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**Semester Two**

**Examination 2024**

**Question/Answer booklet**

**CHEMISTRY**

**UNITS 1 & 2**

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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***TIME ALLOWED FOR THIS PAPER***

Reading time before commencing work: Ten minutes

Working time for the paper: Two and a half hours

***MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER***

**To be provided by the supervisor:**

This Question/Answer Booklet

Multiple-choice Answer Sheet

Chemistry Data Book

**To be provided by the candidate:**

Standard items: pens, pencils, eraser or correction fluid, ruler, highlighter.

Special items: calculators satisfying the conditions set by the SCSA for this subject.

***IMPORTANT NOTE TO CANDIDATES***

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

**Structure of this paper**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Section | Number of questions available | Number of questions to be answered | Suggested working time  (minutes) | Marks available | Percentage of exam |
| Section One:  Multiple-choice | 25 | 25 | 30 | 25 | 25 |
| Section Two:  Short answer | 9 | 9 | 50 | 62 | 35 |
| Section Three:  Extended answer | 4 | 4 | 70 | 74 | 40 |
|  |  |  |  | **Total** | 100 |
| Final percentage | | x 25 + x 35 + x 40 = | | | % |

**Instructions to candidates**

1. Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Sections Two and Three: Write your answers in this Question/Answer Booklet.

2. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

3. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

4. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

* + Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
  + Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

5. The Chemistry Data Book is **not** handed in with your Question/Answer Booklet.

**Section One: Multiple-choice 25% (25 marks)**

This section has **25** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 30 minutes.

**Questions 1 and 2 refer to the following information.**

Potassium ions (K+) produce a distinctive lilac colour in a flame test. Potassium is an essential nutrient for plant growth, and flame tests are a quick way to detect the presence of potassium salts in soil.

1. The lilac colour emitted by potassium ions is produced when electrons move

1. from a metal to a non-metal.
2. from the electron cloud to the nucleus.
3. to an energy level further from the nucleus.
4. to an energy level closer to the nucleus.

2. Which of the following subatomic particle arrangements could represent an excited potassium ion?

1. 2, 8, 8
2. 2, 8, 8, 1
3. 2, 8, 7, 1
4. 2, 8, 7, 1, 1

3. Which of the following has the **least** impact on the first ionisation energy of an element?

1. Number of protons.
2. Number of neutrons.
3. Number of electrons.
4. Distance of valence shell from nucleus.

4. Which of the following correctly identifies a pure substance and a mixture?

**Pure substance Mixture**

(a) lithium nitrate petrol

(b) water sulfur trioxide

(c) chromium(III) chloride heptane

(d) steel air

**Questions 5 and 6 refer to the following information.**

Consider the **unbalanced** equations below, representing the combustion of pentane and pentene.

\_\_\_ C5H12(l) + \_\_\_ O2(g) ® \_\_\_ CO2(g) + \_\_\_ H2O(g) + 3509 kJ

\_\_\_ C5H10(l) + \_\_\_ O2(g) ® \_\_\_ CO2(g) + \_\_\_ H2O(g) + 6700 kJ

5. If an equal number of moles of pentane and pentene were combusted, this would result in

(a) the same number of moles of oxygen being consumed.

(b) the same number of moles of carbon dioxide being produced.

(c) the same number of moles of water vapour being produced.

(d) the same quantity of energy being produced.

6. Pentane is obtained from crude oil. Crude oil is classified as

(a) a renewable biofuel.

(b) a non-renewable biofuel.

(c) a renewable fossil fuel.

(d) a non-renewable fossil fuel.

**Questions 7 and 8 refer to the information in the table below.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Fluoromethane, CH3F | Chloromethane, CH3Cl | Bromomethane, CH3Br | Iodomethane, CH3I |
| Structure |  |  |  |  |
| Boiling point (°C) | -78.4 | -24.2 | 3.56 | 42.4 |

7. How many of these compounds exhibit hydrogen bonding?

1. 0
2. 1
3. 2
4. 4

8. Identify the most polar compound, and the compound with the strongest intermolecular forces.

**Most polar Strongest intermolecular forces**

1. CH3F CH3F
2. CH3F CH3I
3. CH3I CH3F
4. CH3I CH3I

**Questions 9, 10 and 11 refer to the following information.**

Consider the following chemical equation, representing the reaction that takes place between aqueous potassium hydroxide and ammonium nitrate solutions.

