Calculating the amount of nitrogen in a fertilizer

Ammonium salts are frequently used as fertilisers. Their nitrogen content can be estimated by reaction with excess standard alkali followed by 'back-titration' of the unused alkali with an acid.

i. Write an ionic equation for the reaction between ammonium ions and an aqueous alkali such as sodium hydroxide.

$NH_4^+ + NaOH \rightarrow NH_3 + Na^+ + H_20$
or just
$NH_4^+ + HO^- \rightarrow NH_3 + H_20$

ii. A solution containing 1.85g of the fertilizer was boiled with 50.0cm^3 of 1.00moldm^{-3} sodium hydroxide solution until reaction was complete. Calculate the number of moles of hydroxide ion added.

amount of NaOH = (vol. x conc.)/1000
= (50 x 1)/1000
*= **0.05mol***

iii. The solution obtained in (ii) was diluted to 250cm^3. 25.0cm^3 portions of this solution required 22.0cm^3 of 0.100 moldm^{-3} hydrochloric acid for neutralisation. Calculate the number of moles of hydroxide ion still present, unreacted, in the total 250cm^3 of solution.

amount of HCl = (vol. x conc.)/1000
= (22 x 0.1)/1000
= 2.2 x10^{-3}mol

*This is the same as the amount of NaOH in the 25cm^3 portion since HCl + NaOH $\rightarrow H_20$ + NaCl. Therefore in 250cm^3 there is 10x as much i.e. **0.022mol***

iv. Using your answers above, calculate the number of moles of hydroxide ion needed to react with the ammonium ions and hence the number of moles of ammonium ions present.

*The amount of NaOH which reacted is 0.05-0.022 = **0.028mol***
Therefore the amount of NH_4^+ in the fertilizer is the same since $NH_4^+ + HO^- \rightarrow NH_3 + H_20$

v. Calculate the percentage by mass of nitrogen in the fertilizer.

mass of nitrogen = moles x RAM
= 0.028 x 14
= 0.392g

% mass of nitrogen = (mass of nitrogen / mass of fertilizer) x 100
= (0.392 / 1.85) x 100
*= **21.2%***

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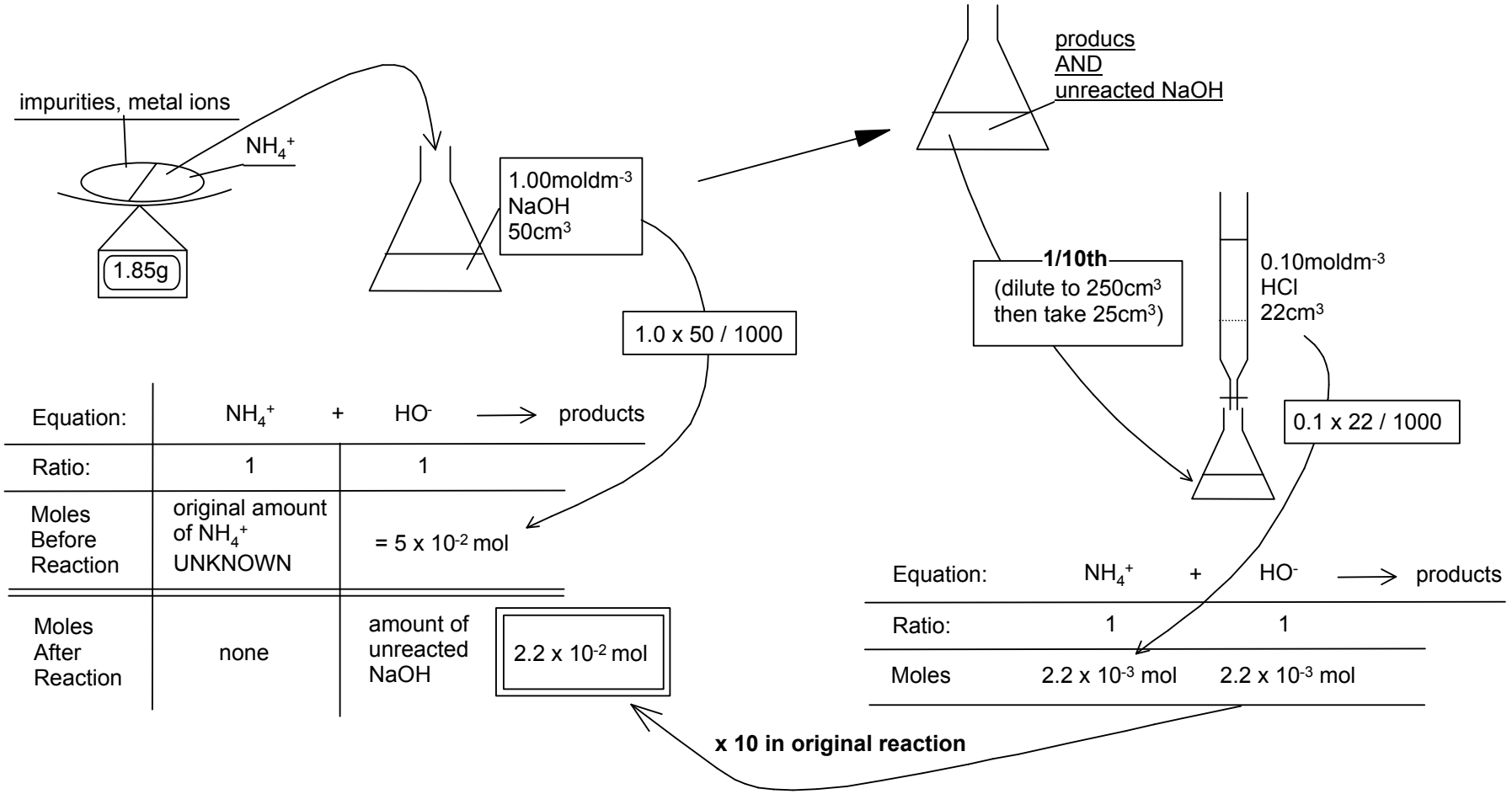

Equation:	NH_4^+ + HO^-	→ products
Ratio:	1	1
Moles Before Reaction	original amount of NH_4^+ UNKNOWN	= 5 x 10^{-2} mol
Moles After Reaction	none	amount of unreacted NaOH: 2.2 x 10^{-2} mol

Equation:	NH_4^+ + HO^-	→ products
Ratio:	1	1
Moles	2.2 x 10^{-3} mol	2.2 x 10^{-3} mol