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VCE Chemistry ½
AOS 1 Revision II [1.13]
Contour Check

Contour Check

[1.7] - Polarity (Checkpoints)

[1.9] – Solubility & Precipitation (Checkpoints)

[1.10] – Principles of Chromatography (Checkpoints)

[1.11] – Chromatography Qualitative & Quantitative Analysis (Checkpoints)

Section A: [1.7] - Polarity (Checkpoints) (33 Marks)

Sub-Section [1.7.1]: Identify Polar & Non-Polar Bonds within a Covalent Molecule, with Reference to Electronegativity

Question 1 (2 marks)

For the following bonds, rank them in increasing polarity:

$$H-Cl, H-I, H-Br, H-F, H-O$$

Question 2 (2 marks)

Max and Raj are investigating atoms and their differences in electronegativity. Max chooses to investigate phosphorus and Raj decides to investigate bismuth. Which of the two would be more electronegative? Justify your answer.

_____

_____

_____

Space for Personal Notes

Question 3 (5 marks)

Determine the type of bond that exists between each of the following substances out of the following options: Non-polar covalent, polar covalent, or ionic bond.

a. H & Br. (1 mark)

_____

b. Al & Cl. (1 mark)

_____

c. N & N. (1 mark)

_____

d. Si & O. (1 mark)

_____

e. Na & F. (1 mark)

_____

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Sub-Section [1.7.2]: Draw Partial Charges & Corresponding Polarity Arrows on Covalent Molecules

Question 4 (3 marks)

Label the partial charges on the following molecules:

a. O – H. (1 mark)

b. C – F. (1 mark)

c. C – N. (1 mark)

Question 5 (4 marks)

Draw the polarity arrows for the following molecules:

a. H – Br. (1 mark)

b. N – O. (1 mark)

c. N – I. (1 mark)

d. C – F. (1 mark)

Question 6 (3 marks)

In the molecule of NH_3, three identical bonds exist, the N – H bond. A student argues that because the three bonds are identical, just like CO_2, this molecule will be non-polar. Evaluate their answer with reference to partial charges and their structure.

Space for Personal Notes

Sub-Section [1.7.3]: Identify Polar & Non-Polar Molecules with Reference to Polar & Non-Polar Bonds, as well as Molecular Geometry

Question 7 (2 marks)

Is PCl_3 non-polar or polar? Briefly justify your answer.

_____

_____

Question 8 (6 marks)

For each of the following, draw the Lewis structures and state their polarities and molecular geometries:

a. H_2O. (2 marks)

b. NH_3. (2 marks)

c. OCN. (2 marks)

Question 9 (6 marks)

For the following pairs of molecules, select the more polar one and explain why:

a. HF and HCl. (2 marks)

b. CH_3N and CH_3O. (2 marks)

c. CH_3Cl and FOH. (2 marks)

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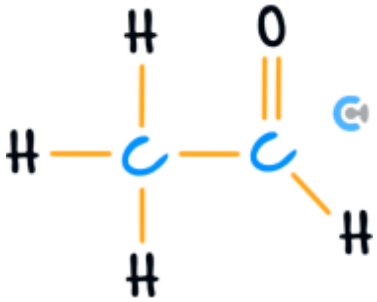
Section B: [1.8] – Intermolecular Bonding (Checkpoints) (25 Marks)

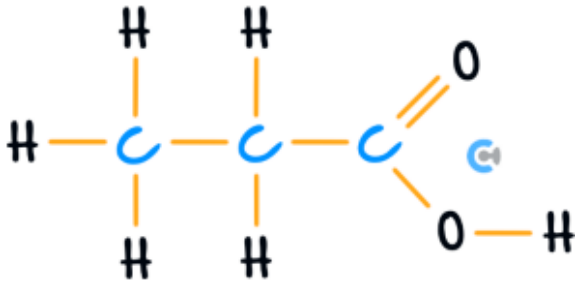
Question 10 (5 marks)

Can the following molecules form hydrogen bonds?

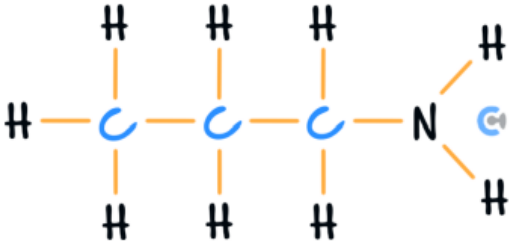
a. Ethanal. (1 mark)



b. Propanoic acid. (1 mark)

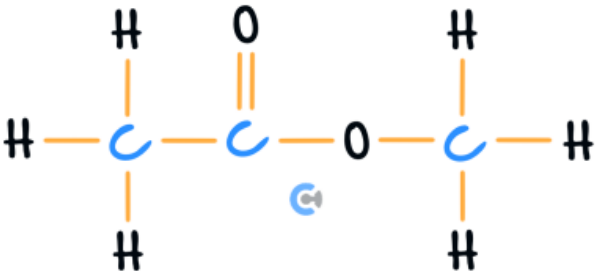


c. Propanamine. (1 mark)



d. Ammonia (NH_3). (1 mark)

e. Methyl ethanoate. (1 mark)