KOH(aq) + NH4NO3(aq) ® KNO3(aq) + NH3(aq) + H2O(l)

A piece of red litmus paper was placed in the beaker at the same time as the **reactants** were mixed. It immediately turned blue.

Upon completion of the reaction, another piece of red litmus paper was added to the final **products**. It also immediately turned blue.

You may assume equal moles of reactants were mixed.

9. Identify the species responsible for causing the colour change of the litmus paper when the **reactants** were tested.

1. K+(aq)
2. OH-(aq)
3. NH4+(aq)
4. NO3-(aq)

10. Identify the species responsible for causing the colour change of the litmus paper when the **products** were tested.

1. K+(aq)
2. NO3-(aq)
3. NH3(aq)
4. H2O(l)

11. Identify the spectator ions in this reaction.

1. K+(aq)
2. OH-(aq)
3. NH4+(aq)
4. NO3-(aq)
5. (i) and (ii) only.
6. (ii) and (iii) only.
7. (i) and (iv) only.
8. (iii) and (iv) only.

12. If a chemical reaction results in the emission of light, this indicates that the reaction

1. has a large activation energy.
2. has a large enthalpy change.
3. occurs very quickly.
4. is exothermic in nature.

**Questions 13 and 14 refer to the information below.**

Thin layer chromatography (TLC) can be used in the authentication and dating of artworks, by analysing the composition of the paint utilised.

Paint consists of two ingredients; the pigment for colour, and the binder to hold the paint together which allows it to spread and dry. Analysis of old paintings has found that artists used substances such as eggs, glue (containing casein) and vegetable oil in their binders.

A chemist took a paint sample from an artwork and analysed the composition of the binder using TLC. They spotted a sample onto two (2) identical plates, X and Y, but then placed each in a different solvent; one in toluene, one in ethanol.

|  |  |
| --- | --- |
| Toluene, C7H8 | Ethanol, C2H5OH |
|  |  |

The results of the TLC analysis are shown below.

**Plate X Plate Y**

solvent: toluene solvent: ethanol

10

9

8

7

6

5

4

3

2

1

0 cm

X

*solvent front*

**A**

**B**

**C**

**D**

*sample*

*line*

X

*solvent front*

*sample*

*line*

13. Which component of the binder is the most polar, and which component exhibits the strongest interactions with the stationary phase?

**Most polar Strongest stationary phase interactions**

1. A A
2. A D
3. D A
4. D D

In order to identify the components of the binder, the chemist compared their data to a TLC control plate, which had also used an ethanol solvent.

X X X X

*solvent front*

*sample*

*line*

Egg white Egg yolk Linseed oil Casein

Rf 0.58

Rf 0.47

Rf 0.89

Rf 0.77

Rf 0.60

Rf 0.70

Rf 0.58

Rf 0.38

Rf 0.13

Rf 0.94

Rf 0.41

Rf 0.30

14. One of the components of the binder used by this artist is most likely to be

(a) egg white.

(b) egg yolk.

(c) linseed oil.

(d) casein.

**Questions 15 and 16 refer to the graph below.**

Consider the information presented in the following solubility graph.

|  |  |  |  |  |  |  |  |  |  |
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0 10 20 30 40 50 60 70 80 90 100

Temperature (°C)

Solubility (g of salt in 100 g water)

100

90

80

70

60

50

40

30

20

10

0

KNO3

NH4Cl

15. If 175 g of KNO3(s) was mixed with 350 g of water at 30 °C, the resulting solution would be

1. unsaturated, with no solute left undissolved.
2. saturated, with no solute left undissolved.
3. saturated, with some solute undissolved.
4. supersaturated, with some solute undissolved.

