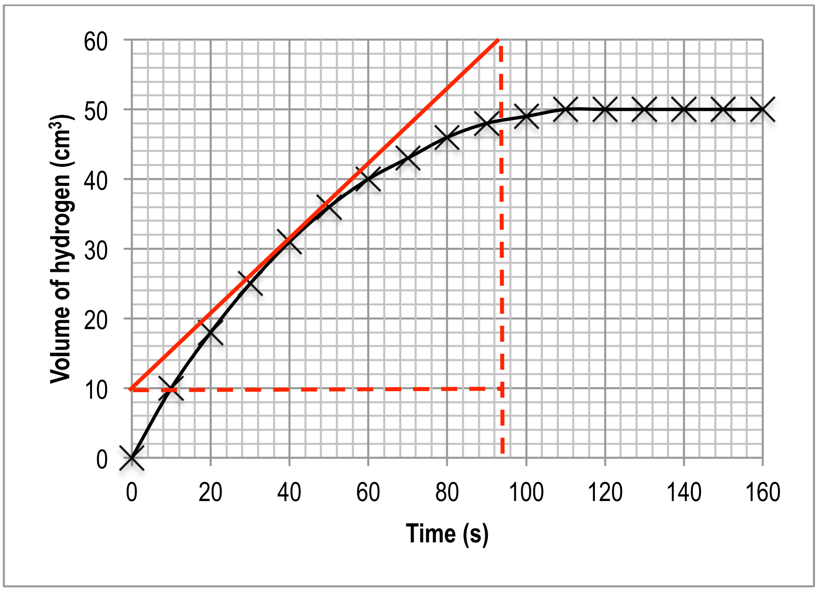
i) which two metals would you use? **zinc & nickel**

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 = $\frac{60-10}{94-0}$ = $\frac{50}{94}$ = 0.53 cm^3/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

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		

GCSE REVISION 16

Chemical reactions 3

1 Complete <u>**word**</u> 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) $I^- \rightarrow I_2$ $\quad$ $\mathbf{2I^- - 2e^- \rightarrow I_2}$ **or** $\mathbf{2I^- \rightarrow I_2 + 2e^-}$

ii) $Na^+ \rightarrow Na$ $\quad$ $\mathbf{Na^+ + e^- \rightarrow Na}$

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

iv) $H^+ \rightarrow H_2$ $\quad$ $\mathbf{2H^+ + 2e^- \rightarrow H_2}$

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

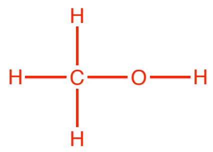
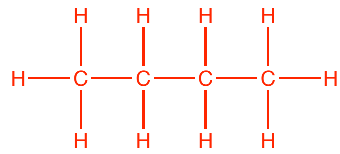
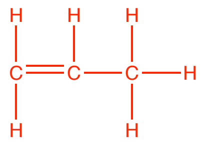
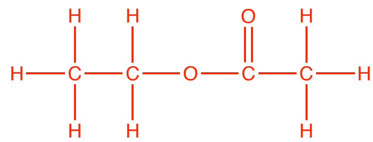
6 The soluble salt calcium chloride is formed when calcium oxide, an insoluble base, reacts with an acid. Describe how crystals of pure calcium chloride could be made in this reaction.

- **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					

GCSE REVISION 17
Organic Chemistry 1

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

methanol	butane
	
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**

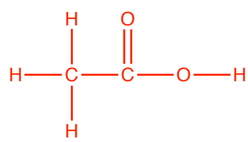
c) Describe a test what you could use to distinguish hexane from hexene. Give the result for each compound.

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

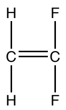
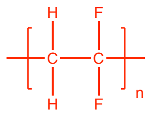
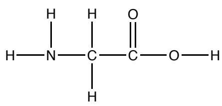
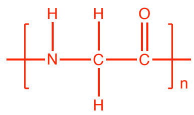
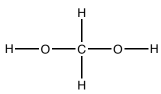
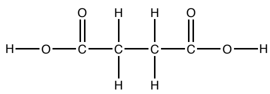
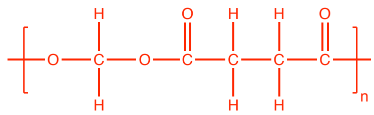
4 Ethene can be made by cracking of long alkanes. Describe **why** this is done and **<u>one way</u>** in which this is done.

- **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
		**addition**
		**condensation**
 		**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					

GCSE REVISION 18

Calculations 4

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 →	2Fe + $2CO_2$
M_r	160	28	56
Mass	160g	3(28)g	2(56)g

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

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

$\therefore$ $Sn + 2Cl_2 \rightarrow SnCl_4$

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 the concentration of oxalic acid ($H_2C_2O_4$) in mol/dm^3 and g/dm^3 given that 25.0 cm^3 of this solution reacts with 22.8 cm^3 0.100 mol/dm^3 sodium hydroxide solution in a titration.

$H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2H_2O$

moles NaOH = $0.100 \, x \, \frac{22.8}{1000}$ = 0.00228 mol

moles $H_2C_2O_4$ = $\frac{0.00228}{2}$ = 0.00114 mol

concentration $H_2C_2O_4$ in mol/dm^3 = $\frac{0.00114}{\frac{25}{1000}}$ = 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 M_r			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					