BRAINIACS OLYMPIAD

GRADES 11-12

CHEMISTRY SAMPLE PAPER

(PRACTICAL PART)

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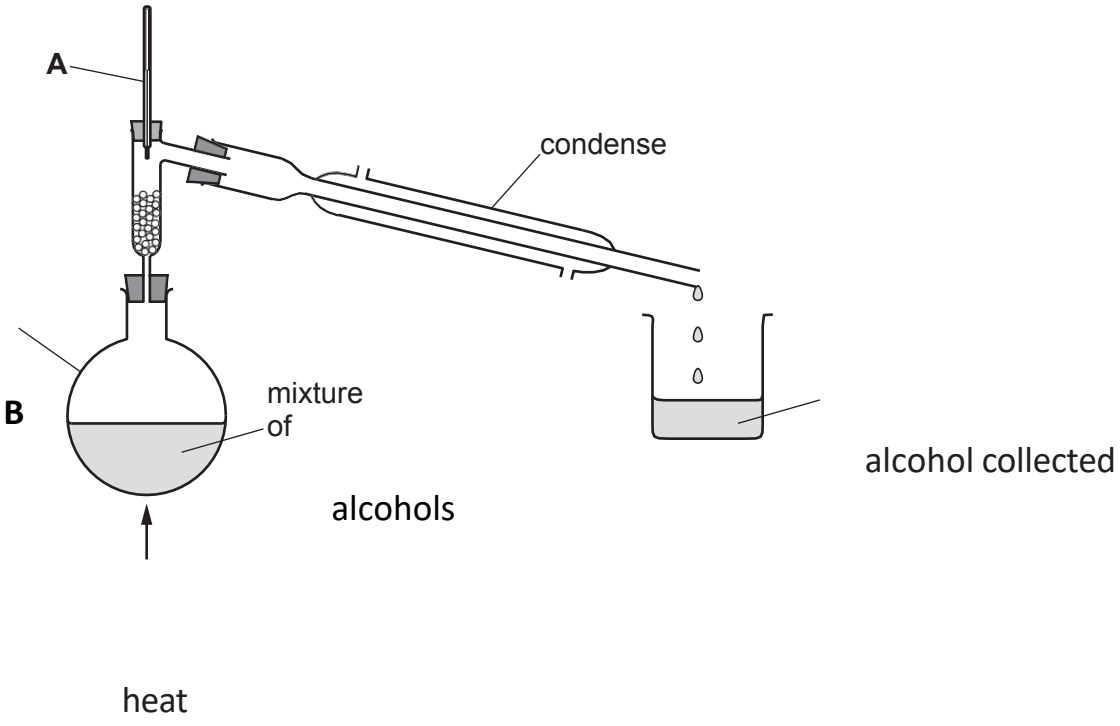
CHEMISTRY SAMPLE PAPER-PRACTICAL PART
Grade: 11-12
Time: 120 minutes
Total points: 100
Equipment: Not required

TASK 1 (50 points)
Fractional distillation of alcohols

Part A (25 points)
The table gives the boiling points of four alcohols.

alcohol	boiling point/ °C
methanol	65
ethanol	79
propan-1-ol	97
butan-1-ol	117

The apparatus shown can be used to separate a mixture of the four alcohols shown in the table.



(a) Name the apparatus labelled **A** and **B**. (4 points)

(b) Add to the diagram **one** arrow to show where water enters the condenser. (2 points)

(c) **(i)** Why is it **not** safe to heat the mixture of alcohols with a Bunsen burner? (2 points)

(ii) Suggest how the mixture of alcohols can be heated safely? (2 points)

(d) Describe how the condenser allows the alcohol to be collected as a liquid. (4 points)

(e) Which alcohol would be collected first? (2 points)

(f) The condenser has two tubes: an inner tube and an outer jacket. What flows in the outer jacket and why must it flow in the opposite direction to the vapor?
Explain your answer. (9 points)

Part B (25 points)
Solution A and solid B were analyzed.
tests on solution A

tests	observations
Solution A was colourless. Solution A was divided into three portions in three test-tubes. **test 1** Universal indicator paper was dipped into the first portion of solution **A**.	the universal indicator paper turned red
test 2 A spatula measure of sodium carbonate was added to the second portion of solution **A**. The gas given off was tested.	effervescence was seen, the gas produced turned limewater milky
test 3 1 cm^3 of dilute nitric acid and a few drops of aqueous silver nitrate were added to the third portion of solution **A**.	a white precipitate formed

(a) Use the observation from **test 1** to suggest the pH of solution **A**. (3 points)

(b) Name the gas given off in **test 2**. (3 points)

(c) Identify solution **A**. (5 points)

