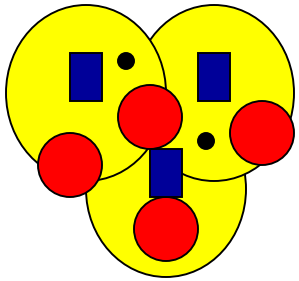
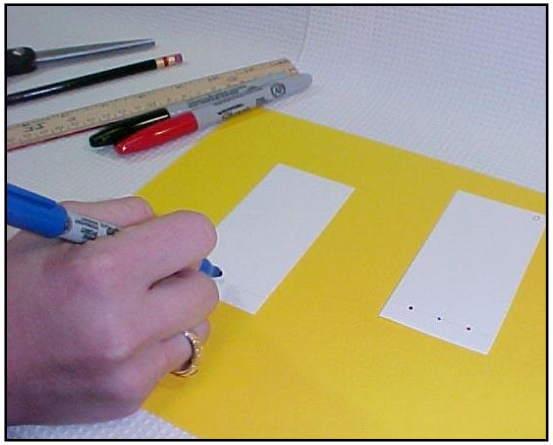
Paper Chromatography

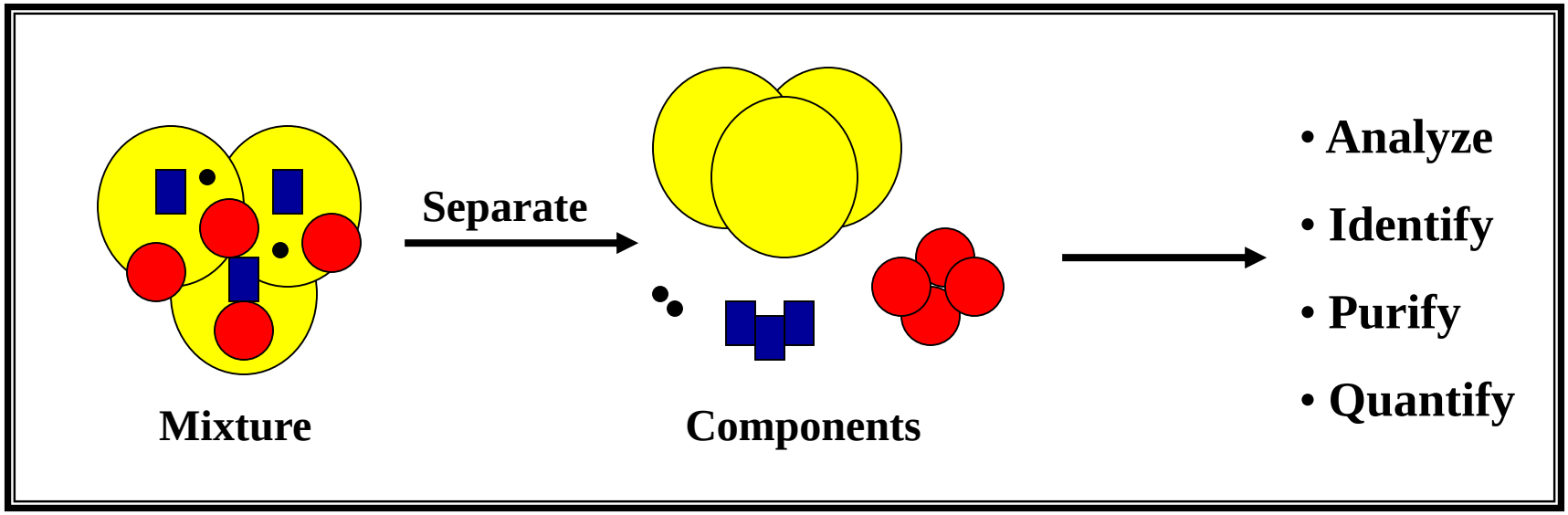




Dr. May Jaleel
First Stage

What is Chromatography?

Chromatography is a technique for separating mixtures into their components in order to analyze, identify, purify, and/or quantify the mixture or components.



Uses for Chromatography

Chromatography is used by scientists to:

- Analyze – examine a mixture, its components, and their relations to one another
- Identify – determine the identity of a mixture or components based on known components
- Purify – separate components in order to isolate one of interest for further study
- Quantify – determine the amount of the a mixture and/or the components present in the sample

Uses for Chromatography

Real-life examples of uses for chromatography:

- Pharmaceutical Company – determine amount of each chemical found in new product
- Hospital – detect blood or alcohol levels in a patient's blood stream
- Law Enforcement – to compare a sample found at a crime scene to samples from suspects
- Environmental Agency – determine the level of pollutants in the water supply
- Manufacturing Plant – to purify a chemical needed to make a product

Definition of Chromatography

Detailed Definition:

Chromatography is a laboratory technique that separates components within a mixture by using the differential affinities of the components for a mobile medium and for a stationary adsorbing medium through which they pass.

Terminology:

- Differential – showing a difference, distinctive
- Affinity – natural attraction or force between things
- Mobile Medium – gas or liquid that carries the components (mobile phase)
- Stationary Medium – the part of the apparatus that does not move with the sample (stationary phase)

