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	$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$
the initial reaction with supplied HCl	$NH_4OH(aq) + HCl(aq) \rightarrow NH_4Cl(aq) + H_2O(l)$
the titration reaction between excess HCl and NaOH	$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

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.

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

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

- the amount, in moles, of HCl that reacted with the ammonia in the titration flask
- the amount, in moles, of ammonia initially pipetted into the 250 mL volumetric flask
- the concentration, in g L^{-1}, of NH_4OH in the cloudy ammonia sample.

ii. The manufacturer claims that the detergent contains 36.6 g L^{-1} ammonia as ammonium hydroxide, NH_4OH. Provide **one** explanation for any difference between the students' results and the manufacturer's claim.

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.