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VCE Chemistry ½

AOS 1 Revision II [1.13]

Contour Check Solutions

Contour Check

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:

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

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

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.

Phosphorus would be more electronegative. This is because although they both have the same effective nuclear charge of +5, phosphorus has fewer electron shells than Bismuth, as such, the electrons are more attracted to the nucleus and therefore P has a higher electronegativity than Bi.

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)

Polar covalent

b. Al & Cl. (1 mark)

Ionic

c. N & N. (1 mark)

Non-polar covalent

d. Si & O. (1 mark)

Polar covalent

e. Na & F. (1 mark)

Ionic

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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)

O = partial negative. H = partial positive.

b. C – F. (1 mark)

C = partial positive. F = partial negative.

c. C – N. (1 mark)

C = partial positive, N = partial negative.

Question 5 (4 marks)

Draw the polarity arrows for the following molecules:

a. H – Br. (1 mark)

H = partial positive. Br = partial negative. Draw arrow from H to Br.

b. N – O. (1 mark)

N = partial positive. O = partial negative. Arrow from N to O.

c. N – I. (1 mark)

N = partial negative. I = Partial positive. Arrow from I to N.

d. C – F. (1 mark)

C = partial positive. F = partial negative. Arrow from C to F.

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.

No, because NH_3 is a pyramidal molecule, this means the N – H bonds are not directly opposing each other, meaning that the N will have a partially negative charge due to its electronegativity, pulling the electrons towards itself, causing the molecule to be polar.

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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)

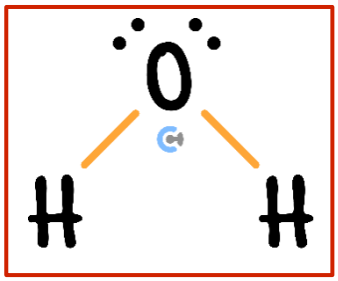
Is PCl_3 non-polar or polar? Briefly justify your answer.

PCl_3 is polar since it is pyramidal.

Question 8 (6 marks)

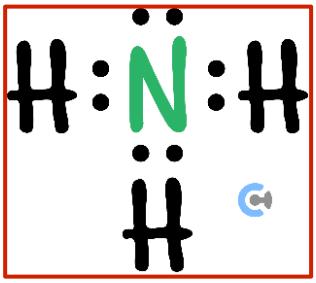
For each of the following, draw the Lewis structures and state their polarities and molecular geometries:

a. H_2O. (2 marks)



Polar, V-Shaped/Bent.

b. NH_3. (2 marks)



Polar, Pyramidal

c. OCN. (2 marks)

Polar, Linear

Question 9 (6 marks)

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

a. HF and HCl. (2 marks)

HF is more polar because the H – F bond is more polar than the H – Cl bond due to F being more electronegative than Cl.

b. CH_3N and CH_3O. (2 marks)

CH_3O is more polar because oxygen is more electronegative than nitrogen.

c. CH_3Cl and FOH. (2 marks)

FOH is more polar because the O – H bond and the O – F bond are more polar than the C – Cl bond in CH_3Cl which is the only polar bond that exists within that molecule, hence FOH is more polar than CH_3Cl.

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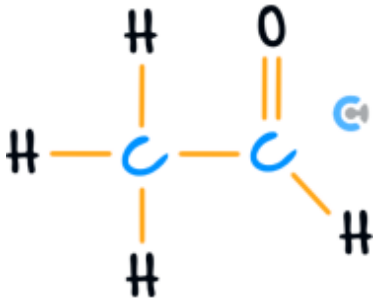
Section B: [1.8] – Intermolecular Bonding (Checkpoints) (25 Marks)

Question 10 (5 marks)

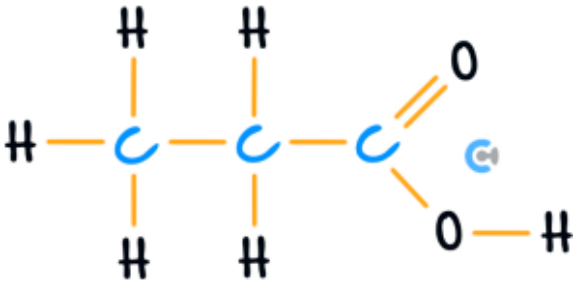
Can the following molecules form hydrogen bonds?

a. Ethanal. (1 mark)



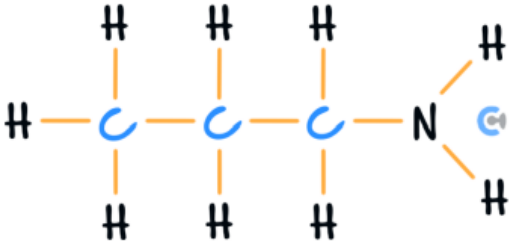
No

b. Propanoic acid. (1 mark)



Yes

c. Propanamine. (1 mark)