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Question 11 (6 marks)

Consider a molecule of methanol:

a. Draw the Lewis structure of methanol (CH_3OH). (2 marks)

b. State its polarity and explain what the strongest type of intermolecular bonding it can make with itself. (2 marks)

_____

_____

_____

c. If we replaced the oxygen with sulphur instead, how would this change the intermolecular bonding, if at all? Briefly explain your answer. (2 marks)

_____

_____

_____

Space for Personal Notes

Question 12 (6 marks)

Identify whether the following molecules would form hydrogen bonds with water:

a. Methanol (CH_3OH). (1 mark)

_____

b. CF_4. (1 mark)

_____

c. Methyl methanoate ($HCOOCH_3$). (1 mark)

_____

d. NH_3. (1 mark)

_____

e. HF. (1 mark)

_____

f. CO_2. (1 mark)

_____

Space for Personal Notes

Question 13 (8 marks)

Consider the molecules octane (C_8H_{18}) and methanol (CH_3OH):

a. State and explain whether octane is non-polar or polar. (2 marks)

_____

_____

b. Which item do you expect to have a higher boiling point? Justify your answer. (3 marks)

_____

_____

_____

_____

c. Consider a container of H_2O, what is the strongest type of intermolecular bond it can make with each of these molecules? (1 mark)

_____

_____

d. As such, when dropped into a container of H_2O, which molecule do you expect to form more bonds with H_2O? Briefly explain your answer. (2 marks)

_____

_____

_____

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Section C: [1.9] – Solubility & Precipitation (Checkpoints) (35 Marks)

Sub-Section [1.9.1]: Explain the Process by which Ionic Compounds Dissolve in Water with Reference to Ion-Dipole Bonding

Question 14 (2 marks)

Explain why NaCl dissolves in water but not in another molecule like hexane, C_6H_{14}.

Question 15 (3 marks)

Explain why hydrogen bonding is stronger than dipole-dipole interactions but weaker than ion-dipole bonds.

Space for Personal Notes

Question 16 (4 marks)

Aside from understanding intermolecular bonds themselves, we also need to understand how they compare with each other.

a. Explain why ion-dipole bonds are stronger than dipole-dipole interactions. (2 marks)

_____

_____

_____

b. Would this behaviour be the same as when we compare ion-dipole bonds with ionic bonding? Justify your answer. (2 marks)

_____

_____

_____

Space for Personal Notes

Sub-Section [1.9.2]: Write Balanced Equations for Ionic Compounds Dissociating/Ionising in Water

Question 17 (1 mark)

What is the difference between solvent and solute?

Question 18 (3 marks)

Write the dissolution reactions for the following:

a. NH_4NO_3. (1 mark)

b. $Al_2(SO_4)_3$. (2 marks)

Question 19 (3 marks)

Describe how the compound $CaCO_3$ would dissolve in water, including writing the reaction that represents this process.

Sub-Section [1.9.3]: Identify which Compounds will or will not Dissolve in Water, with Reference to SNAPE and/or Solubility Tables

Question 20 (2 marks)

For each of the following, determine whether they are soluble or not, giving justification:

a. $Fe(NO_3)_2$. (1 mark)

_____

b. Na_2CO_3. (1 mark)

_____

Question 21 (2 marks)

Suggest something the SNAPE rule does not tell you about the solubility of compounds.

_____

_____

_____

Space for Personal Notes

Question 22 (3 marks)

Determine whether the following are soluble, referring to solubility tables.

a. Lead (II) sulphate. (1 mark)

_____

b. Potassium carbonate. (1 mark)

_____

c. Silver chloride. (1 mark)

_____

Space for Personal Notes

Sub-Section [1.9.4]: Write Full & Ionic Equations for Precipitation Reactions

Question 23 (2 marks)

For the reaction below, explain whether a precipitate is formed:

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

Question 24 (4 marks)

For the following full reactions, write the ionic equations and identify the spectator ions, if any:

a. $MgBr_2 + K_2SO_4 \rightarrow MgSO_4 + 2KBr$

i. Ionic equation. (1 mark)

ii. Spectator ions. (1 mark)

b. $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

i. Ionic equation. (1 mark)

ii. Spectator ions. (1 mark)

Question 25 (6 marks)

For each of the following compounds, write the reaction that will occur between them and specify any precipitate and spectator ions.

a. Aluminium phosphate and silver (I) nitrate.

i. Full reaction. (1 mark)

_____

ii. Spectator ions. (1 mark)

_____

iii. Precipitate. (1 mark)

