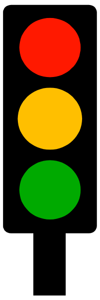
Dalziel High School

Chemistry

Name: …………………………………………………………………………………….	
Class: ………………	Teacher: ………………………………

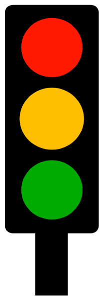


Self-Evaluation

CfE Higher

Unit 3

Chemistry & Society



Section	Title	Completed
3.1a	Factors Affecting the Design of a Chemical Process	
3.1b	Calculation of the Mass	
3.1c	Calculations in Reactions That Involve Solutions	
3.1d	Reversible Reactions	
3.1e	Excess Calculations	
3.2a+b	Enthalpy	
3.2c	Hess's Law	
3.2d	Bond Enthalpies	
3.3a	Oxidising & Reducing Agents	
3.3b	Ion-Electron and Redox Equations	
3.4a	Chromatography	
3.4b	Volumetric Titrations	

	Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.1a Factors Affecting Design of a Chemical Process	Page	Red	Amber	Green
1		Industrial processes are designed to: a) maximise profit b) minimise the impact on the environment.		☹	😐	☺
2		Factors that influence the design of an industrial process include: a) availability b) sustainability c) cost of feedstock(s) d) opportunities for recycling e) energy requirements f) marketability of by-products g) product yield.		☹	😐	☺
3		Environmental issues need to be considered when designing a chemical process. These include: a) minimising waste b) avoiding the use or production of toxic substances c) designing products which will biodegrade if appropriate.		☹	😐	☺

	Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.1b Calculation of the Mass	Page	Red	Amber	Green
4		I am able to use balanced equations to work out mole ratios of reactants and products. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ 1mol 3mol 2mol		☹	😐	☺
5		The mass of products formed from reactants can be calculated using balanced equations and formula masses. e.g. calculate the mass of carbon dioxide produced if 5g of calcium carbonate reacts with excess HCl Ca 1 x 40 = 40 C 1 x 12 = 12 O 3 x 16 = 46 $CaCO_3$ gfm = 100g C 1 x 12 = 12 O 2 x 16 = 32 CO_2 gfm = 44g $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ 1mol 2mol 1mol 1mol 1mol 100g 44g 5g $44g \times {}^{5}/_{100}$ = 2.2g		☹	😐	☺
6		The volume of a gas can be calculated from the number of moles and vice versa. e.g. *Calculate the volume of 0.8g of oxygen gas if molar volume = 24litres mol⁻¹* no. of mol $O_2 = \frac{\text{mass}}{\text{gfm}} = \frac{0.8g}{32g\ mol^{-1}} = 0.025mol$ Volume = no. of mol x molar volume = 0.025mol x 24litres mol^{-1} = <u>0.6litres</u>		☹	😐	☺
7		Molar volume is the same for **all** gases at the same conditions of temperature and pressure. • the volume taken up by 1 mole of a gas is called the molar volume and has units *litres mol^{-1}* • molar gas volume is 22.4 litres mol^{-1} at STP (standard temperature & pressure i.e. 25°C and 1 atmosphere)		☹	😐	☺
8		I can calculate the volumes of reactant and product gases from the number of moles of each reactant and product. e.g. Calculate the final volume and composition of the mixture produced when $100cm^3$ of ethane is completely burned in $500cm^3$ of oxygen. $C_2H_{6(g)} + 3\frac{1}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$ 1mol 3.5mol 2mol 3mol 1vol 3.5vol 2vol negligible volume $100cm^3$ $350cm^3$ $200cm^3$ - (+$150cm^3$ O_2 leftover) Final Volume = $350cm^3$ ($200cm^3$ CO_2 + $150cm^3$ O_2)		☹	😐	☺

