

Chemfax Acid Base Titrations Lab Prelab Answers

Chemfax Acid Base Titrations Lab Prelab Answers Chemfax AcidBase Titrations Lab PreLab Answers This document provides answers to the prelab questions for a Chemfax experiment on acid base titrations It aims to guide you through the fundamental concepts and calculations involved in the experiment

1 Define the following terms

a Titration Titration is a quantitative analytical technique used to determine the concentration of an unknown solution called the analyte by reacting it with a solution of known concentration called the titrant The titrant is carefully added to the analyte until the reaction is complete which is indicated by a change in the solutions color or pH

b Titrant The titrant is a solution of known concentration used in a titration It reacts with the analyte which is the solution of unknown concentration

c Analyte The analyte is the solution of unknown concentration that is being analyzed in a titration It reacts with the titrant to determine its concentration

d Equivalence Point The equivalence point in a titration is the point at which the moles of titrant added are stoichiometrically equal to the moles of analyte present in the solution At the equivalence point the reaction between the titrant and analyte is complete

e End Point The endpoint in a titration is the point at which a visual indicator signals that the reaction is complete The endpoint is usually very close to the equivalence point but not always identical

2 Explain the difference between a strong acid and a weak acid

Strong Acids Completely ionize in solution meaning they donate all of their protons H^+ to the solvent Have very low pH values less than 1

2 Examples Hydrochloric acid HCl Sulfuric acid H_2SO_4 Nitric acid HNO_3

Weak Acids Partially ionize in solution meaning they only donate a fraction of their protons Have higher pH values than strong acids usually between 2 and 6

3 Examples Acetic acid CH_3COOH Carbonic acid H_2CO_3 Phosphoric acid H_3PO_4

3 Explain the difference between a strong base and a weak base

Strong Bases Completely dissociate in solution releasing all of their hydroxide ions OH^- into the solution Have very high pH values greater than 13

3 Examples Sodium hydroxide $NaOH$ Potassium hydroxide KOH Calcium hydroxide $Ca(OH)_2$

Weak Bases Partially dissociate in solution meaning they only release a fraction of their hydroxide ions Have lower pH values than strong bases usually between 8 and 12

3 Examples Ammonia NH_3 Methylamine CH_3NH_2 Pyridine C_5H_5N

4 What is a pH indicator How does it work

A pH indicator is a substance that changes color in response to changes in pH It is used to visually signal the endpoint of a titration which is often very close to the equivalence point

How it works pH indicators are typically weak acids or bases that exhibit different colors in their acidic and basic forms When an indicator is added to a solution it exists in equilibrium between its acidic HIn and basic In^- forms

$$HIn \rightleftharpoons H^+ + In^-$$

HIn Acidic Form In^- Basic Form The color of the solution is determined by the relative concentrations of these two forms In acidic solutions the

acidic form HIn predominates resulting in one color In basic solutions the basic form In^- predominates resulting in a different color As the pH of the solution changes the equilibrium shifts leading to a change in the color of the indicator

5 Describe the procedure for standardizing a solution of NaOH

Standardization of NaOH solution

3 1 Preparation Weigh out a known mass of a primary standard usually potassium hydrogen phthalate KHP KHP is a weak acid that is stable nonhygroscopic does not absorb water and has a high molar mass making it an ideal primary standard

2 Dissolution Dissolve the weighed KHP in distilled water and transfer it to a clean dry flask

3 Titration Add a few drops of phenolphthalein indicator to the KHP solution This indicator will turn pink in the presence of excess NaOH Slowly titrate the KHP solution with the NaOH solution until a faint pink color persists for at least 30 seconds

4 Calculation Record the volume of NaOH solution used to reach the endpoint Use the mass of KHP its molar mass and the volume of NaOH used to calculate the concentration of the NaOH solution

5 Repeat Repeat the titration at least twice to ensure accurate results

6 A solution of NaOH is standardized using 0.650 g of KHP The titration requires 28.40 mL of the NaOH solution to reach the endpoint Calculate the molarity of the NaOH solution

Calculations

1 Moles of KHP

Molar mass of KHP KHCHO 204.22 g/mol

Moles of KHP $0.650 \text{ g} / 204.22 \text{ g/mol} = 0.00318 \text{ mol}$

2 Molarity of NaOH

Volume of NaOH solution 28.40 mL 0.02840 L

Since the reaction between KHP and NaOH is a 1:1 mole ratio the moles of NaOH are equal to the moles of KHP 0.00318 mol

Molarity of NaOH $0.00318 \text{ mol} / 0.02840 \text{ L} = 0.112 \text{ M}$

Therefore the molarity of the NaOH solution is 0.112 M

7 A 25.00 mL sample of an unknown acid is titrated with 0.100 M NaOH The titration requires 35.40 mL of NaOH solution to reach the endpoint Calculate the molarity of the acid

Calculations

1 Moles of NaOH

Molarity of NaOH 0.100 M

Volume of NaOH 35.40 mL 0.03540 L

Moles of NaOH $0.100 \text{ mol/L} \times 0.03540 \text{ L} = 0.00354 \text{ mol}$

2 Moles of Acid

Assuming the acid is monoprotic donates one proton the mole ratio between NaOH and the acid is 1:1

Therefore the moles of acid are also 0.00354 mol

3 Molarity of Acid

Volume of acid 25.00 mL 0.02500 L

Molarity of acid $0.00354 \text{ mol} / 0.02500 \text{ L} = 0.142 \text{ M}$

Therefore the molarity of the unknown acid is 0.142 M

8 What are some of the sources of error in an acidbase titration

Sources of error in acidbase titrations

Inaccurate measurement of titrant volume This can occur due to misreading the burette or air bubbles in the burette tip

Inaccurate measurement of analyte volume This can occur due to misreading the pipette or volumetric flask

Inaccurate endpoint determination This can occur if the indicator used is not a good match for the titration or if the endpoint is not observed carefully

Improper standardization of the titrant If the titrant is not accurately standardized the results of the titration will be inaccurate

Contamination of reagents If the titrant or analyte solutions are contaminated the results of the titration will be inaccurate

Temperature variations The concentration of solutions can vary with temperature which can affect the accuracy of the titration

Incomplete reaction If the reaction between the titrant and analyte is not complete the results of the titration will be inaccurate

Conclusion This document provided answers to the prelab questions for a Chemfax experiment on acid base titrations

Understanding the fundamental definitions concepts and calculations involved is crucial for conducting successful and accurate titrations

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