Definition of Chromatography

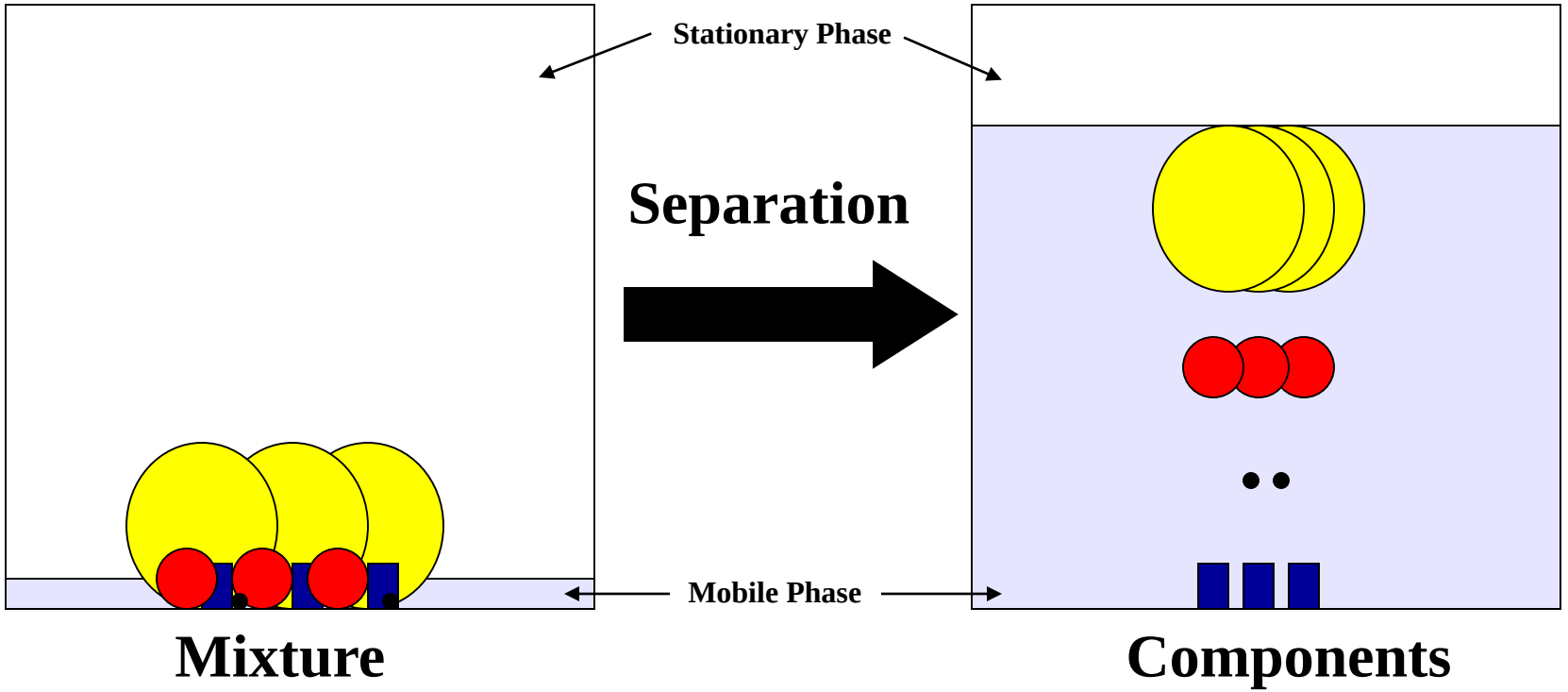
Simplified Definition:

Chromatography separates the components of a mixture by their distinctive attraction to the mobile phase and the stationary phase.

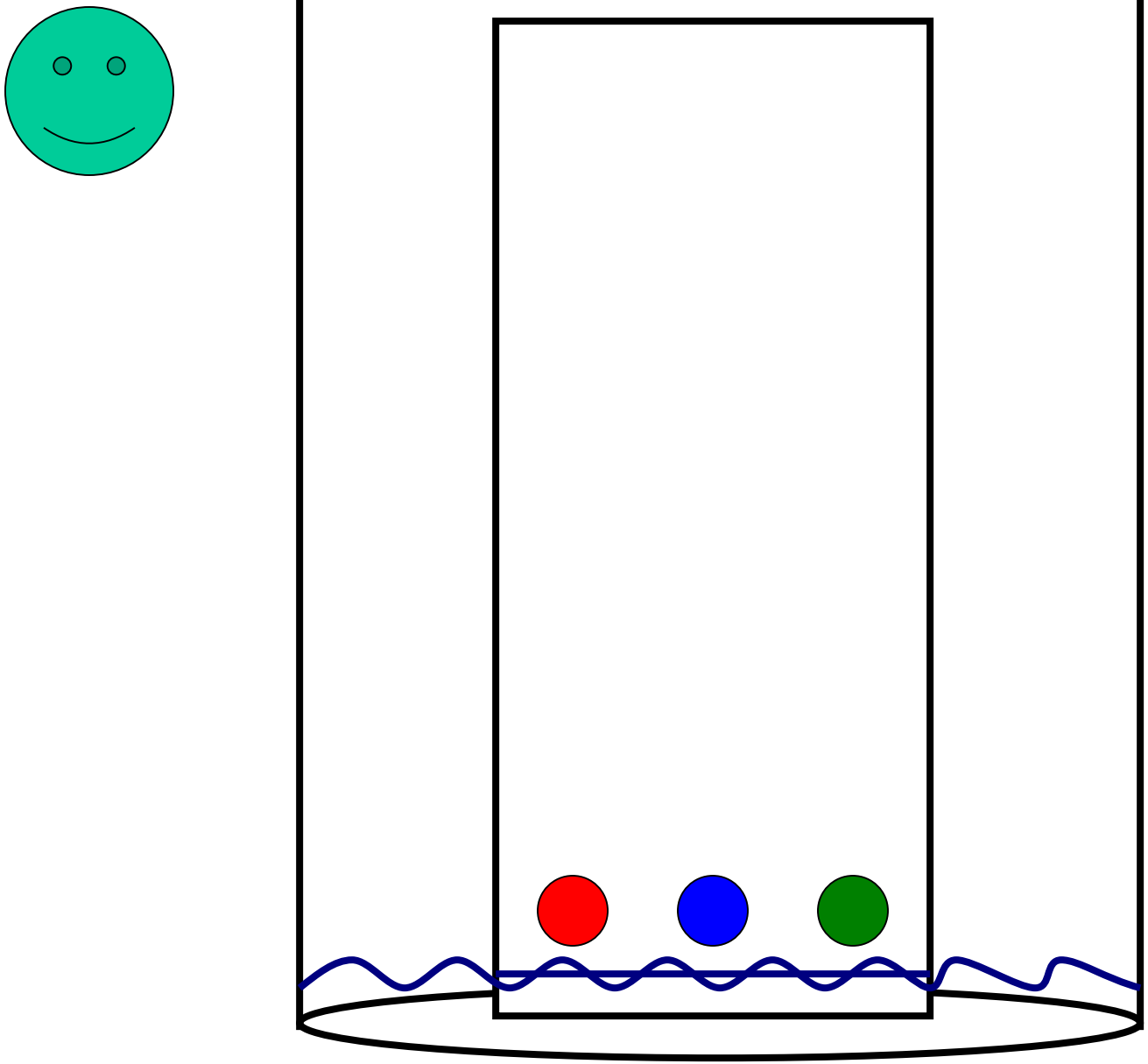
Explanation:

- Compound is placed on stationary phase
- Mobile phase passes through the stationary phase
- Mobile phase solubilizes the components
- Mobile phase carries the individual components a certain distance through the stationary phase, depending on their attraction to both of the phases