9	Concentration is a measure of how many moles of solute is dissolve in a known volume of solvent. Units of concentration are moles per litre (mol l^{-1})		☹	😐	☺
10	I can work out quantities of reactants and/or products using one or more of the following: ○ Balanced equations. ○ Concentrations and volumes of solutions. ○ Masses of solutes. e.g. *Calculate the mass of calcium carbonate required to completely react with 80cm³ of 0.1mol l⁻¹ hydrochloric acid.* no of mol HCl = volume x concentration = 0.08litres x 0.1mol l^{-1} = 0.008mol $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ 1mol 2mol 0.004mol 0.008mol 1mol $CaCO_3$ = (1x40.1)+(1x12)+(3x16) = 40.1+12+48 = 100.1g mass = no of mol x **gfm** = 0.004mol x 100.1g mol^{-1} = 0.4004g e.g. *Calculate the concentration of a solution when 5.85g of NaCl is dissolved in 50cm³ water.* Calculate the gfm of NaCl: Na 1 x 23 = 23; Cl 1 x 35.5 = 35.5; gfm = 58.5g Calculate number of moles of NaCl: $n = \frac{m}{gfm} = \frac{5.85}{58.5} = 0.1mol$ Calculate the concentration: $c = \frac{n}{V} = \frac{0.1mol}{0.05litres} = 2\ mol\ l^{-1}$		☹	😐	☺

Dalziel High School	**Higher Chemistry Self-Evaluation Unit 3.1d Reversible Reactions**	Page	Traffic Light: Red	Amber	Green

11 12 (16) Reversible reactions attain a state of dynamic equilibrium when the rates of forward and reverse reactions are equal
- reversible reactions are reactions where the forward reaction and the reverse reactions both take place at the same time

☹ 😐 ☺

13 (17) At equilibrium, the concentrations of reactants and products remain **constant**,
- concentrations of reactants and products are unlikely to be equal at equilibrium
- the reaction has not stopped at equilibrium

☹ 😐 ☺

14 Le Chatelier's Principle states: An equilibrium will move to undo any change imposed upon it by temporarily favouring either the forward or backward reaction until a new equilibrium position is reached.

☹ 😐 ☺

15a (18b) Le Chatelier's Principle can explain the effect on the equilibrium position of changing pressure:

$$\underbrace{\underset{\substack{1mol\\ \downarrow \\ 1vol}}{N_{2(g)}} + \underset{\substack{3mol\\ \downarrow \\ 3vol}}{3H_{2(g)}}} \rightleftharpoons \underbrace{\underset{\substack{2mol\\ \downarrow \\ 2vol}}{2NH_{3(g)}}}$$

$$\text{4vol of gas} \rightleftharpoons \text{2vol of gas}$$

Increase in Pressure	Decrease in Pressure
System fights back by trying to lower pressure	System fights back by trying to raise pressure
Pressure reducing reaction is favoured ∴ forward reaction is favoured	Pressure increasing reaction is favoured ∴ reverse reaction is favoured
Equilibrium moves to the right ∴ *more* products at equilibrium	Equilibrium moves to the left ∴ *less* products at equilibrium

☹ 😐 ☺

15b (18a) Le Chatelier's Principle can explain the effect on the equilibrium position of changing concentration:

Change	Effect on Equilibrium		
Addition of a reactant	Equilibrium tries to remove additional reactant	Forward reaction favoured	Equilibrium shifts to right
Removal of a reactant	Equilibrium tries to replace removed reactant	Reverse reaction favoured	Equilibrium shifts to left
Addition of a product	Equilibrium tries to remove additional product	Reverse reaction favoured	Equilibrium shifts to left
Removal of a product	Equilibrium tries to replace removed product	Forward reaction favoured	Equilibrium shifts to right

☹ 😐 ☺

15c (18c) Le Chatelier's Principle can explain the effect on the equilibrium position of changing temperature:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -92.4\,kJ\,mol^{-1}$$