_____

b. Calcium chloride and sodium carbonate.

i. Full reaction. (1 mark)

_____

ii. Spectator ions. (1 mark)

_____

iii. Precipitate. (1 mark)

_____

Space for Personal Notes

Section D: [1.10] – Principles of Chromatography (Checkpoints) (41 Marks)

Sub-Section [1.10.1]: Identify which Substances would Dissolve One Another Based on Miscibility and Polarity

Question 26 (4 marks)

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

a. HF. (2 marks)

_____

_____

b. NH_3. (2 marks)

_____

_____

Question 27 (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 28 (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

Sub-Section [1.10.2]: Apply the Concepts of Adsorption and Desorption to Stationary and Mobile Phases

Question 29 (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 30 (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 31 (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

Sub-Section [1.10.3]: Apply Chromatography Principles to Thin Layer Chromatography (TLC)

Question 32 (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 33 (2 marks)

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

$$C_2H_5OH, CH_2O, CH_4$$

_____

_____

Space for Personal Notes

Question 34 (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 the regular TLC, do you expect your answers to be the same? Justify your answer. (2 marks)

_____

_____

_____

Space for Personal Notes

Sub-Section [1.10.4]: Calculate Retardation Factor (R_f) Values for Components on a TLC Plate

Question 35 (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

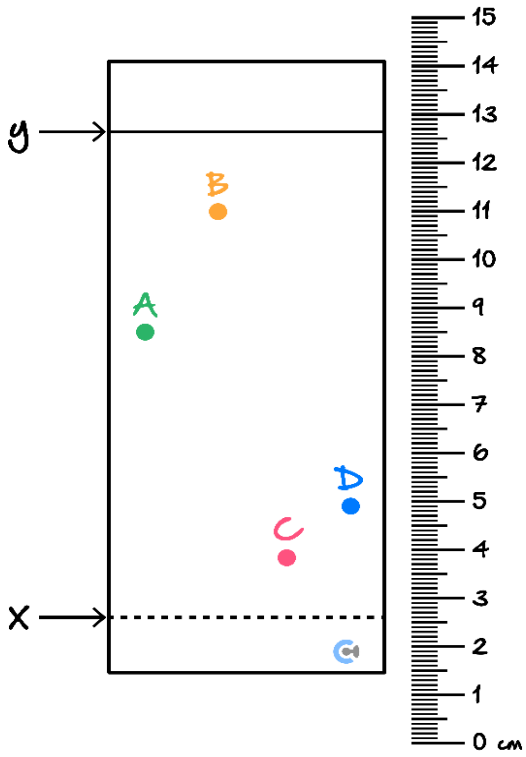
Question 36 (2 marks)

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 37 (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)

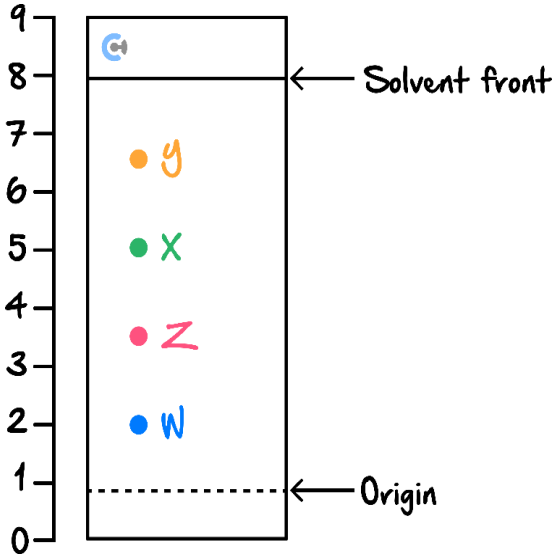
b. If the potential components the substance could be made of were either $CH_4, C_2H_6, CH_3Br, CH_3OH$ identify what component *A* would be and why? (2 marks)

Section E: [1.11] – Chromatography Qualitative & Quantitative Analysis (Checkpoints) (35 Marks)

Sub-Section [1.11.1]: Apply R_f Values to Qualitative Analysis for TLC

Question 38 (4 marks)

Given the following chromatogram, find the R_f value of the following substances.



a. Substance X. (1 mark)

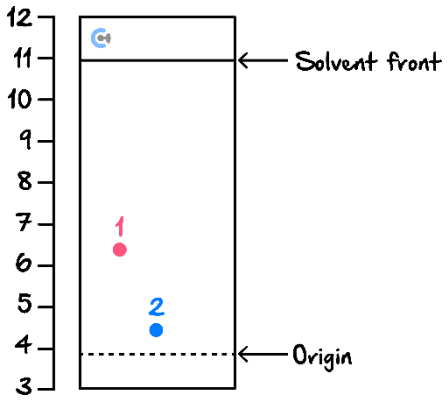
b. Substance Y. (1 mark)

c. Substance Z. (1 mark)

d. Substance W. (1 mark)

Question 39 (4 marks)

Two water samples were tested for harmful chemicals using chromatography. It is known that the harmful chemical has an R_f of 0.35 under this setup.

