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VCE Chemistry ½

Principles of Chromatography [1.10]

Homework

Homework Outline:

Compulsory Questions	Pg 2 - Pg 14
Supplementary Questions	Pg 15 - Pg 26

Section A: Compulsory Questions (52 Marks)

Sub-Section: Identify Which Substances Would Dissolve one Another Based on Miscibility and Polarity

Question 1 (4 marks)

For the following molecules, label their polarities and determine if they will dissolve in each other.

a. Water and HCl.

i. Polarity. (0.5 marks)

_____

ii. Miscibility. (0.5 marks)

_____

b. CH_4 and HF.

i. Polarity. (0.5 marks)

_____

ii. Miscibility. (0.5 marks)

_____

c. C_2H_5OH and CH_3F.

i. Polarity. (0.5 marks)

_____

ii. Miscibility. (0.5 marks)

_____

d. C_3H_8 and $C_{10}H_{22}$.

i. Polarity. (0.5 marks)

_____

ii. Miscibility. (0.5 marks)

_____

Question 2 (4 marks)

For the following molecules, state and identify whether they are soluble or miscible in each other.

a. NH_3 and H_2O. (1 mark)

_____

b. CCl_4 and CH_3OH. (1 mark)

_____

c. CH_3Cl and CO_2. (1 mark)

_____

d. H_2S and HCl. (1 mark)

_____

Space for Personal Notes

Question 3 (4 marks)

For the following molecules, explain whether the following molecules are soluble in a non-polar, organic solvent.

a. Ethane, C_2H_6. (2 marks)

b. Methanol, CH_3OH. (2 marks)

Space for Personal Notes

Sub-Section: Apply the Concepts of Adsorption and Desorption to Stationary and Mobile Phases

Question 4 (3 marks)

For the following pairs of items, identify which is the stationary phase and which is the mobile phase.

a. Water passing through a sponge. (1 mark)

_____

b. Paper dipped into a solution of ink. (1 mark)

_____

c. A glass tube and a solution of CH_3OH. (1 mark)

_____

Space for Personal Notes

Question 5 (4 marks)

Explain how the following would affect a substance's speed and distance travelled along a stationary phase and mobile phase.

a. Substance adsorbing to the stationary phase. (2 marks)

_____

_____

_____

b. Substance desorping to the mobile phase. (2 marks)

_____

_____

_____

Question 6 (4 marks)

For the following list of molecules,

$$C_2H_6, CH_3OH, CH_3Cl$$

a. Rank how far each of the substance would travel along a polar mobile phase and a non-polar stationary phase in a TLC setup. (2 marks)

_____

_____

b. Explain the process by which the furthest molecule will travel. (2 marks)

_____

_____

_____

Sub-Section: Apply Chromatography Principles to Thin Layer Chromatography (TLC)

Question 7 (2 marks)

For each of the following, identify which is the stationary phase and which is the mobile phase.

a. A plastic plate coated with silica gel and a solvent mixture solution. (1 mark)

_____

b. A thin piece of paper suspended in a glass beaker with water inside the beaker. (1 mark)

_____

Question 8 (3 marks)

Consider a TLC setup. If a substance had stronger adsorption to the stationary phase:

a. Would the component move faster or slower? Explain why. (2 marks)

_____

_____

_____

b. Hence, would it be far along the stationary phase? (1 mark)

_____

_____

Space for Personal Notes

Question 9 (4 marks)

Consider a TLC setup that involves a polar stationary phase and a non-polar mobile phase.

a. Given a list of the following molecules, rank how far along they would travel. (2 marks)

$$HF, CH_4, H_2O, C_2H_6$$

_____

_____

b. Describe the movement of the most polar compound. (2 marks)

_____

_____

_____

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Sub-Section: Calculate Retardation Factor (Rf) Values for Components on a TLC Plate

Question 10 (3 marks)