Forward Reaction is **exo**thermic — Reverse Reaction is **endo**thermic

Increase in Temperature	Decrease in Temperature
System fights back by trying to lower temperature	System fights back by trying to raise temperature
Temperature reducing reaction is favoured ∴ endothermic reaction is favoured	Temperature increasing reaction is favoured ∴ exothermic reaction is favoured
Equilibrium moves to the left ∴ *less* products at equilibrium	Equilibrium moves to the right ∴ *more* products at equilibrium

☹ 😐 ☺

15c (19) A catalyst speeds up the rate of attainment of equilibrium but does not affect the position of equilibrium
- position of equilibrium does not change by adding a catalyst
- final percentage of products is the same with or without a catalyst at equilibrium

☹ 😐 ☺

16 (20) The Haber Process is a very important industrial process:

a) the effects of pressure
- high pressure increases the products at equilibrium

b) use of temperature
- moderate temperatures are used as high temperatures favour the reverse reaction which breaks down ammonia back to the reactants

c) the use of a catalyst
- use of an iron catalyst increases the rate of ammonia production by achieving equilibrium more quickly (but does not produce more ammonia at equilibrium)

d) recycling of unreacted gases
- ammonia is easily separated from unreacted nitrogen & hydrogen as ammonia has a much higher boiling point. Unreacted nitrogen & hydrogen are returned to the reaction vessel

e) removal of product
- removal of ammonia product before equilibrium is achieved means the system tried to replace ammonia to try to achieve equilibrium

☹ 😐 ☺

17	Percentage yield is a measure of how much of a product is obtained compared to the amount expected if there was complete conversion. $$\text{Percentage Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$		☹	😐	☺
18 (2.92)	Percentage yields can be calculated from balanced equations and masses of reactants and products: e.g. Calculate the %yield of ester if 2g of methyl ethanoate is formed when 1.6g of methanol is used. methanol + ethanoic acid → methyl ethanoate + water CH_3OH + CH_3COOH → CH_3OCOCH_3 + H_2O 1mol 1mol 32g 74g 1.6g $74g \times {}^{1.6}/_{32}$ Theoretical = 3.7g $\%\text{yield} = \frac{\text{actual}}{\text{theoretical}} \times 100$ $= \frac{2}{3.7g} \times 100$ $= 54.1\%$		☹	😐	☺
19	Costs and percentage yields can be used to work out the cost of the feedstock(s) to produce a given mass of product.		☹	😐	☺
20	Atom economy measures the proportion of the total mass of all starting materials successfully converted into the desired product. $$\text{Atom Economy} = \frac{\text{mass of desired products}}{\text{total mass of reactants}} \times 100$$		☹	😐	☺
21	The atom economy of a reaction can be calculated using correct formula: e.g. calculate the atom economy of $C_9H_8O_4$ in the following reaction. $C_7H_6O_3 + C_4H_6O_3 \longrightarrow C_9H_8O_4 + C_2H_4O_2$ 1mol 1mol 1mol 1mol 138g 102g 180g $\text{atom economy} = \frac{\text{mass of desired product}}{\text{total mass of reactants}} \times 100 = \frac{180g}{240g} \times 100 = 75\%$		☹	😐	☺
22 23	Different routes are taken in manufacturing products depending on percentage yield and atom economy: • high percentage yield and a low atom economy results in a lot of waste products being produced • industrial process want efficiency i.e. high percentage yield and high atom economy.		☹	😐	☺

	Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.1e Excess Calculations	Page	Traffic Light		
				Red	Amber	Green
24	Excess reactant(s) can be identified and explained • the chemical reaction is over once one of the reactants (the limiting reactant) is used up • the other reactant in the chemical reaction is said to be 'in excess'.			☹	😐	☺
25	The cost of excess reactant(s) used in industrial processes need to be controlled • costs can be minimised by having the cheaper reactant in excess, where possible.			☹	😐	☺
26	I can use a balanced equation to work out the reactant in excess and therefore the limiting reactant, for a chemical reaction. e.g. Calculate which reactant is in excess when 2g of hydrogen reacts with 8g of oxygen. $2H_2 + O_2 \longrightarrow 2H_2O$ 2mol 1mol 4g 32g 2g $32g \times {}^{2}/_{4}$ = 16g of oxygen needed to react all hydrogen but only 8g of oxygen available ∴ hydrogen is in excess ∴ oxygen is the limiting reactant as it runs out $2H_2 + O_2 \longrightarrow 2H_2O$ 2mol 1mol 4g 32g $4g \times {}^{8}/_{32}$ 8g = 1g of hydrogen needed to react all oxygen 2g of hydrogen available ∴ hydrogen is in excess ∴ oxygen is the limiting reactant as it runs out			☹	😐	☺
27	Excess reactant(s), percentage yields and atom economy can be related to the idea of an economic/ environmental balance in an industrial process • excess reactants which do not turn into products are a waste of resources and money. • processes with high percentage yields and high atom economy are efficient economically • disposal of unwanted chemicals can have environmental considerations			☹	😐	☺

Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.2a+b Enthalpy	Page	Traffic Light: Red	Amber	Green
28	Enthalpy (H) is a measure of the energy stored in a chemical. • Enthalpy change is given the symbol ΔH		☹	😐	☺
29 (31)	The enthalpy of combustion of a substance is the amount of energy given out when one mole of a substance burns in excess oxygen.		☹	😐	☺
30 31 (34)	The enthalpy change for a reaction can be calculated from the data for specific heat capacity, mass and temperature change. • By calculation of how much of 1 mole was burned, the enthalpy of combustion can be calculated e.g. Calculate the enthalpy of combustion of ethanol if 0.92g of ethanol burned to heat up 200cm^3 of water by 6°C. $E_h = c \times m \times \Delta T$ $= 4.18 \times 0.2 \times 6$ $= 5.016$ kJ c = specific heat capacity = 4.18 kJ kg^{-1} °C^{-1} m = mass of water being heated up (worked out by converting volume of water into mass) (NB 1000cm^3 water = 1kg of water) 1mol of ethanol C_2H_5OH = (2x12)+(6x1)+(1x16) = 24 + 6 + 16 = 46g 0.92g ethanol $\longleftrightarrow$ 5.016kJ 46g $\longleftrightarrow$ 5.016kJ x $^{46}/_{0.92}$ = 250.8 kJ mol^{-1} but exothermic reaction ΔH= -250.8 kJ mol^{-1}		☹	😐	☺

Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.2c Hess's Law	Page	Traffic Light: Red	Amber	Green
32	<u>Hess's Law</u>: Enthalpy change for any particular chemical reaction is the same regardless of chemical route taken.		☹	😐	☺
33	Enthalpy changes can be calculated by application of Hess's Law: e.g. Calculate the enthalpy of formation for SiH_4 (2009 Higher question 15b) $\boxed{Si + 2H_2 \longrightarrow SiH_4}$ ❶ $SiH_4 + 2O_2 \longrightarrow SiO_2 + 2H_2O$ ΔH= -1517 kJ ❷ $Si + O_2 \longrightarrow SiO_2$ ΔH= -911 kJ ❸ $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ ΔH= -286 kJ ❶x-1 $SiO_2 + 2H_2O \longrightarrow SiH_4 + 2O_2$ ΔH= +1517 kJ ❷ $Si + O_2 \longrightarrow SiO_2$ ΔH= -911 kJ ❸x2 $2H_2 + O_2 \longrightarrow 2H_2O$ ΔH= -572 kJ add $Si + 2H_2 \longrightarrow SiH_4$ ΔH= +34 kJ		☹	😐	☺
	e.g. calculate the enthalpy of formation of ethyne (2007 Higher question 12b) $\boxed{2C + H_2 \rightarrow C_2H_2}$ ❶ $C + O_2 \rightarrow CO_2$ $\Delta H = -394 kJ\ mol^{-1}$ ❷ $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H = -286 kJ\ mol^{-1}$ ❸ $C_2H_2 + 2\frac{1}{2}O_2 \rightarrow 2CO_2 + H_2O$ $\Delta H = -1300 kJ\ mol^{-1}$ ❶x2 $2C + 2O_2 \rightarrow 2CO_2$ $\Delta H = -788 kJ\ mol^{-1}$ ❷ $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H = -286 kJ\ mol^{-1}$ ❸x-1 $2CO_2 + H_2O \rightarrow C_2H_2 + 2\frac{1}{2}O_2$ $\Delta H = +1300 kJ\ mol^{-1}$ add $2C + H_2 \rightarrow C_2H_2$ $\Delta H = +226 kJ\ mol^{-1}$		☹	😐	☺

Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.2d Bond Enthalpies	Page	Traffic Light: Red	Amber	Green
34	Molar Bond Enthalpy is the energy required to break one mole of bonds in a substance. e.g. 1mol of C-H bonds requires 412 kJ of energy to break 1mol of C-H bonds releases 412 kJ of energy when formed Mean bond enthalpy can be slightly different or the molar bond enthalpy for a particular substance as the environment the bonds being broken are around have a slight effect on the energy required. The mean bond enthalpy is the average for the bond enthalpy for different substances.		☹	😐	☺
35	Bond enthalpies can be used to calculate the enthalpy change for reactions in the gas phase: e.g. calculate the enthalpy of formation of HCl: $\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \longrightarrow HCl_{(g)}$ <u>Endothermic Steps: Bond Breaking</u> $\frac{1}{2}$mol H-H $\frac{1}{2}$ x +436kJ = +218kJ $\frac{1}{2}$mol Cl-Cl $\frac{1}{2}$ x +243kJ = +121.5kJ +339.5kJ <u>Exothermic steps: Bond forming</u> 1mol H-Cl -432kJ -432kJ ∴ Enthalpy Change = +337.5kJ + (-432kJ) = -94.5kJ mol^{-1}		☹	😐	☺

	Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.3a Oxidising & Reducing Agents	Page	Traffic Light: Red	Amber	Green
36a 37a (37a) (38a)		An oxidising agent is a substance which accepts electrons • oxidising agent oxidises something else • agent itself is reduced and accepts/gains electrons • oxidising agents tend to become more negative e.g. acidified permanganate solution is an example of an oxidising agent which gains electrons $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$		☹	😐	☺
36b 37b (37b) (38b)		A reducing agent is a substance which donates electrons • reducing agent reduces something else • agent itself is oxidised and loses electrons • reducing agents tend to become more positive e.g. sulphite ions are an example of a reducing agent which loses electrons $SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e^-$		☹	😐	☺
38		Electronegativity can be used to predict which elements lose or gain -electrons when they form ions: • metals have low electronegativity values and tend to lose electrons to become positive ions • non-metals have high electronegativities and tend to gain electrons to become negative ions		☹	😐	☺

Element	Metal/Non-metal	Electronegativity Value	Equation
Potassium	Metal	0.8	$K \rightarrow K^+ + e^-$
Lithium	Metal	1.0	$Li \rightarrow Li^+ + e^-$
Chlorine	Non-metal	3.0	$Cl + e^- \rightarrow Cl^-$
Fluorine	Non-metal	4.0	$F + e^- \rightarrow F^-$

39		Metals can often be reducing agents as they lose electrons as they form ions. • The electrons released from an metal forming a metal ion allow a reduction reaction to take place (hence the name reducing agent) Non-metals can often be oxidising agents as they tend to gain electrons as they form ions • The electrons accepted by a non-metal turning into a non-metal ion allow an oxidation reaction to happen as the electrons released by the oxidation reaction have a place to go to (hence the name oxidising agent)		☹	😐	☺
40		Group 1 elements are the strongest reducing agents • Alkali metals: Lithium, sodium, potassium, rubidium, caesium and francium Group 7 elements are the strongest oxidising agents • Halogens: fluorine, chlorine, bromine, iodine		☹	😐	☺

