

# Identifying substances with chemical tests

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

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Class: \_\_\_\_\_

These 20 problems train the main analysis skills: judging purity, calculating  $R_f$  values from chromatograms, recognising flame colours, interpreting precipitates, and writing ionic equations for the tests. They are written for GCSE, IGCSE, O Level, CBSE Class 9-10 and NGSS high school chemistry.

Take the problems in order. The first five are recall and reading; the middle ten need a calculation or an explanation; the last five combine tests, equations and masses.

**Level:** Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE C8

## Problem 1 Pure or impure (easy)

Sofia in Lisbon heats three solid samples. Sample A melts sharply at 80 °C. Sample B starts to melt at 63 °C and is completely liquid at 74 °C. Sample C melts sharply at 122 °C.

1. Which samples are likely to be pure?
2. Explain why sample B is not pure.
3. State what a formulation is and give one example.

## Problem 2 Simple $R_f$ values (easy)

Rahim in Dhaka measures three spots on a chromatogram. Spot 1 moved 3.0 cm while the solvent moved 6.0 cm. Spot 2 moved 4.5 cm with a solvent distance of 9.0 cm. Spot 3 moved 1.2 cm with a solvent distance of 8.0 cm.

1. Calculate the  $R_f$  of each spot.
2. Why does  $R_f$  have no unit?
3. Could spots 1 and 2 be the same substance?

## Problem 3 Flame test colours (easy)

Match each ion to its flame colour: lithium, sodium, potassium, calcium, copper(II). The colours are lilac, crimson, yellow, orange-red and blue-green.

1. Write the matches.
2. A firework shows a crimson flame. Which metal ion does it contain?

## Problem 4 Gas tests (easy)

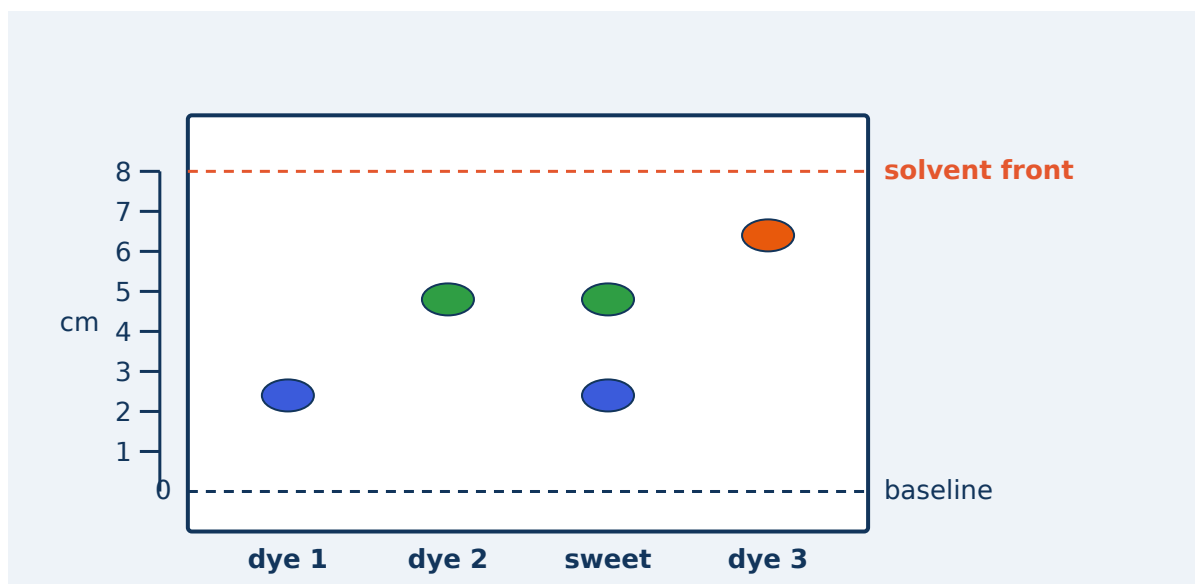
Joy in Accra collects four gases in test tubes: hydrogen, oxygen, carbon dioxide and chlorine.

1. Give the test and positive result for each gas.

2. Which gas is made when marble chips react with dilute acid?

### Problem 5 Reading a chromatogram (easy)

A food scientist in Seoul compares dyes. Lanes show dye 1, dye 2, a sweet extract and dye 3. The solvent front moved 8.0 cm.



1. Which lane shows a mixture?
2. Which dyes does the sweet contain?
3. Calculate the  $R_f$  of dye 2.
4. Is dye 3 present in the sweet?

### Problem 6 $R_f$ for two spots (medium)

A student runs a chromatogram where the solvent front moves 7.5 cm. Two spots are 1.8 cm and 4.5 cm from the baseline.