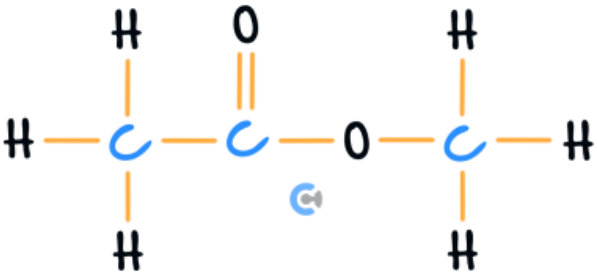


Yes

d. Ammonia (NH_3). (1 mark)

Yes

e. Methyl ethanoate. (1 mark)



No

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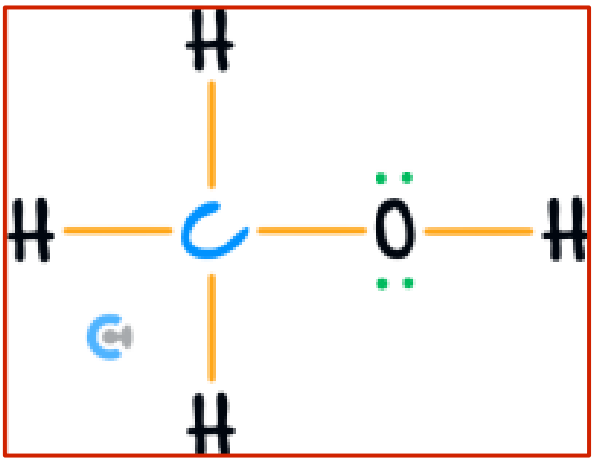
Question 11 (6 marks)

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)

It is polar, the strongest intermolecular bonding is hydrogen bonds because of the O – H bond which allows other electronegative atoms to approach closely to the H in the O – H bond.

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)

If there was a S atom bonded there instead, there would only be dipole-dipole attraction and no hydrogen bond because the S atom is not electronegative enough to isolate the H atom to allow for hydrogen bonding to commence.

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Question 12 (6 marks)

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

a. Methanol (CH_3OH). (1 mark)

Yes

b. CF_4. (1 mark)

No

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

Yes

d. NH_3. (1 mark)

Yes

e. HF. (1 mark)

Yes

f. CO_2. (1 mark)

Yes

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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)

Non-polar because there are no polar bonds as the C – H bond is non-polar.

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

Methanol has hydrogen bonding whereas octane does not, however octane has so many more atoms than methanol that the strength of octane's dispersion forces will outweigh the strength of methanol's hydrogen bonding with itself. As such, overall, the octane will have stronger intermolecular bonding and will have a higher boiling point.

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)

With octane- dispersion forces.
With methanol- hydrogen bond.

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)

When methanol is dropped into a beaker of H_2O, because they both form the same type of intermolecular bonding, hydrogen bonds, with itself, it is suspected that H_2O will also form hydrogen bonds with the methanol, whereas it is not possible for octane because it only forms dispersion forces.

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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}.

NaCl dissolves in water because water is polar and has dipoles whereas hexane does not. Due to hexane's inability to have dipoles, therefore it cannot form ion-dipole bonds to pull apart and dissolve the NaCl whereas H_2O can.

Question 15 (3 marks)

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

Hydrogen bonding is stronger than dipole dipole as it contains stronger partial charges that are closer together due to the exposed hydrogen. However, it is weaker than ion-dipole bonds as ion-dipole bonds contain a partial and a full charge but hydrogen bonds only have partial charges.

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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)

Ion-Dipole bonds have an electrostatic attraction between a partial charge and a full charge whereas dipole-dipole interactions only occur between partial charges. Hence, ion-dipole bonds will be stronger due to their greater charge

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

No, because ionic bonding is between two full charges whereas ion-dipole bonds involve a partial charge, hence, ionic bonding would be stronger than ion-dipole bonds. Furthermore, ionic bonding is intramolecular and not intermolecular

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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?

Solute is the substance that is being dissolved, whereas solvent is the liquid the solute is being dissolved in.

Question 18 (3 marks)

Write the dissolution reactions for the following:

a. NH_4NO_3. (1 mark)

$NH_4NO_3\ (l) \rightarrow NH_4^+\ (aq) + NO_3^-\ (aq)$

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

$Al_2(SO_4)_3\ (s) \rightarrow 2Al^{3+}\ (aq) + 3SO_4^{2-}\ (aq)$

Question 19 (3 marks)

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

$CaCO_3$ would first be surrounded by H_2O molecules, and as the H_2O molecules are dipoles, they will be attracted towards the cation component (Ca^{2+}) and the anion component CO_3^{2-}. Then the H_2O would form ion-dipole bonds with the respective ions, and eventually these bonds will overcome the ionic bond that holds $CaCO_3$ together and thus the ions will separate and dissociate. Once they dissociated and become surrounded by water molecules, $CaCO_3$ would have become completely dissolved

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)

Soluble as NO_3^- is a SNAPE ion

b. Na_2CO_3. (1 mark)

Soluble as Na^+ is a SNAPE ion

Question 21 (2 marks)

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

SNAPE does not tell you the extent to which a substance is soluble, it only says whether it generally is or is not.