Illustration of Chromatography

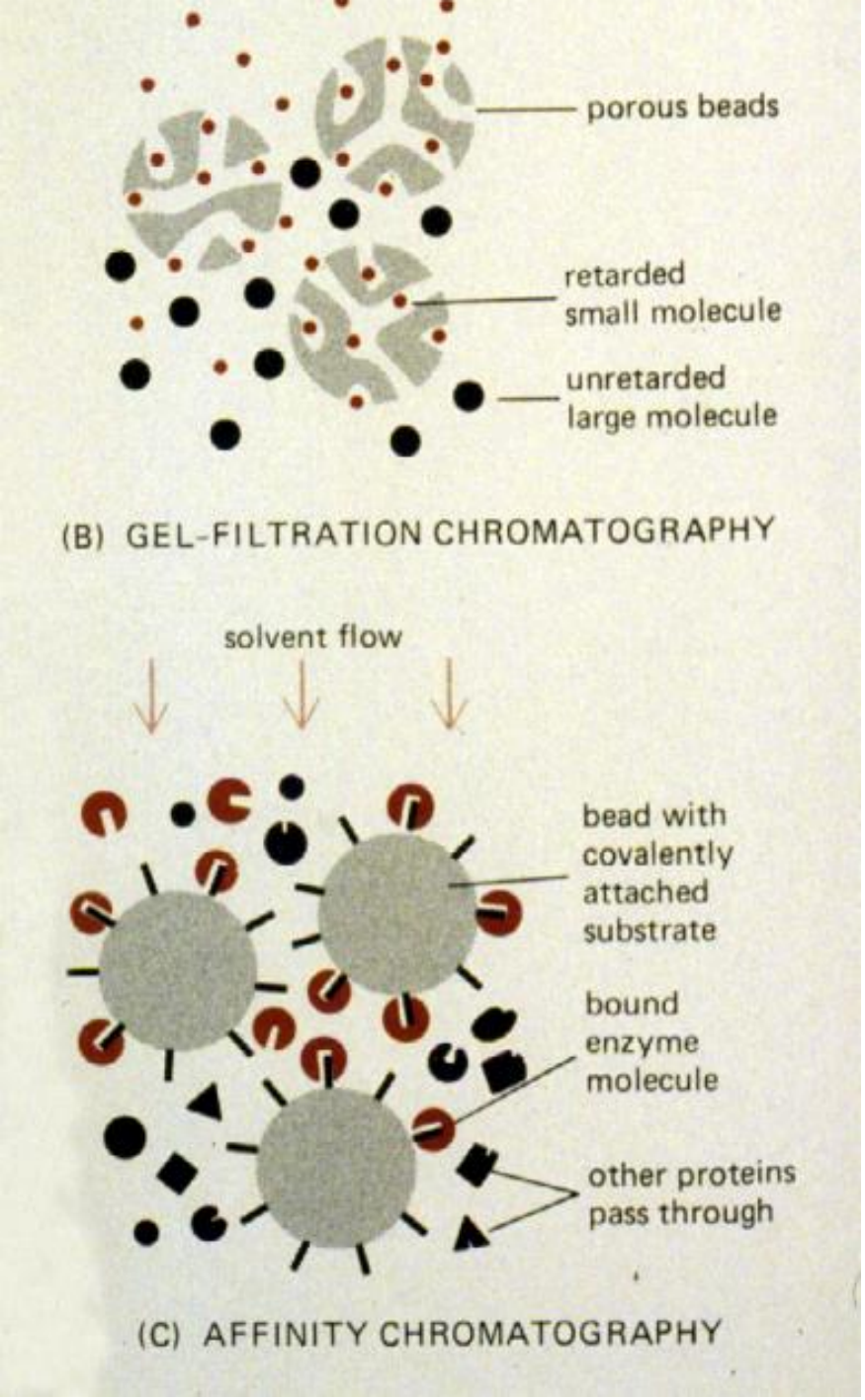


Components	Affinity to Stationary Phase	Affinity to Mobile Phase
Blue	----------	Insoluble in Mobile Phase
Black	✓ ✓ ✓ ✓ ✓ ✓	✓ ✓
Red	✓ ✓	✓ ✓ ✓ ✓ ✓
Yellow	✓	✓✓✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓



Types of Chromatography

- Liquid Chromatography – separates liquid samples with a liquid solvent (mobile phase) and a column composed of solid beads (stationary phase)
- Gas Chromatography – separates vaporized samples with a carrier gas (mobile phase) and a column composed of a liquid or of solid beads (stationary phase)
- Paper Chromatography – separates dried liquid samples with a liquid solvent (mobile phase) and a paper strip (stationary phase)
- Thin-Layer Chromatography – separates dried liquid samples with a liquid solvent (mobile phase) and a glass plate covered with a thin layer of alumina or silica gel (stationary phase)



(A) uses charge, (B) uses pores, and (C) uses covalent bonds to create the differential affinities among the mixture components for the stationary phase.

Principles of Paper Chromatography

- Capillary Action – the movement of liquid within the spaces of a porous material due to the forces of adhesion, cohesion, and surface tension. The liquid is able to move up the filter paper because its attraction to itself is stronger than the force of gravity.

- Solubility – the degree to which a material (solute) dissolves into a solvent. Solutes dissolve into solvents that have similar properties. (Like dissolves like) This allows different solutes to be separated by different combinations of solvents.

  Separation of components depends on both their solubility in the mobile phase and their differential affinity to the mobile phase and the stationary phase.

Paper Chromatography Experiment

What Color is that Sharpie?

Overview of the Experiment

Purpose:

To introduce students to the principles and terminology of chromatography and demonstrate separation of the dyes in Sharpie Pens with paper chromatography.