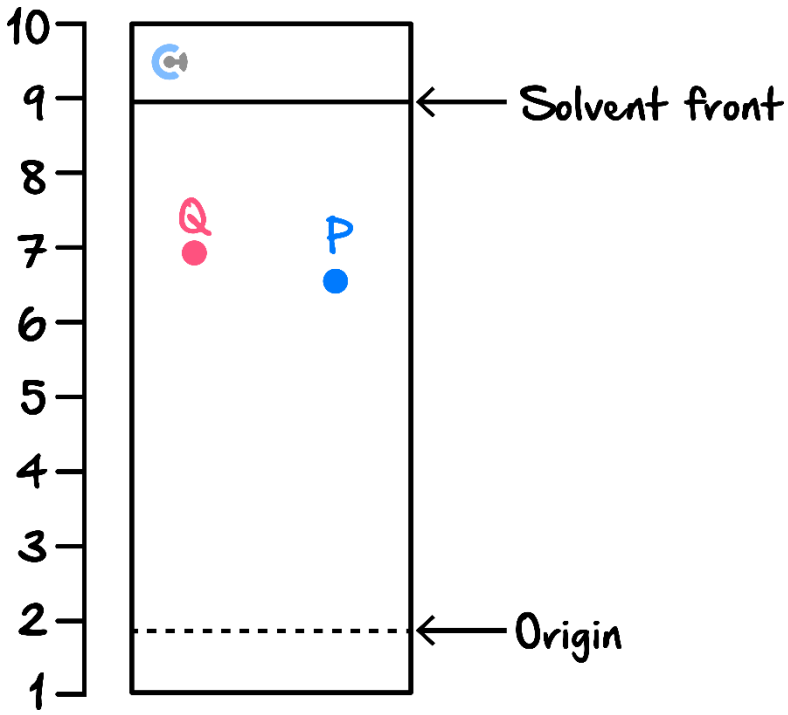


a. Based on the chromatogram, can we conclude that the sample 1 contains the harmful chemical? Assume conditions are the same. (2 marks)

b. If the solvent used was changed to be more polar, how would the distance travel of the substances change, assuming that the samples are also mainly polar? Explain. (2 marks)

Question 40 (6 marks)

A TLC experiment was conducted, and the chromatogram below shows the movement of two substances, P and Q, on the plate.



a. Calculate the R_f value of points P and Q. (2 marks)

b. If a known compound has an R_f value of 0.64, is this compound present in the chromatogram? (2 marks)

c. What assumption did you make to answer **part b.**? (2 marks)

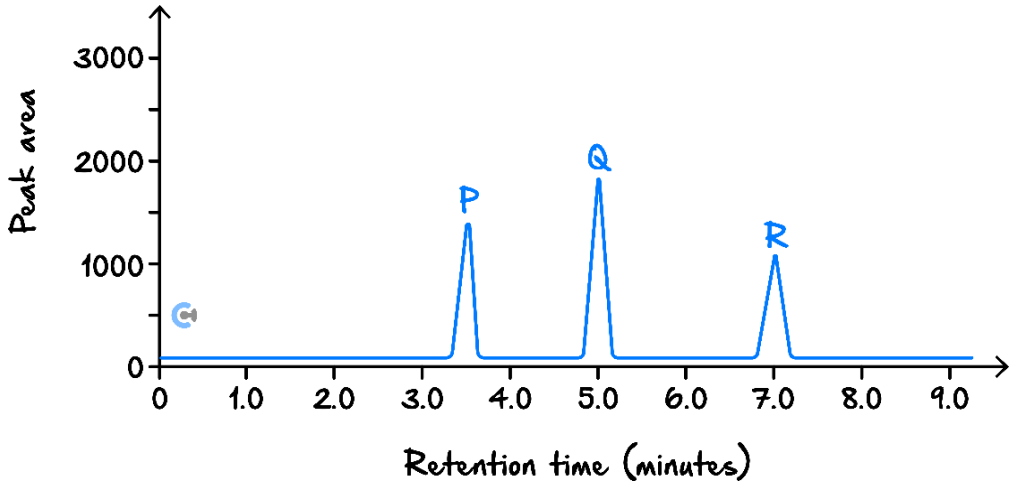
Sub-Section [1.11.2]: Apply Retention Time (R_t) to Qualitative Analysis for Column Chromatography/HPLC

Question 41 (2 marks)

If a substance in reverse-phase HPLC gave a high retention time output, what can be concluded about its attraction to the stationary phase? Explain.

