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| --- | --- |
| C:\Users\s.kanakis\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\ACC Logo_L_rgb_lrg.jpg | **Aranmore Catholic College**  **Chemistry Examination, 2012**  **Question/Answer Booklet** |

Please place your student identification label in this box

CHEMISTRY

**Stage 3**

Student Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Student’s Teacher \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

#### Time allowed for this paper

Reading time before commencing work: ten minutes

Working time for paper: three hours

**Materials required/recommended for this paper**

To be provided by the supervisor

This Question/Answer Booklet

Multiple-choice Answer Sheet

Chemistry Data Sheet

***To be provided by the candidate***

Standard items: pens, pencils, eraser, correction fluid/tape, ruler, highlighters

Special items: non-programmable calculators satisfying the conditions set by the Curriculum Council for this course

**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 | 50 | 25 | 25 |
| Section Two:  Short answer | 9 | 9 | 60 | 70 | 35 |
| Section Three:  Extended answer | 6 | 6 | 70 | 80 | 40 |
|  | | | | | 100 |

**Instructions to candidates**

1. The rules for the conduct of examinations at Aranmore are detailed in the *Examination Information Handbook 2012.* Sitting this examination implies that you agree to abide by these rules.

2. 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, do not erase or use correction fluid, and shade your new answer. 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.

3. When calculating numerical answers, show your working or reasoning clearly, unless instructed otherwise.

4. 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.

5. 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.

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

This section has **25** questions. Answer **all** question on the separate Multiple-choice Answer Sheet provided. For each question place a line to indicate your answer. Use only a blue or black pen. If you make a mistake, place a cross through that square, do not erase or use correction fluid, and use a line to indicate your new answer. 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: 50 minutes.

***\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

1. In which of the following alternatives do the species listed have the same electronic configuration?

(a) Ca2+, Ar, Cl-

(b) S2-, Ne, Cl

(c) S, Ar, K

(d) Ca2+, K+, Ne

1. Which of the following is the best description of bonding in NaF?

(a) Electrostatic attraction between ions, electrons and nuclei.

(b) Electrostatic attraction between oppositely charged ions.

(c) Sharing of electrons between non-metal and metal atoms.

(d) Atoms of Na and F held together by ionic bonds.

1. Which of the following best explains why solid silver conducts electricity?

(a) Silver ions are free to move when a current passes through the metal.

(b) Valence electrons can move and create a current when a voltage is applied.

(c) The atoms of silver become ionised when a voltage is applied.

(d) The metallic silver lattice breaks down when a current passes through the metal.

1. The table below gives information about the first four ionisation energies of three elements.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Ionisation energies (**1** to **4**) in MJ mol-1 | | | |
| **Element** | **1** | **2** | **3** | **4** |
| **A** | 0.7 | 1.5 | 7.8 | 10 |
| **B** | 0.6 | 1.8 | 2.7 | 12 |
| **C** | 0.5 | 4.6 | 6.9 | 9.6 |

Which of the following could be the elements **A**, **B** and **C** respectively?

(a) Magnesium, aluminium and sodium.

(b) Phosphorus, aluminium and nitrogen.

(c) Sodium, magnesium and aluminium.

(d) Sodium, aluminium and magnesium.

1. The concentration of vitamin C in a particular brand of orange juice is 35 mg per 100 mL. Which one of the following is the correct mass of vitamin C contained in a 2.5 L bottle of orange juice?

(a)  87.5 mg

(b)  875 mg

(c)  8.75 g

(d)  875 g

1. In which of the following pairs do each of them have both covalent and ionic bonding within their overall structures?

(a) NH4NO3, CuSO4

(b) Cl2CO, NH3

(c) CO2, NaCl

(d) KOH, CH4

1. Which one of the following sets of 0.1 mol L–1 solutions can be mixed to make a green solution without a precipitate?
2. sodium iodide, nickel chloride, silver nitrate
3. chromium(III) sulfate, ammonium carbonate, iron(II) chloride
4. chromium (III) nitrate, sodium carbonate, sodium phosphate
5. magnesium sulfate, potassium nitrate, nickel (II) ethanoate
6. Which of the following best describes a necessary condition for the system below to be at equilibrium?

2NO(g) + O2(g)   2NO2(g)

(a) All chemical reactions have stopped.

(b) The concentrations of NO(g) and NO2(g) are equal.

(c) The concentrations of all species are equal.

