

How acids, bases and salts behave

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These problems cover the language of acids and bases, the pH scale, word and ionic equations, making soluble salts and the difference between strong and weak acids. Early problems check recall; later ones involve calculations and explanations.

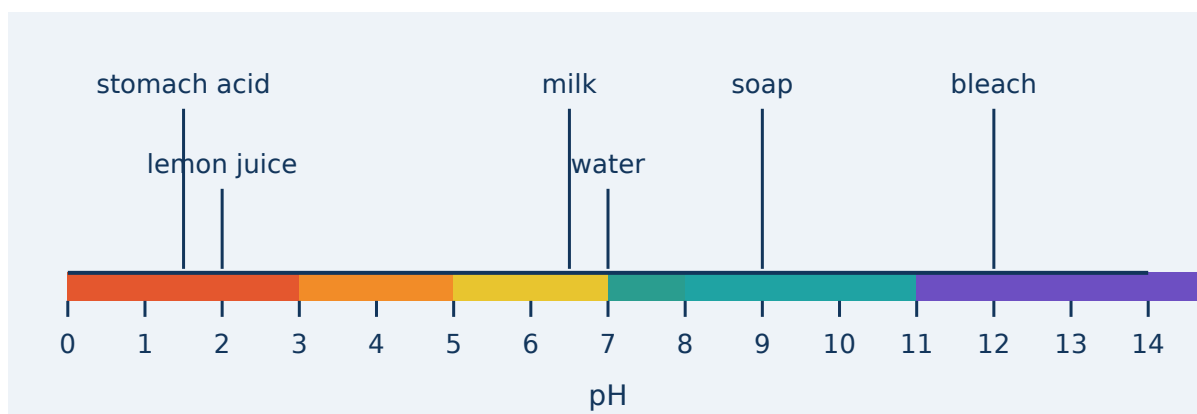
The set suits GCSE, IGCSE, O Level and Class 9-10 students. Write equations with state symbols when asked, and always link pH to the number of H^+ ions.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE C4, IGCSE 7

Problem 1 Sort the household liquids (easy)

Esther tests six liquids: lemon juice pH 2, pure water pH 7, bleach pH 12, milk pH 6.5, soapy water pH 9, stomach acid pH 1.5.

1. Name the acids, the neutral liquid and the alkalis.
2. State which liquid is the most acidic.
3. Name the colour of universal indicator in lemon juice.



The six liquids on the pH scale.

Problem 2 Name the salt (easy)

Name the salt formed in each reaction.

1. Hydrochloric acid + sodium hydroxide.
2. Sulfuric acid + copper(II) oxide.
3. Nitric acid + potassium hydroxide.
4. Hydrochloric acid + zinc.

Problem 3 Complete the word equations (easy)

Complete each word equation.

1. acid + metal oxide → ?
2. acid + carbonate → ?
3. acid + reactive metal → ?
4. acid + alkali → ?

Problem 4 Ions in acids and alkalis (easy)

1. Name the ion that all acids form in water.
2. Name the ion that all alkalis form in water.
3. Write the ionic equation for neutralisation, with state symbols.
4. State the pH of a neutral solution.

Problem 5 Reading indicator colours (easy)

Bilal in Lahore tests a clear liquid. It turns phenolphthalein pink, litmus blue and methyl orange yellow.

1. State whether the liquid is acidic, neutral or alkaline.
2. Predict the colour of universal indicator.
3. Name the ion responsible.

Problem 6 An ant sting (easy)

An ant sting contains methanoic (formic) acid. A first-aid guide suggests rubbing the skin with a paste of baking soda, a mild alkali.

1. Explain why an alkali helps.
2. Explain why a strong alkali such as sodium hydroxide should not be used.
3. Name the type of reaction.

Problem 7 Balance the equations (medium)

Balance each equation.

1. $\text{CuO} + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{H}_2\text{O}$
2. $\text{Mg}(\text{OH})_2 + \text{HNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + \text{H}_2\text{O}$
3. $\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2$
4. $\text{Al}_2\text{O}_3 + \text{HCl} \rightarrow \text{AlCl}_3 + \text{H}_2\text{O}$

Problem 8 Ionic equations (medium)

1. Write the ionic equation for the reaction of sodium hydroxide with hydrochloric acid, cancelling spectator ions.
2. Name the spectator ions in that reaction.
3. Write the ionic equation for $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$.

