# Candy Cane Chromatography Lab

Grades 6–12



Name _____ Partner _____ Date _____

## Background

The red and green stripes on a candy cane are made with food dyes. Some colours come from a single dye; others are a **mixture** of two or more dyes. You cannot tell just by looking. In this lab you will use **paper chromatography** to find out.

Chromatography separates the substances in a mixture. A small dot of colour is placed on a strip of paper, and the bottom of the strip is dipped in a liquid called the **solvent** (the **mobile phase**). As the solvent soaks up the paper (the **stationary phase**), it carries the dyes with it. Each dye is attracted to the paper and to the solvent by different amounts, so each one travels a different distance. A mixture separates into several spots; a single dye stays as one spot.

To compare results, scientists calculate the **retention factor ($R_f$)** of each spot. Under the same conditions, the same dye always has the same $R_f$, which lets you identify unknown dyes by matching them with known ones.

$$R_f = \frac{\text{distance travelled by the spot}}{\text{distance travelled by the solvent}}$$

**Question:** Are the colours in a candy cane's stripes made from a single dye or a mixture of dyes?

**My prediction:** I think the red stripe is a _____ and the green (or other) stripe is a _____ because

_____

### Materials

- Candy canes with red stripes (and green, if you can find them)
- White coffee filters or chromatography paper
- Food colouring (red, yellow, blue) as known dyes
- Toothpicks, a small plate and a few drops of water
- Salt water: 1/8 teaspoon salt in 3 cups (about 700 mL) water
- Clear cups or jars, one per strip
- Pencils (not pens), ruler, scissors
- Paper clips or clothes pegs
- Paper towel, a timer
- *Optional:* a hair dryer on a cool setting to dry dots faster

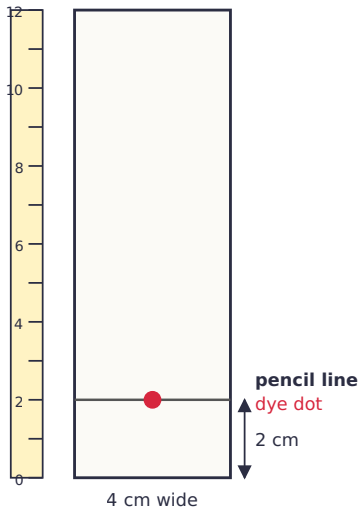
**Safety:** do not eat or drink anything used in the lab. Food colouring stains clothes and skin, so wear an apron or old shirt and wipe spills straight away. Handle scissors carefully.

# Candy Cane Chromatography: Procedure

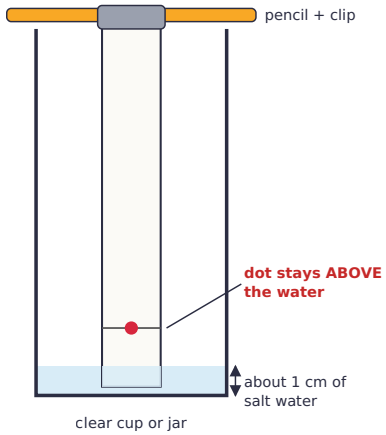
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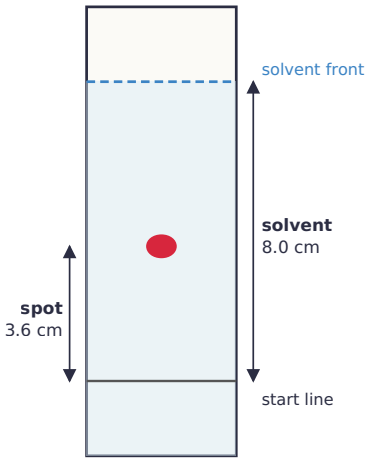
### 1 Prepare the strip




### 2 Run the strip




### 3 Measure




## Procedure

1. Cut coffee filter paper into strips about 4 cm wide and 12 cm long. Handle them by the edges.
2. With a **pencil**, draw a line across each strip 2 cm from the bottom. Write the sample name in pencil at the top.
3. Put 3 or 4 drops of water on a plate. Dip a toothpick in the water and rub it on the red stripe of a candy cane until the tip is coloured.
4. Touch the toothpick to the centre of the pencil line to make a small dot. Let it dry, then add more colour to the **same dot**. Repeat 5 to 6 times. A small, dark dot works best.
5. Make a second strip the same way for the green (or other) stripe, and one strip each for red, yellow and blue food colouring. Use a clean toothpick each time.
6. Pour about 1 cm of salt water into each cup. The water level must be **below** the pencil line.
7. Hang each strip from a pencil laid across the cup, held with a paper clip, so the bottom just touches the salt water.
8. Wait 10 to 20 minutes, until the solvent is about 2 cm from the top. Do not move the cups while they run.
9. Take out each strip and **immediately** mark the solvent front (the highest wet point) with a pencil line. Lay the strips on paper towel to dry.
10. Measure from the start line to the centre of each spot, and from the start line to the solvent front. Record your results on the next page.

# Candy Cane Chromatography: Results

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Name _____ Partner _____ Date _____

## Data table

Use one row for each spot. A sample that separates into two spots needs two rows.

| Sample | Colour of spot | Distance travelled by spot (cm) | Distance travelled by solvent (cm) | $R_f$ |
|---|---|---|---|---|
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## Your chromatograms

Tape your dry strips here,
or sketch them and colour the spots.