(d) Forward and reverse reactions are continuing at equal rates.

1. When a system is at equilibrium the pressure of that system can be altered by changing its volume. Which of the following statements can be made with certainty?

(a) Increasing the pressure favours the production of reactants.

(b) Adding an inert gas has no effect on the equilibrium..

(c) Reducing the volume increases the pressure so it favours the products.

(d) Decreasing the pressure will increase the rate of reaction.

1. Which of the following is the shape of boron trihydride?

(a) Pyramidal

(b) Tetrahedral

(c) Linear

(d) Triangular planar

1. Which of the following puts the elements in the correct order of **increasing** electronegativity?

(a) C → Si → Ge

(b) K → Ca →Rb

(c) P → N → O

(d*)* S → Cl → Br

1. The values for the first two ionisation energies for Aluminium are:

1st 584 kJmol-1 2nd 1 823 kJmol-1

The next two ionization energies are most likely to be:

(a) 3rd 9 876 kJmol-1 4th 10 234 kJmol-1

(b) 3rd 2 713 kJmol-1 4th 3 489 kJmol-1

(c) 3rd 2 845 kJmol-1 4th 11 654 kJmol-1

(d) 3rd 9 777 kJmol-1 4th 43 657 kJmol-1

1. Barium nitrate and barium chloride was mixed with water to form solution A. Sodium carbonate and potassium sulfate were mixed with water to form solution B.

When A and B are mixed, a white precipitate forms. The white precipitate is

1. Barium sulfate
2. Barium carbonate
3. Potassium carbonate
4. Barium sulfate and barium carbonate
5. When 1.0 mol L-1 solutions of the following are mixed, which combinations will result in the formation of precipitates?

(1) Ba(NO3)2 and HCl

(2) Ca(NO3)2 and Na2CO3

(3) Cu(NO3)2 and KOH

(4) Zn(NO3)2 and Na2S

1. 1, 2 and 3 only
2. 2 and 3 only
3. 2, 3 and 4 only
4. 1, 2, 3 and 4
5. The element arsenic is obtained from its ores by first allowing the arsenic ore to react with oxygen to form As4O6. The As4O6 is then reduced at 750oC using coke as follows:

As4O6(g) + 6C(s) <=> As4(g) + 6CO(g)  H = +675kJmol-1

For this equilibrium process, the equilibrium yield of As4(g) could be increased by

1. using a suitable catalyst
2. reducing the pressure in the reaction vessel
3. grinding the coke before reaction
4. decreasing the temperature of the system.
5. Addition of a catalyst to a chemical reaction causes
   1. the activation energy to increase, and hence rate increases
   2. a lower heat of reaction
   3. more collisions between reactant particles
   4. rates of both forward and reverse reactions to increase
6. A single piece of zinc was added to a beaker containing 2 molL-1 hydrochloric acid. It was observed that the rate of production of hydrogen soon reached a maximum, and then decreased. The following reasons were suggested for this:

**I The concentration of the acid decreased as the reaction proceeded.**

**II The surface area of the zinc decreased as the reaction proceeded**

**III The reaction was endothermic**

Which of these suggestions explains this observation

1. All of I, II III
2. I and II only
3. II and III only
4. I only
5. A rise in the temperature of gaseous reactants results in an increase in the rate of the reaction. This is mainly due to an increase in the:

(a) activation energy of the reaction.

(b) proportion of molecules with energies greater than the activation energy.

(c) frequency of collision between reactant molecules.

(d) pressure inside the reaction vessel.

1. A stock solution contains 1.00gL-1 copper (as Cu2+). What volume of this solution must be diluted to 50.0 mL to give a solution containing 5.00mgL-1 copper?
   1. 0.100 mL
   2. 0.250 mL
   3. 1.00 mL
   4. 2.50 mL
   5. 10.0 mL
2. A sealed glass tube at room temperature contains nitrogen dioxide (a brown gas) and dinitrogen tetroxide (a colourless gas) in equilibrium as given by the following equation:

2NO2(g)  N2O4(g) + heat

If the appearance of the gas mixture at room temperature is pale brown, which of the following indicates the changes which would be observed in the tube if it was placed in hot water?

1. The gas mixture would gradually become darker and darker brown over a few minutes in the hot water.
2. The gas mixture would become darker at first, but it would then become almost as pale brown as its original appearance while it remained in the hot water.
3. The gas mixture would not undergo any noticeable change in appearance because the volume of the glass tube does not noticeably change while it remains in the hot water.
4. The gas mixture would become even paler at first, but would then return to its original appearance of pale brown.
5. The equation below shows carbon and hydrogen reacting to form methane.