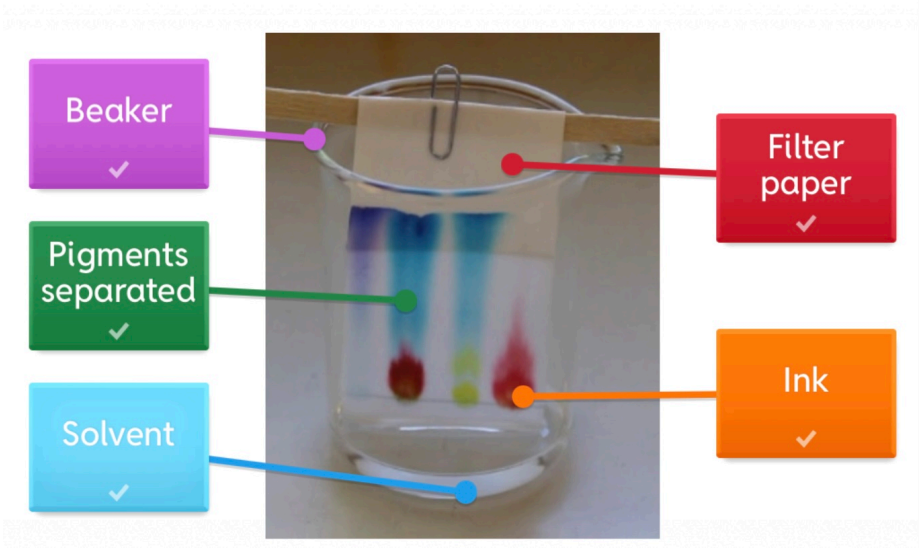
tests on solid B

Solid **B** was ammonium nitrate. Complete the expected observations.
Solid **B** was dissolved in water to produce solution **B**. Solution **B** was divided into two equal portions.

(d) About 1 cm^3 of dilute nitric acid and a few drops of aqueous barium nitrate were added to the first portion of solution **B**. (6 points)

(e) 2 cm^3 of aqueous sodium hydroxide was added to the second portion of solution **B**. The mixture was warmed and the gas given off was tested. (8 points)

TASK 2 (50 points)
Paper Chromatography — Mystery Ink Investigation



Chromatography (from the Greek chroma, meaning "color," and graphein, meaning "to write") is a general term for a group of laboratory techniques used to separate mixtures. In simple paper chromatography, the method is commonly used in analytical chemistry to separate and identify mixtures that are colored or can be made visible, such as pigments.Chromatography plays a major role in chemistry because it allows scientists to separate and identify the different substances inside a mixture.It helps chemists analyze chemical components, check the purity of substances, and detect even very small amounts of chemicals. Chromatography is widely used in laboratories, medicine, environmental testing, and forensic investigations.

OBJECTIVE

Use paper chromatography to identify which of three known markers was used to make an unknown ink sample (Pen X) and to compare how different solvents affect the separation of ink components.

MATERIALS

- 6 pieces of filter paper (or coffee filter / chromatography paper), about 15 × 4 cm
- Pencil and ruler
- Tape and scissors
- A small clear cup or jar (2)
- Solvents: water and isopropyl rubbing alcohol (70% or 90%) — one cup per solvent

- 3 different ink pens/markers (labelled A, B, C) — one of them is the match for Pen X
- The unknown Pen X (already used to mark one filter paper)
- A small dropper (optional)
- Protective gloves and safety goggles (recommended)
- Waterproof tray or paper to protect the bench
- Labels or sticky notes

SETUP & PREPARATION

1. Label each filter paper at the top edge with group name, solvent type, and sample number (e.g., “Water 1”, “Alcohol 1”). Use pencil for marks — not pen.
2. On each filter strip, draw a light pencil baseline about 2 cm from the bottom. Mark four equally spaced small dots on that line for the inks: Unknown (Pen X), Marker A, Marker B, Marker C. Keep marks small (dot ≈ 2–3 mm).

PROCEDURE

1. Place a small dot of each ink (Unknown, A, B, C) on the pencil baseline. Allow dots to dry.
2. Roll the paper into a loose cylinder so the baseline is near the bottom and the dots are not touching each other. Tape the paper so it keeps its cylindrical shape but do not let the lower edge overlap. Alternatively, keep the strip flat and stand it in the cup (either method works — just ensure solvent can travel up).
3. Pour about 1 cm of solvent (water in one cup, alcohol in the other) into separate cups. The solvent level must be below the pencil baseline so the ink dots are above the liquid.
4. Carefully place one filter paper into the cup (one paper per solvent), so only the bottom edge touches the solvent. Cover the cup with a loose lid or paper to slow evaporation (do not seal tightly).
5. Watch as the solvent rises. Stop the experiment when the solvent front reaches about 1–2 cm from the top of the paper. Mark the solvent front with pencil immediately and remove the paper.
6. Air-dry the paper. If you have several papers, repeat using the other solvent so you have one water result and one alcohol result for comparison.
7. Tape one finished strip from each solvent onto your answer sheet for submission.

OBSERVATIONS

- For each ink spot, observe how many different color bands appear and how far each band moved from the baseline.
- Measure (with a ruler) the distance from the baseline to the center of each separated color band and the total distance from baseline to solvent front to compute Rf values (see extension below).

QUESTIONS

1. Which known marker (A, B, or C) matches Pen X?
2. Describe the differences in separation between water and alcohol results. Which solvent separated the inks best?
3. Why does the pencil baseline not move with the solvent?
4. What would happen if the original ink dots were placed directly into the solvent (touching the liquid) at the start?
5. Why must the cup not be disturbed while the solvent is rising?
6. (Extension) Calculate the Rf value for one visible band: Rf = (distance from baseline to band center) ÷ (distance from baseline to solvent front). Which pen has the most similar Rf values to Pen X?