Chromatography and Rf values

Worked solutions

GCSE science calculations

This topic online

1 Lily runs a paper chromatogram of a green food colouring. A yellow spot moves 3.6 cm from the start line. The solvent moves 8.0 cm from the start line.

Calculate the R_f value of the yellow spot.

(2 marks)

R_f = distance moved by substance ÷ distance moved by solvent

$$R_f = \frac{3.6}{8.0}$$

0.45

2 A spot of black ink moves 2.1 cm up a strip of chromatography paper. In the same time, the solvent front moves 7.0 cm. Both distances are measured from the start line.

Calculate the R_f value of the ink spot.

(2 marks)

R_f = distance moved by substance ÷ distance moved by solvent

$$R_f = \frac{2.1}{7.0}$$

0.3

3 Ibrahim uses a piece of chromatography paper 12.0 cm tall. He stops the experiment when the solvent front has moved 6.0 cm from the start line. A red spot has moved 5.1 cm from the start line.

Calculate the R_f value of the red spot.

(2 marks)

Use the solvent distance (6.0 cm), not the paper height

R_f = distance moved by substance ÷ distance moved by solvent

$$R_f = \frac{5.1}{6.0}$$

0.85

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4 Mia measures a chromatogram of a felt-tip pen.

- Distance moved by a blue spot = 34 mm
- Distance moved by the solvent = 8.5 cm

Both distances are measured from the start line.

Calculate the R_f value of the blue spot.

(3 marks)

Same units: 10 mm = 1 cm

34 mm = 34 ÷ 10 = 3.4 cm

R_f = distance moved by substance ÷ distance moved by solvent

$$R_f = \frac{3.4}{8.5}$$

0.4

5 A food scientist tests the colouring in a sweet. An orange spot moves 5.2 cm from the start line. The solvent front moves 80 mm from the start line.

Calculate the R_f value of the orange spot.

(3 marks)

Same units: 10 mm = 1 cm

80 mm = 80 ÷ 10 = 8.0 cm

R_f = distance moved by substance ÷ distance moved by solvent

$$R_f = \frac{5.2}{8.0}$$

0.65

6 Sam measures all his distances from the bottom edge of the chromatography paper.

- The pencil start line is 1.5 cm above the bottom edge.
- The centre of a purple spot is 6.3 cm above the bottom edge.
- The solvent front is 9.5 cm above the bottom edge.

Calculate the R_f value of the purple spot.

(3 marks)

Measure from the start line, not the edge: subtract 1.5 cm

spot = 6.3 − 1.5 = 4.8 cm

solvent = 9.5 − 1.5 = 8.0 cm

R_f = distance moved by substance ÷ distance moved by solvent

$$R_f = \frac{4.8}{8.0}$$

0.6

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7 A dye has an R_f value of 0.35 in water. On a chromatogram, the solvent moves 9.0 cm from the start line.

Calculate how far the dye moves from the start line. (2 marks)

R_f = distance moved by substance ÷ distance moved by solvent

$$0.35 = \frac{d}{9.0}$$

$\times 9.0$ $\quad d = 0.35 \times 9.0$ $\quad \times 9.0$

3.15 cm

8 A chemical in a plant extract has an R_f value of 0.72. Its spot is 54 mm from the start line.

Calculate the distance the solvent front moved from the start line, in mm. (2 marks)

R_f = distance moved by substance ÷ distance moved by solvent

$$0.72 = \frac{54}{s}$$

Rearrange: s = distance moved by substance ÷ R_f

$$s = 54 \div 0.72$$

75 mm

9 An amino acid has an R_f value of 0.82 in a solvent. The solvent front moves 6.5 cm from the start line.

Calculate how far the amino acid moves from the start line, in mm.

Give your answer to 2 significant figures. (3 marks)

Answer is in mm: 1 cm = 10 mm

$$6.5 \text{ cm} = 6.5 \times 10 = 65 \text{ mm}$$

R_f = distance moved by substance ÷ distance moved by solvent

$$0.82 = \frac{d}{65}$$

$\times 65$ $\quad d = 0.82 \times 65$ $\quad \times 65$

$$d = 53.3 \text{ mm}$$

53 mm

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10 A brown food colouring separates into two spots. Measured from the start line:

- spot 1 moved 27 mm
- spot 2 moved 54 mm
- the solvent front moved 7.5 cm.

Dye	P	Q	R	S
R_f value	0.24	0.36	0.55	0.72

a. Calculate the R_f value of spot 1.

b. Calculate the R_f value of spot 2.

c. Which two dyes are in the brown food colouring?

Show your working. (4 marks)

Same units: 7.5 cm = 75 mm

solvent = 7.5 × 10 = 75 mm

a)

$$R_f = \frac{27}{75}$$

0.36

b)

$$R_f = \frac{54}{75}$$

0.72

c)

0.36 is dye Q, 0.72 is dye S

Q and S

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11 Chen runs three chromatograms of the same ink. Each time he stops when the solvent front has moved 8.2 cm from the start line. The distance moved by the pink spot each time is shown.

Chromatogram	1	2	3
Distance moved by pink spot in cm	3.9	4.1	4.3

Calculate the R_f value of the pink spot using the mean distance. Show your working.

(3 marks)

Find the mean distance (not the total)

$$\text{mean} = \frac{3.9 + 4.1 + 4.3}{3}$$

$$\text{mean} = \frac{12.3}{3} = 4.1 \text{ cm}$$

R_f = distance moved by substance ÷ distance moved by solvent

$$R_f = \frac{4.1}{8.2}$$

0.5

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12 A forensic lab tests the ink on a forged letter. The ink separates into two spots. All distances are measured from the bottom edge of the paper.

- Start line: 1.5 cm
- Spot 1: 3.3 cm
- Spot 2: 7.2 cm
- Solvent front: 9.0 cm

The lab has three suspect pens. Each pen ink has two spots with these R_f values:

Pen	R_f values
A	0.24 and 0.60
B	0.24 and 0.76
C	0.32 and 0.76

a. Calculate the R_f value of spot 1.

b. Calculate the R_f value of spot 2.

c. Which pen was used to write the letter?

Show your working. (5 marks)

Measure from the start line: subtract 1.5 cm from each

solvent = 9.0 − 1.5 = 7.5 cm

spot 1 = 3.3 − 1.5 = 1.8 cm

spot 2 = 7.2 − 1.5 = 5.7 cm

a)

$$R_f = \frac{1.8}{7.5}$$

0.24

b)

$$R_f = \frac{5.7}{7.5}$$

0.76

c)

Pen B has both 0.24 and 0.76 (A and C match only one)

B

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