Question Revision

1.

The concentration of hydrochloric acid in a liquid concrete cleaner was determined using the following method. A 25.00 mL sample was diluted to 250 mL in a volumetric flask. A pipette was used to transfer a 10.00 mL sample of this diluted concrete cleaner to a conical flask. An indicator was added and the sample of diluted concrete cleaner was titrated against a 0.200 M solution of sodium carbonate in a burette. The titre was found to be 23.15 mL.

2.

The contents of a laboratory reagent bottle containing solid potassium hydroxide, $KOH_{(s)}$, has been contaminated by moisture. You have been given the job of determining the extent of contamination. This is to be done by titrating a solution of this KOH with a standardised hydrochloric acid solution (HCl) of pH 1.14. You are to use the following procedure:

Step 1: Dissolve 2.80 g of the contaminated $KOH_{(s)}$ into 500.0 mL of solution.

Step 2: Fill a burette with this solution and use it to titrate a 20.00 mL sample of the $HCl_{(aq)}$ using a suitable indicator.

Step 3: Repeat the titrations until a consistent end point is obtained.

After completing the titrations, the following data is available:

- Titration end point = 15.80 mL of $KOH_{(aq)}$.
- pH of $HCl_{(aq)}$ = 1.14.

3.

A supermarket brand of vinegar is to be analysed for its ethanoic acid content by a titration technique. This requires the preparation of a $Na_2CO_3(aq)$ primary standard. The primary standard is made by dissolving 1.416 g of anhydrous $Na_2CO_3(s)$ in some distilled water and making the solution up to exactly 500.0 mL using a volumetric flask.

A 50.00 mL sample of the vinegar is diluted to exactly 1.000 L in another volumetric flask. Four 25.00 mL samples of this solution are placed into separate conical flasks and titrated with the $Na_2CO_3(aq)$ primary standard. On average 23.55 mL of the Na_2CO_3 solution was required for equivalence.

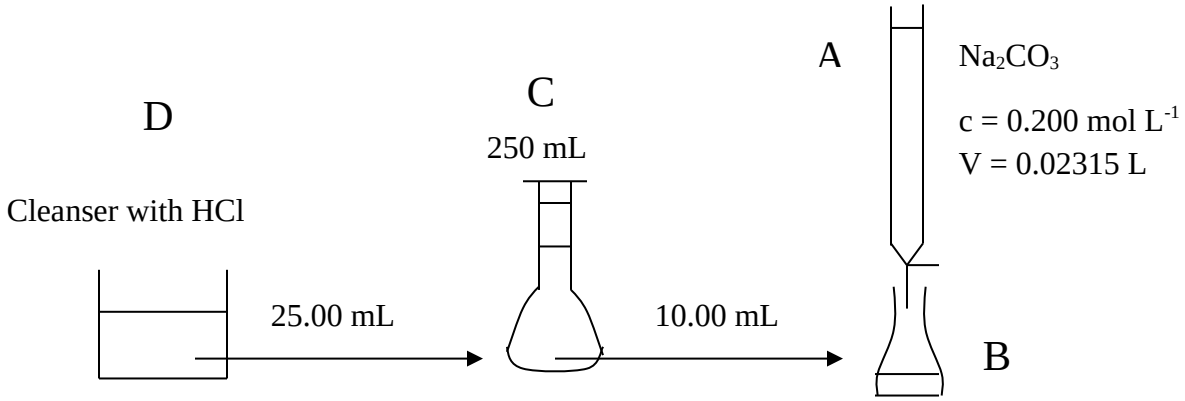
$Na_2CO_3(aq) + 2CH_3COOH(aq) \text{-------}> 2NaCH_3COO(aq) + H_2O(l) + CO_2(g)$

Determine the percentage by mass of ethanoic acid in the undiluted vinegar if this vinegar has a density of 1.060 g mL^{-1}.

1

The concentration of hydrochloric acid in a liquid concrete cleaner was determined using the following method. A 25.00 mL sample was diluted to 250 mL in a volumetric flask. A pipette was used to transfer a 10.00 mL sample of this diluted concrete cleaner to a conical flask. An indicator was added and the sample of diluted concrete cleaner was titrated against a 0.200 M solution of sodium carbonate in a burette. The titre was found to be 23.15 mL.