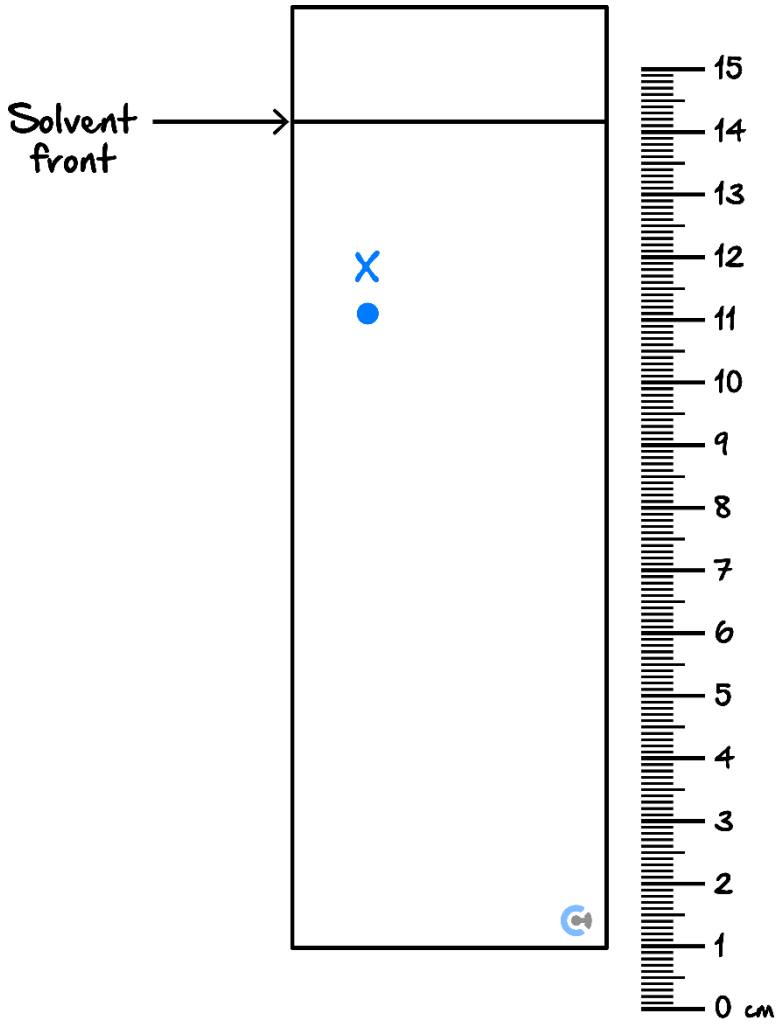
Given the following data, calculate the R_f values of the following substances:

Substance	**Distance Travelled** (cm)
Solvent	11.00
Sample A	3.50
Sample B	6.00
Sample C	5.75

Space for Personal Notes

Question 11 (4 marks)

Consider the following paper chromatography setup.

