

Net ionic equations, titration and redox

AP Chemistry · Worksheet

Name: _____ Date: _____ Class: _____

These problems train you to classify solubility, write net ionic equations, predict precipitates, carry out titration and limiting reagent calculations, and recognise redox reactions. They follow AP Chemistry unit 4 and the style of free-response questions on reactions.

The first problems are single steps. Later ones combine stoichiometry with solution volumes, data from titrations and short written arguments. In the last five, show every conversion from volume to moles and justify each choice.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 4

Problem 1 Soluble or insoluble (easy)

Use the solubility rules to classify each compound as soluble or insoluble in water: NaCl, AgCl, BaSO₄, K₂CO₃, Mg(OH)₂, NH₄NO₃.

Problem 2 Find the spectators (easy)

Silver nitrate and sodium chloride solutions react: $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{NaNO}_3(\text{aq})$.

1. Write the net ionic equation.
2. Name the spectator ions.

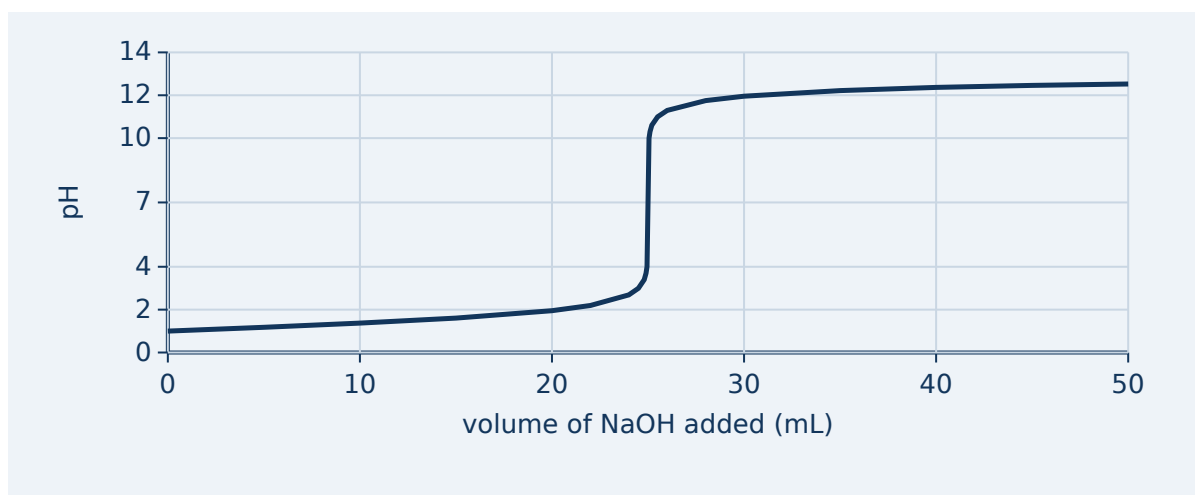
Problem 3 Oxidation numbers (easy)

Determine the oxidation number of (1) S in SO₄²⁻, (2) Cr in Cr₂O₇²⁻, (3) N in NH₄⁺, (4) Cl in ClO₃⁻.

Problem 4 Oxidised or reduced (easy)

In the reaction $\text{Mg}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Mg}^{2+}(\text{aq}) + \text{Cu}(\text{s})$, state which species is oxidised, which is reduced, and name the reducing agent.

Problem 5 Reading a titration curve (easy)