Problem 9 Order the method (medium)

Wanjiru makes zinc sulfate crystals. The steps are listed in the wrong order: (A) filter off the zinc oxide; (B) warm the sulfuric acid; (C) leave the solution to crystallise; (D) add zinc oxide until it stops dissolving; (E) evaporate some of the water.

1. Put the steps in the correct order.
2. Explain why zinc oxide is added in excess.
3. State what you would see to show the acid has all reacted.

Problem 10 Choose the method (medium)

For each salt, choose one method: (i) excess insoluble solid then filter; (ii) titration with an indicator then crystallise; (iii) precipitation by mixing two solutions.

1. Zinc chloride from zinc oxide and hydrochloric acid.
2. Potassium sulfate from potassium hydroxide solution and sulfuric acid.
3. Barium sulfate, which is insoluble, from barium nitrate and sodium sulfate solutions.

Problem 11 Mass of zinc sulfate (medium)

$\text{ZnO} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{O}$. Diego in Texas reacts 4.05 g of zinc oxide with excess acid (Ar: Zn = 65, O = 16, S = 32).

1. Calculate the moles of ZnO.
2. State the moles of ZnSO₄ formed.
3. Calculate the maximum mass of ZnSO₄.

Problem 12 Fertiliser from ammonia (medium)

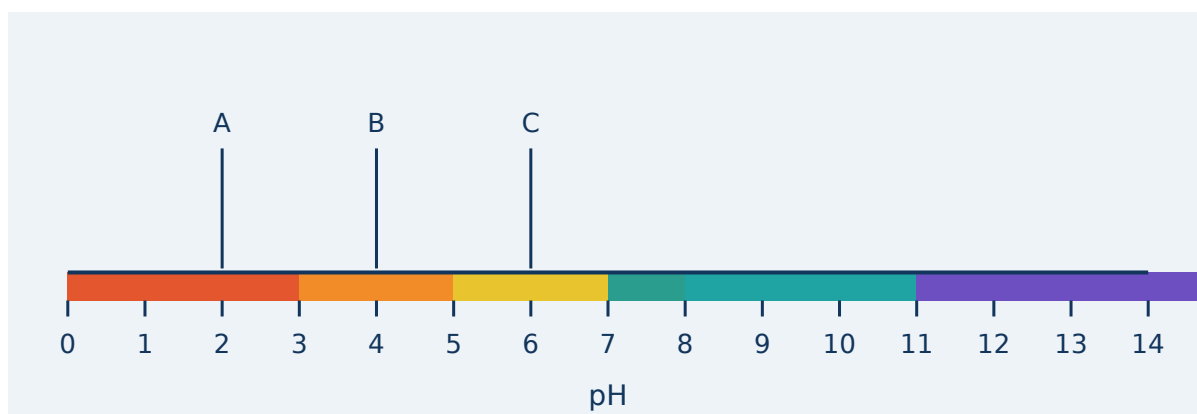
A farm co-operative near Eldoret makes ammonium nitrate: $\text{NH}_3 + \text{HNO}_3 \rightarrow \text{NH}_4\text{NO}_3$ (Ar: N = 14, H = 1, O = 16).

1. Calculate the moles in 8.5 kg of ammonia.
2. Calculate the theoretical mass of ammonium nitrate in kg.
3. The yield is 92%. Calculate the actual mass.

Problem 13 Comparing pH values (medium)

Solutions A, B and C have pH 2, 4 and 6.

1. State which solution has the most H⁺ ions.
2. Calculate how many times more H⁺ ions A has than B.
3. Calculate how many times more H⁺ ions A has than C.
4. 1 cm³ of A is mixed with 9 cm³ of water. Predict the new pH.

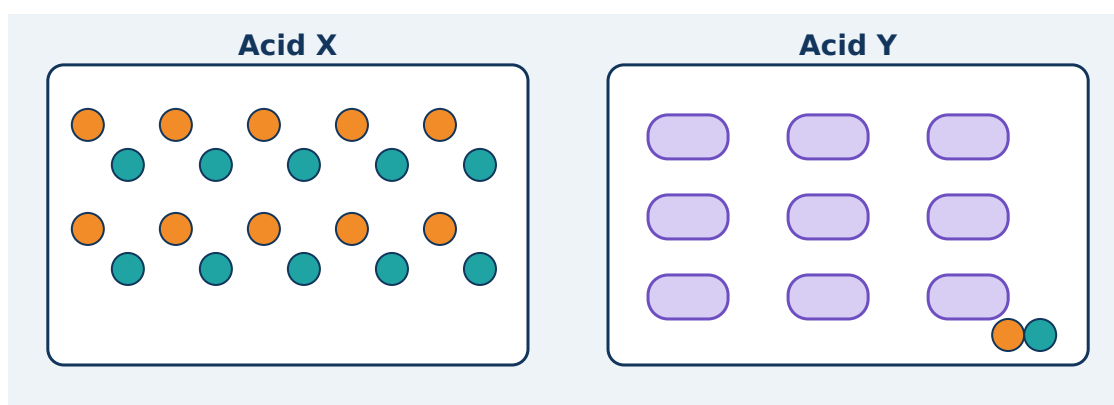


Solutions A, B and C.

