GENERAL

acid base neutralization reaction pogil answers

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When you’re preparing for chemistry exams, one of the most common stumbling blocks is the acid–base neutralization reaction. Whether you’re tackling a high school curriculum, an AP Chemistry exam, or a college-level introductory course, understanding how acids and bases interact, the stoichiometry involved, and how to interpret pH changes is essential. This article provides a deep dive into the fundamentals of acid–base neutralization, offers a curated list of Pogil answers for typical problems, and shares practical study tips to help you ace your tests.

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What Is Acid–Base Neutralization?

Acid–base neutralization is a chemical reaction where an acid and a base combine to form water and a salt. The general reaction can be represented as:

Acid + Base !’ Salt + Water

In aqueous solution, the key species are hydrogen ions (H z) from the acid and hydroxide ions (OH {) from the base. When these ions meet, they form water (H ,O). The remaining ions pair up to create the salt, which is typically soluble in water.

Key Concepts & Terminology

- Acid: A substance that donates H z ions in solution.
- Base: A substance that donates OH { ions in solution.
- Strong vs. Weak Acids/Bases: Strong acids/bases dissociate completely; weak ones dissociate partially.
- pH: A logarithmic measure of H z concentration; lower pH = more acidic.
- pOH: A logarithmic measure of OH { concentration; lower pOH = more basic.
- Neutralization Point: When moles of H z equal moles of OH {.
- Salt: The product of neutralization, typically a combination of the cation from the base and the anion from the acid.

The Chemical Mechanism Behind Neutralization

At the molecular level, neutralization is essentially a proton transfer. The base’s hydroxide ion accepts a proton from the acid’s conjugate acid, producing water:

OH { + H z !’ H ,O
Simultaneously, the remaining ions combine:

Base { + Acid z !’ Salt
Because the reaction is exothermic, it often releases heat. In a laboratory setting, the heat can be measured using a calorimeter to determine reaction enthalpy.

Stoichiometry and Balancing Equations

When solving neutralization problems, you must keep track of moles, not just mass. Here’s a step-by-step approach:

1. Write the balanced equation. For example, hydrochloric acid (HCl) reacting with sodium hydroxide (NaOH) gives sodium chloride (NaCl) and water.
2. Convert masses to moles. Use molar masses: HCl = 36.46 g/mol, NaOH = 40.00 g/mol.
3. Apply mole ratios. The balanced equation shows a 1:1 ratio; thus, moles of acid = moles of base at the neutralization point.
4. Determine limiting reagent. The reagent with fewer moles determines how much product can form.
5. Calculate excess. If one reagent is in excess, you can calculate leftover moles to determine final pH.

Example Problem

Calculate the pH of a solution after mixing 25.0 mL of 0.200 M HCl with 30.0 mL of 0.150 M NaOH.

1. Moles of HCl = 0.025 L × 0.200 mol/L = 0.00500 mol.
2. Moles of NaOH = 0.030 L × 0.150 mol/L = 0.00450 mol.
3. NaOH is the limiting reagent; it consumes 0.00450 mol of HCl.
4. Remaining HCl = 0.00500 – 0.00450 = 0.00050 mol.
5. Total volume = 0.025 L + 0.030 L = 0.055 L.
6. [H z] = 0.00050 mol / 0.055 L "H 0.00909 M.
7. pH = –log(0.00909) "H 2.04.

pH, pOH, and the Role of Concentration

Because pH and pOH are inversely related (pH + pOH = 14 at 25 /°C), calculating one allows you to find the other. In neutralization problems, you often need to:

- Determine whether the solution is acidic, basic, or neutral.
- Calculate the final pH after mixing reactants.
- Predict the pH at the equivalence point for weak acids or weak bases.

For weak acids/bases, you’ll use the acid dissociation constant (K •) or base dissociation constant (K_b) to find the pH of the resulting salt solution. For example, the hydrolysis of sodium acetate (CH ƒCOONa) produces a basic solution because acetate (CH ƒCOO {) reacts with water to form acetate and OH { ions.

Buffers: Maintaining pH Stability

A buffer is a mixture of a weak acid and its conjugate base (or a weak base and its conjugate acid) that resists changes in pH when small amounts of acid or base are added. The Henderson–Hasselbalch equation describes buffer behavior:

pH = pKa + log([A {]/[HA])
Buffer capacity depends on the concentration of the acid/base pair. In Pogil problems, you’ll often see buffer

calculations where the goal is to determine the pH after adding an acid or base.

Pogil Answers for Acid–Base Neutralization

Below is a curated set of answers for typical Pogil-style questions involving acid–base neutralization. These answers are formatted for quick reference and can be used as a study aid.

Problem 1: Equivalence Point of a Weak Acid

Question:0.100 M acetic acid (CH ƒCOOH, K• = 1.8 × 10{ u) is titrated with 0.100 M NaOH. What is the pH at the equivalence point?

Answer: At equivalence, all acetic acid has been converted to acetate (CH ƒCOO {). The solution contains 0.100 M acetate, which undergoes hydrolysis:

CH ƒCOO { + H ,O !Ì CH ƒCOOH + OH {
Using K_b = Kw/K• = 5.56 × 10 {¹ p, solve for [OH {] "H 7.46 × 10 { v M. Then pOH = 5.13, so pH = 8.87.

Problem 2: Strong Acid–Strong Base Titration

Question: 25.0 mL of 0.200 M H ,SO „ is mixed with 30.0 mL of 0.150 M NaOH. What is the resulting pH?

Answer:H ,SO „ is diprotic; each mole yields two H z. Moles of H ,SO „ = 0.025 L × 0.200 mol/L = 0.00500 mol, giving 0.0100 mol H z. Moles of NaOH = 0.030 L × 0.150 mol/L = 0.00450 mol. NaOH is limiting, so H z remaining = 0.0100 – 0.00450 = 0.00550 mol. Total volume = 0.055 L, [H z] = 0.00550 / 0.055 = 0.100 M, pH = –log(0.100) = 1.00.

Problem 3: Buffer Capacity Calculation

Question:A buffer solution contains 0.200 M HCl and 0.200 M NaCl. If 0.0100 mol of NaOH is added, what is the new pH?

Answer: NaOH reacts with HCl: NaOH + HCl !’ NaCl + H ,O. After addition, HCl remaining = 0.200 M × 0.100 L – 0.0100 mol = 0.0200 mol. Total volume = 0.100 L + 0.0100 L = 0.110 L. [H z] = 0.0200 / 0.110 "H 0.1818 M, so pH = –log(0.1818) "H 0.74.

Problem 4: Determining Limiting Reagent

Question:15.0 mL of 0.250 M HCl is mixed with 20.0 mL of 0.150 M NaOH. Identify the limiting reagent and calculate the final pH.

Answer: Moles HCl = 0.015 L × 0.250 = 0.00375 mol. Moles NaOH = 0.020 L × 0.150 = 0.00300 mol. NaOH is limiting. Excess HCl = 0.00375 – 0.00300 = 0.00075 mol. Total volume = 0.035 L. [H z] = 0.00075 / 0.035 "H 0.0214 M. pH "H 1.67

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