Chromatography

OCR A H432 · A level

Show your working where needed. Check the worked answers when you finish.

Name _____ Date _____

1. Calculate a retention factor

From the pencil baseline, a spot moves 3.2 cm and the solvent front moves 8.0 cm. Calculate the Rf value and state whether it has units.

2. Check a TLC setup

A student draws the starting line on a TLC plate with a pen, adds the samples and stands the plate in solvent. The solvent initially covers the spots. Explain two changes to the setup that would improve the chromatogram.

3. Explain different retention factors

Substances A and B have Rf values 0.33 and 0.75 on the same TLC plate. A student claims B interacts more strongly with the stationary phase relative to the solvent. Use the results to assess the claim.

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4. Compare with a standard

An unknown mixture gives spots at Rf 0.28 and 0.59. A pure standard run on the same plate under the same conditions gives Rf 0.59. State the strongest conclusion supported by this evidence.

5. Read a gas chromatogram

An unknown gives peaks at 2.3, 4.7 and 6.2 min. In the same conditions standards X and Y give retention times of 2.3 and 6.2 min respectively. Identify any possible matches and explain why the two matching peaks have different retention times.

6. Read peak areas in the right way

A gas chromatogram has peaks A and B with integrated areas 140 and 70 units. A and B give the same detector response per mole under these conditions. Find the amount ratio and the mole percentage of A.

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7. Choose a suitable calibration range

The highest calibration standard gives a peak area of 410. Measured under the same conditions, the unknown gives an area of 690. Explain how to obtain a more reliable concentration and how to calculate the original value.

8. Apply a GC calibration

A calibration gives peak area = 96 × c + 12, with c in mg dm^{-3}. A sample diluted fivefold gives an area of 252. Calculate the concentration before dilution.

9. Extra challenge · Compare two calibrated concentrations

A sample is diluted fourfold before GC. For a standard in mg dm^{-3}, peak area P = 50c + 20 and area Q = 90c + 10. The diluted sample gives P area 220 and Q area 280.

Calculate the concentrations before dilution and the mass proportion of P among these two components. Explain why comparing the raw areas directly gives the wrong order.

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Worked answers

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1. Calculate a retention factor

Rf = distance moved by the spot ÷ distance moved by the solvent front = 3.2 ÷ 8.0 = 0.40. The ratio has no units.

2. Check a TLC setup

Lower the solvent level below the sample spots. If covered, the samples can wash into the solvent reservoir.

Draw the baseline in pencil because graphite stays in place. Some components of pen ink may travel with the solvent and give extra spots.

3. Explain different retention factors

A is retained more strongly relative to its attraction to the solvent. It has the lower Rf and spends a greater proportion of its time retained by the stationary phase.

4. Compare with a standard

One component could be the standard. Matching Rf values under the same conditions support that identification. Different compounds can give the same Rf, so a further separating system or technique can strengthen the identification.

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Worked answers

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5. Read a gas chromatogram

The first peak is consistent with X and the last is consistent with Y. The 4.7 min peak has no supplied match. The later-eluting component spends a greater fraction of its journey retained by the stationary phase.

6. Read peak areas in the right way

A:B = 140:70 = 2:1. A contributes 140 ÷ (140 + 70) = 0.667 of the total, so it is 66.7% by amount.

7. Choose a suitable calibration range

Dilute the unknown by a known factor so its peak area lies inside the calibrated range. Use the curve to find the diluted concentration and multiply by the dilution factor. Extrapolating past the highest standard assumes the measured trend continues.

8. Apply a GC calibration

Diluted concentration = (252 − 12) ÷ 96 = 2.50 mg dm^{-3}. Original concentration = 5 × 2.50 = 12.5 mg dm^{-3}.

9. Extra challenge · Compare two calibrated concentrations

In the diluted sample P = (220 − 20)/50 = 4.00 mg dm^{-3} and Q = (280 − 10)/90 = 3.00 mg dm^{-3}. Before dilution these are 16.0 and 12.0 mg dm^{-3}.

P contributes 16.0/(16.0 + 12.0) = 57.1% by mass among P and Q. Q has the steeper calibration slope, so its larger raw area does not mean a higher mass concentration.

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