Worksheet: Formulations & Chromatography

ChemistrySheets

Specification: GCSE Chemistry (AQA 5.8.1 / Edexcel SC23 / OCR Gateway C3.1)

Core Concepts: Understand the definitions of pure substances, mixtures, and formulations. Explain the principles of chromatography, including stationary phase, mobile phase, and Rf values.

Section A: Key Terms & Concepts

1. Match the following scientific keywords to their correct definitions. Write the letter of the definition next to the keyword.

Pure substance	**b**
Mixture	**c**
Formulation	**d**
Chromatography	**a**

a) A separation technique used to separate components of a mixture based on their differential partitioning between a stationary phase and a mobile phase.
b) A single element or compound, not mixed with any other substance.
c) Two or more substances not chemically bonded together.
d) A mixture designed to have specific properties, often by mixing components in carefully measured quantities.

Model Answer:
Pure substance (b), Mixture (c), Formulation (d), Chromatography (a)

2. Complete the following sentences using the most appropriate scientific terms.

a) A pure substance melts or boils at a **specific/fixed** temperature, unlike a mixture which melts or boils over a range of temperatures.

b) In paper chromatography, the paper acts as the **stationary phase**, while the solvent is the **mobile phase**.

c) The **mobile phase** in chromatography is a solvent that moves through the stationary phase, carrying the components of the mixture with it.

d) Formulations are important in industries such as **pharmaceuticals**, **paints**, and **fuels**, where precise properties are required.

Section B: Core Concepts & Explanations

3. Explain what a pure substance is and provide one example.

Model Answer:
A pure substance consists of only one type of element or compound, not mixed with any other substance. It has a fixed melting and boiling point. For example, pure water or pure copper.

4. Describe what a formulation is, explaining why they are important.

Model Answer:
A formulation is a mixture that has been designed to have specific properties for a particular use. It is made by mixing components in carefully measured quantities to ensure the product has the required properties. They are important in industries like pharmaceuticals, paints, and fuels, where precise performance is critical.

5. Outline the basic principle of how chromatography separates substances.

Model Answer:
Chromatography separates substances based on their differential partitioning between a stationary phase and a mobile phase. Components that are more soluble in the mobile phase and less adsorbed to the stationary phase will travel further and faster up the stationary phase, leading to separation.

6. Explain how an Rf (retardation factor) value is calculated and what it indicates in chromatography.

Model Answer:
The Rf value is calculated by dividing the distance travelled by the spot (from the origin) by the distance travelled by the solvent front (from the origin). It is a ratio that helps identify substances, as a pure substance will have a specific Rf value under a given set of conditions (same stationary phase, mobile phase, and temperature). It indicates how far a component travels relative to the solvent front.

Section C: Exam Application & Extended Writing

7. A student performs paper chromatography on a mixture of food colourings (M) and two known pure food colourings (X and Y). The chromatogram is shown below.

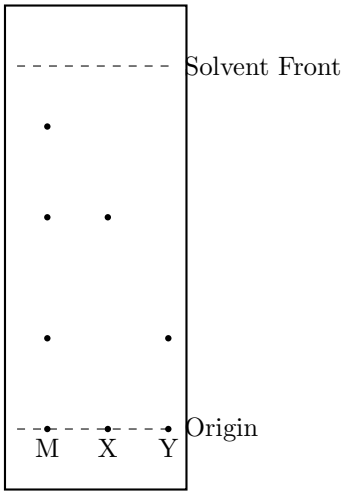

Figure 1: Chromatogram of food colourings

a) Based on the chromatogram, state whether M, X, and Y are pure substances or mixtures. Identify which components are present in mixture M.

Model Answer:
M is a mixture because it separates into three distinct spots. X and Y are pure substances because they each produce only one spot. Mixture M contains components that match pure substances X and Y, as well as one other unknown component.

8. Explain, in detail, how paper chromatography can be used to separate a mixture of coloured inks and how you would identify the different components present in the mixture. (6 marks)

Model Answer:
First, draw a pencil line (the origin) near the bottom of a piece of chromatography paper (the stationary phase). Place small spots of the ink mixture and any known pure inks you want to test on this origin line. Ensure the spots are small and dry. Next, place the paper vertically into a beaker containing a suitable solvent (the mobile phase), making sure the solvent level is below the origin line. The solvent will then move up the paper by capillary action, dissolving the ink spots. As the solvent moves, it carries the components of the ink mixture with it. Different components will travel at different speeds depending on their solubility in the mobile phase and their adsorption to the stationary phase. Components that are more soluble in the solvent and less adsorbed to the paper will travel further up. Once the solvent front is near the top, remove the paper and immediately mark the solvent front with a pencil. Allow the chromatogram to dry. To identify the components, compare the distances travelled by the spots from the mixture to those of the known pure inks. If a spot from the mixture travels the same distance and has the same colour as a spot from a known pure ink, then that component is present in the mixture. Rf values can also be calculated for more precise identification.