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CHEMISTRY

ORGANIC CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	CHROMATOGRAPHY
PAPER TYPE:	SOLUTION - 1
TOTAL QUESTIONS	10
TOTAL MARKS	41

Chromatography - 1

1.

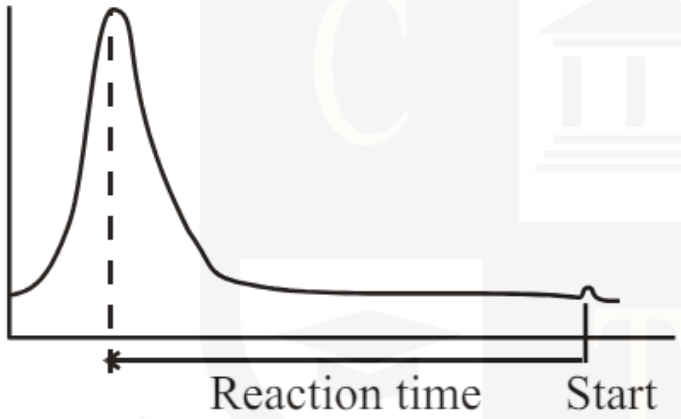
(a)

Retention time value is normally used to identify the components in Gas-liquid chromatography.

(1)

(b)

Chromatogram:



(1)

(c)

Gas-liquid chromatography separates components based on their partitioning between a gas (mobile phase) and a liquid (stationary phase).

(1)

2.

(a)

The process by which components in a mixture are separated during gas/liquid chromatography is called partition chromatography.

(1)

I am Sorry !!!!!

(b)

Role of gas:

Carrier gas / mobile phase / to carry the sample through the chromatography column.

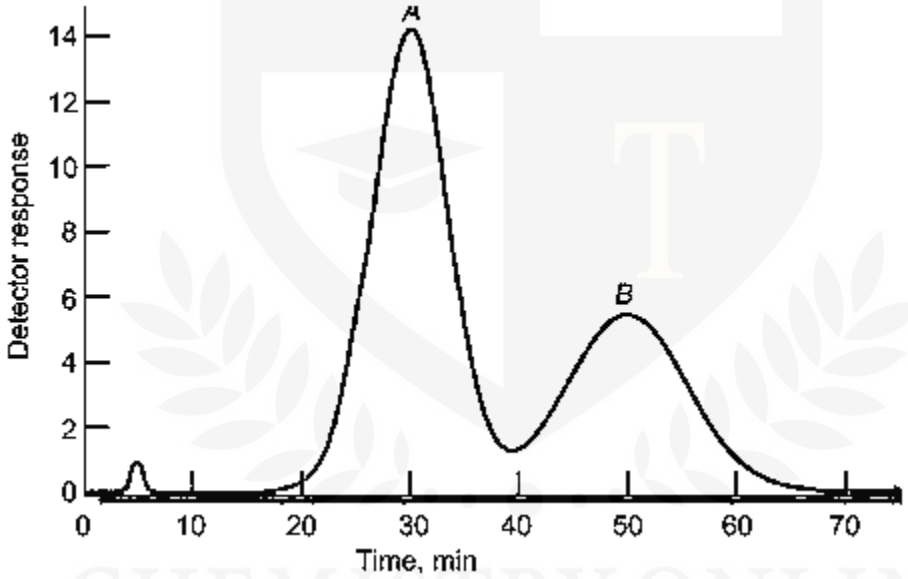
Role of liquid:

Stationary phase

(2)

(c)

Diagram of a gas/liquid chromatogram for a mixture containing two components is as:



(1)

(d)

Measure Area under Each Peak:

Using software or manual integration techniques, the area under each peak on the chromatogram is measured.

This area represents the quantity of each component in the mixture.

Find Total Area:

The sum of the areas under all peaks in the chromatogram is calculated to determine the total area.

Calculate Percentage Composition:

For each component, its percentage composition in the mixture is calculated using the formula:

Percentage= (Area of one peak/Total area)×100%

This calculation provides the relative abundance of each component in the mixture.

By applying these, the percentage composition of each component in the mixture can be determined accurately from the chromatogram.

(3)

3.

(a)

The process by which TLC separates α-amino acids is called adsorption chromatography.

(1)

(b)

To identify the α-amino acids present in the sample using the chromatogram:

- Measure how far each spot travels relative to the solvent front (R_f value).
- Compare R_f values to those for known amino acids.
- Confirm with standards or visually compare spots on the same plate with known amino acids.

I am Sorry !!!!!

(2)

(c)

The similarity in R_f (retention factor) values of similar α-amino acids can lead to overlapping spots on the TLC plate, making it difficult to distinguish and separate them effectively.

(1)

4.

Chemical Process Leading to Contamination

Propan-2-ol can become contaminated with propanone through the oxidation of the alcohol by oxygen in the air.

$CH_3CH(OH)CH_3 + O_2 \rightarrow CH_3COCH_3 + H_2O$

Identification via Infrared Spectrum

The presence of propanone is indicated in the infrared (IR) spectrum by an absorption band in the range of 1680-1750 cm^{-1} due to the C=O stretching vibration.