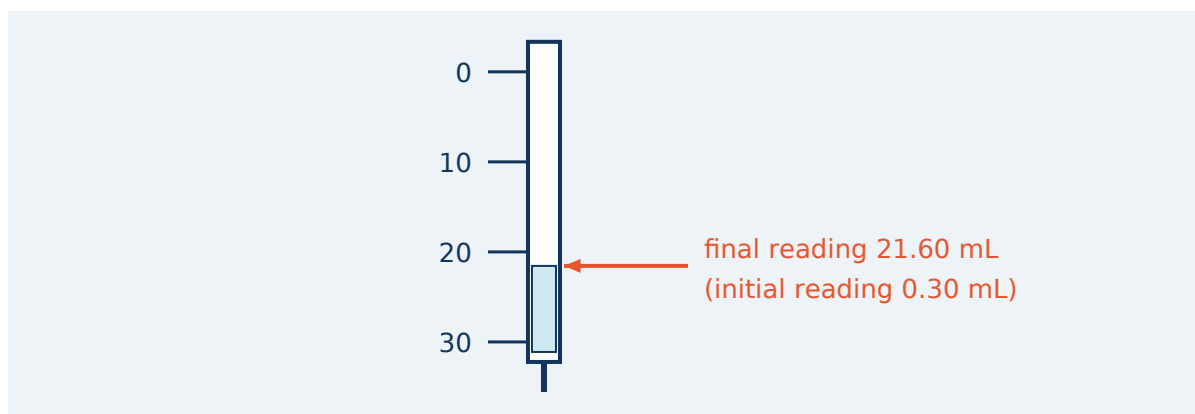


pH against volume of 0.100 M NaOH added to 25.0 mL of 0.100 M HCl.

Study the curve for the titration of 25.0 mL of HCl with 0.100 M NaOH.

1. State the pH at the start.
2. Estimate the volume of NaOH at the equivalence point.
3. State the pH at the equivalence point and suggest a suitable indicator.

Problem 6 Volume added from a burette (easy)



A burette.

In a titration of HCl with 0.100 M NaOH, the initial burette reading was 0.30 mL and the final reading was 21.60 mL. The acid sample was 10.00 mL.

1. Calculate the volume of NaOH added.
2. Calculate the concentration of the acid.

Problem 7 Three kinds of equation (medium)

Aqueous sodium carbonate reacts with aqueous calcium chloride, forming a white precipitate.

1. Write the balanced molecular equation.
2. Write the complete ionic equation.
3. Write the net ionic equation.

Problem 8 Neutralisation equations (medium)

Write the net ionic equation for (1) nitric acid with potassium hydroxide, and (2) ethanoic acid (weak) with sodium hydroxide.

Problem 9 Predict the precipitate (medium)

State whether a precipitate forms when equal volumes of these solutions are mixed, and name it: (1) Na_2SO_4 and BaCl_2 ; (2) KNO_3 and NaCl ; (3) $\text{Fe}(\text{NO}_3)_3$ and NaOH ; (4) $(\text{NH}_4)_2\text{S}$ and $\text{Zn}(\text{NO}_3)_2$.

Problem 10 Mass of precipitate (medium)

Mei in Singapore adds excess NaCl solution to 25.0 mL of 0.200 M AgNO_3 . Calculate the mass of AgCl (143.32 g/mol) formed.

Problem 11 Limiting reagent in solution (medium)

Diego in Texas mixes 50.0 mL of 0.120 M $\text{Pb}(\text{NO}_3)_2$ with 50.0 mL of 0.300 M KI . Determine the limiting reagent and the mass of PbI_2 (461.0 g/mol).

Problem 12 Percent yield (medium)

Wanjiru in Nairobi collects 2.45 g of dry PbI_2 from the reaction in the previous problem. Calculate the percent yield.

Problem 13 Sulfuric acid titration (medium)

A 25.00 mL sample of H_2SO_4 requires 30.50 mL of 0.1000 M NaOH . $\text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$. Calculate $c(\text{H}_2\text{SO}_4)$.

Problem 14 Half-equations (medium)

Zinc displaces silver from silver nitrate: $\text{Zn}(\text{s}) + 2\text{Ag}^+(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{Ag}(\text{s})$.

1. Write the oxidation and reduction half-equations.
2. Explain why 2 Ag^+ are needed per Zn .

Problem 15 Dissolving ionic compounds (medium)

Write equations for dissolving (1) Na_3PO_4 and (2) $\text{Al}(\text{NO}_3)_3$ in water. Then give the concentration of every ion in 0.10 M Na_3PO_4 .