Time Required:

Prep. time: 10 minutes

Experiment time: 45 minutes

Costs:

Less than $10

Materials List

- 6 beakers or jars
- 6 covers or lids
- Distilled H2O
- Isopropanol
- Graduated cylinder
- 6 strips of filter paper
- Different colors of Sharpie pens
- Pencil
- Ruler
- Scissors
- Tape

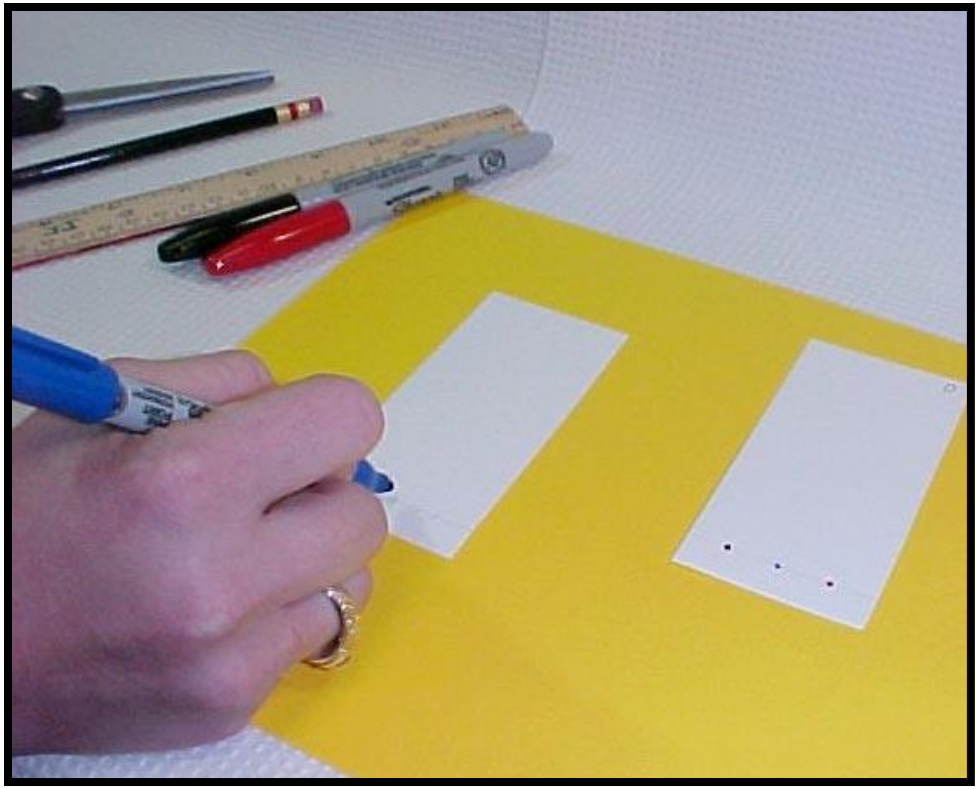
Preparing the Isopropanol Solutions

- Prepare 15 ml of the following isopropanol solutions in appropriately labeled beakers:

  - 0%, 5%, 10%, 20%, 50%, and 100%

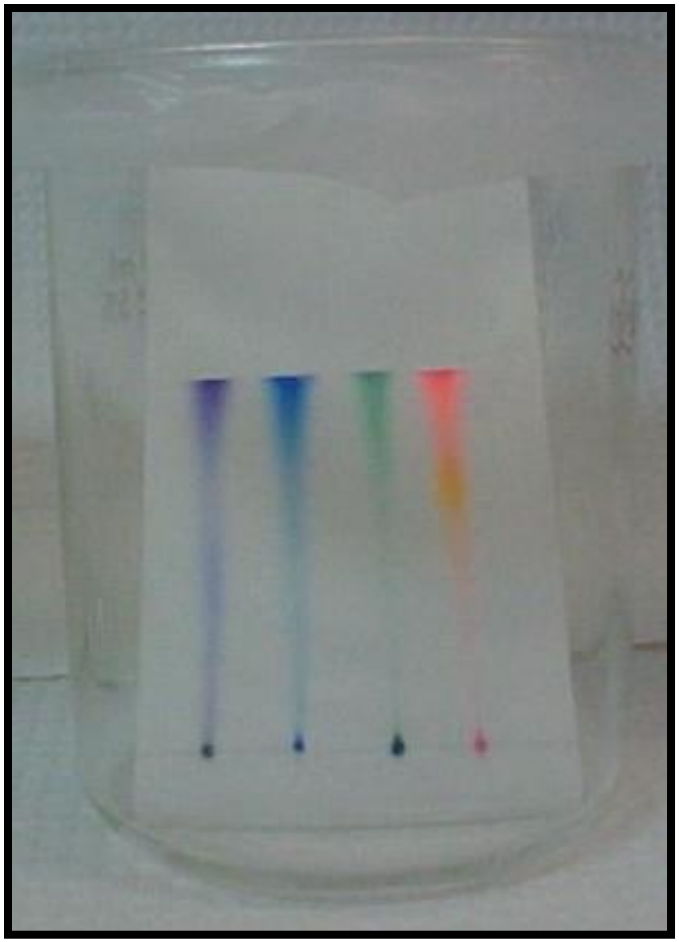
Preparing the Chromatography Strips

- Cut 6 strips of filter paper
- Draw a line 1 cm above the bottom edge of the strip with the pencil
- Label each strip with its corresponding solution
- Place a spot from each pen on your starting line



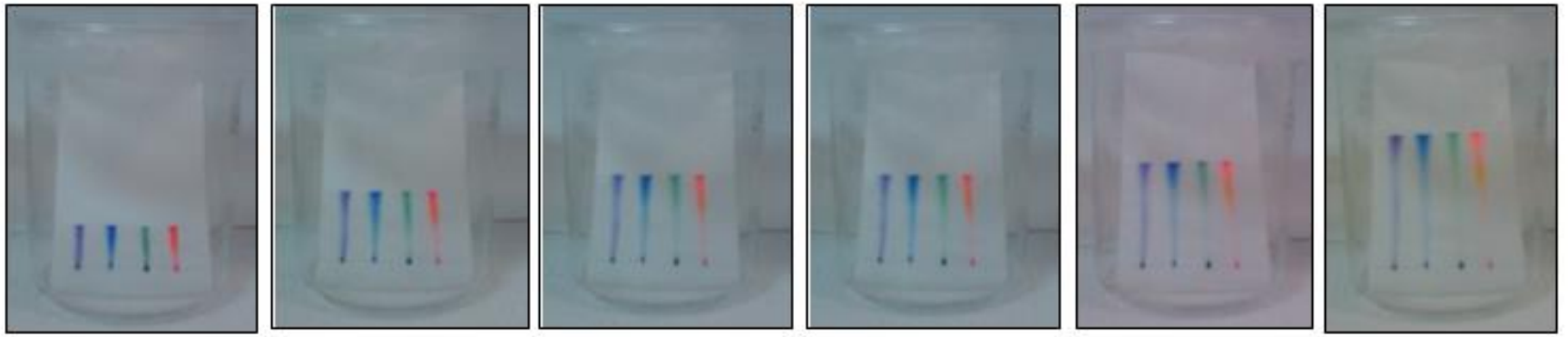
Developing the Chromatograms

- Place the strips in the beakers
- Make sure the solution does not come above your start line
- Keep the beakers covered
- Let strips develop until the ascending solution front is about 2 cm from the top of the strip
- Remove the strips and let them dry