Retention Times in Column Chromatography:

Propanone is less polar compared to propan-2-ol, which is more polar.

This difference in polarity affects their interaction with the stationary phase and their solubility in the mobile phase:

Propanone has dipole-dipole forces and is more soluble in the non-polar mobile phase (hexane).

Propan-2-ol has hydrogen bonding and a greater affinity for the polar stationary phase (silica gel).

So, propanone, being less polar, has a weaker attraction to the stationary phase and is more soluble in the mobile phase, resulting in it being eluted first with shorter retention times.

Propan-2-ol, being more polar, has a stronger attraction to the stationary phase and is less soluble in the mobile phase, resulting in it being eluted later with longer retention times.

(4)

5.

Relationship between a sample and the mobile phase:
Components that are more soluble in or have a higher affinity for the mobile phase move faster.

(2)

6.

(a)

Wearing plastic gloves to hold a TLC plate:

- **Essential**
  This step is crucial to prevent contamination from oils, sweat, or other substances on the hands that could interfere with the TLC results.

Add the developing solvent to a depth of not more than 1 cm:

- **Essential**
  Ensuring the solvent depth is not more than 1 cm is important because if the solvent is too deep, it can dissolve the sample spots from the plate before they separate properly, leading to inaccurate results.

Allow the developing solvent to rise up the plate to the top:

- **Not essential**
  The Rf values can be calculated even if the solvent front does not reach the top of the plate. As long as the solvent front moves a sufficient distance from the baseline, the separation of the amino acids can be measured accurately.

Allow the plate to dry in a fume cupboard:

- **Essential**
  Since the solvent used is toxic, it is necessary to allow the plate to dry in a fume cupboard to ensure that hazardous fumes do not pose a risk to the person handling the plate.

(4)

(b)

To locate the positions of the amino acids on the TLC plate and determine their Rf values, follow these steps:

Visualization of Spots:

- Spray the TLC plate with a developing agent (such as ninhydrin) or use UV light to visualize the amino acid spots.
- Ninhydrin reacts with amino acids to produce colored spots, while UV light can reveal spots if the amino acids are fluorescent or have been labeled with a fluorescent marker.

Measuring Distances:

- Using a ruler or caliper, measure the distances from the initial pencil line to the center of each developed spot.
- This distance represents the distance traveled by each amino acid spot and is denoted as x.
- Measure the distance from the initial pencil line to the solvent front line. This distance represents the total distance traveled by the solvent and is denoted as y.

Calculating Rf Values:

- Once the distances xx and yy are measured, calculate the Rf value for each amino acid using the formula:

  $R_f = x/y$
- The R_f value is a dimensionless quantity that represents the relative migration of each amino acid spot compared to the solvent front.

(4)

(c)

Amino acids have different polarities due to differences in their side chains.
This variation in polarity directly influences their behavior in thin-layer chromatography (TLC).

Therefore, have different retention on the stationary phase or different solubility in the developing solvent

(2)

7.

Dipeptide responsible for spot M:

Serine-Alanine

Dipeptide responsible for spot N:

Alanine-Lysine

Order of amino acids in tripeptide L:

Serine-Alanine-Lysine

(3)

8.

Mobile phase:

The mobile phase in chromatography is the fluid (usually a liquid or gas) that carries the sample through the stationary phase.
It moves over or through the stationary phase, allowing the components of the sample to separate based on their interactions with both the mobile and stationary phases.

(2)

9.

Gas chromatography

Gas chromatography (GC) separates compounds based on their interactions with a stationary phase and a mobile phase.

The dipeptides J and K can be separated by gas chromatography due to:

Different Retention Times:
J and K likely have different affinities for the stationary phase and the mobile phase (gas carrier).
This results in different retention times as they travel through the GC column.
The dipeptides elute from the column at distinct times, allowing for their separation.

Different Balance of Solubility and Retention:

The balance between solubility in the mobile phase and retention by the stationary phase varies for J and K.
They have different relative affinities for the mobile and stationary phases, causing them to interact differently with the GC column and leading to separation.

Mass spectrometry (MS) using electrospray ionization (ESI) may not enable the identification of J and K due to:

- **Same m/z Values:**

  J and K have the same molecular formula and molecular weight. So, they produce ions with the same mass-to-charge ratio (m/z) in the mass spectrometer.
  This prevents differentiation between the two dipeptides based solely on their mass spectra.

- **Same Molecular Formula:**

  Both dipeptides J and K have identical molecular formulas and molecular weights.
  So, their mass spectra do not provide distinguishing information, making it difficult to identify them solely based on mass spectrometry.

(4)

10.

If suitable stationary and mobile phases are chosen, each component of the mixture interacts differently with these phases.

The balance between the component's affinity for the mobile phase and its affinity for the stationary phase varies.

Consequently, the components move at different rates through the chromatographic system and are separated over time.

(2)

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