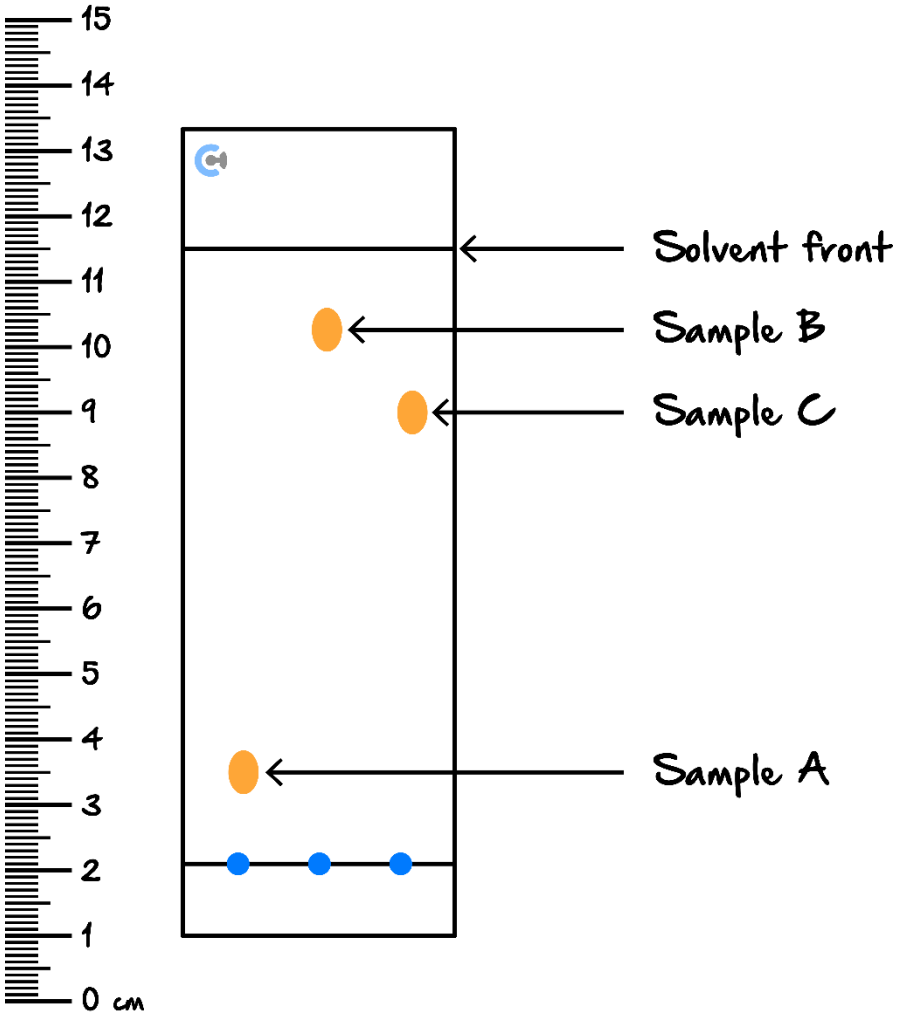


a. Calculate the R_f value of component X. (2 marks)

b. Explain why the R_f value will always be less than one no matter what. (2 marks)

Question 12 (5 marks)

The following TLC setup has a polar stationary phase and a non-polar mobile phase.



a. Calculate the R_f values of each of the samples. (2 marks)

b. The following molecules were used for this experiment: CH_3OH, C_2H_6 and C_3H_8.

i. Identify the samples according to the molecules. (1 mark)

_____

_____

ii. Explain why Sample *A* is so low on the TLC plate, with reference to the molecules' bonding. (2 marks)

_____

_____

_____

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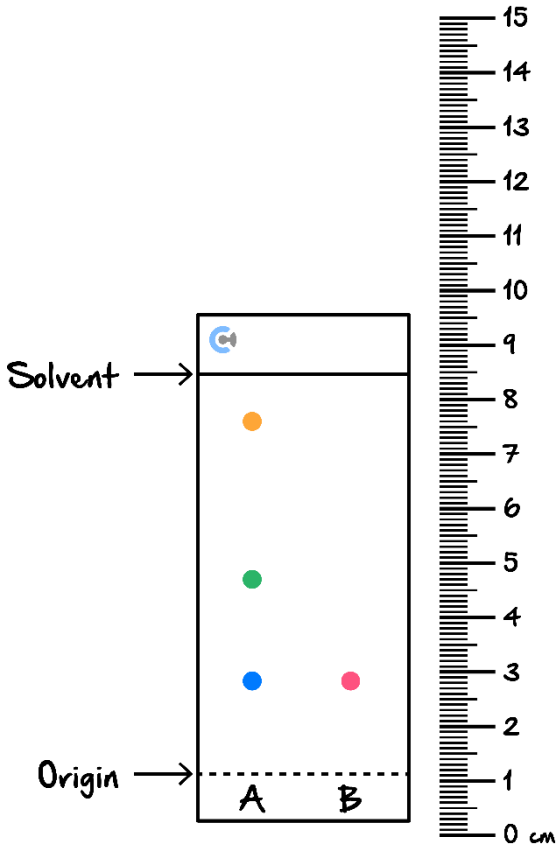
Sub-Section: The 'Final Boss'

Question 13 (8 marks)

A normal phase TLC setup was done to analyse laundry detergent (sample *A*) which comprises of several components. The following chromatogram was obtained when comparing it to sample *B*, components of a dangerous compound.



a. Explain which component is the least polar in this setup from sample *A*. (2 marks)

b. If another component has an R_f value of 0.75, what is the distance that it has travelled? (2 marks)

c. Sample *B* represents that of a dangerous compound that is not allowed in laundry detergent. Calculate its R_f value and state its relative polarity. (2 marks)

d. Is this laundry detergent permitted to go on sale? Explain your answer. (2 marks)