1. Calculate both  $R_f$  values.
2. Which spot is held more strongly by the paper? Explain.

### Problem 7 Using an $R_f$ value (medium)

In a solvent, a dye has  $R_f = 0.35$ .

1. The solvent front moves 12.0 cm. How far does the dye move?
2. Another dye has  $R_f = 0.60$  and moves 5.1 cm. How far did the solvent front move?

### Problem 8 Method questions (medium)

Thabo in Durban sets up a chromatography experiment.

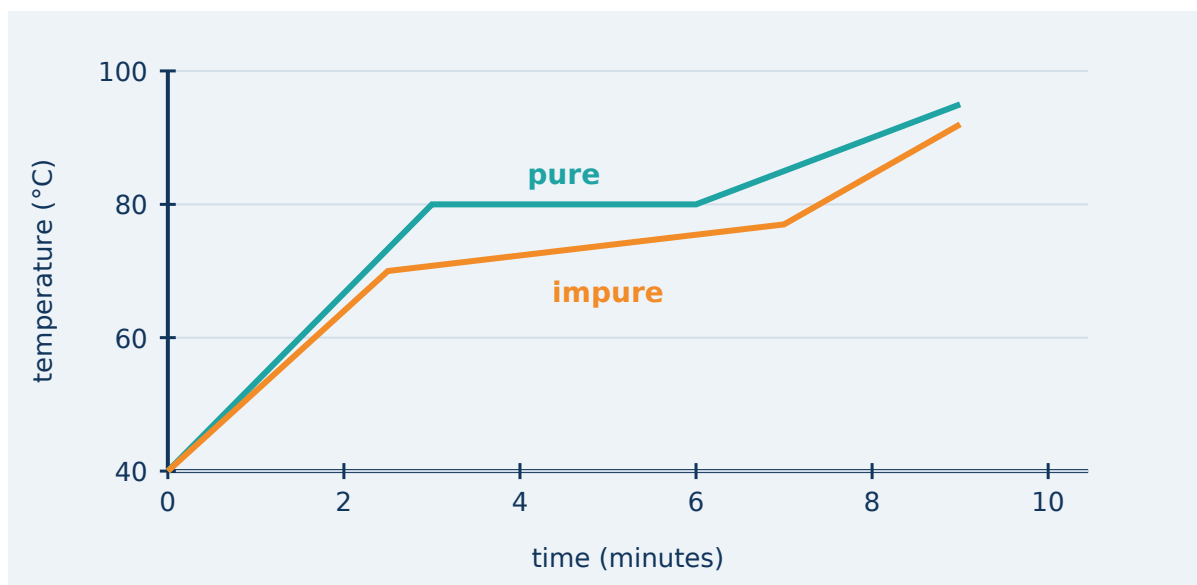
1. Why must the solvent level be below the baseline?
2. Why is a lid placed on the beaker?
3. Why should the paper be removed and the solvent front marked as soon as the solvent

nears the top?

4. What happens to  $R_f$  if a different solvent is used?

### Problem 9 Melting graph (medium)

A chemist in Edinburgh heats a pure sample and an impure sample steadily and plots temperature against time.



Heating curves of a pure and an impure sample.

1. Read the melting point of the pure sample.
2. Describe how the impure curve differs.
3. Explain why impurities change the melting behaviour.

### Problem 10 Sodium hydroxide results (medium)

Three colourless solutions are tested with sodium hydroxide. A gives a pale blue precipitate. B gives a white precipitate that dissolves in excess. C gives a white precipitate that stays in excess, and its flame test is orange-red.

1. Identify the metal ion in each solution.
2. Name the ion that could be present in C if the flame test gave no colour.

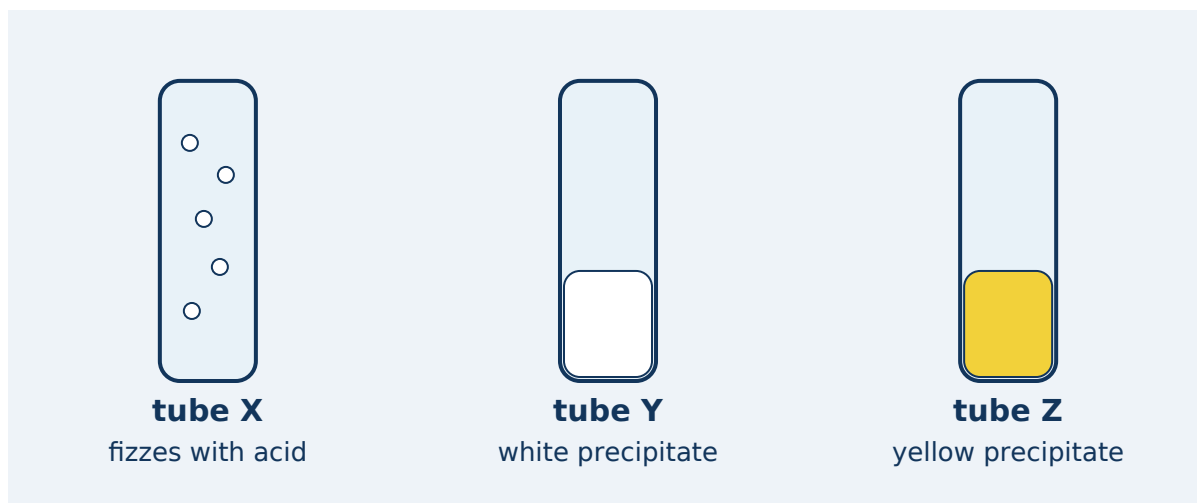
### Problem 11 Ionic equations (medium)