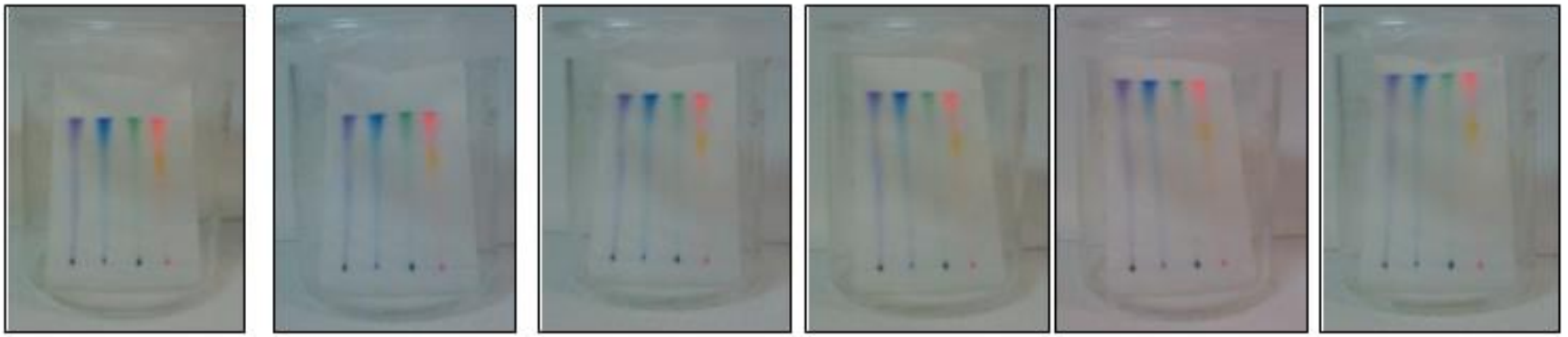


Developing the Chromatograms

50% Isopropanol



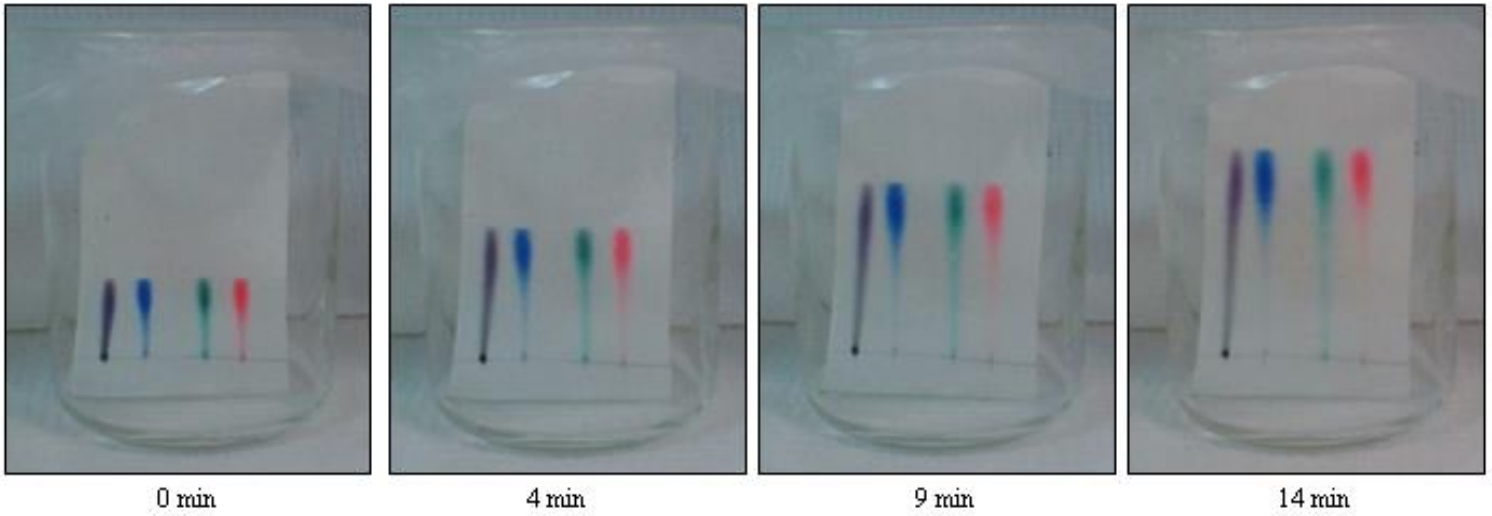
0 min | 4 min | 9 min | 14 min | 20 min | 25 min



