

Identifying substances with chemical tests

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

Each answer gives the rule, then the working, then the result in bold. Read the working for the method: exam markers reward correct chemistry and correct equations as well as final numbers.

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

Problem 1 Pure or impure

1. **A and C:** each melts at one sharp temperature.
2. B melts over a **range** (63 to 74 °C) and below the sharp melting points typical of pure solids, which is the sign of impurities.
3. A **formulation is a mixture designed with exact amounts of components** for a useful purpose, for example paint, fuel or fertiliser.

Problem 2 Simple R_f values

1. Spot 1: $3.0 \div 6.0 = \mathbf{0.50}$. Spot 2: $4.5 \div 9.0 = \mathbf{0.50}$. Spot 3: $1.2 \div 8.0 = \mathbf{0.15}$.
2. It is a ratio of two distances in the same unit, so the units cancel.
3. **Yes:** they have the same R_f in what is presumably the same solvent.

Problem 3 Flame test colours

1. Lithium **crimson**; sodium **yellow**; potassium **lilac**; calcium **orange-red**; copper(II) **blue-green**.
2. **Lithium, Li⁺**.

Problem 4 Gas tests

1. Hydrogen: lit splint gives a **squeaky pop**. Oxygen: glowing splint **relights**. Carbon dioxide: limewater turns **cloudy**. Chlorine: damp litmus paper is **bleached white**.
2. **Carbon dioxide**.

Problem 5 Reading a chromatogram

1. The **sweet** extract has two spots.
2. **Dye 1 and dye 2:** the spots match their distances.
3. $4.8 \div 8.0 = \mathbf{0.60}$.
4. **No:** no spot at 6.4 cm in the sweet lane.

Problem 6 Rf for two spots

1. $1.8 \div 7.5 = \mathbf{0.24}$; $4.5 \div 7.5 = \mathbf{0.60}$.
2. The spot with $R_f = \mathbf{0.24}$ is held more strongly by the paper (or dissolves less in the solvent), so it travels less far.

Problem 7 Using an Rf value

1. $0.35 \times 12.0 = \mathbf{4.2\text{ cm}}$.
2. Front = $5.1 \div 0.60 = \mathbf{8.5\text{ cm}}$.

Problem 8 Method questions

1. Otherwise the sample would **dissolve into the solvent** in the beaker and nothing would travel up the paper.
2. The lid keeps the air saturated with solvent vapour so the solvent does not evaporate from the paper.
3. The front position is needed for the R_f calculation and it must be marked before it evaporates.
4. R_f **changes**, because the substances dissolve differently.

Problem 9 Melting graph

1. The pure sample stays flat at **80 °C** while melting.
2. The impure curve **does not have a flat part**; it rises slowly through a range, about 70 to 77 °C, and begins melting lower.
3. Impurities disturb the regular arrangement of particles, so the solid melts at a **lower temperature and over a range**.

Problem 10 Sodium hydroxide results

1. A: **Cu²⁺**. B: **Al³⁺**. C: **Ca²⁺** (orange-red flame).
2. **Mg²⁺**, which gives a white precipitate that stays in excess and no flame colour.

Problem 11 Ionic equations

1. **Fe³⁺(aq) + 3OH⁻(aq) → Fe(OH)₃(s)**.
2. **Fe²⁺(aq) + 2OH⁻(aq) → Fe(OH)₂(s)**.
3. **Mg²⁺(aq) + 2OH⁻(aq) → Mg(OH)₂(s)**.
4. Fe(OH)₃ is **red-brown**; Fe(OH)₂ is **green**. Charges balance in each equation.

Problem 12 Identifying negative ions

1. X contains **carbonate**; the gas, carbon dioxide, turns limewater cloudy.
2. Y: **chloride** (white). Z: **iodide** (yellow).



Problem 13 Why acidify first

1. Barium carbonate is also a **white precipitate**, so carbonate would give a false positive.
2. The acid reacts with carbonate and removes it as carbon dioxide gas.
3. A **white precipitate of barium sulfate** remains.

Problem 14 Gas from a metal

1. $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$.
2. A lit splint held at the mouth of the tube makes a **squeaky pop**.
3. P is **oxygen**, Q is **carbon dioxide**, R is **chlorine**.

Problem 15 Paint formulation

1. Pigment $0.40 \times 5.0 = \mathbf{2.0 \text{ kg}}$; binder $0.35 \times 5.0 = \mathbf{1.75 \text{ kg}}$.
2. Solvent = $5.0 - 2.0 - 1.75 = \mathbf{1.25 \text{ kg}}$, which is **25 %**.
3. A formulation is designed, so exact amounts give the right colour, thickness and drying time every time.

Problem 16 Identify a white solid

1. Lilac flame: potassium; white precipitate with barium: sulfate. X is **potassium sulfate, K_2SO_4** .
2. $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$.
3. $M(\text{K}_2\text{SO}_4) = 2 \times 39 + 32 + 64 = 174$; $n = 0.87 \div 174 = 0.0050 \text{ mol}$. 1 : 1 ratio, so $\text{BaSO}_4 = 0.0050 \text{ mol}$; $M = 233$. Mass = $0.0050 \times 233 = \mathbf{1.17 \text{ g}}$.

Problem 17 Matching dyes

1. $5.4 \div 12.0 = \mathbf{0.45}$; $7.2 \div 12.0 = \mathbf{0.60}$; $8.4 \div 12.0 = \mathbf{0.70}$.
2. **Dye B (0.45) and dye C (0.70)**.
3. The spot at R_f 0.60 matches none of the reference dyes, so the extract contains a **different dye** (so at least three dyes).

Problem 18 Identify a blue solution

1. Cu^{2+} and Cl^- : **copper(II) chloride, CuCl_2** .
2. $\text{Cu}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Cu}(\text{OH})_2(\text{s})$ and $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$.
3. $M(\text{CuCl}_2) = 134.5$; $n = 1.35 \div 134.5 = 0.0100 \text{ mol}$. $\text{Cl}^- = 0.0201 \text{ mol}$, so $\text{AgCl} = 0.0201 \text{ mol}$; $M(\text{AgCl}) = 143.5$; mass = $0.0201 \times 143.5 = \mathbf{2.9 \text{ g}}$.

Problem 19 Faulty notes

1. All four are wrong.
2. (a) The wire is cleaned in **hydrochloric acid**, which gives volatile chlorides. (b) This shows **aluminium**; calcium gives a precipitate that stays. (c) R_f cannot exceed 1: the substance cannot outrun the solvent front, so the measurement is wrong. (d) The **acid is added first** to remove carbonate, then barium chloride.

Problem 20 Plan to separate four powders

1. Plan: (i) add dilute acid to a little of each: the **two carbonates fizz**. (ii) Flame test: lilac flame is **K_2CO_3** ; orange-red flame is **$CaCO_3$** . (iii) For the other two, dissolve and add acidified barium chloride to one portion and acidified silver nitrate to another.
2. **Na_2SO_4** : white precipitate with barium chloride, yellow flame. **$NaCl$** : white precipitate with silver nitrate, yellow flame. The yellow flame shows sodium in both.