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Question 22 (3 marks)

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

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

Insoluble

b. Potassium carbonate. (1 mark)

Soluble

c. Silver chloride. (1 mark)

Insoluble

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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:

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

A precipitate is formed was water is considered a precipitate as the ions have combined to form a new compound that is not itself soluble in water.

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)

$Mg^{2+}(aq) + SO_4^{2-}(aq) \rightarrow MgSO_4(s)$

ii. Spectator ions. (1 mark)

K^+ and Br^-

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

i. Ionic equation. (1 mark)

$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

ii. Spectator ions. (1 mark)

Na^+ and Cl^-.

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)

$AlPO_4\ (s) + AgNO_3\ (aq) \rightarrow Ag_3PO_4\ (s) + Al(NO_3)_3\ (aq)$

ii. Spectator ions. (1 mark)

Al^{3+} and NO_3^-.

iii. Precipitate. (1 mark)

Ag_3PO_4

b. Calcium chloride and sodium carbonate.

i. Full reaction. (1 mark)

$CaCl_2\ (aq) + Na_2CO_3\ (aq) \rightarrow CaCO_3\ (s) + 2NaCl\ (aq)$

ii. Spectator ions. (1 mark)

Na^+ and Cl^-.

iii. Precipitate. (1 mark)

$CaCO_3\ (s)$

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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)

Polar- Because F is electronegative and pulls electrons towards itself strongly.

b. NH_3. (2 marks)

Polar- Because the N is electronegative and pulls electrons from the H towards itself strongly, creating a dipole.

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)

Yes

b. C_6H_6 and H_2O. (1 mark)

No

c. CH_3OH and C_3H_8. (1 mark)

No

d. HCl and NH_3. (1 mark)

Yes

Question 28 (4 marks)

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

a. CH_3COOH. (2 marks)

Not soluble, as CH_3COOH is a polar compound.

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

This molecule is soluble despite having a $-OH$ in its structure, this is due to the length and size of the molecule, making it majorly non-polar, meaning it exhibits the same intermolecular bonding as the non-polar solvent.

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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)

Air- mobile, Filter- stationary.

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

TLC plate- stationary, Solvent- mobile.

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

Coffee- mobile, Straw- stationary.

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)

This means the substance will be more strongly adsorbed onto the stationary phase and weakly desorbed into the mobile phase, making it move slower and a lesser distance in the setup.

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

If the molar mass of a substance increases, its strength of dispersion forces increases. This will result in its desorption into the polar mobile phase weaker, and hence, adsorption onto the stationary phase stronger, making it move slower and lesser distance too as the size increases.

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)

Polar- because F is electronegative and pulls electrons towards itself strongly.

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

Polar- because the N is electronegative and pulls electrons from the H towards itself strongly, creating a dipole.

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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.

If a substance has high polarity, that means it will have weak intermolecular bonding to the non-polar mobile phase and therefore, will adsorb strongly onto the stationary phase instead, and will not travel far up the TLC plate.

Question 33 (2 marks)

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

$$C_2H_5OH, CH_2O, CH_4$$

Shortest Distance: C_2H_5OH, CH_2O, CH_4: Longest Distance

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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)

CH_3OH will travel the shortest distance as it is the most polar, and in the normal phase TLC, the mobile phase is non-polar and the stationary phase is polar. Therefore, CH_3OH will adsorb strongly onto the stationary phase and hence, will travel not very far.

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

CH_4 will travel the furthest as it is the most non-polar, meaning it will form the strongest intermolecular bonds with the non-polar mobile phase, making it travel further.

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)

No, the answers would be the exact opposite as the mobile phase would encourage polarity and vice versa.

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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

X- 0.405, Y- 0.676, Z- 0.571

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.

If a substance is more polar in this setup, that means it will adsorb more strongly onto the stationary phase and travel less of a distance. Therefore, when we calculate its R_f value it will be smaller.

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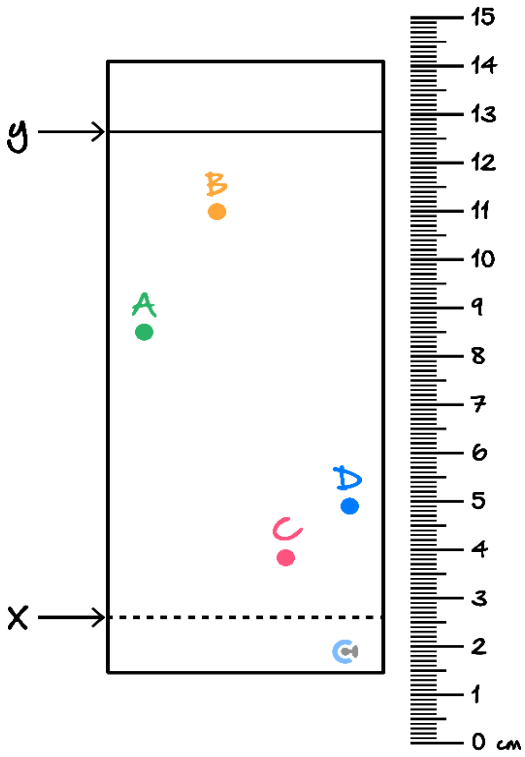
Question 37 (4 marks)

