# 37.1 THIN LAYER CHROMATOGRAPHY

**Learning outcomes**

Candidates should be able to:

1. describe and understand the terms
   (a) stationary phase, for example aluminium oxide (on a solid support)
   (b) mobile phase; a polar or non-polar solvent
   (c) $R_f$ value
   (d) solvent front and baseline
2. interpret $R_f$ values
3. explain the differences in $R_f$ values in terms of interaction with the stationary phase and of relative solubility in the mobile phase

## Introduction

Thin Layer Chromatography (TLC) is a technique used to analyse small samples via separation

There are 2 phases involved in TLC:

1. Stationary phase

This phase is commonly a thin metal sheet/glass slide coated in alumina ($Al_2O_3$) or silica ($SiO_2$).

The solute molecules **adsorb** onto the surface.

Depending on the strength of interactions with the stationary phase, the separated components will travel particular distances through the plate.

The more they interact with the stationary phase, the more they will 'stick' to it.

2. Mobile phase

Flows over the stationary phase.

It is a polar or nonpolar liquid (solvent) or gas that carries components of the compound being investigated

- Polar solvents - water or alcohol
- Non-polar solvents - alkanes

If the sample components are coloured, they are easily identifiable

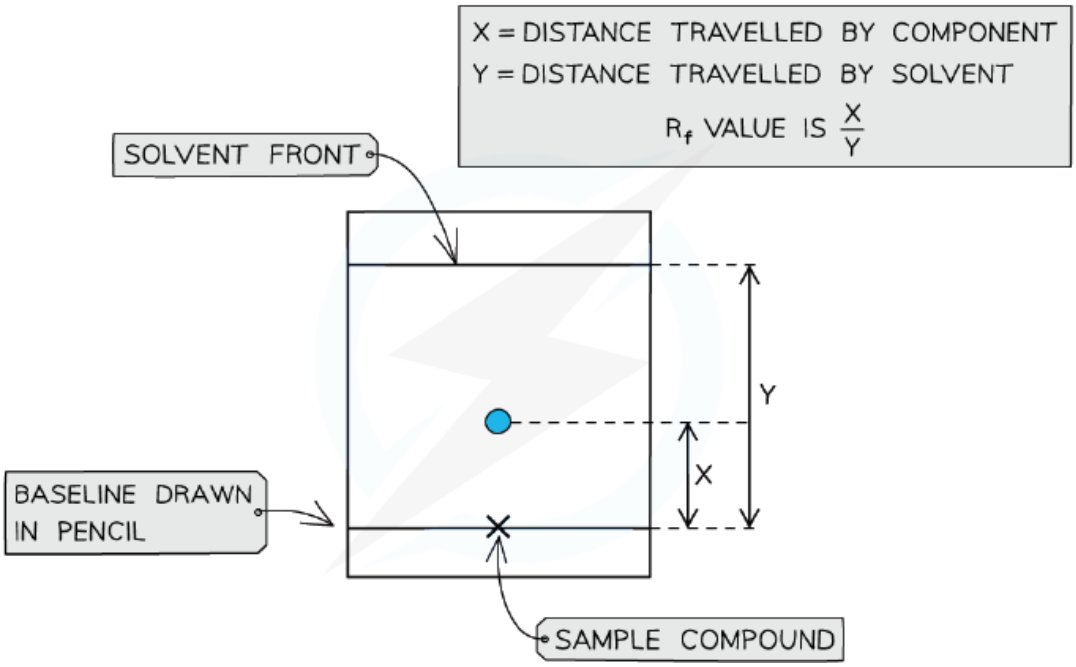
We can examine the plate under UV light using ninhydrin to identify uncoloured components

**Rf values**

A TLC plate can be used to calculate $R_f$ values for compounds:

$R_f$ = distance travelled by component / distance travelled by solvent

These values can be used alongside other analytical data to deduce the composition of mixtures




The less polar components travel further up the TLC plate

- Their Rf values are higher than those closer to the baseline
- They are more soluble in the mobile phase and get carried forward with the solvent

More polar components do not travel far up the plate, they are more attracted to the polar stationary phase

The extent to which the components within the investigated sample are separated depends on:

- The solubility of each component in the mobile phase
- The interaction between each component and the stationary phase

Knowing the Rf values of compounds being analysed, helps to compare the polarity of various molecules.

Thin Layer Chromatography (TLC)

1. Thin-layer and gas / liquid chromatography can be used to separate mixtures into their individual components.
   Define the following terms used in chromatography.

   Rf value .....

   .....

   retention time .....

   .....[2]

2. A mixture of two substances A and B is analysed by thin-layer chromatography.
   The $R_f$ value of substance A is larger than that of substance B.
   Suggest why substance A has a larger $R_f$ value.