Question 42 (4 marks)

In reverse-phase column chromatography, a polar stationary phase is used to analyse and separate a mixture of HCl, CH_4 and C_2H_6. The output is shown below:

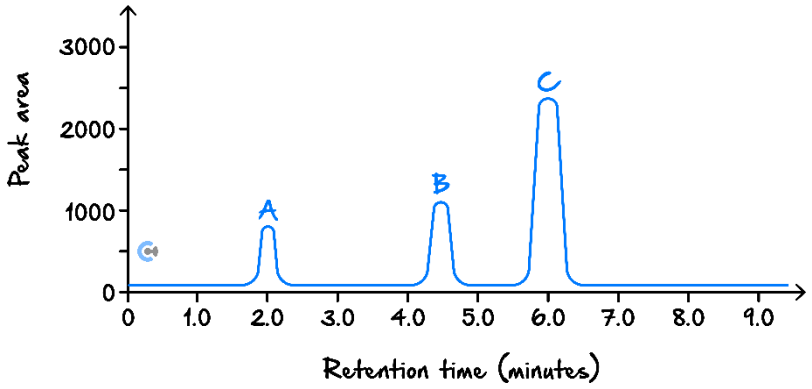


a. Identify the retention times for substances P, Q, and R. (2 marks)

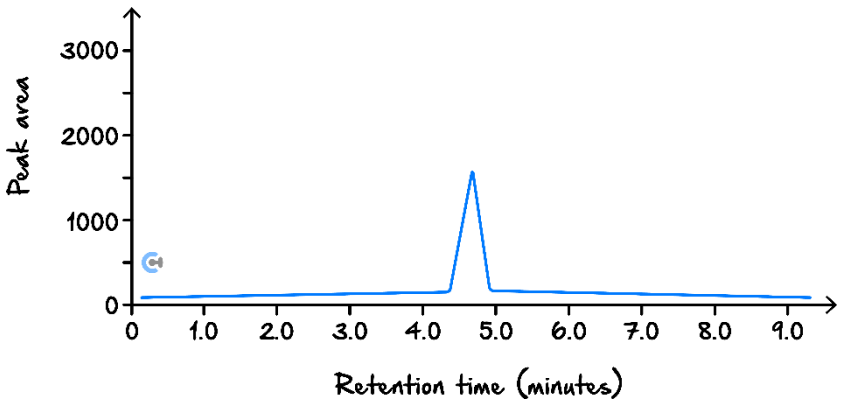
b. State the identity of substances *P* and *R*, with reasoning for your answer. (2 marks)

Question 43 (4 marks)

A fruit juice sample is passed through an HPLC column, and the following chromatogram is obtained:



It is known that citric acid is present in the fruit juice. When pure citric acid is run through the same HPLC column under identical conditions, the following result is obtained:



a. Identify the retention time of citric acid. (1 mark)

b. Identify which peak in the fruit juice chromatogram most likely correlates to citric acid. (1 mark)

_____

c. Given that ascorbic acid (vitamin C) has a retention time of 6.0 minutes when run under the same conditions, determine whether ascorbic acid is present in the fruit sample. (2 marks)

_____

_____

_____

Space for Personal Notes

Sub-Section [1.11.3]: Draw Calibration Curves & Apply Them to Quantitative Analysis for Column Chromatography/HPLC

Question 44 (2 marks)

Explain what the difference between quantitative and qualitative analysis is in HPLC/Column chromatography. Identify the key features used for both techniques in your answer.

_____

_____

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Space for Personal Notes

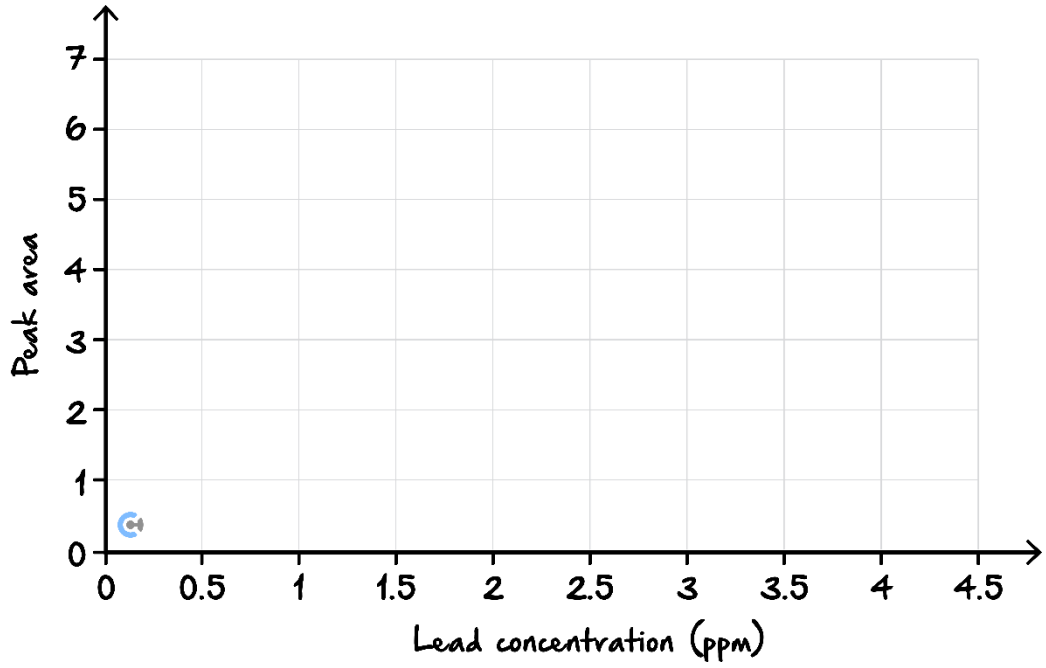
Question 45 (4 marks)