16. When NH4Cl(s) dissolves in water, it produces a small amount of hydrogen ions, H+(aq). A 45 g sample of NH4Cl(s) was mixed with 100 g of water at 20 °C. The mixture was then slowly heated to 80 °C, whilst stirring, and the pH was constantly monitored.

Which of the following pH values are **most likely** for the various solution temperatures?

**20 °C 50 °C 80 °C**

1. pH 2 pH 3 pH 3
2. pH 3 pH 4 pH 5
3. pH 6 pH 5 pH 4
4. pH 5 pH 4 pH 4

17. Consider the table below.

|  |  |
| --- | --- |
| Name | Chemical formula |
| **X** | CuBr2 |
| sodium hydrogenphosphate | **Y** |
| carbonic acid | **Z** |

Which of the following correctly completes this table?

**X Y Z**

1. copper(II) bromide NaH2PO4 H2CO2
2. copper(I) bromide Na2HPO4 H2CO2
3. copper(II) bromide Na2HPO4 H2CO3
4. copper(I) bromide NaH2PO4 H2CO3

18. Isotopes of an element will always have the same

1. number of protons.
2. number of neutrons.
3. number of electrons.
4. atomic number.
5. mass number.
6. electron configuration.
7. (i), (ii) and (v) only.
8. (i), (iii), (iv) and (v) only.
9. (i), (iii), (iv) and (vi) only.
10. (ii), (iii), (v) and (vi) only.

19. The gas canisters below each held an equal number of moles (n) of the same gas.

**Canister A Canister B**

n

n

V = 10 L

T = 400 K

V = 5 L

T = 200 K

The pressure in Canister A would be

1. higher than Canister B.
2. lower than Canister B.
3. the same as Canister B.
4. dependent upon the identity of the gas.

**Questions 20 and 21 refer to the following information.**

Consider the information regarding trichloromethane and methanol in the table below.

|  |  |  |
| --- | --- | --- |
|  | Trichloromethane | Methanol |
| Formula | CHCl3 | CH3OH |
| Structure |  |  |
| Boiling point (°C) | 61.2 | 64.7 |

20. Which of the following correctly identifies the substance with the strongest dispersion forces, and the substance with the highest vapour pressure?

**Strongest dispersion forces Highest vapour pressure**

1. trichloromethane trichloromethane
2. trichloromethane methanol
3. methanol trichloromethane
4. methanol methanol

21. Distillation could **not** be used to separate a mixture of trichloromethane and methanol because they

1. are highly polar substances.
2. are both liquids at room temperature.
3. have similar boiling points.
4. do not conduct electricity.

22. Which of the following is the correct IUPAC name for the compound whose structural formula is shown below?

Cl C3H7

CH3 - CH - CH - CH2 - CH3

(a) 2-chlorooctane

(b) 2-chloro-3-ethylhexane

(c) 5-chloro-3-ethylhexane

(d) 2-chloro-3-propylpentane

23. Citric acid is a weak acid for which of the following reasons?

(a) It is only slightly soluble in water.

(b) It contains very few hydrogen atoms.

(c) It is only partially ionized in water.

(d) It is fully ionized when dissolved in water.

24. When ethanol (C2H5OH) dissolves in water, the surface tension of this mixture is lower than that of pure water. This is primarily because the

(a) molecular shape of water is altered.

(b) hydrogen bonding between water is disrupted.

(c) density of water has been increased.

(d) solution contains only non-electrolytes.

25. Which of the following statements about catalytic converters is **not** correct?

1. They reduce the amount of unburnt petrol emitted.
2. They reduce the amount of nitrogen oxides emitted.
3. They increase the rate of chemical reactions.

(d) They increase the energy content of the fuel being combusted.

