

**Friday Worksheet**

Name: .....

**Analytical chemistry volumetric analysis worksheet 9**

A household cleaner containing ammonia was analysed.

The procedure for the analysis was as follows:

Step 1 – Pipette 25.00 mL of the cloudy ammonia into a 250.00 mL volumetric flask.

Step 2 – A Using a burette, add 90.00 mL of hydrochloric acid, which is in excess.

Step 3 – Make the volume up to the 250 mL mark with deionised water. Label this 'Solution A'.

Step 4 – Fill a burette with sodium hydroxide solution.

Step 5 – Transfer a 20.00 mL aliquot of Solution A (from Step 3) to a titration flask. Add indicator and titrate with the sodium hydroxide solution

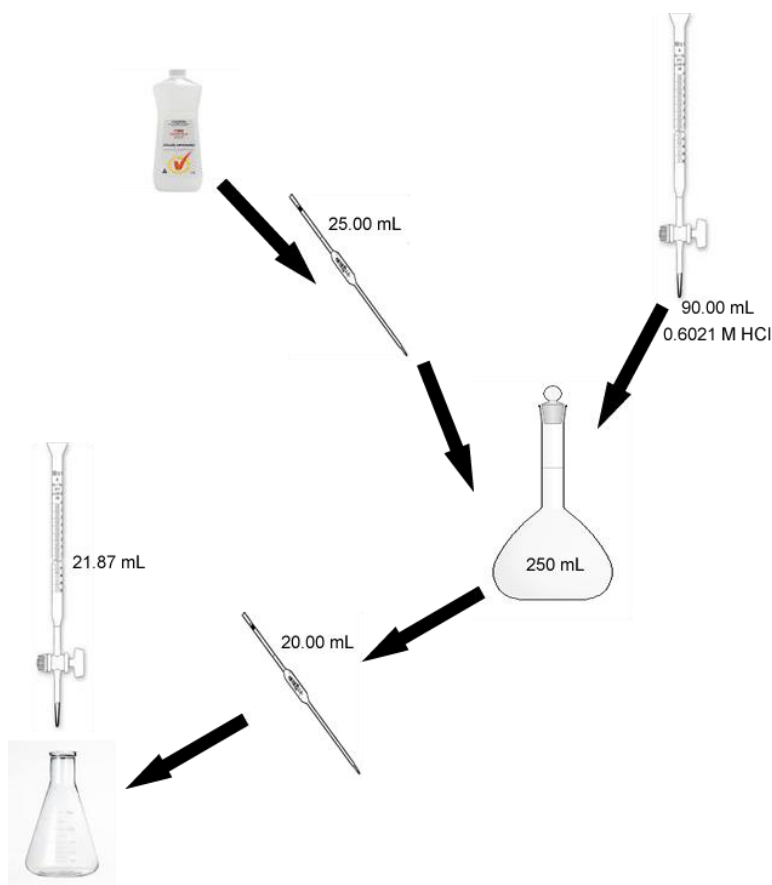
Step 6 – Repeat Step 5 until three concordant results are obtained.

The relevant equations for this analysis are as follows.

the equilibrium mixture in cloudy ammonia	$\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$
the initial reaction with supplied HCl	$\text{NH}_4\text{OH}(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{NH}_4\text{Cl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
the titration reaction between excess HCl and NaOH	$\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$

The students' results for the analysis are shown in the table below.

Measurement	Result
volume of cloudy ammonia sample	25.00 mL
volume of HCl added to cloudy ammonia sample	90.00 mL
concentration of HCl added to cloudy ammonia sample	0.6021 M
total volume of Solution A	250.00 mL
volume of aliquot of Solution A used in each titration	20.00 mL
concentration of NaOH solution	0.1200 M
mean titre	21.87 mL



a. Calculate the amount, in moles, of hydrochloric acid initially added to the undiluted ammonia sample.

$$n_{\text{HCl}} = C \times V = 0.6021 \times 0.09000 = 0.05419$$

b. Calculate the amount, in moles, of excess hydrochloric acid in a 20.00 mL aliquot of the diluted solution from Step 5.

$$n_{\text{NaOH}} = C \times V = 0.1200 \times 0.02187 = 0.002624$$

c. i. Use the students' experimental results to calculate

- the amount, in moles, of HCl that reacted with the ammonia in the volumetric flask  
 $n(\text{HCl}) \text{ reacted} = ([\text{Question a.}] - ([\text{Question b.}] \times 250/20))$   
 $\Rightarrow n(\text{HCl}) \text{ reacted} = (0.05419 - 0.002624 \times 250/20 = 0.05419 - 0.03280 = 0.02139)$
- the amount, in moles, of ammonia initially pipetted into the 250 mL volumetric flask  
**0.02139**
- the concentration, in  $\text{g L}^{-1}$ , of  $\text{NH}_4\text{OH}$  in the original 25.0 mL cloudy ammonia sample.  
**Step 1 Find the mol of  $\text{NH}_4\text{OH}$  present in the original 25.00 mL sample**  
 $\Rightarrow 0.02139$   
**Step 2 Find the mass of  $\text{NH}_4\text{OH}$**   
 $\Rightarrow 0.02139 \times 35.0 = 0.7487$   
**Step 3 Find the concentration of  $\text{NH}_4\text{OH}$  in g/L**  
 $\Rightarrow 0.7487 \times 1000/25 = 29.95 \text{ g L}^{-1}$

ii. The manufacturer claims that the detergent contains  $36.6 \text{ g L}^{-1}$  ammonia as ammonium hydroxide,  $\text{NH}_4\text{OH}$ . Provide **one** explanation for any difference between the students' results and the manufacturer's claim.

- **most likely the burette may have being washed with water.**

iii. A student had initially washed the pipette used to deliver the aliquots to the conical flask with water. A fellow student, John, argued that this would have made no difference to the final

calculation if the same pipette had been used for all the subsequent titrations without further washing. Is John right? Explain.

The impact of rinsing the pipette used to transfer aliquots of Solution A with water would, most likely, have no effect.

The titre for the first aliquot would certainly be higher than it should be, but since the same pipette is used for subsequent aliquots and concordant titres are needed to calculate the average titre, the first titre would have been discarded.