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)

Solvent front- $12.8 - 1.5 = 11.3$

A- $(8.5 - 1.5)/11.3 = 0.619$

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)

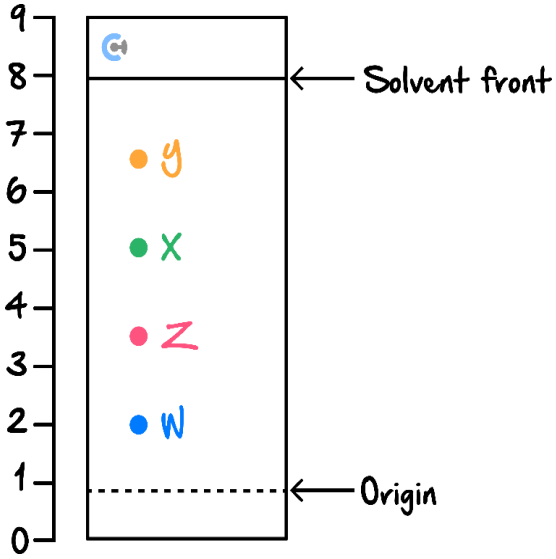
As this is reverse phase, the mobile phase is polar, and therefore, the second most polar component here would be CH_3Br. As component A travels the second furthest, this means CH_3Br would desorb relatively strongly into the mobile phase and hence, travel further.

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)

$4/7 = 0.571$

b. Substance Y. (1 mark)

$5.5/7 = 0.786$

c. Substance Z. (1 mark)

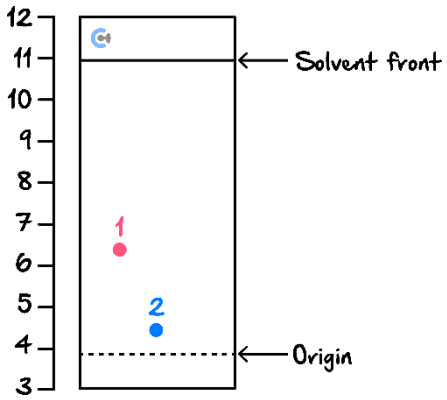
$2.5/7 = 0.357$

d. Substance W. (1 mark)

$1/7 = 0.143$

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)

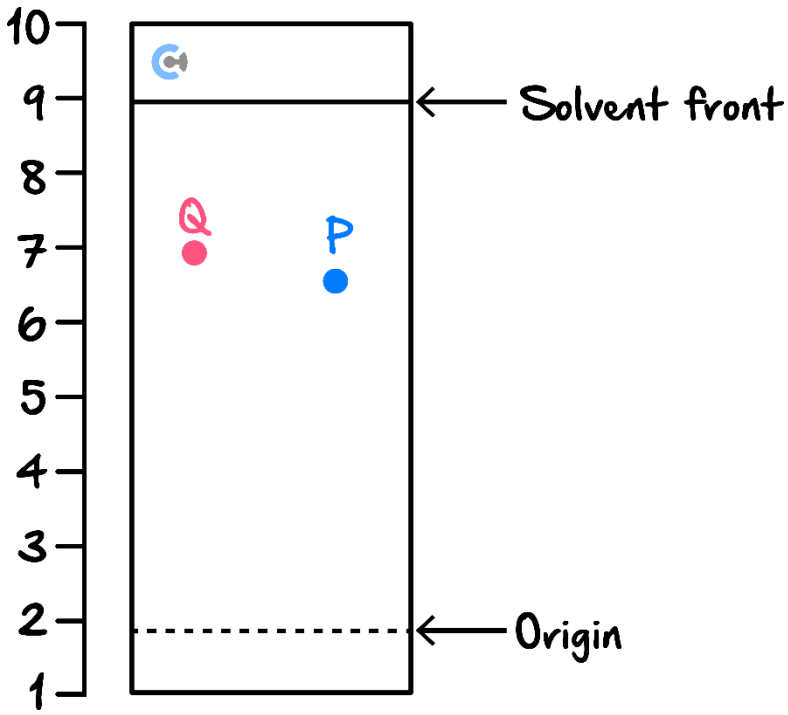
Yes, sample 1 does contain it.
$R_f = 0.35 \rightarrow 2.45 + 4\text{ (origin)} = 6.45$

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)

The distance would increase as they would desorb more strongly into the mobile phase and travel more.

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)

$Q = 5/7 = 0.714$
$P = 4.5/7 = 0.642$

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

Yes, sample P would have the compound.

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

Conditions of chromatography were the same.