Write balanced ionic equations with state symbols for sodium hydroxide reacting with:

1.  $\text{Fe}^{3+}$  ions.
2.  $\text{Fe}^{2+}$  ions.
3.  $\text{Mg}^{2+}$  ions.
4. Give the colour of the precipitate in parts 1 and 2.

**Problem 12 Identifying negative ions** (medium)

Three solutions are tested. In tube X, dilute hydrochloric acid is added. In tubes Y and Z, dilute nitric acid and then silver nitrate are added.



*Results for tubes X, Y and Z.*

1. Identify the ion in X and describe the gas test.
2. Identify the ions in Y and Z.
3. Write the ionic equation for Y.

**Problem 13 Why acidify first** (medium)

A solution is suspected to contain sulfate ions, but it may also contain carbonate ions.

1. Explain why barium chloride alone is not a reliable test.
2. Explain what dilute hydrochloric acid does.
3. State the positive result for sulfate.

**Problem 14 Gas from a metal** (medium)

Ana in Madrid adds magnesium ribbon to dilute hydrochloric acid.

1. Balance  $\text{Mg} + \text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$ .
2. Describe the test that proves the gas is hydrogen.
3. Three unknown gases: P relights a glowing splint, Q turns limewater cloudy, R bleaches damp litmus. Identify them.

**Problem 15 Paint formulation** (medium)

A 5.0 kg tin of paint contains 40 % pigment and 35 % binder by mass; the rest is solvent.

1. Calculate the mass of pigment and of binder.
2. Calculate the mass and percentage of solvent.
3. Explain why a manufacturer controls these amounts.

**Problem 16 Identify a white solid** (hard)

A white solid X gives a lilac flame. Its solution gives no precipitate with sodium hydroxide, but a white precipitate with acidified barium chloride.

1. Name X and give its formula.
2. Write the ionic equation for the barium chloride test.
3. A 0.87 g sample of X is dissolved and excess barium chloride added. Calculate the mass of precipitate. ( $A_r$ : K = 39, S = 32, O = 16, Ba = 137)

**Problem 17 Matching dyes** (hard)

An unknown dye extract and four reference dyes are run in the same solvent. The solvent front is at 12.0 cm. The extract has spots at 5.4 cm, 7.2 cm and 8.4 cm. Reference  $R_f$  values: dye A 0.20, dye B 0.45, dye C 0.70, dye D 0.88.

1. Calculate the  $R_f$  of each spot.
2. Which reference dyes are present?
3. What can you say about the third spot?

**Problem 18 Identify a blue solution** (hard)

Solution Y is blue. With sodium hydroxide it gives a pale blue precipitate, and with nitric acid and silver nitrate a white precipitate. ( $A_r$ : Cu = 63.5, Cl = 35.5, Ag = 108)

1. Identify the compound Y.
2. Write ionic equations for both tests.
3. A sample containing 1.35 g of Y reacts with excess silver nitrate. Calculate the mass of the white precipitate.

**Problem 19 Faulty notes** (hard)

Notes: (a) "A flame test wire is cleaned in sulfuric acid." (b) "A white precipitate that dissolves in excess sodium hydroxide shows calcium." (c) "An  $R_f$  of 1.4 means the substance moved faster than the solvent." (d) "Barium chloride is added first, then acid, to test for sulfate."

1. Decide whether each is correct.
2. Correct every wrong one.

**Problem 20 Plan to separate four powders** (hard)

Four white powders are labelled NaCl,  $\text{Na}_2\text{SO}_4$ ,  $\text{CaCO}_3$  and  $\text{K}_2\text{CO}_3$ , but the labels are mixed up.

1. Describe a plan using flame tests, dilute acid and solutions of reagents.
2. State the expected result for each powder.