**End of Section One**

**Section Two: Short answer 35% (62 marks)**

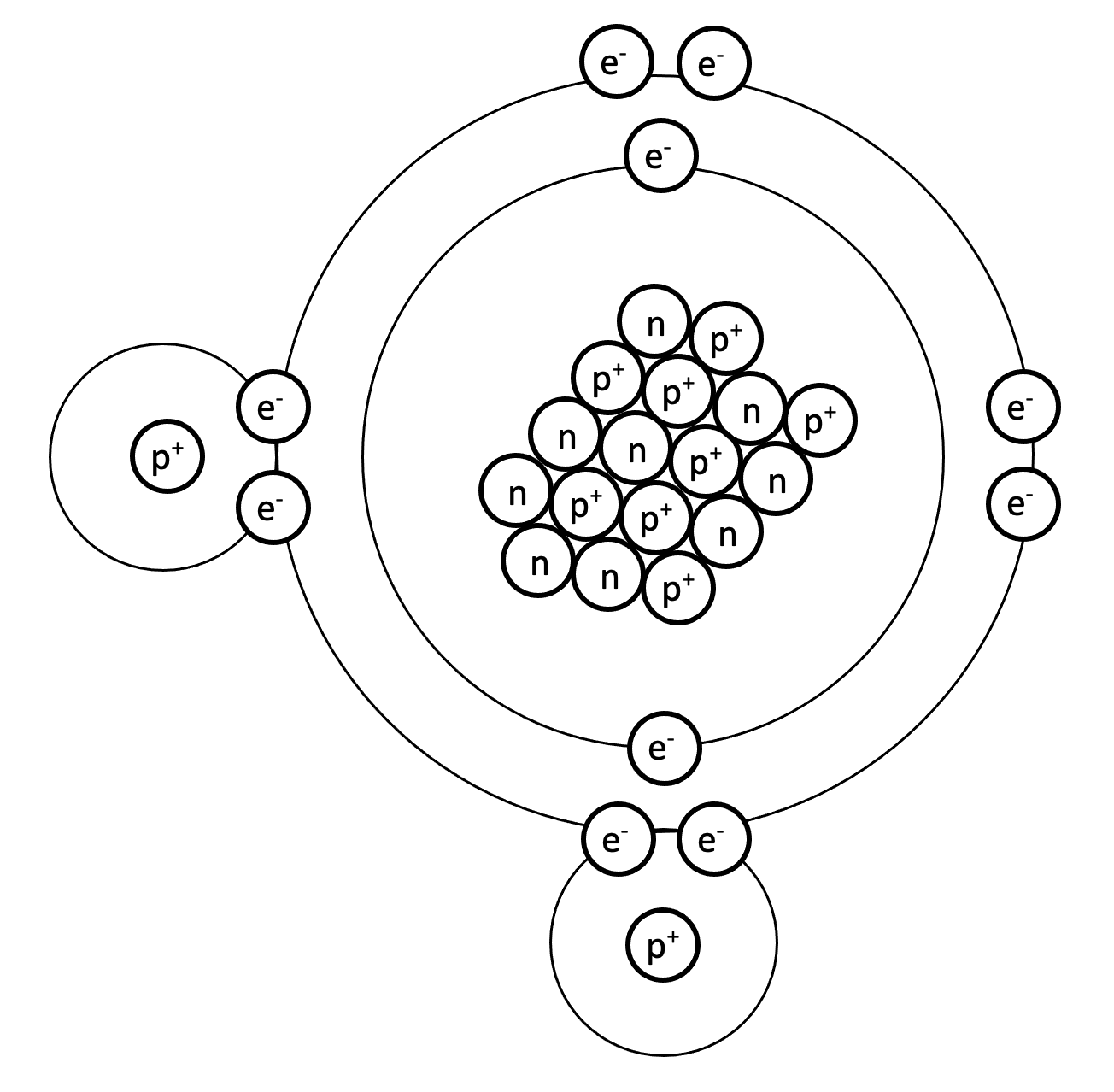
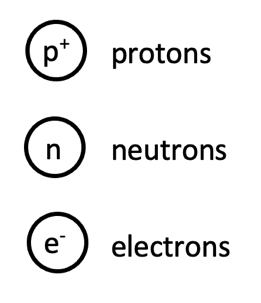
This section has **nine (9)** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 50 minutes.

**Question 26 (4 marks)**

Consider the diagram of the molecule below.