41
42
		The Electrochemical Series to determine the effectiveness of oxidising & reducing agents:
		• Strongest oxidising agents are at the bottom left hand corner of the electrochemical series
		  ○ Equation proceeds as written in data booklet (i.e. reduction reaction)
		• Strongest reducing agents are at the top right hand corner of the electrochemical series
		  ○ Equation reverses what is written in data booklet (i.e. oxidation reaction)
				☹	😐	☺

43		Acidified dichromate solution reacts by the following equation: $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ • Acidified dichromate is an oxidising agent as accepts electrons and is reduced itself Acidified permanganate solution reacts by the following equation: $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ • Acidified dichromate is an oxidising agent as accepts electrons and is reduced itself		☹	😐	☺
44		Hydrogen Peroxide reacts by the following equation: $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$ • Acidified peroxide is an oxidising agent as it accepts electrons and is reduced itself Carbon Monoxide reacts by the following equation: $CO + H_2O \rightarrow CO_2 + 2H^+ + 2e^-$ • Carbon monoxide is a reducing agent as it loses electrons and is oxidised itself		☹	😐	☺
45		Oxidising agents can be used as a chemical to • Bleach for clothes or hair • Kill fungi and bacteria and inactive viruses		☹	😐	☺

Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.3b Ion-Electron and Redox Equations	Page	Traffic Light: Red	Amber	Green

46 (41)

Given reactant and product species, ion-electron equations which include $H^+(aq)$ and $H_2O(l)$ can be written.

1. **Write down the main species involved in the reaction**

$$IO_3^- \rightarrow I_2$$

2. **Balance all atoms except O and H**

$$2IO_3^- \rightarrow I_2$$

3. **Add H_2O to other side to balance O atoms**

$$2IO_3^- \rightarrow I_2 + 6H_2O$$

4. **Add H^+ ions to other side to balance H atoms**

$$2IO_3^- + 12H^+ \rightarrow I_2 + 6H_2O$$

5. **Add e^- to most positive side to balance charge**

$$2IO_3^- + 12H^+ + 10e^- \rightarrow I_2 + 6H_2O$$

47 (39) (40)

Ion-electron equations can be combined to produce redox equations

Reduction: $I_2 + 2e^- \rightarrow 2I^-$

Oxidation: $2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e^-$

Redox: $I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$

Where the electrons do not cancel out, ion-electron equations may have to be multiplied:

❶ $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

❷ $Fe^{2+} \rightarrow Fe^{3+} + e^-$

❶ $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$

❷x5 $5Fe^{2+} \rightarrow 5Fe^{3+} + 5e^-$

add and cancel down $MnO_4^- + 8H^+ + \cancel{5e^-} \rightarrow Mn^{2+} + 4H_2O$

$5Fe^{2+} \rightarrow 5Fe^{3+} + \cancel{5e^-}$

redox $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$

(42) The concentration of a reactant can be calculated from the results of redox titrations.

2008 Higher Question 17c(ii)

> Oxalic acid is found in rhubarb. The number of moles of oxalic acid in a carton of rhubarb juice can be found by titrating samples of the juice with a solution of potassium permanganate, a powerful oxidising agent. The equation for the overall reaction is:
>
> $$5(COOH)_2 + 6H^+ + 2MnO_4^- \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$
>
> In an investigation using a 500 cm^3 carton of rhubarb juice, separate 25.0cm^3 samples were measured out. Three samples were then titrated with 0.040 mol l^{-1} potassium permanganate solution and the average volume of potassium permanganate solution used was 26.9cm^3.
>
> Calculate the number of moles of oxalic acid in the 500 cm^3 carton of rhubarb juice.

no. of mol MnO_4^- = v x c = 0.0269 x 0.040 = 0.001076mol

$$5(COOH)_2 + 6H^+ + 2MnO_4^- \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

5mol 2 mol

0.001076mol x $^5/_2$ 0.001076mol

= 0.00269mol

0.00269 mol oxalic acid in 25cm^3 rhubarb juice

$^{500}/_{25}$ x 0.00269 mol oxalic acid in 500cm^3 rhubarb juice

= 0.0538mol oxalic acid

	Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.4a Chromatography	Page	Traffic Light Red	Amber	Green