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

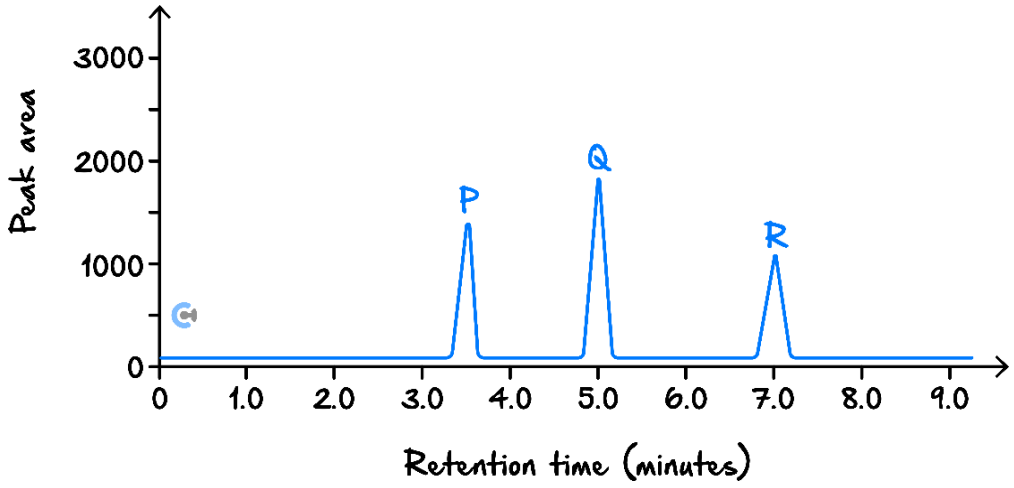
Question 41 (2 marks)

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.

In reverse phase HPLC, the mobile phase is polar and so if it has a high retention time, it spent more time in the column and hence, more strongly adsorbed onto the stationary phase.

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)

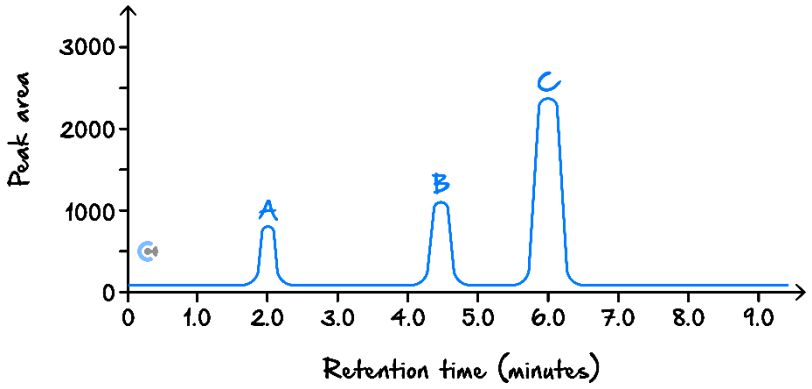
$P = 3.5\ mins, Q = 5.0\ mins, R = 7.0\ mins$

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

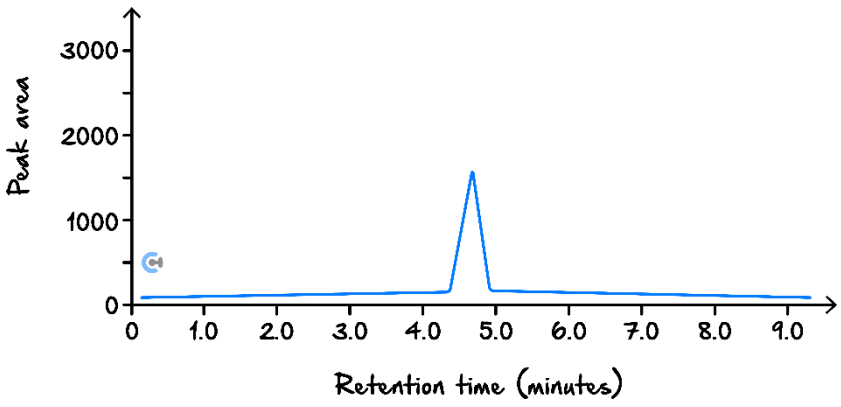
P = HC (most polar → attracted to mobile phase → least time in col)
l, R = C_2H_6 (most non-polar → attracted to stat phase → more time in col).

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)

4.5 *mins*

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

Peak *B*

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)

Yes, it is also in the fruit sample (peak C).

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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.

Quantitative aims to find the concentration of an unknown sample by leveraging the relative peak area output of a HPLC whereas qualitative analysis relies on the retention time output of a HPLC analysis to determine whether a chemical substance is present in a sample.