Lead contamination in drinking water is a serious health concern, as prolonged exposure can cause neurological issues. HPLC is used to test water samples for lead concentration.

The relative peak areas from HPLC of a water sample and some standard lead solutions are shown below:

Lead concentration (ppm)	**Relative peak area**
Water Sample	4.8
Standard A $(100\ ppm)$	1.0
Standard B $(200\ ppm)$	2.5
Standard C $(300\ ppm)$	4.0
Standard D $(400\ ppm)$	5.5

a. Plot a calibration curve of relative peak area vs lead concentration (ppm). (2 marks)



b. Use your calibration curve to determine the lead concentration in the water sample. (2 marks)

_____

_____

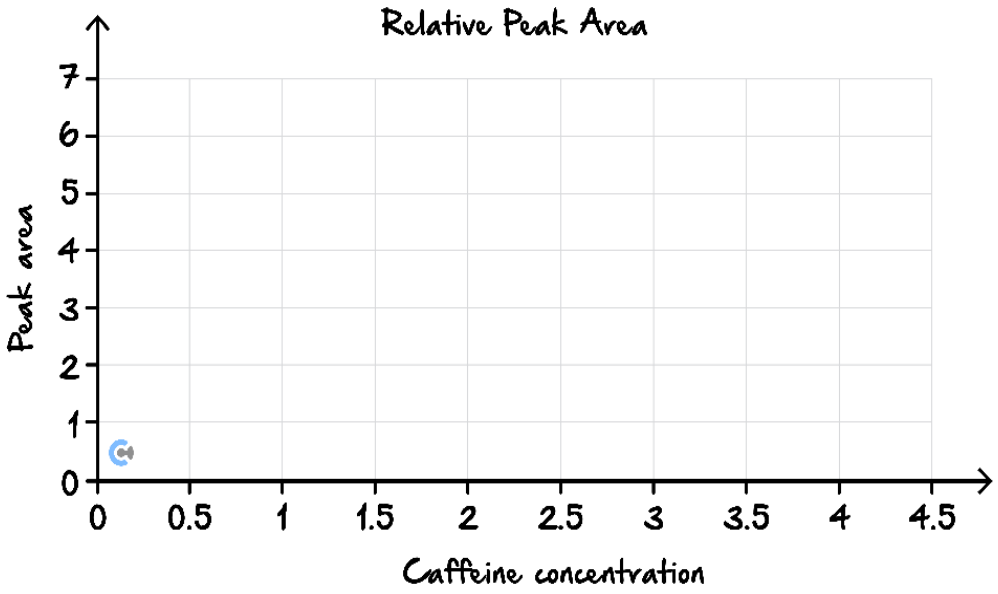
Question 46 (5 marks)

A consumer health organisation tested a new energy drink using HPLC to verify if the caffeine content matched the amount listed on the label. One of the caffeine peaks in the chromatogram of the energy drink sample had a peak area of 27.5 mm^2.

The peak areas of caffeine in a series of standards were recorded as follows:

Caffeine Concentration (mg/mL)	**Peak area (mm^2)**
5.0	10.2
10.0	20.5
15.0	30.7
20.0	40.9

a. Draw a calibration curve by plotting peak area vs caffeine concentration. (2 marks)



b. Use the calibration curve to determine the caffeine concentration in the energy drink sample. (2 marks)

_____

_____

c. From the table, is it possible to deduce whether aspartame, an artificial sweetener, is in this energy drink? (1 mark)

_____

_____

Space for Personal Notes

Section F: [1.7 - 1.11] - Overall (VCAA Qs) (60 Marks)

Question 47 (3 marks)

Define and explain how dispersion forces would arise between two molecules of nitrogen gas.

Question 48 (3 marks)

Compare the intermolecular bonding strength of CH_4 compared to CH_3Cl, stating which will more likely have a higher boiling point.

Space for Personal Notes

Question 49 (3 marks)

Draw the Lewis Structure of NH_3, showing the polarity arrows and state whether it is polar.