48

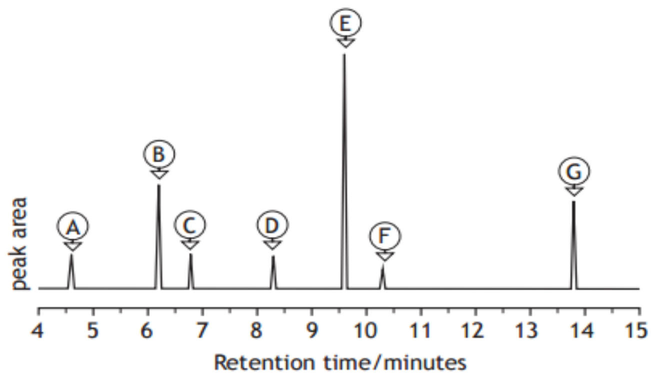
Chromatography is dependent on the relationship a substance has between the mobile phase and the stationary phase, their relative affinity for the mobile phase and the stationary phase decides how far/fast the substances travels during chromatography

- mobile phase is a liquid or a gas which carries the sample through the material.
  - size of molecules and their polarity affect how soluble they are in the mobile phase (and how far they travel in the mobile phase)
- stationary phase may be paper, silica gel, or an inert packing material in a column.
  - size and polarity of the compounds may affect their affinity for the stationary phase (how little they travel in the mobile phase)

☹ 😐 ☺

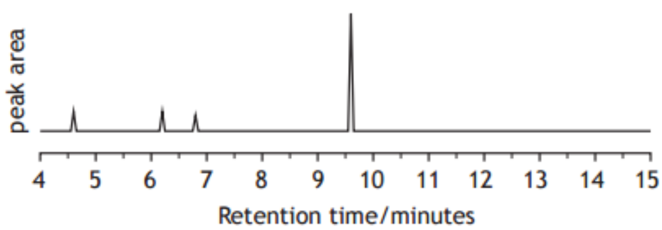
49

I can read and interpret retention/time graphs from results of chromatography experiments. (source: 2015 SQA Higher Q4)



The band name perfume gives the following gas chromatogram showing varying quantities of 7 different chemicals

- (A) linalool
- (B) citronellol
- (C) geraniol
- (D) eugenol
- (E) anisyl alcohol
- (F) coumarin
- (G) benzyl salicylate



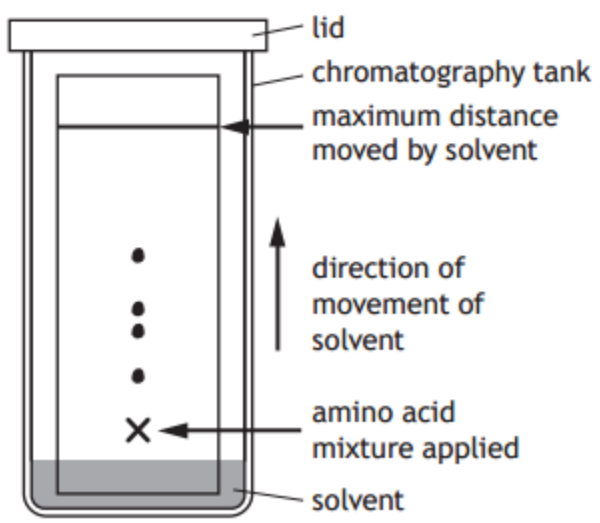
The counterfeit brand of perfume contains some but not all peak of the brands name perfume:

Retention Time (min)	Chemical Identified
4.6	A (linalool)
6.2	B (citronellol)
6.8	C (geraniol)
9.6	E (anisyl alcohol)

☹ 😐 ☺

50

Chromatograms can be identified using R_f values



Each chemical in the sample travels a different difference and can be quantified by the R_f value:

$$R_f = \frac{\text{distance travelled by sample}}{\text{distance travelled by solvent}}$$

☹ 😐 ☺

Dalziel High School	Higher Chemistry Self-Evaluation Unit 3.4b Volumetric Titrations	Page	Traffic Light Red	 Amber	 Green

51 Volumetric analysis uses exact quantities of a known substance to determine the exact quantity of another substance using titration.