## Worked example

A red spot travelled **3.6 cm** from the start line. The solvent travelled **8.0 cm**.

$$R_f = \frac{3.6\ \text{cm}}{8.0\ \text{cm}} = 0.45$$

$R_f$ has no units, because the centimetres cancel. It is always between 0 and 1, because no spot can travel farther than the solvent.

### Observations

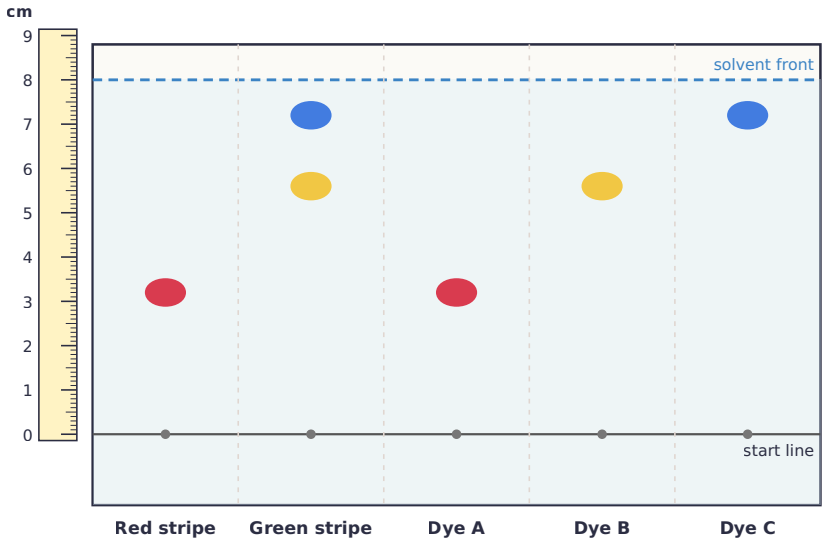
Describe what you saw. Did any sample split into more than one colour?

# Candy Cane Chromatography: Analysis

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A student ran the chromatogram below. It is drawn to scale. Use the ruler to answer the questions.




**1. Use the ruler to measure how far the solvent travelled from the start line.**

**2. Calculate the $R_f$ value of the red spot from the red stripe. Show your work.**

**3. How many dyes are in the green stripe? How do you know?**

**4. Calculate the $R_f$ of each spot in the green stripe.**

**5. Dyes A, B and C are known food dyes. Which known dyes are in each candy cane stripe? Use $R_f$ values as evidence.**

**6. Is the red stripe colour a pure substance or a mixture? Explain.**

**7. Why must the start line be drawn in pencil, not pen?**

**8. Why must the dye dot sit above the level of the salt water at the start?**

**9. Compare your own results with this sample. Did your candy canes use the same dyes? Suggest one reason results might be different.**

# Candy Cane Chromatography

Teacher Key

## Analysis answers

**1. Use the ruler to measure how far the solvent travelled from the start line.**

8.0 cm

**2. Calculate the $R_f$ value of the red spot from the red stripe. Show your work.**

3.2 ÷ 8.0 = **0.40**

**3. How many dyes are in the green stripe? How do you know?**

Two. The green sample split into two separate spots, a yellow one and a blue one.

**4. Calculate the $R_f$ of each spot in the green stripe.**

Yellow: 5.6 ÷ 8.0 = **0.70**; blue: 7.2 ÷ 8.0 = **0.90**

**5. Dyes A, B and C are known food dyes. Which known dyes are in each candy cane stripe? Use $R_f$ values as evidence.**

Red stripe: Dye A (same $R_f$, 0.40, and colour). Green stripe: Dye B and Dye C ($R_f$ 0.70 and 0.90 match).

**6. Is the red stripe colour a pure substance or a mixture? Explain.**

In this sample it behaves as a single dye: it gives one spot that matches Dye A. (Some brands use mixtures that split.)

**7. Why must the start line be drawn in pencil, not pen?**

Pencil (graphite) does not dissolve in water, so it stays put. Pen ink would dissolve and run up the paper, adding extra spots.

**8. Why must the dye dot sit above the level of the salt water at the start?**

If the dot is under the water, the dye dissolves into the solvent in the cup instead of travelling up the paper.

**9.**

Answers will vary. Different brands and colours use different dyes; results also change with dot size, how long the strip ran and the type of paper.

## Teacher notes

**Timing:** about 45 minutes, including 10 to 20 minutes of running time. Strips can dry overnight and be measured the next day if the solvent front was marked straight away.

**What to expect:** results depend on the brand. Many red stripes give a single red spot; green stripes are often a mixture and separate into blue and yellow. If a red stripe gives pink and red spots, it contains two dyes, which is a good discussion point.

**Tips:** small, concentrated dots give sharp spots, so build up colour slowly. If spots smear, the dot was too big or too wet. If nothing moves, check that the strip actually touches the salt water. Coffee filters vary; thicker chromatography paper gives cleaner separations.

**Why salt water?** A very dilute salt solution helps the dyes separate more clearly than plain water. Keep the same solvent for every strip so $R_f$ values can be compared.

**Extension:** repeat with a different solvent (plain water or a 1:1 mix of water and rubbing alcohol, with adult supervision) and compare $R_f$ values. Ask students why $R_f$ values are only comparable when conditions stay the same.