Problem 16 Concentration of vinegar (hard)

Chiamaka in Lagos dilutes 10.00 mL of vinegar to 100.0 mL. A 25.00 mL portion of the diluted solution needs 18.20 mL of 0.1000 M NaOH . $\text{CH}_3\text{COOH} + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}$.

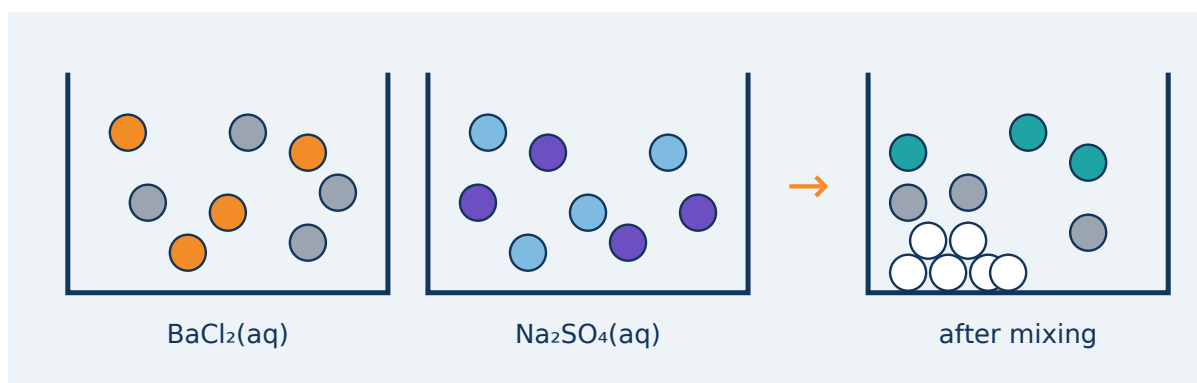
1. Calculate the concentration of CH_3COOH in the diluted solution.
2. Calculate its concentration in the original vinegar.
3. Calculate the mass of CH_3COOH (60.05 g/mol) in 100 mL of vinegar.

Problem 17 Redox titration of iron (hard)

In acid solution MnO_4^- oxidises Fe^{2+} : $\text{MnO}_4^- + 5\text{Fe}^{2+} + 8\text{H}^+ \rightarrow \text{Mn}^{2+} + 5\text{Fe}^{3+} + 4\text{H}_2\text{O}$. A 25.00 mL sample of Fe^{2+} solution needs 20.40 mL of 0.02000 M KMnO_4 .

1. Calculate the concentration of Fe^{2+} .
2. State the change in oxidation number of Mn and of Fe.

Problem 18 Ions left after precipitation (hard)



Before and after mixing BaCl_2 and Na_2SO_4 solutions (orange: Ba^{2+} , grey: Cl^- , blue: Na^+ , violet: SO_4^{2-}).

Barium chloride solution (50.0 mL of 0.100 M) is mixed with 50.0 mL of 0.100 M sodium sulfate.

1. Write the net ionic equation.
2. Calculate the mass of precipitate ($\text{BaSO}_4 = 233.39 \text{ g/mol}$).
3. Calculate the concentrations of Na^+ and Cl^- after mixing.

Problem 19 Analyse titration data (hard)

Aarav in Pune titrates 25.00 mL portions of HCl with 0.1050 M NaOH. Volumes of NaOH needed: trial 1 (rough) 23.10 mL; trial 2 21.60 mL; trial 3 21.55 mL; trial 4 21.65 mL.

1. Explain which results are used for the mean.
2. Calculate the mean volume and the concentration of the HCl.

Problem 20 Identify four solutions (hard)

Four colourless solutions 1 to 4 are $\text{Pb}(\text{NO}_3)_2$, KI, Na_2SO_4 and NaNO_3 . Results of mixing pairs: 1 + 2 gives a yellow precipitate; 1 + 3 gives a white precipitate; no other pair gives a precipitate.

Identify each solution and write the two net ionic equations.