(a) Name this molecule. (1 mark)

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(b) List the individual atoms in this molecule, using the notation AX. (2 marks)

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(c) State the reason, in terms of electron arrangement, why these individual atoms formed chemical bonds to create this molecule. (1 mark)

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**Question 27 (6 marks)**

Scented candles are often hand-poured into decorative glass jars to be sold. Both the candle wax and the glass jar are composed of covalent substances, though their properties differ greatly.

(a) Describe how covalent bonding is formed. (2 marks)

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(b) Explain, in terms of structure and bonding, why candle wax and glass exhibit such different physical strength. (4 marks)

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**Question 28 (8 marks)**

A chemistry student was given two (2) unlabelled beakers containing colourless solutions. The student was tasked with identifying the solutions.

The identities of the solutions were known to be;

* sodium carbonate, Na2CO3(aq)
* sodium sulfide, Na2S(aq)

The student decided to add a few drops of silver nitrate solution to each beaker to distinguish between the two solutions.

(a) Explain how this would allow identification of each solution. Your answer should include any relevant chemical equations. (4 marks)

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An alternative test the student could have used to distinguish the chemicals, would have involved the addition of a few drops of hydrochloric acid to each solution.

The reaction that would occur in the beaker containing sodium sulfide solution would produce a characteristic ‘rotten egg gas’ odour. The chemical equation for this reaction is shown below.

Na2S(aq) + 2 HCl(aq) ® 2 NaCl(aq) + H2S(g)

(b) Write a balanced ionic equation, and corresponding observations, for the reaction that would have taken place when hydrochloric acid was added to the beaker containing sodium carbonate solution. (4 marks)

|  |
| --- |
| Equation |

Observations

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Question 29 (6 marks)**

Complete the following table by identifying the element that matches the description, and writing the corresponding electron configuration for that element.

|  |  |  |
| --- | --- | --- |
| Description | Name of element | Electron configuration |
| The metallic element, with 2 valence electrons, that has an atomic radius smaller than argon. |  |  |
| The element, with valence electrons in the n=3 (third) shell, that has the highest electronegativity. |  |  |
| The element, with the highest first ionisation energy, that forms anions with a 3- charge. |  |  |

**Question 30 (8 marks)**

Consider the energy profile diagram below.

**E**

**D\D**

**C**

Enthalpy (kJ mol-1)

Progress of reaction

**A**

**B**

**F**

(a) Which letter (A-F) represents each of the following. (4 marks)

|  |  |
| --- | --- |
|  | Letter |
| The activation energy of the reverse reaction. |  |
| The enthalpy of the transition state. |  |
| The enthalpy change of the forward reaction. |  |
| The enthalpy of the products. |  |

(b) Classify the reaction as endothermic or exothermic. (1 mark)

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(c) As this reaction progresses, identify whether heat energy is absorbed from, or released to, the surroundings (circle your choice). Justify how this can occur whilst satisfying the Law of Conservation of Energy. (3 marks)

heat absorbed from surroundings **or** heat released to surroundings

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**Question 31 (5 marks)**

Sodium thiosulfate, Na2S2O3, can be used to destroy excess chlorine left over from textile bleaching. The chemical equation for this reaction is shown below.

Na2S2O3(aq) + 4 Cl2(g) + 5 H2O(l) ® 2 NaHSO4(aq) + 8 HCl(aq)

A 7.22 g sample of sodium thiosulfate was dissolved into 215 L of water.

Calculate the volume of chlorine gas, at STP, that could be destroyed. State your answer to the appropriate number of significant figures. (5 marks)

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**Question 32 (12 marks)**

(a) Complete the following table by either writing the IUPAC name or drawing a structural diagram of the organic compound. (6 marks)

|  |  |
| --- | --- |
| **Structural diagram** | **IUPAC Name** |
|  |  |
|  | 3-ethylpent-2-ene |
|  |  |

(b) What are isomers? (2 marks)

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(c) Draw two isomers of the compound shown below. (4 marks)



**Question 33 (7 marks)**

High-performance liquid chromatography (HPLC) was used to study the carbohydrate profile of different types of yoghurt, by analysing which sweeteners each contained.