30 min | 35 min | 40 min | 45 min | 50 min | 55 min

Developing the Chromatograms

100% Isopropanol



0 min 4 min 9 min 14 min

20 min 25 min 30 min

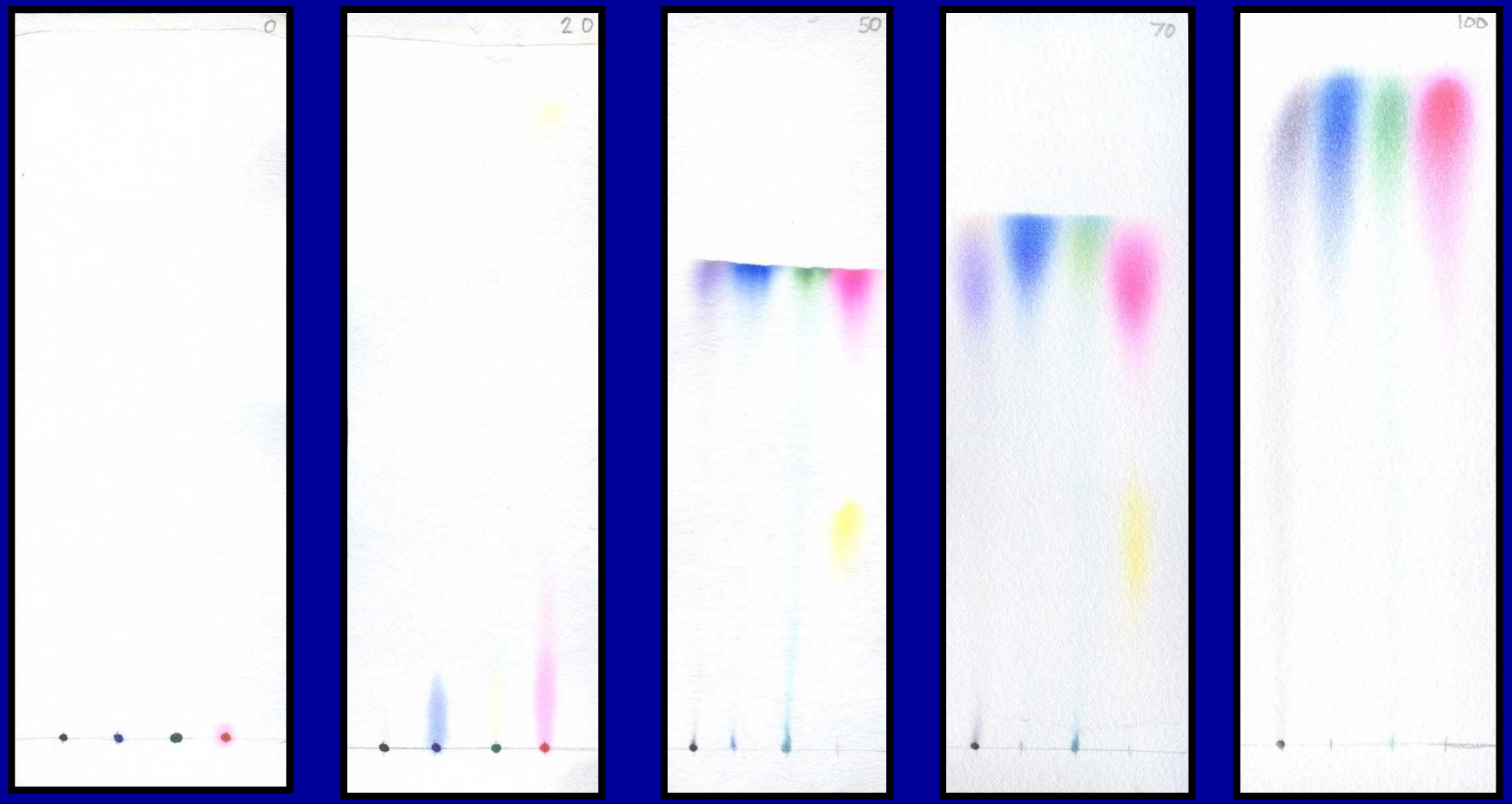
Observing the Chromatograms

1. Observe how some of the dyes are made up of more than one color

2. Observe how spots of the same color separated in low concentrations of isopropanol compared to higher concentrations

3. Observe when spots of different colors first started separating in the different concentrations

Observing the Chromatograms