Question 50 (4 marks)

Consider the molecule of HF.

a. Describe the reaction of how HCl would become dissolved in water, naming this type of reaction. (2 marks)

_____

_____

_____

b. What is the difference between HF before and after it dissolves in water, in relation to its intermolecular bonding? (2 marks)

_____

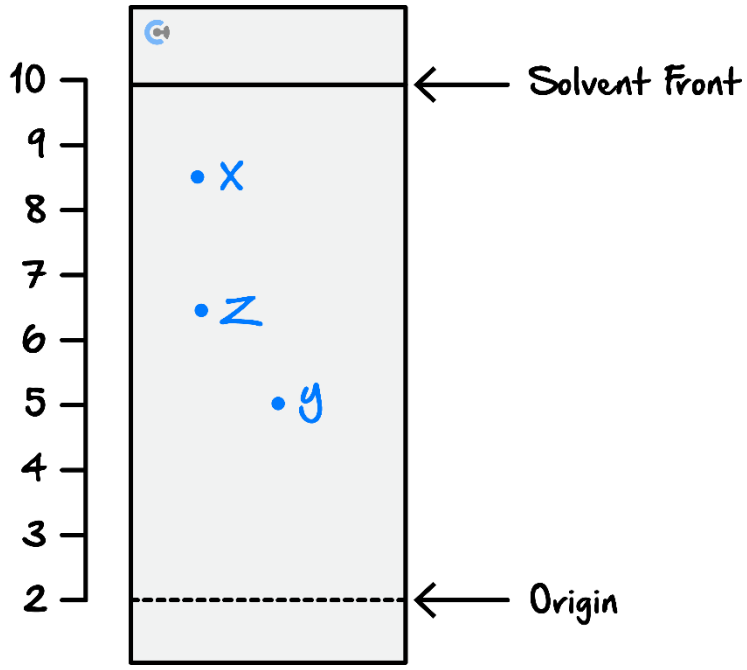
_____

_____

Space for Personal Notes

Question 51 (4 marks)

Consider the following chromatogram.



a. Calculate the R_f values of the components. (2 marks)

b. If the mobile phase was polar, rank the components based on their polarity. (2 marks)

Space for Personal Notes

Question 52 (3 marks)

Consider the process of HPLC experimentation.

a. If two substances came out with the same retention time, what is the primary assumption that we make to compare them? (1 mark)

b. What would be the effect of lengthening the column in terms of the retention time output? Explain. (2 marks)

Question 53 (3 marks)

A student claims that because CO_2 is a linear molecule with two oxygen atoms on either side of the carbon, the molecule itself must be polar. Evaluate this statement.

Space for Personal Notes

Question 54 (6 marks)

Consider a molecule of ethanol, C_2H_5OH.

a. Draw its Lewis structure. (2 marks)

b. State its polarity and explain what the strongest type of intermolecular bond that it can make with itself is. (2 marks)

_____

_____

_____

c. If we replaced the oxygen with S instead, would this change the intermolecular bonding? (2 marks)

_____

_____

_____

Space for Personal Notes

Question 55 (7 marks)

Consider the substance of KBr.

a. What type of intramolecular bond exists in KBr? (1 mark)

_____

b. Write the reaction where KBr dissolves in water. (1 mark)

_____

c. Describe the process in which KBr dissolves in water. (3 marks)

_____

_____

_____

_____

d. If KBr was replaced with AgBr instead, what would change? Explain what this means in terms of intermolecular bonding. (2 marks)

_____

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_____

Space for Personal Notes

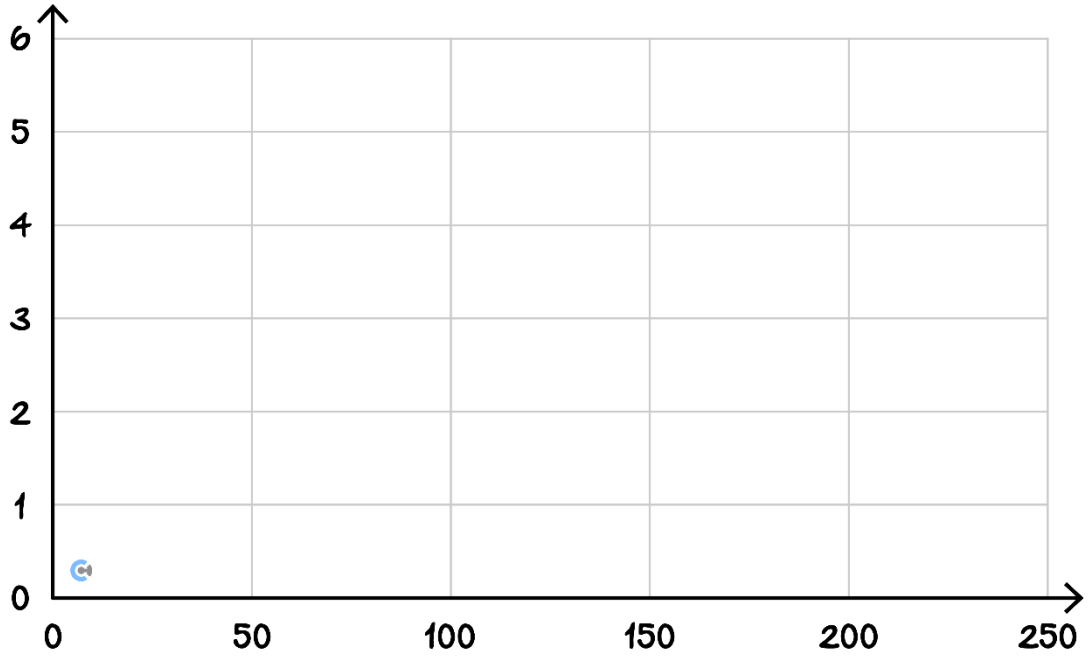
Question 56 (4 marks)