- an exact volume and concentration of a substance will allow the calculation of the number of moles of a substance.
- using the mole ratio from a balanced equation, the number of moles of a second substance can be calculated
- the exact volume of the second substance, measured accurately using a burette, will allow the calculation of the concentration of the second substance.

☹ 😐 ☺

52 An indicator is a substance which will change colour in response to the chemical conditions around it

- starch indicator for the prescence of iodine (blue/black⇔colourless)
- phenolphthalein (pink ⇔ colourless)
- permanganate is a self-indicating oxidising agent (purple⇔colourless)

☹ 😐 ☺

53 The end point of a reaction is indicated by a change in colour by an indicator

- the reactants have been added in the correct quantities so they are exacted matched according to the balanced equation and have reacted with each other to form products.

☹ 😐 ☺

54 Titrations and Balanced Redox Equations are used to calculate the concentration of a reactant, given the concentration of the other.

<u>Question Source: 2014 SQA Higher Q13</u>

The vitamin C content in a fruit drink can be determined by titrating it with iodine.

$$\underset{\text{Vitamin C}}{C_6H_8O_6(aq)} + I_2(aq) \longrightarrow C_6H_6O_6(aq) + 2H^+(aq) + 2I^-(aq)$$

To determine the vitamin C content in a 1·0 litre carton of orange juice, three separate 20cm^3 samples of the juice were titrated with a 0·00125mol l^{-1} iodine solution. Starch indicator was used to determine the endpoint.

The following results were obtained from titration of the three 20cm^3 samples of orange juice.

Titration	Volume of 0.00125mol l^{-1} iodine solution used /cm^3
1	26.3
2	25.5
3	25.3

Calculate the mass, in grams, of vitamin C, in the 1·0 litre carton of orange juice. (1 mole vitC = 176 g)

<u>Solution to Problem</u>

$$\text{Average titre} = \frac{25.3+25.5}{2} = \frac{50.8}{2} = 25.4\text{cm}^3$$

no. of mol I_2 = v x c = 0.0254litres x 0.00125mol l^{-1} = 3.175x10^{-5}mol

$C_6H_8O_6$	+	I_2	$\longrightarrow$	$C_6H_6O_6$	+	$2H^+$	+	$2I^-$
1mol		1mol						
3.175x10^{-5}mol		3.175x10^{-5}mol						

∴ 20cm^3 orange juice contains 3.175x10^{-5}mol Vitamin C ($C_6H_8O_6$)

∴ 1000cm^3 orange juice contains 3.175x10^{-5}mol x$^{1000}/_{20}$

= 1.5975x10^{-3} mol Vitamin C ($C_6H_8O_6$)

1 mol Vitamin C ($C_6H_8O_6$) = (6x12) + (8x1) + (6x16) = 72+8+96 = 176g

∴ mass = **no** of moles x **gfm** = 3.175x10^{-5}mol x 176g mol^{-1}

= 0.2794g

☹ 😐 ☺

55 A standard solution is a solution of accurately known concentration

- dissolve a calculated mass of solid in a volume of deionised water
- transfer the solution to a standard flask, rinsing the container carefully
- make up the solution to the mark on the standard flask, using a dropper for the last few drops so that the bottom of the meniscus is touching the line on the flask.

☹ 😐 ☺

56 Accuracy is an important factor in all titrations

- errors may occur in judging the endpoint/colour change accurately/consistently
- burettes and pipettes are more accurate for measuring exact volumes of liquid in titrations
    - measuring cylinders and beakers are not accurate enough to measure volumes in titrations.

☹ 😐 ☺