C(s) + 2H2(g) → CH4(g) + 75 kJ

If the reaction has reached equilibrium, how could you increase the yield of methane?

(a) Decrease the temperature.

(b) Decrease the pressure.

(c) Add a suitable catalyst.

(d) Both (a) and (c) above.

1. Which of the following is the shape of a molecule formed between atoms from group 14 and group 17 in the periodic table?

(a) Pyramidal

(b) Tetrahedral

(c) Linear

(d) Triangular planar

1. Which of the following correctly identifies the trends in atomic radii, first ionisation energy and electronegativity as you go across period 3 from Na to Cl?

Atomic radii First Ionisation Energy Electronegativity

(a) Increases Decreases Increases

(b) Decreases Increases Increases

(c) Decreases Increases Decreases

(d) Increases Decreases Decreases

1. Which of the following **best** explains the polarity of carbon dioxide?

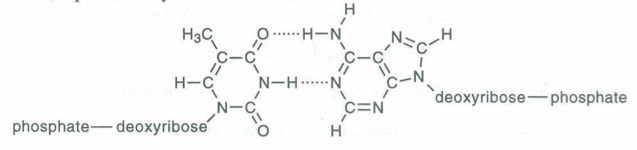
(a) The CO2 molecule is non-polar because, although the carbon/oxygen bond is polar, the molecule is linear.

(b) The CO2 molecule is non-polar because the valence electrons in the molecule are distributed evenly over the volume of the molecule.

(c) The CO2 molecule is polar because O is more electronegative than C.

(d) The CO2 molecule is polar because the molecule is bent (or V-shaped).

1. The diagram shows part of the DNA double helix in which the bases thymine (on the left) and adenine (on the right) are linked. What is the name given to the linking bonds, represented by the dotted lines?



* 1. covalent bonds
  2. hydrogen bonds
  3. ionic bonds
  4. metallic bonds

**End of Section One.**

**Section Two: Short Answer 35% (70 Marks)**

This section has **10** questions. Answer **all** questions. Write your answers in the spaces provided.

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 question 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.

Suggested working time: 60 minutes

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**Question 26 (9 marks)**

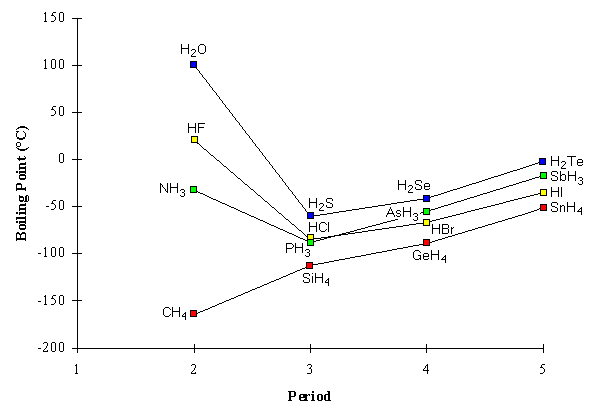
Complete the table below by drawing the Lewis structures of the molecules listed and either drawing or naming the shape of the molecule. State the polarity of each species in the final column. All valence shell electron pairs should be represented either as **׃** or as **−** .­

The first row has been completed as an example.

|  |  |  |  |
| --- | --- | --- | --- |
| **Molecule** | **Lewis structure** | **Sketch or name of shape** | **Polarity** |
| Water | OR | OR  Bent | Polar |
| Sulfate ion |  |  |  |
| Nitrogen trifluoride |  |  |  |
| Ammonium chloride |  |  |  |

**Question 27 (7 marks)**

The approximate boiling points of the Group 14, 15, 16 and 17 hydrides are plotted on the graph below.



1. The hydrides of Group 14 are non-polar molecules. Apply your understanding of intermolecular interactions to explain the steadily increasing boiling points of the Group 14 hydrides CH4, SiH4, GeH4 and SnH4. (2 marks)

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1. The Group 15, 16 and 17 hydrides are polar molecules. Consider the Group 17 hydrides HCl, HBr and HI. List HCl, HBr and HI in order of increasing polarity. (1 mark)

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1. Compare the trend in polarities of HCl, HBr and HI with the observed trend in their boiling points. Briefly explain your reasoning. (2 marks)

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1. The first member of each hydride series (NH3 in Group 15, H2O in Group 16, and HF in Group 17) has a much higher boiling point than the next hydride in its series. Apply your understanding of intermolecular interactions to explain the anomalous boiling points of NH3, H2O and HF. (2 marks)

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**Question 28 (6 marks)**

Explain the following observations.