Problem 14 Strong or weak? (medium)

Both beakers hold acid of the same concentration, 0.1 mol/dm^3 . In the diagram each orange dot is an H^+ ion.

1. Identify which acid is strong, giving evidence from the diagram.
2. Predict which acid has the lower pH.
3. Predict which acid reacts faster with magnesium ribbon.



Orange: H^+ ion. Teal: negative ion. Violet: whole molecule.

Problem 15 Dilution data (medium)

Esther measures the pH of hydrochloric acid at different concentrations.

Concentration (mol/dm^3)	pH
0.1	1.0
0.01	2.0
0.001	3.0
0.0001	?

1. Describe the pattern.
2. Predict the missing pH.
3. Ethanoic acid of 0.1 mol/dm^3 has pH 2.9. Explain why it differs from hydrochloric acid of

the same concentration.

Problem 16 Acid rain on a statue (hard)

A limestone statue (CaCO_3) is hit by 2400 dm^3 of rain per year. The rain has pH 4.0, which means $[\text{H}^+] = 1.0 \times 10^{-4} \text{ mol/dm}^3$. Assume all H^+ reacts: $\text{CaCO}_3 + 2\text{H}^+ \rightarrow \text{Ca}^{2+} + \text{H}_2\text{O} + \text{CO}_2$ (Ar: Ca = 40, C = 12, O = 16).

1. Calculate the moles of H^+ in the rain.
2. Calculate the moles of CaCO_3 dissolved.
3. Calculate the mass lost per year.
4. Rain of pH 3.0 hits the statue. State by what factor the mass lost changes.

Problem 17 Treating a fish pond (hard)

A fish pond in Uganda holds 50 m^3 of water ($1 \text{ m}^3 = 1000 \text{ dm}^3$) at pH 5.0, so $[\text{H}^+] = 1.0 \times 10^{-5} \text{ mol/dm}^3$. The owner adds calcium hydroxide: $\text{Ca(OH)}_2 + 2\text{H}^+ \rightarrow \text{Ca}^{2+} + 2\text{H}_2\text{O}$ (Ar: Ca = 40, O = 16, H = 1).

1. Calculate the volume of the pond in dm^3 .
2. Calculate the moles of H^+ to neutralise.
3. Calculate the mass of Ca(OH)_2 needed.
4. Suggest why adding a little more than this amount is not harmful but a large excess is.

Problem 18 Spot the errors (hard)

A student writes: "Hydrochloric acid at pH 1 is strong because it is concentrated. Ethanoic acid is weak because it is dilute, and a weak acid cannot have a pH below 3." Ethanoic acid of concentration 1.0 mol/dm^3 has pH 2.4. Hydrochloric acid of concentration 0.001 mol/dm^3 has pH 3.0.

1. Identify the two errors.
2. Use the data to show that a weak acid can have a lower pH than a strong acid.
3. Rewrite the student's statement correctly.

Problem 19 Copper sulfate crystals (hard)

Mei in Singapore adds excess copper(II) oxide to 50.0 cm^3 of 0.500 mol/dm^3 sulfuric acid, then crystallises hydrated copper(II) sulfate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (Ar: Cu = 63.5, S = 32, O = 16, H = 1).

1. Calculate the moles of acid.
2. Calculate the minimum mass of CuO needed.
3. Calculate the theoretical mass of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.
4. She collects 5.10 g. Calculate the percentage yield.

Problem 20 Pure potassium chloride (hard)

Kofi in Accra wants dry crystals of potassium chloride from 25.0 cm^3 of 0.200 mol/dm^3

potassium hydroxide and hydrochloric acid (Ar: K = 39, Cl = 35.5).

1. Explain why excess solid cannot be used here.
2. Describe how he can obtain a pure salt without leaving indicator in it.
3. Calculate the maximum mass of KCl.