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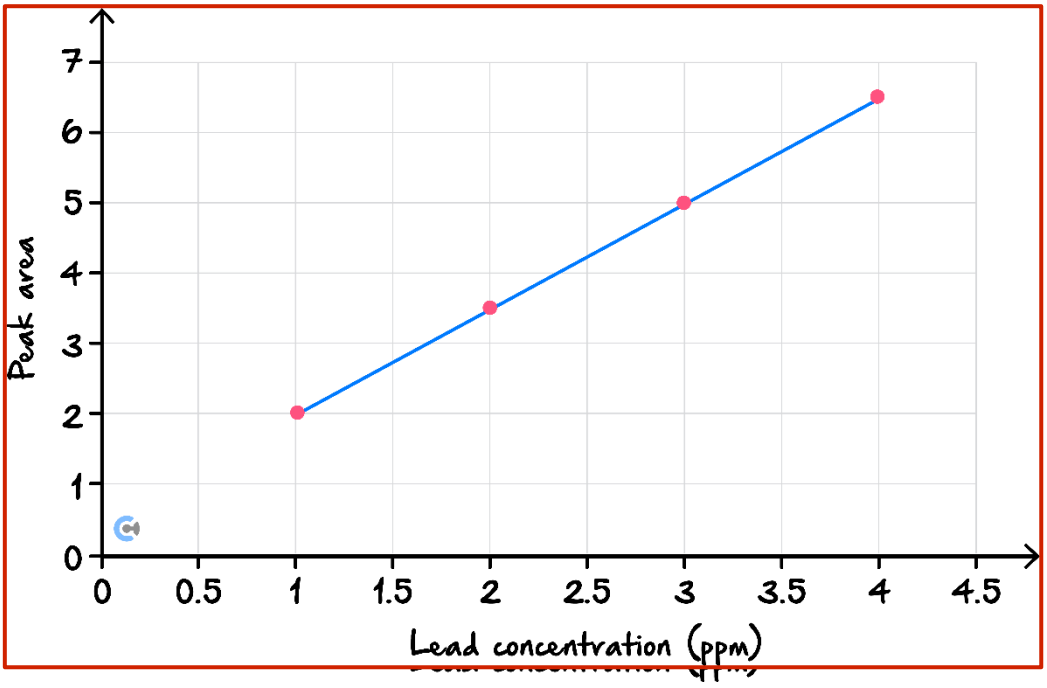
Question 45 (4 marks)

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)

Approx. 350 ppm

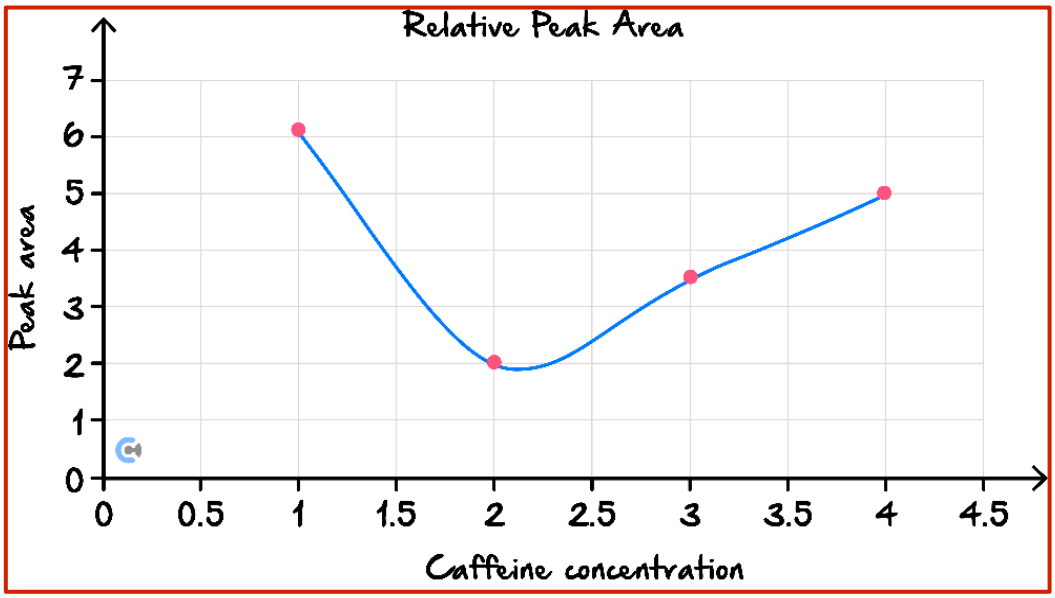
Question 46 (5 marks)

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)

Approximately 13 $mg\ /mL$

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

No, because the peak area only corresponds to caffeine so we have no information on aspartame.

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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.

Dispersion forces are a type of intermolecular bonding formed from temporary dipoles from electrons moving around randomly in a molecule.
If the two N_2 molecules are next to each other there will be a temporary dipole that causes one to be slightly positive and the other to be slightly negative, and when this happens electrostatic attraction between them forms, creating dispersion forces.

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.

CH_3Cl will have a higher boiling point as the Cl results in the compound being polar, forming dipole-dipole attractions instead of only dispersion forces. This means that CH_3Cl's overall intermolecular bond strength is greater than CH_4, hence it requires more energy to break it and therefore it will have a higher boiling point.

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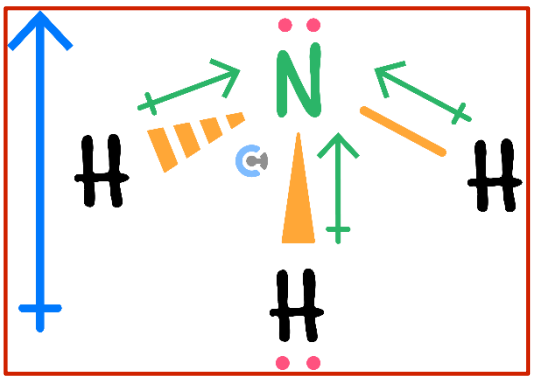
Question 49 (3 marks)

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



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)

$HCl(l) \rightarrow H^+(aq) + Cl^-(aq)$
(with water on top of the reaction arrow) Dissociation/Ionisation reaction.