   .....

   ..... [1]

3. A student uses thin-layer chromatography (TLC) to analyse a mixture containing different metal cations. The student repeats the experiment using different solvents.
   Fig. 6.1 shows the chromatogram obtained by the student using water as a solvent.

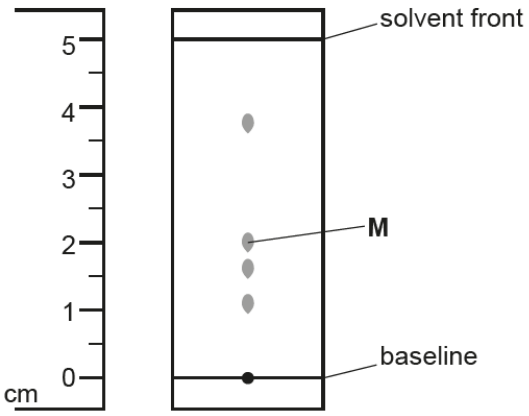



**Fig. 6.1**

**(a) (i)** Suggest a compound that could be used as the stationary phase in this experiment.

..... [1]

**(ii)** Table 6.1 shows the $R_f$ values for different metal cations when separated by TLC using water as a solvent.
Table 6.1

| Cation | $R_f$ value (water) |
|---|---|
| $Cd^{2+}$ | (aq) 0.40 |
| $Co^{2+}$ | (aq) 0.77 |
| $Cu^{2+}$ | (aq) 0.32 |
| $Fe^{3+}$ | (aq) 0.12 |
| $Hg^{2+}$ | (aq) 0.23 |
| $Ni^{2+}$ | (aq) 0.75 |

Suggest the identity of the cation that causes the spot at **M** in Fig. 6.1.
Explain your answer.

.....

..... [1]

(b) The student repeats the experiment using butan-1-ol as a solvent.
The metal cations do **not** travel as far up the TLC plate in this experiment.
Suggest why the metal cations do not move as far up the TLC plate with butan-1-ol as a solvent.

.....

..... [1]

**(c)** The student sprays the TLC plate in Fig. 6.1 with KSCN(aq).
The colour of some of the spots changes, as some of the metal cations undergo a ligand exchange reaction.
Identify the ligands involved in the ligand exchange reaction.

..... exchanges with ..... [1]

4. Tyrosine and lysine, shown in Fig. 9.1, are naturally occurring amino acids found in proteins.

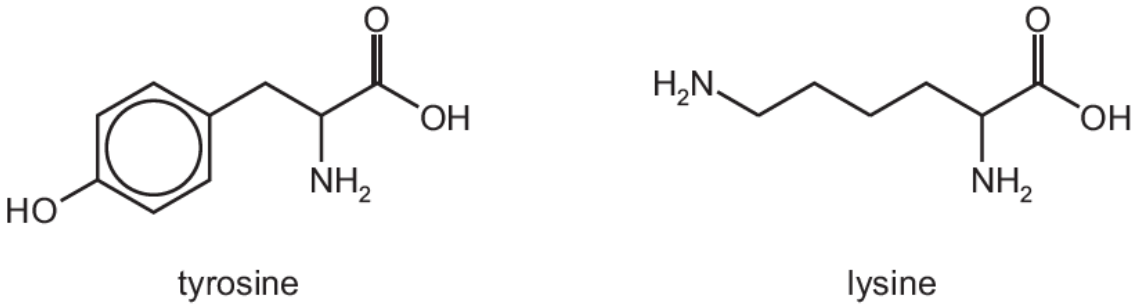



**Fig. 9.1**

A mixture of tyrosine and lysine can be separated by thin-layer chromatography. Under certain conditions the *R*f value of lysine is 0.14 and the $R_f$ value of tyrosine is 0.45.

**(i)** Explain what is meant by $R_f$ value.

.....

..... [1]

**(ii)** Suggest an explanation for the difference in $R_f$ values.

.....

..... [1]

5. The purity of lidocaine can be checked using thin-layer chromatography.
Ethyl ethanoate is used as the solvent.
The $R_f$ values of **X** and lidocaine are given in Table 6.1.
Table 6.1

| Compound | *R*f |
|---|---|
| **X** | 0.49 |
| lidocaine | 0.71 |

**(i)** Identify the substances used as the mobile and stationary phases in this thin-layer chromatography experiment.

mobile phase .....

stationary phase ..... [1]

**(ii)** Describe how an $R_f$ value can be calculated.

.....

..... [1]

**(iii)** Suggest why the $R_f$ value for **X** is less than that for lidocaine.

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..... [1]