Space for Personal Notes

Section B: Supplementary Questions (67 Marks)

Sub-Section: Identify Which Substances Would Dissolve one Another Based on Miscibility and Polarity

Question 14 (4 marks)

For the following substances, state their polarity and explain why.

a. HF. (2 marks)

_____

_____

b. NH_3. (2 marks)

_____

_____

Question 15 (4 marks)

For the following molecules, state and identify whether they are soluble or miscible in each other.

a. SO_2 and H_2O. (1 mark)

_____

b. C_6H_6 and H_2O. (1 mark)

_____

c. CH_3OH and C_3H_8. (1 mark)

_____

d. HCl and NH_3. (1 mark)

_____

Question 16 (4 marks)

For the following molecules, explain whether they are soluble in a non-polar, organic solvent.

a. CH_3COOH. (2 marks)

_____

_____

b. $C_7H_{15}OH$. (2 marks)

_____

_____

Space for Personal Notes

Question 17 (6 marks)

Consider a solvent that is comprised of benzene C_6H_6, a non-polar compound.

a. Why do we find that a compound of CH_4 dissolves well in benzene whereas H_2O does not? Explain, with reference to intermolecular bonding. (3 marks)

b. A student suggests that C_4H_9Cl will not be miscible in benzene since it has a polar Cl compound which will cause it to be polar. Evaluate their statement. (3 marks)

Space for Personal Notes

Sub-Section: Apply the Concepts of Adsorption and Desorption to Stationary and Mobile Phases

Question 18 (3 marks)

For the following scenarios, identify which is the stationary phase and which is the mobile phase.

a. Air passing through an activated charcoal filter. (1 mark)

_____

b. A TLC plate with a solvent moving upward. (1 mark)

_____

c. Drinking coffee with a straw. (1 mark)

_____

Question 19 (4 marks)

Explain how the following factors influence the movement of substances in chromatography.

a. Increased attraction between a substance and the stationary phase. (2 marks)

_____

_____

_____

_____

b. Increased molar mass of a substance when the mobile phase is polar. (2 marks)

_____

_____

_____

_____

Question 20 (4 marks)

A chromatogram under analysis has a polar mobile phase, and a non-polar stationary phase. H_2S is passed through the chromatogram to analyse it.

a. Is H_2S polar? Explain. (2 marks)

_____

_____

_____

b. Which phase of the chromatogram will H_2S be more attracted to? Explain. (2 marks)

_____

_____

_____

Space for Personal Notes

Question 21 (6 marks)

Two objects *X* and *Y* are analysed using chromatography. *X* and *Y* have differing strengths of attraction to the phases of the chromatogram.

a. If object *Y* is seen to travel further along than *X* given the same amount of time, then explain its attraction to a phase in the chromatogram. (2 marks)

_____

_____

_____

_____

b. As such, describe the motion for object *X* in the chromatogram. (2 marks)

_____

_____

_____

_____

c. If object *X* was analysed in the chromatogram using a different solvent to object *Y*, then can results still be comparable? Justify your answer. (2 marks)

_____

_____

_____

_____

Space for Personal Notes

Sub-Section: Apply Chromatography Principles to Thin Layer Chromatography (TLC)

Question 22 (2 marks)

In a TLC experiment that has a non-polar mobile phase, if a substance has a high polarity, describe its movement along the TLC setup.

_____

_____

_____

Question 23 (2 marks)

Consider a TLC experiment using a polar stationary phase. Rank the following compounds based on how far they will travel.

$$C_2H_5OH, CH_2O, CH_4$$

_____

_____

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Question 24 (6 marks)

During normal phase TLC, a mixture which consists of CH_4, CH_3Cl and CH_3OH was used.

a. Which substance is expected to travel the shortest distance? (2 marks)