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

HCl was previously undergoing covalent bonding but after dissociating it is technically considered ionic because the H and the Cl have been ionised.

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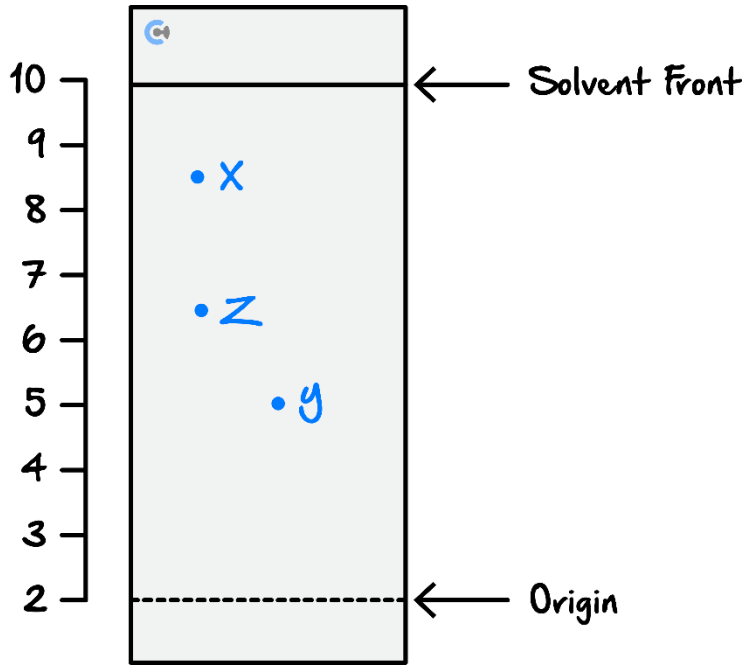
Question 51 (4 marks)

Consider the following chromatogram.



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

$X = 8.5 - 2/10 - 2 = 0.8125$
$Y = 5 - 2/10 - 2 = 0.375$
$Z = 6.5 - 2/10 - 2 = 0.5625$

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

Most polar: X, Z, Y (least polar)

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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)

Exact same chromatography conditions.

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

Retention time would be on average larger, because the components will spend more time travelling through the column if all other conditions are held the same.

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.

The student is incorrect as even though the individual $C = O$ bonds are polar due to the electronegativity difference between carbon and oxygen, because the two $C = O$ bonds are positioned opposite to each other, they will pull in opposite directions and hence, cancel out. This makes CO_2 non-polar overall.

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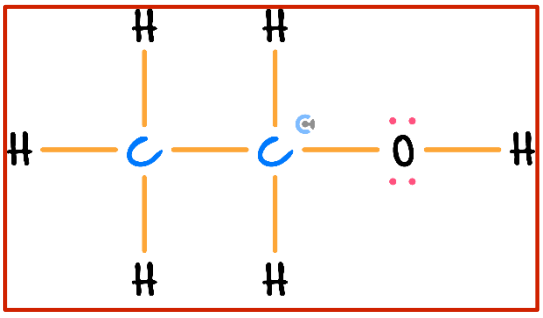
Question 54 (6 marks)

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)

Ethanol is polar and it can form hydrogen bonds as its strongest form of intermolecular bonding due to the O connected to the H.

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

It can no longer form hydrogen bonds but can form dipole-dipole interactions instead. Which would make its overall intermolecular bond strength weaker.

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Question 55 (7 marks)

Consider the substance of KBr.

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

Ionic

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

$KBr(aq) \rightarrow K^+(aq) + Br^-(aq)$

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

The KBr will be surrounded by water molecules, and the positive end of the water (H) will form ion-dipole bonds with the Br^- and the oxygen end of water will form the same with the K^+ of the KBr lattice. These ion-dipole bonds will overpower the ionic bonding that exists within the lattice, and this will cause the lattice to be dismantled and the individual ions of K^+ and Br^- will separate, making KBr dissolved in water.

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

As AgBr is not part of SNAPE and is not part of the soluble compounds in the solubility tables, this is not soluble. This means that the ionic bonding within AgBr is stronger than the ion-dipole bonds that the ions in AgBr forms with the H_2O molecules, meaning it is insoluble.