Information about the relevant carbohydrate sweeteners is provided in the following table.

|  |  |  |
| --- | --- | --- |
| Peak | Carbohydrate / Sweetener | Carbohydrate description |
| 1 | sucrose | common table sugar |
| 2 | lactose | a sugar found in milk / dairy products |
| 3 | glucose | a sugar made by plants during photosynthesis |
| 4 | galactose | a component of lactose, found in dairy products |
| 5 | fructose | a sugar found in fruits |

Samples of plain yoghurt, strawberry yoghurt and blueberry yoghurt were analysed under identical HPLC conditions. The chromatograms for each are shown below.

**Chromatogram A Chromatogram B Chromatogram C**

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Retention time (min)

Absorbance units

0.8

0.7

0.6

0.5

0.4

0.3

0.2

0.1

0

2

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Retention time (min)

Absorbance units

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Retention time (min)

Absorbance units

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(a) Identify the carbohydrate / sweetener that exhibits the strongest interactions with the stationary phase. Justify your choice. (3 marks)

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(b) Identify which chromatogram (A, B or C) is likely to represent plain yoghurt. Justify your answer. (2 marks)

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The following calibration curve can be used to quantify the concentration of galactose in a sample.

(c) Identify which chromatogram (A, B or C) represented the yoghurt with the lowest concentration of galactose. (1 mark)

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(d) Using the calibration curve above, determine the concentration of galactose, in parts per million, in this yoghurt sample. (1 mark)

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**Question 34 (6 marks)**

Acetylsalicylic acid (C9H8O4), also known as aspirin, is a weak, monoprotic acid.

(a) Define an acid according to the Arrhenius theory. (1 mark)

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(b) Define the term ‘weak’ as it relates to the nature of an acid. (1 mark)

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(c) Write an equation which illustrates acetylsalicylic acid behaving as a weak acid. (2 marks)

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(d) Calculate the percentage by mass of carbon in acetylsalicylic acid. (2 marks)

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**End of Section Two**

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**Section Three: Extended answer 40% (74 marks)**

This section contains **four (4)** questions. You must answer **all** questions. Write your answers in the spaces provided below.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 70 minutes.

**Question 35 (17 marks)**

A powdered mixture of magnesium hydroxide, Mg(OH)2(s), and magnesium chloride, MgCl2(s), was weighed and found to have a mass of 2.91 g.

An excess of distilled water was then added to this powdered sample, and the mixture was stirred for 5 minutes. The resulting mixture was poured through a funnel lined with filter paper, as illustrated in the diagram below.

Compound A

filtrate had a final volume of 115 mL, with Mg2+(aq) concentration of 0.121 mol L-1

dry residue was transferred to a clean beaker

Compound B

(a) Label the identity of the residue (Compound A) and the filtrate (Compound B) in the boxes on the diagram above. Include state symbols for each. (2 marks)

The residue was washed several times with distilled water, resulting in a final filtrate volume of 115 mL. The concentration of magnesium ions in the filtrate was determined to be 0.121 mol L-1.

The residue was dried and completely transferred to a clean beaker. A sample of 0.274 mol L-1 HCl(aq) was then poured over the residue.

(b) Write a balanced molecular equation for the reaction that would take place. (2 marks)

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(c) Calculate the mass of compound B in the filtrate. (2 marks)

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(d) Calculate the volume of HCl(aq) that would be required to react with all of the residue. (4 marks)

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The calculated minimum volume of HCl(aq) was added to the residue, and upon completion of the reaction, no residue was present. This reaction mixture was then added to the beaker containing the filtrate.

(e) Calculate the concentration of chloride ions present in this final mixture. (4 marks)

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(f) Draw a labelled diagram, showing the predominant forces acting between the chloride ions and the surrounding water molecules in this mixture. (3 marks)

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**Question 36 (17 marks)**

Nitrogen trichloride, NCl3, is an oily, yellow and pungent-smelling liquid at room temperature. It is one of the chemicals that can contribute to the ‘chlorine smell’ associated with swimming pools. This is because it forms due to the reaction of hypochlorous acid with ammonia, as shown in the equation below.