Mercury contamination in drinking water is a serious health concern that is constantly monitored by water authorities, such as Yarra Valley Water. HPLC is used to test water samples for mercury concentration.

The relative peak areas from HPLC of a water sample and some standard mercury solutions are shown below:

Mercury Concentration (ppm)	**Relative peak area**
Water Sample	3.6
Standard A (50 ppm)	1.2
Standard B (100 ppm)	2.4
Standard C (150 ppm)	3.0
Standard D (200 ppm)	4.8

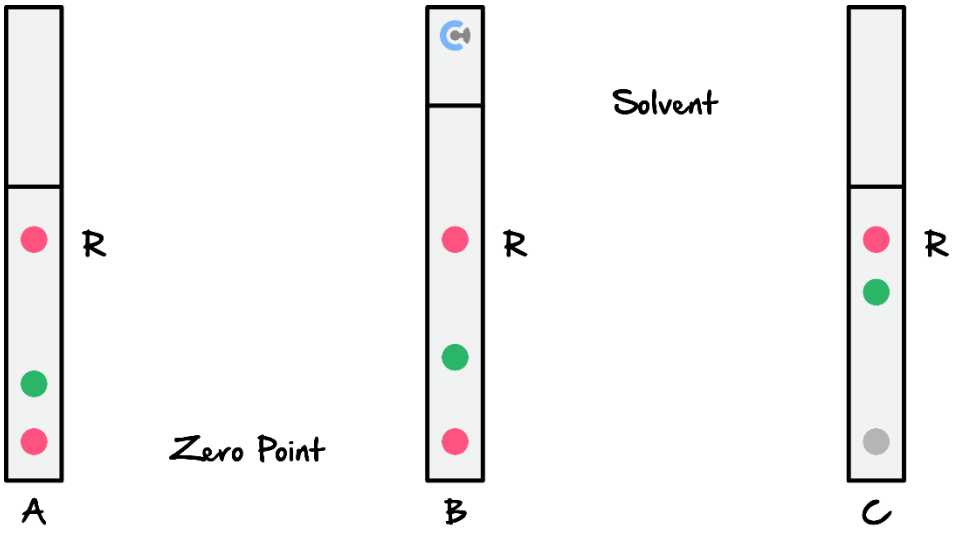
a. Plot a calibration curve of relative peak area vs mercury concentration. (2 marks)



b. Use your calibration curve to determine the mercury concentration in the water sample. (2 marks)

Question 57 (9 marks)

A food chemist is using paper chromatography to investigate the brown dyes used in lollies. Three separate chromatograms are shown below.



The solvent for samples A and B is ethanol, while the solvent for sample C is a salt solution. Each brown dye used produces a red spot that has been marked with an R.

a. If you are asked to calculate the R_f value of each brown spot, does it matter what units are used on the scale on the left? Explain your answer. (3 marks)

_____

_____

b. Is the red dye used in sample A likely to be the same as that used in sample B? Explain your answer. (2 marks)

_____

_____

c. Is the red dye used in sample C likely to be the same as that in sample A? Explain your answer. (2 marks)

_____

_____

_____

d. The other spot shown in each sample is yellow. Which dye, out of yellow and red, is likely to be the more polar? Explain your answer. (2 marks)

_____

_____

_____

Question 58 (11 marks)

Consider the molecule H_2S.

a. Draw its Lewis structure and label the partial charges present. (2 marks)

b. Explain how electronegativity affects the overall polarity of H_2S. (3 marks)

_____

_____

_____

_____

c. Consider the molecule of NOCl additionally.

Would the polarity and molecular geometry of NOCl be similar to H_2S? Justify your answer. (2 marks)

_____

_____

_____

d. Compare the bond polarity between $Cl-O$ and $N-O$ bonds. (2 marks)

_____

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_____

e. Would you expect H_2S to have a higher boiling point than H_2O? Explain. (2 marks)

_____

_____

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Space for Personal Notes

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