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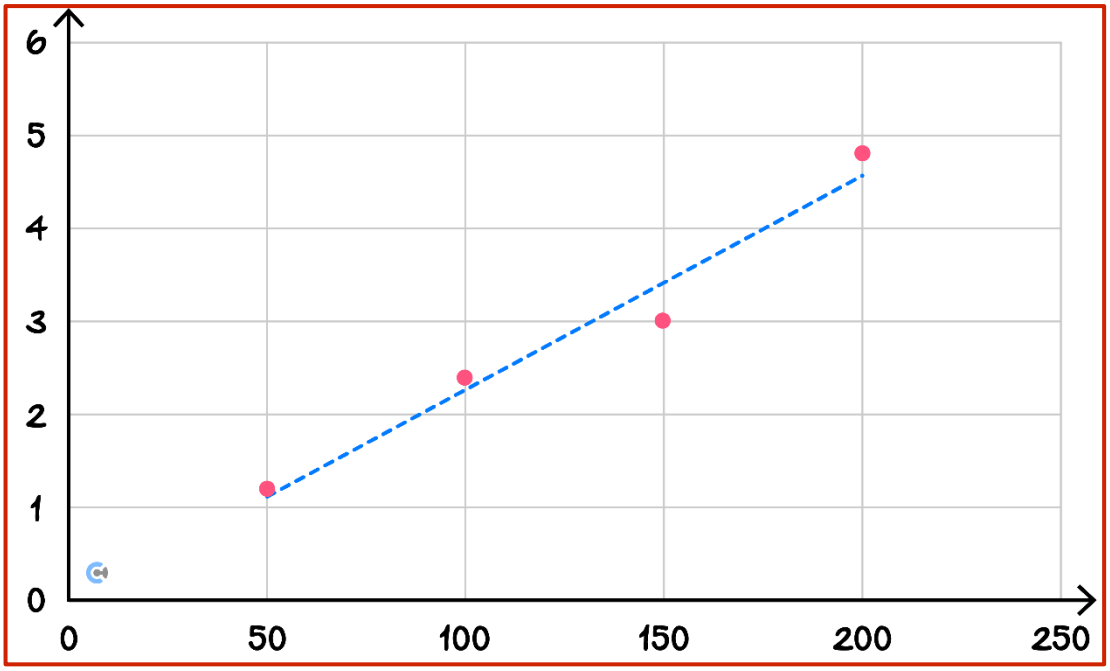
Question 56 (4 marks)

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)

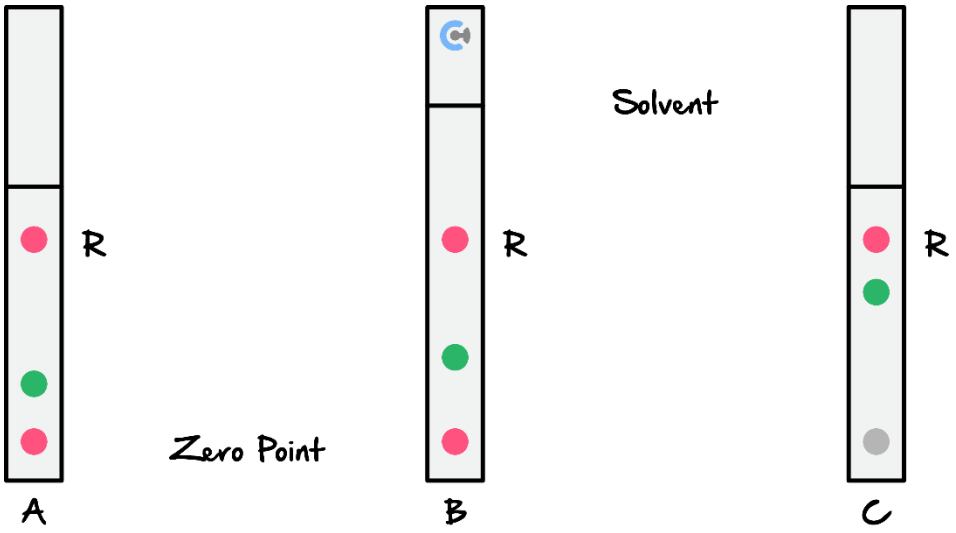


b. Use your calibration curve to determine the mercury concentration in the water sample. (2 marks)

Approx. $160 - 165\ ppm$

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)

The units do not matter* because a ratio is being calculated (if you make both measurements in the same unit)*.

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)

It will not be the same as the R_f value is different for both spots*.

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

We have no way of knowing because a different solvent is used. Further testing would be required*.

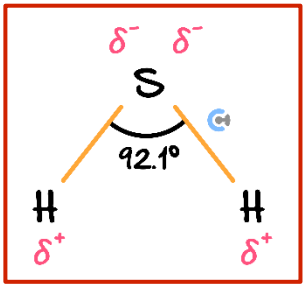
d. The other spot shown in each sample is yellow. Which dye, out of yellow and red, is likely to be the more polar? Explain your answer. (2 marks)

Yellow is probably less polar as it does not move as far in a polar solvent as red*.

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)

As S is more electronegative than H, it will pull the electrons in the bonds towards itself causing an imbalanced electron distribution. This causes the S-end of the molecule to become partially negative and the H-ends to become partially positive creating a dipole. Hence, H_2S is polar.

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)

Both of their geometries will be V-Shaped but it will be more polar than H_2S since the electronegativity difference of the atoms in NOCl are much greater than that of H_2S.

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

As the electronegativity difference between $N-O$ is greater than that of $Cl-O$, we say that $N-O$ is a more polar bond as the electron distribution will be more imbalanced.

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

H_2S would have a lower boiling point than H_2O because it cannot form hydrogen bonds in the same way that H_2O can, therefore its overall intermolecular bonding will be weaker due to only having dipole-dipole attractions. Thus, H_2O will require more energy to break those bonds and hence, will have a higher boiling point than H_2S.

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