(a) Calculate the concentration of HCl in the original sample of concrete cleaner.



$2HCl_{(aq)} + Na_2CO_{3(aq)} \longrightarrow 2NaCl_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

$n(Na_2CO_3)_A = cV = 0.200 \times 0.02315 = 0.00463$
$n(HCl)_B = 2 \times n(Na_2CO_3)_A = 2 \times 0.00463 = 0.00926$ mol
$c(HCl)_C = (n(HCl)_B)/0.0100 = 0.00926/0.01 = 0.926$ M
$n(HCl)_C = cV = 0.926 \times 0.250 = 0.2315$ mol
$c(HCl)_D = n/V = 0.2315/0.025 =$ **9.26 M**

2.

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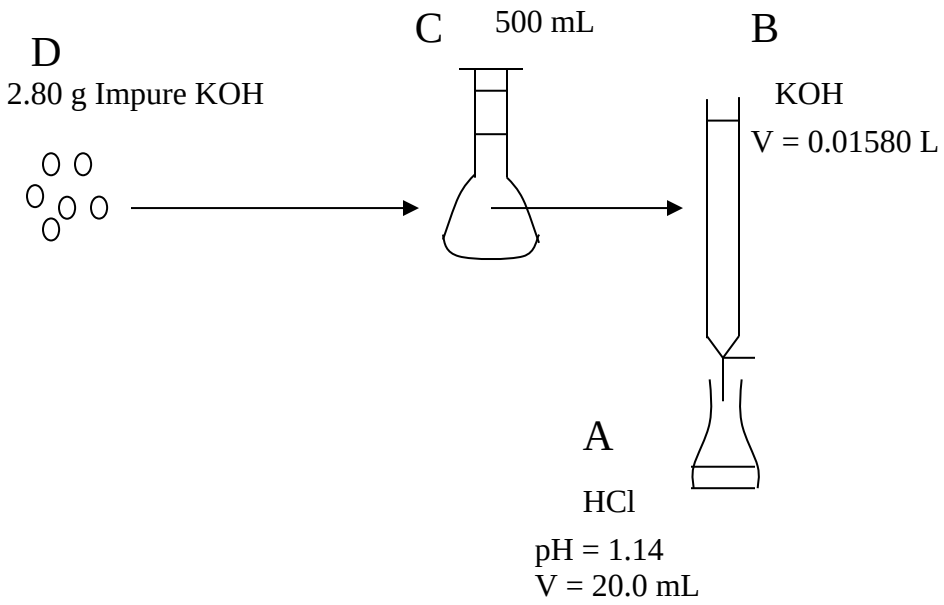
Step 2: Fill a burette with this solution and use it to titrate a 20.00 mL sample of the $HCl_{(aq)}$ using a suitable indicator.

Step 3: Repeat the titrations until a consistent end point is obtained.

After completing the titrations, the following data is available:

- Titration end point = 15.80 mL of $KOH_{(aq)}$.
- pH of $HCl_{(aq)}$ = 1.14.

Calculate the percentage by mass of moisture in the contaminated KOH(s)



$n(HCl)_A = cV = 10^{-1.14} \times 0.020 = 1.45 \times 10^{-3}$ mol
$n(KOH)_B = n(HCl)_A = 1.45 \times 10^{-3}$ mol
$c(KOH)_B = n/V = (1.45 \times 10^{-3})/0.01580 = 9.17 \times 10^{-2}$ M
$c(KOH)_C = 9.17 \times 10^{-2}$ M
$n(KOH)_C = c \times V = (9.17 \times 10^{-2}) \times 0.500 = 0.0459$
$m(NaOH)_D = n \times M = 0.0459 \times 56.1056 = 2.58$ g
%(KOH) in impure sample = (2.58/2.80) x 100 = **92.0%**