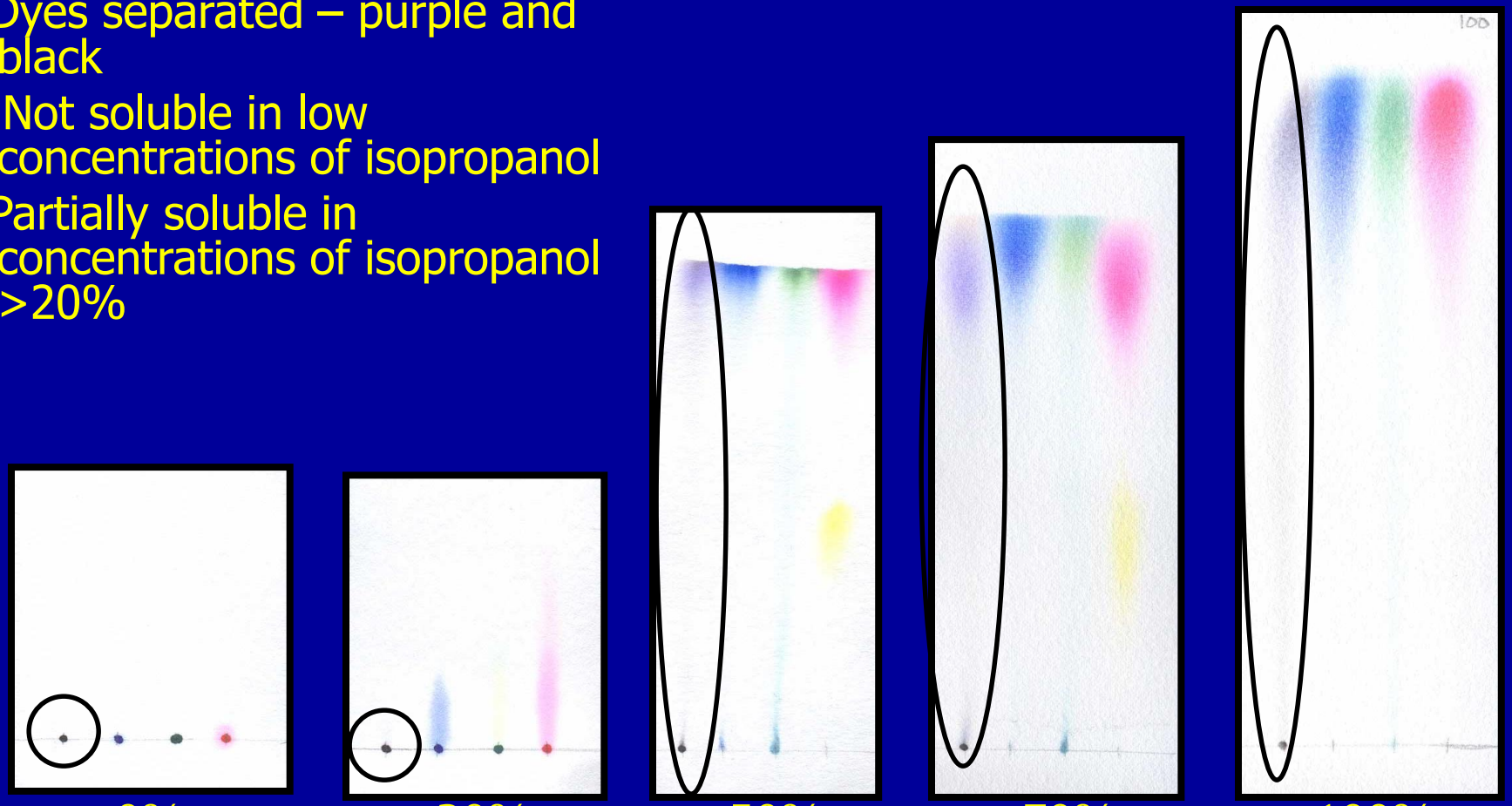


0% 20% 50% 70% 100%

Concentration of Isopropanol

Black Dye

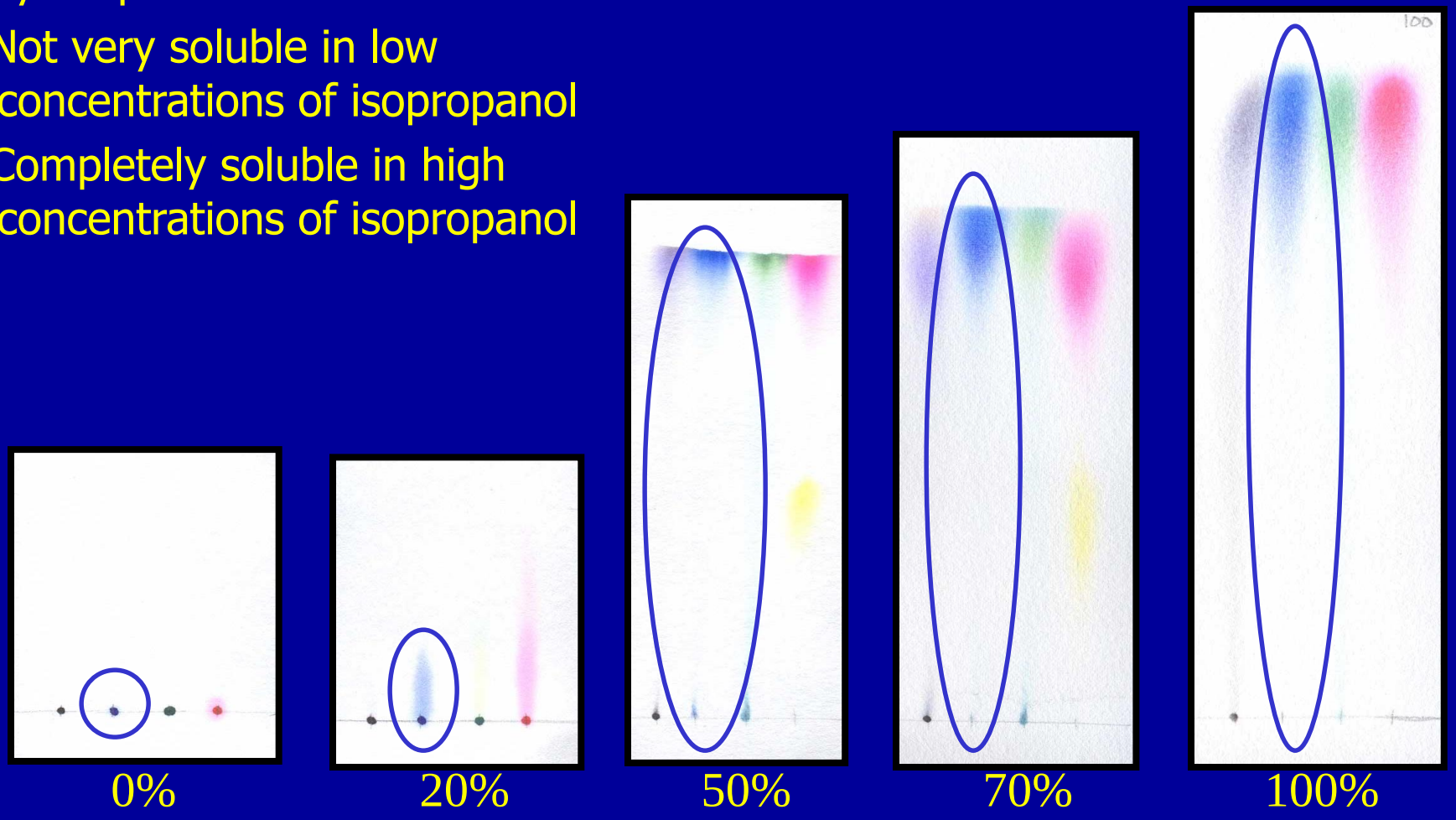
1. Dyes separated – purple and black
2. Not soluble in low concentrations of isopropanol
3. Partially soluble in concentrations of isopropanol >20%



Concentration of Isopropanol

Blue Dye

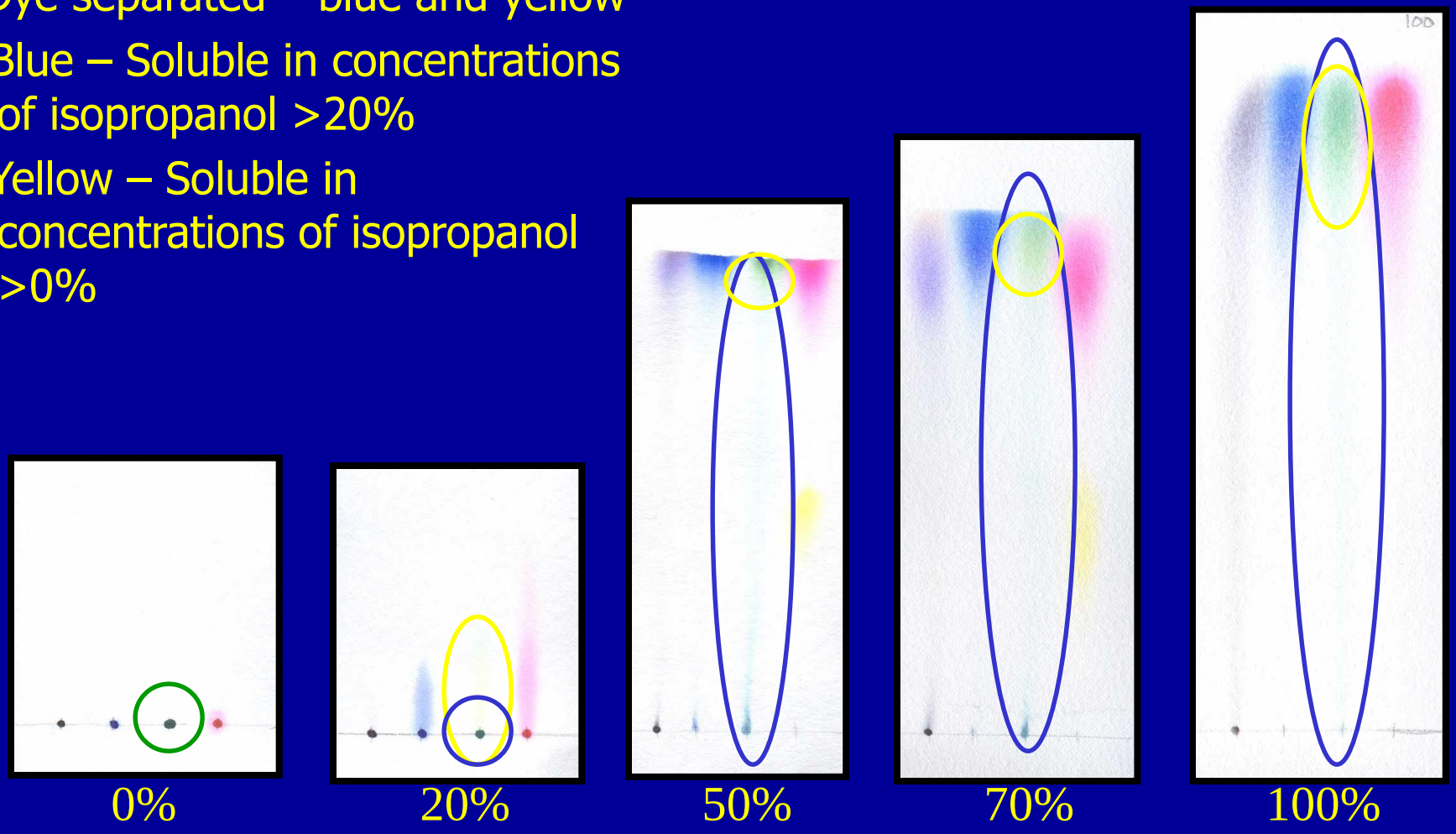
1. Dye separated – blue
2. Not very soluble in low concentrations of isopropanol
3. Completely soluble in high concentrations of isopropanol



