$$\begin{array}{ccccccc} 78.114\ g/mol & & & & 123.111\ g/mol & & \text{<- Formula weights} \\ 22.4\ g & & & & 31.6\ g\ \text{ACTUAL} & & \\ C_6H_6 & + & HNO_3 & \longrightarrow & C_6H_5NO_2 & + & H_2O \\ \text{benzene} & & \text{nitric acid} & & \text{nitrobenzene} & & \end{array}$$

22.4 grams of benzene are reacted with excess nitric acid. If 31.6 grams of nitrobenzene are collected from the reaction, what is the percent yield?

To find the percent yield, we need to know both the THEORETICAL and ACTUAL yields of nitrobenzene. From the experiment, we already know the ACTUAL YIELD (31.6 g). We must CALCULATE the theoretical yield!

$78.114\ g\ C_6H_6 = \text{mol}\ C_6H_6$ | $\text{mol}\ C_6H_6 = \text{mol}\ C_6H_5NO_2$ | $123.11\ g\ C_6H_5NO_2 = \text{mol}\ C_6H_5NO_2$

$$22.4\ g\ C_6H_6 \times \frac{\text{mol}\ C_6H_6}{78.114\ g\ C_6H_6} \times \frac{\text{mol}\ C_6H_5NO_2}{\text{mol}\ C_6H_6} \times \frac{123.11\ g\ C_6H_5NO_2}{\text{mol}\ C_6H_5NO_2} = 35.3\ g\ C_6H_5NO_2$$

<- THEORETICAL YIELD

$$\%\ \text{YIELD} = \frac{\text{ACTUAL YIELD}}{\text{THEORETICAL YIELD}} \times 100\%$$

$$= \frac{31.6\ g}{35.3\ g} \times 100\% = \boxed{89.5\%}$$

25.0 mL of acetic acid solution requires 37.3 mL of 0.150 M sodium hydroxide for complete reaction. The equation for this reaction is:

$$NaOH + HC_2H_3O_2 \rightarrow NaC_2H_3O_2 + H_2O$$

What is the molar concentration of the acetic acid?

$$\frac{\text{mol } HC_2H_3O_2}{\text{L solution}} \leftarrow = 25.0\text{ mL or } 0.0250\text{ L}$$

Since we know the volume of solution, we just need to calculate MOLES of acid.

0.150 mol NaOH = L   mol NaOH = mol $HC_2H_3O_2$

units: 37.3 mL → 0.0373 L

$$0.0373\text{ L} \times \frac{0.150\text{ mol NaOH}}{\text{L}} \times \frac{\text{mol } HC_2H_3O_2}{\text{mol NaOH}} = 0.005595\text{ mol } HC_2H_3O_2$$

$$\text{So, } M = \frac{\text{mol } HC_2H_3O_2}{\text{L solution}} = \frac{0.005595\text{ mol } HC_2H_3O_2}{0.0250\text{ L}} = \boxed{0.224\text{ M } HC_2H_3O_2}$$

Shortcut: Use millimoles!

$$37.3\text{ mL} \times \frac{0.150\text{ mol NaOH}}{\text{L}} \times \frac{1\text{ mol } HC_2H_3O_2}{1\text{ mol NaOH}} = 5.595\text{ mmol } HC_2H_3O_2$$

$$M = \frac{\text{mol}}{\text{L}} = \frac{\text{mmol}}{\text{mL}} = \frac{5.595\text{ mmol } HC_2H_3O_2}{25.0\text{ mL}} = 0.224\text{ M } HC_2H_3O_2$$

42.081 g/mol $\qquad\qquad\qquad\qquad$ 53.064 g/mol

$$4\,C_3H_6 + 6\,NO \longrightarrow 4\,C_3H_3N + 6\,H_2O + N_2$$

propylene $\qquad\qquad\qquad\qquad$ acrylonitrile

Calculate how many grams of acrylonitrile could be obtained from 651 kg of propylene, assuming there is excess NO present. (651000 g)

1 - Convert mass propylene to moles using formula weight of propylene.
2 - Convert moles propylene to moles acrylonitrile using chemical equation
3 - Convert moles acrylonitrile to mass using formula weight of acrylonitrile

$42.081\,g\,C_3H_6 = mol\,C_3H_6$	$4\,mol\,C_3H_6 = 4\,mol\,C_3H_3N$	$53.064\,g\,C_3H_3N = mol\,C_3H_3N$

$$651000\,g\,C_3H_6 \times \frac{mol\,C_3H_6}{42.081\,g\,C_3H_6} \times \frac{4\,mol\,C_3H_3N}{4\,mol\,C_3H_6} \times \frac{53.064\,g\,C_3H_3N}{mol\,C_3H_3N} =$$

① $\qquad$ ② $\qquad$ ③

$$= \boxed{821000\,g\,C_3H_3N} \quad (821\,kg)$$

151.90 g/mol

$$10\,FeSO_4 + 2\,KMnO_4 + 8\,H_2SO_4 \rightarrow 5\,Fe_2(SO_4)_3 + 2\,MnSO_4 + K_2SO_4 + 8\,H_2O$$

How many mL of 0.250M potassium permangenate are needed to react with 3.36 g of iron(II) sulfate?

1 - Change the mass of iron(II) sulfate to moles using formula weight of iron(II) sulfate
2 - Change the moles of iron(II) sulfate to moles potassium permangenate using chemical equation
3 - Change moles of potassium permangenate to volume using concentration (0.250 mol/L)

$151.90\,g\ FeSO_4 = mol\ FeSO_4$	$10\,mol\ FeSO_4 = 2\,mol\ KMnO_4$	$0.250\,mol\ KMnO_4 = L$

$$3.36\,g\ FeSO_4 \times \frac{mol\ FeSO_4}{151.90\,g\ FeSO_4} \times \frac{2\,mol\ KMnO_4}{10\,mol\ FeSO_4} \times \frac{L}{0.250\,mol\ KMnO_4} = 0.0177\,L$$

$$mL = 10^{-3}\,L$$

$$0.0177\,L \times \frac{mL}{10^{-3}\,L} = 17.7\,mL \text{ of } 0.250\,M\ KMnO_4$$