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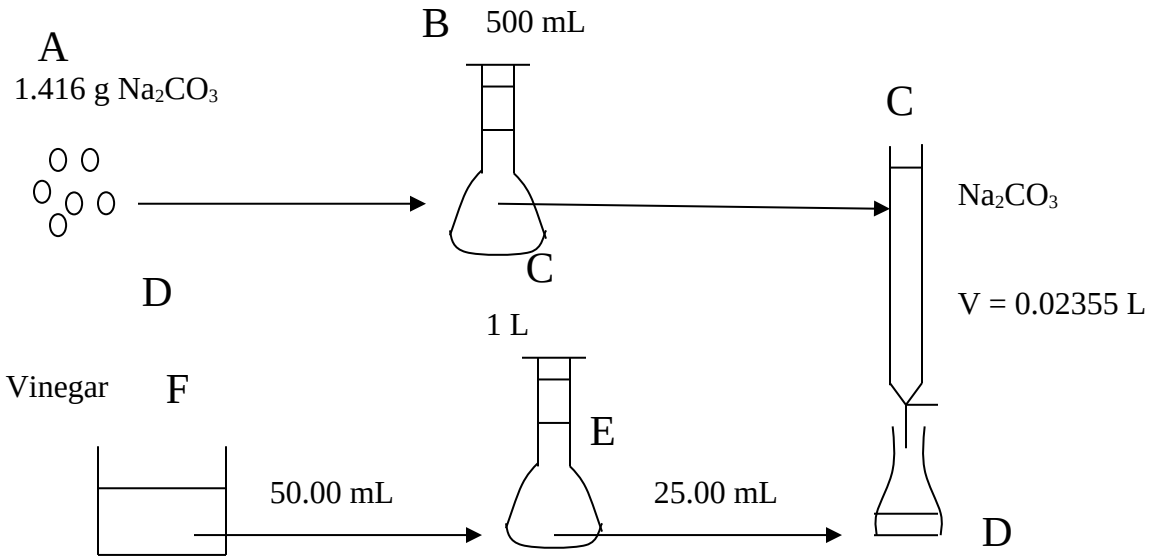
A 50.00 mL sample of the vinegar is diluted to exactly 1.000 L in another volumetric flask. Four 25.00 mL samples of this solution are placed into separate conical flasks and titrated with the $Na_2CO_3(aq)$ primary standard. On average 23.55 mL of the Na_2CO_3 solution was required for equivalence.

$Na_2CO_3(aq) + 2CH_3COOH(aq) \text{-------}> 2NaCH_3COO(aq) + H_2O(l) + CO_2(g)$

Determine the percentage by mass of ethanoic acid in the undiluted vinegar if this vinegar has a density of 1.060 g mL^{-1}.

[10 marks]



$n(Na_2CO_3)_A = m/M = 1.416/105.9884 = 1.336 \times 10^{-2}$ mol
$c(Na_2CO_3)_B = n/V = (1.336 \times 10^{-2})/0.500 = 2.67 \times 10^{-2}$ M
$n(Na_2CO_3)_{\text{added from Burette C}} = cV = (2.67 \times 10^{-2}) \times 0.02355 = 6.29 \times 10^{-4}$ mol
$n(CH_3COOH)_D = 2 \times n(Na_2CO_3)_{\text{added from Burette C}} = 2 \times (6.29 \times 10^{-4}) = 1.26 \times 10^{-3}$ mol
$c(CH_3COOH)_E = n/V = (1.26 \times 10^{-3})/0.02500 = 5.03 \times 10^{-2}$ M
$n(CH_3COOH)_E = cV = (5.03 \times 10^{-2}) \times 1 = 5.03 \times 10^{-2}$ mol
$c(CH_3COOH)_E = n/V = (5.03 \times 10^{-2})/0.0500 = 1.01$ M

density of vinegar = 1060 g / L
therefore, mass of 1 L solution = 1060 g
number of moles CH_3COOH in 1 L = 1.01
therefore, mass of CH_3COOH in 1 L = n x M = 1.01 x 60.0519 = 60.5g
%(CH_3COOH) = [(mass of CH3COOH)/(mass of solution)] x 100
= (60.5/1060) x 100 = **5.7%**