3 HOCl(aq) + NH3(aq) ® NCl3(aq) + 3 H2O(l)

(a) Complete the following table by drawing Lewis structures, and stating the shape of both the hypochlorous acid and nitrogen trichloride molecules. (4 marks)

|  |  |  |
| --- | --- | --- |
|  | Lewis structure diagram | Shape |
| HOCl |  |  |
| NCl3 |  |  |

(b) Briefly outline the valence shell electron pair repulsion (VSEPR) theory, and describe how it can be applied to predict each of the shapes in part (a). (4 marks)

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Consider the information provided in the following table.

|  |  |  |
| --- | --- | --- |
|  | Boiling point (°C) | Solubility in water |
| NCl3 | 71 | insoluble |
| NH3 | -33 | readily dissolves |

(c) Explain, in terms of intermolecular forces, why the boiling point of NCl3 is higher than that of NH3. (4 marks)

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(d) Explain, in terms of intermolecular forces, why NCl3 and NH3 display such different solubilities in water. (5 marks)

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**Question 37 (19 marks)**

A chemistry teacher gave her class four separate solutions labelled A, B, C and D. The identities of the solutions were;

* 0.15 mol L-1 HNO3(aq)
* 0.15 mol L-1 K2CO3(aq)
* 0.15 mol L-1 Ba(OH)2(aq)
* 0.15 mol L-1 Na2SO3(aq)

She then asked the students to design and perform an investigation that would correctly identify A, B, C and D.

The students decided to mix a small amount of each solution with each of the other three solutions. They drew up a table and recorded their results. The initial data they collected is shown below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **A** | **B** | **C** | **D** |
| **A** |  | white precipitate formed | no change observed | no change observed |
| **B** |  |  | colourless gas produced | no change observed |
| **C** |  |  |  | colourless gas produced |
| **D** |  |  |  |  |

a) Which two solutions must have been mixed to produce the white precipitate? Write a balanced ionic equation for this reaction, include states. (4 marks)

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Two different solution combinations (C + D and B + C) produced colourless gases.

b) Write balanced chemical equations showing how each of these gases was produced. (7 marks)

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One group of students had noted an additional observation which they shared with the class.

“The gas produced from the reaction between A + D had a pungent odour.”

c) Identify each of the four original solutions. (4 marks)

Solution A: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Solution B: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Solution C: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Solution D: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d) Define ‘acids’ and ‘bases’ according to the Arrhenius theory. Give an example of each and give any necessary equations. (4 marks)

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**Question 38 (21 marks)**

Copper can be extracted from its sulfide ore by reacting it with nitric acid. One of the steps in this extraction process is shown in the chemical equation below.

3 CuS(s) + 8 HNO3(aq) ® 3 CuSO4(aq) + 8 NO(g) + 4 H2O(l)

(a) State three (3) observations that would be noted as this reaction took place. (3 marks)

|  |  |
| --- | --- |
| 1 |  |
| 2 |  |
| 3 |  |

(b) Explain, using collision theory, two ways that the rate of this reaction could be increased. (6 marks)

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A 612 kg sample of 93.3% pure copper(II) sulfide was crushed and placed into a tank containing 6500 L of nitric acid.

(c) Calculate the concentration of nitric acid required, to ensure all the copper(II) sulfide reacts. (4 marks)

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As the reaction was taking place in the tank, the conductivity of the mixture was monitored. Both the initial reaction mixture, as well as the final product mixture, were noted to conduct electricity. This was due to the presence of HNO3(aq) and CuSO4(aq) respectively.

(d) Complete the table below, by drawing Lewis structures for both compounds. (4 marks)

|  |  |
| --- | --- |
| HNO3 | CuSO4 |
|  |  |

(e) Explain why each of these substances conduct electricity when dissolved in aqueous solution. Distinguish between the processes of dissociation and ionisation in your response. (4 marks)

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**End of questions**

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