TITRATION VALIDATION TEST

NAME: **ANSWERS** **25 Marks + 5 for accuracy = 30 marks**

Mark = _____/30

AIM

To determine the percentage by mass of ammonia in household ammonia.

METHOD

1. Rinse the equipment with the appropriate solution or distilled water, if necessary.
2. Pipette 20 mL of household ammonia into a 250 mL volumetric flask. Determine the exact mass of the household ammonia solution. Do not pipette the ammonia solution into the volumetric flask while it is on the balance.
3. Make the volume up to 250 mL with distilled water and mix well. (Use the appropriate technique for doing this).
4. Titrate the standard HCl solution from a burette against 20mL aliquots of diluted household ammonia solution, each with 3-5 drops of methyl orange indicator added.
5. Record your results below.
6. Repeat steps 3 and 4 until you obtain 3 concordant results.

RESULTS

Concentration of the standard HCl solution = **0.1002 molL^{-1}**

Mass of the 250 mL volumetric flask = **91.83 g**

Mass of the 250 mL volumetric flask + 20mL of household ammonia = **111.66 g**

Mass of 20 mL of household ammonia = **19.83 g**

	Rough estimate	Titration 1	Titration 2	Titration 3	Average Titration volume (mL)
Initial reading (mL)		**0.40**	**0.50**	**0.35**	
Final reading (mL)		**23.65**	**23.70**	**23.60**	
Titration volume (mL)		**23.25**	**23.20**	**23.25**	**23.233**

(1 mark)

ANALYSIS OF RESULTS

1. Write an appropriate equation for the reaction between the ammonia and hydrochloric acid then calculate the percentage by mass of ammonia in the household ammonia.

$NH_3\,(aq) + HCl\,(aq) \rightarrow NH_4^+(aq) + Cl^-\,(aq)$ (1)

n(HCl) = Vav x concentration

n(HCl) = c x V = 23.233 x 10^{-3} x 0.1002 = 2.32798 x 10^{-3} mole (1)

$n(NH_3)$ = n(HCl) = 2.32798 x 10^{-3} mole (1)

$n(NH_3)$ in 250mL = 2.32798 x 10^{-3} x 250/20 = 2.909975 x 10^{-2} mole (1)

$n(NH_3)$ in 20mL of Household ammonia= 2.909975 x 10^{-2} mole (1)

$m(NH_3)$ in 20mL of HA = 2.909975 x 10^{-2} x 17.034 = 0.4957g (1)

% (NH_3) in HA = 0.4957/19.83 x 100 = 2.49967% (1)

(7 marks)

to calculate % NH_3 from student results:

% NH3 = Vav x 10^{-3} x 0.1002 x 250/20 x 17.034 /$m(NH_3)$ x 100

= Vav/m(HA) x 2.13351

Calculated error from the standardisation of HCl and the % of NH3 titrations is

= 2.49967 +/- 0.0535%

corrected to 4 sig figs,

% NH_3 in Household ammonia = 2.500 +/- -0.054%

5 marks 2.466 ← 2.500 → 2.554 (+/- 1 error range either side of the correct value)

4 marks 2.392 ← 2.466 2.554 → 2.608 (+/- 2 error ranges)

3 marks 2.338 ← 2.392 2.608 → 2.662 (+/- 3 error ranges)

2 marks 2.284 ← 2.338 2.662 → 2.716 (+/- 4 error ranges)

1 mark 2.230 ← 2.284 2.716 → 2.77 (+/- 5 error ranges)

ANY ERROR OUTSIDE THIS RANGE GETS ZERO MARKS

Accuracy : Mark = ……../5

QUESTIONS

1.(a) Complete the following table by circling the correct alternative in the right hand column

Equipment	Rinsed with	
Volumetric flask	Water	Ammonia solution
Burette	Water	Hydrochloric acid
Conical flask	Water	Ammonia solution

(3 marks)

(b) How would the titration volume be affected if the burette was rinsed with the ***incorrect*** solution in part (a)? Justify your answer.

H_2O would remain in the burette. HCl would be diluted.
Greater volume of HCl would be required to neutralise the NH_3

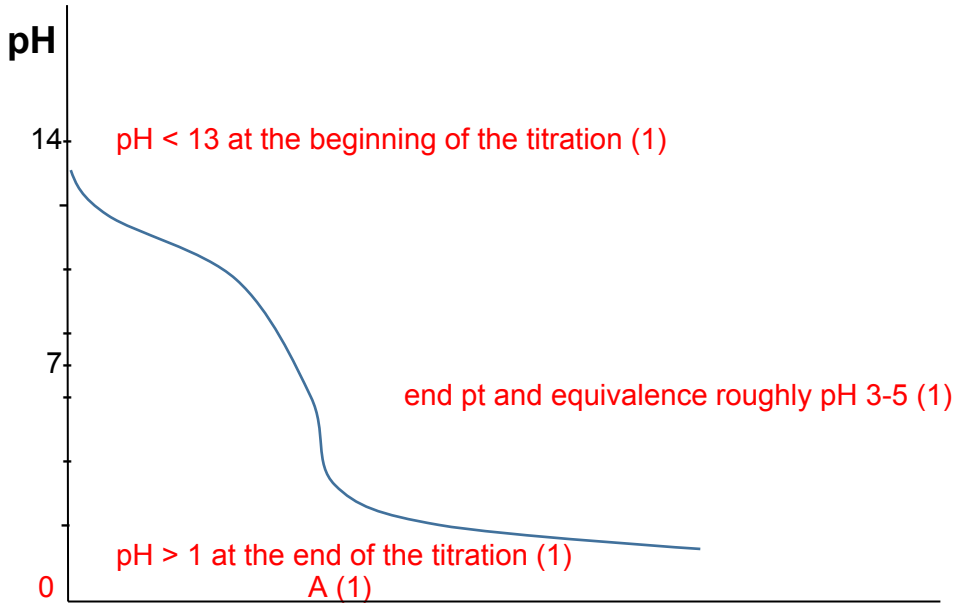
(2 marks)

2. During the titration one group of students washed their pipette with water but neglected to rinse it with ammonia solution before titrating. Assuming they do only one titration, what effect would this have on the calculated percentage of ammonia in their household ammonia. Explain your answer.

The NH_3 solution would be diluted. Therefore V(HCl) titrated would be less. (1)
n(HCl) calculated would be less (1)
n(NH_3) calculated would be less (1)
%(NH_3) would be less (1)

(4 marks)

3.(a) Sketch a titration curve on the axes below for the HCl/NH_3 titration you performed in the laboratory. Indicate the volume of HCl added at the end point. Label this point **A.**



(4 marks)

(b) Use your graph to explain why methyl orange (pH range 3.2 – 4.4) was chosen as the indicator in preference to phenolphthalein (pH range 8.2 – 10) for this titration. Use equations to support your answer.

$NH_3(aq) \rightarrow HCl(aq) \rightarrow NH_4^+(aq) + Cl^-(aq)$ (1)

NH_4^+ is a acidic $NH_4^+(aq) + H_2O(l) \rightarrow NH_3(aq) + H_3O^+(aq)$ (1)

At equivalence where the n(HCl) added = n(NH_3) the solution is acidic; pH < 7. (1)

If phenolphthalein was chosen the end point would have been at pH = 10 meaning a lower volume of HCl would have been recorded. (1)

(4 marks)

END OF TEST