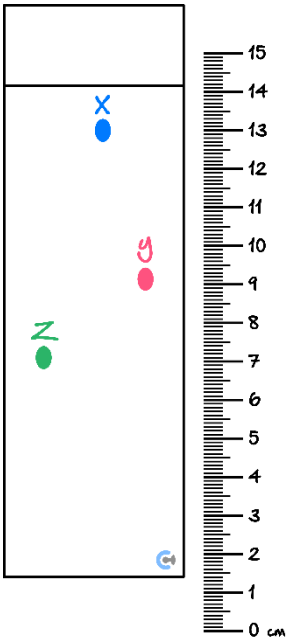
b. Which substance is expected to travel the longest distance? Explain. (2 marks)

c. If a different TLC set-up was used where the polarities were swapped than regular TLC, do you expect your answers to be the same? Justify your answer. (2 marks)

Space for Personal Notes

Question 25 (6 marks)

A TLC setup was utilised to examine three compounds, CH_3OH, C_2H_5OH and $C_6H_{12}O_6$. Consider the following results.



a. Rank the compounds in terms of decreasing polarity. (2 marks)

b. Identify what chemical is most likely substance *Y* and explain your answer. (2 marks)

c. Which compound travels the fastest through the TLC setup? Explain. (2 marks)

Sub-Section: Calculate Retardation Factor (Rf) Values for Components on a TLC Plate

Question 26 (2 marks)

Given the following data, calculate the R_f values of the following substances:

Substance	Distance (cm)
Solvent	10.50
Sample X	4.25
Sample Y	7.10
Sample Z	6.00

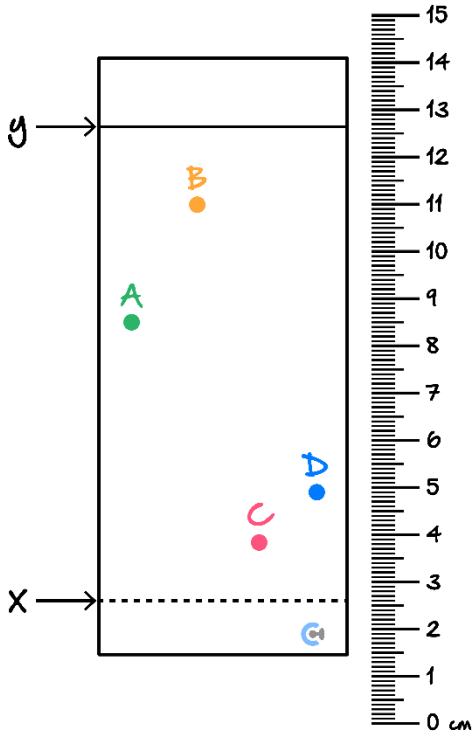
Question 27 (2 marks)

How does the polarity of a substance affect its R_f value if the chromatography setup involved a polar stationary phase? Explain.

Space for Personal Notes

Question 28 (4 marks)

Consider the following reverse phase TLC setup involving a substance with three known components.

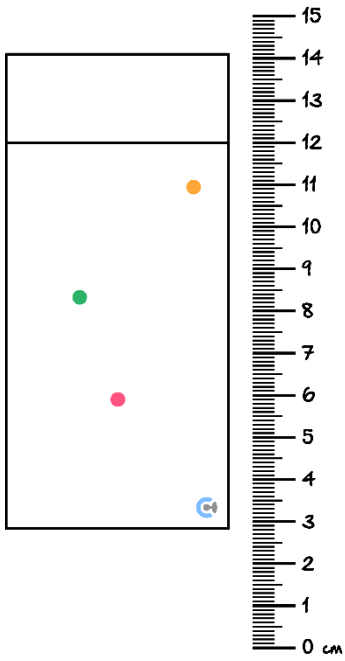


a. Calculate the R_f value of component A. (2 marks)

b. If the potential components the substance could be made of were either $CH_4, C_2H_6, CH_3Br, CH_3OH$, identify what component A would be and why? (2 marks)

Question 29 (8 marks)

Consider the following normal phase TLC setup involving a mixture of three substances: HF, H_2O and CH_3Cl. The following results are observed.



a. Label the points on the chromatogram above with their respective compounds. (2 marks)

b. If a compound of HCl was also added into the mixture, where we would observe it on the chromatogram? (2 marks)

_____

_____

c. A student suggested that we can just predict where the spots are on a chromatogram in normal phase TLC just by knowing the molar masses of the compounds involved, saying that the bigger the molecule, the further it will travel along the mobile phase. Evaluate their statement. (4 marks)

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