Concentration of Isopropanol

Green Dye

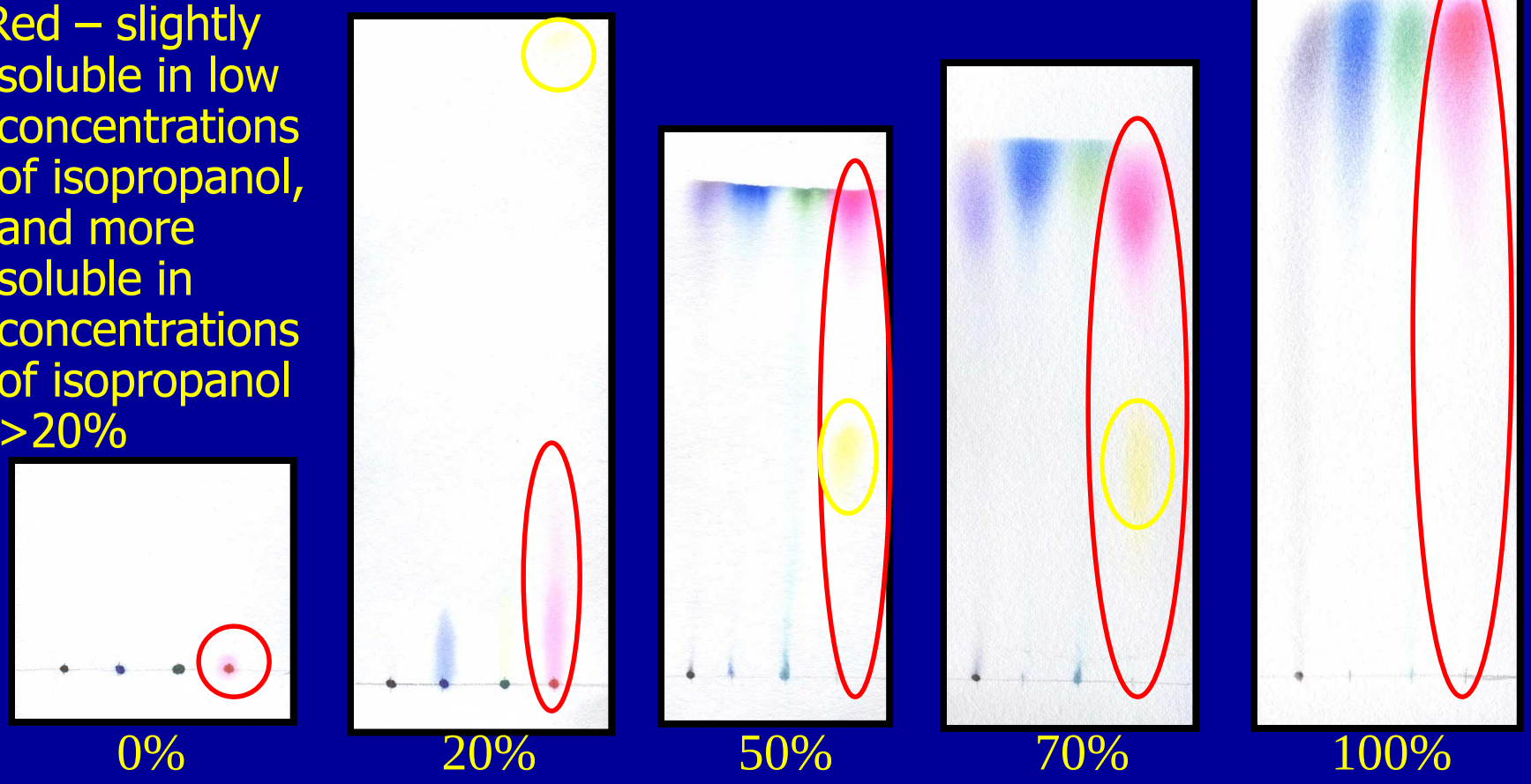
1. Dye separated – blue and yellow
2. Blue – Soluble in concentrations of isopropanol >20%
3. Yellow – Soluble in concentrations of isopropanol >0%



Concentration of Isopropanol

Red Dye

1. Dyes separated – red and yellow
2. Yellow –soluble in low concentrations of isopropanol and less soluble in high concentrations of isopropanol
3. Red – slightly soluble in low concentrations of isopropanol, and more soluble in concentrations of isopropanol >20%



Concentration of Isopropanol

Alternative Experiments

- Test different samples:
  - Other markers, pens, highlighters
  - Flower pigments
  - Food Colors
- Test different solvents:
  - Other alcohols: methanol, ethanol, propanol, butanol
- Test different papers:
  - Coffee filters
  - Paper towels
  - Cardstock
  - Typing paper

Thanks

- Thanks for your listening and attention