Yield and Atom Efficiency/Atom Economy : 8th December 2018

(This is a blog for First Year students who are just starting to do calculations for 'A' Level chemistry.)

YIELD

- Students are required to know how to calculate the **yield** of reactions, and there are many different reasons why the **Actual** output of a particular reaction may not be the same as its **Theoretical** output.

- Yield is a measure of how **successful** a process may be.

$$\textbf{Yield} = \frac{\textbf{Actual Output}}{\textbf{Theoretical Output}} \times 100\ \%$$

If we obtain 44 g mol^{-1} out of a theoretical output of 88 g mol^{-1}, then the yield would be 50%.

- Calculating the "Yield" of a particular experiment is very easy and it is best shown by doing the calculation involved. Let us look at a sample question, and please remember to start always with the appropriate reaction equation (otherwise you will arrive at an incorrect answer) e.g. "Only 44g of Ethyl Ethanoate were obtained by reacting 1 mole of CH_3COOH (ethanoic acid) with 1 mole of CH_3CH_2OH (ethanol) in the presence of conc. Sulphuric Acid. What was the Yield?" *(The reaction below takes place in the presence of concentrated Sulphuric Acid.)*

		ethanoic acid	ethanol		ethyl ethanoate	water
Reaction Equation	=	CH_3COOH	+ CH_3CH_2OH	—>	$CH_3COOC_2H_5$	+ H_2O
RMM		60 (g mol^{-1})	46 (g mol^{-1})		88 (g mol^{-1})	18 (g mol^{-1})
Actual grammage			46 (g mol^{-1})		44 (g mol^{-1})	
Therefore Yield	=	$\frac{44 \times 100}{88}$ %				
	=	50%				

ATOM ECONOMY/EFFICIENCY

- AE is a measure of how **wasteful or** how **fruitful** a process may be. Here we have used 106 g mol^{-1} to obtain 44 g mol^{-1}. The AE is 41.5%, viz. we used 58.5% of the materials consumed *without obtaining what we wanted*. 58.5% was used unproductively. That is a rather wasteful/inefficient process!

$$\textbf{Atom Economy} = \frac{\textbf{Actual Output}}{\textbf{Total Mass of the Reactants}} \times 100\ \%$$

$$= \left(\frac{44}{106} \times 100\right)\% = 41.5\ \%$$

NB The Conservation of Mass Law requires that the total mass of the reactants = the total mass of the products.[1]

[1] At 'A' Level we do not worry about the conversion of mass into energy (Einstein's famous $E = m.c^2$).