1. The first ionisation energy for potassium is lower than for lithium. (2 marks)

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1. The first ionisation energy for magnesium is lower than for phosphorus. (2 marks)

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Below are the successive ionisation energies for the beryllium atom.

|  |  |
| --- | --- |
| 1st ionisation energy | 900 kJ mol-1 |
| 2nd ionisation energy | 1757 kJ mol-1 |
| 3rd ionisation energy | 14,849 kJ mol-1 |
| 4th ionisation energy | 21,007 kJ mol-1 |

1. Explain why the second ionisation energy is greater than the first ionisation energy.

(1 mark)

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

1. Explain the significant increase between the second and third ionisation energies. (1 mark)

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**Question 29 (6 marks)**

Complete the table below by giving a brief description of a test that could be used to distinguish between the substances listed. List the observations relating to the test for each of Substance 1 and Substance 2.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Substances to be distinguished** | | **Description of test** | **Observation with Substance 1** | **Observation with Substance 2** |
| **Substance 1** | **Substance 2** |
| Solution of Sodium chloride | Solution of Sugar (C12H22O11) |  |  |  |
| Solid Sodium phosphate | Solid Potassium chloride |  |  |  |

**Question 30 (6 marks)**

Write ionic equations for any reactions that occur in the following procedures. If no reaction occurs write ‘no reaction’ or if a reaction occurs but the change is not visible, state this.

In each case describe **in full** what you would observe, including any:

* Colours - precipitates (give the colour)
* Odours - and/or gases evolved (give the colour or describe as colourless).

1. Sodium carbonate is added to hydrochloric acid. (3 marks)

**Equation** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Observation** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

1. Barium hydroxide solution is mixed with silver nitrate solution (3 marks)

**Equation** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Observation** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**Question 31 (6 marks)**

For the following set of observations:

(i) write a description of any **one** reaction that matches the observations, and

(ii) give an appropriate equation (full or ionic) for **that** reaction.

**e.g.** A brown solution is added to a colourless solution, producing a brown precipitate.

**Reaction** *iron (III) nitrate is mixed with sodium hydroxide solution*

**Equation** *Fe3+ + 3 OH- → Fe(OH)3*

1. Two colourless solutions react to produce a white precipitate. (3 marks)

**Reaction \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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

**Equation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. A soft, silvery solid dissolved vigorously forming a colourless solution. A colourless, odourless gas is produced which responds to a “pop” test. (3 marks)

**Reaction** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**Equation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Question 32 (5 marks)**

When white phosphorus, P4, is left to stand in air, after a time it spontaneously ignites producing white fumes of tetraphosphorus decaoxide.

1. In the space below, draw potential energy diagram for the reaction. On the diagram label the reactants and products, activation energy, transition state and enthalpy change, ∆H. (4 marks)
2. Write the equation for the reaction (1 mark)

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

**Question 33 (12 marks)**

When chlorine gas is added to water, the following equilibrium is established:

Cl2 (g) + H2O(l) ↔ HOCl(aq) + H+(aq) + Cl-(aq) ∆H = +ve

1. Write the equilibrium constant expression for this equilibrium. (1 mark)
2. The value of the equilibrium constant for the above reaction, at 25°C,

is about 3.4 x 10-7. What does this mean? (1 mark)

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1. Predict the direction the equilibrium will shift immediately after the changes indicated in the table below. Write ‘left’, ‘right’ or ‘no change’. Using your understanding of Collision Theory, write an explanation of why each shift in equilibrium did/did not occur in the final column of the table. (8 marks)

|  |  |  |
| --- | --- | --- |
| **Change** | **Direction of initial equilibrium shift** | **Explanation** |
| Increase the partial pressure of Cl2 (g) |  |  |
| Increase the temperature of the system |  |  |
| Add a suitable catalyst |  |  |
| Acidify the system by the addition of nitric acid solution |  |  |

1. This reaction is carried out industrially at high temperatures and in alkaline (basic) conditions. Suggest why these conditions are used. (2 marks)

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

**Question 34 (4 marks)**

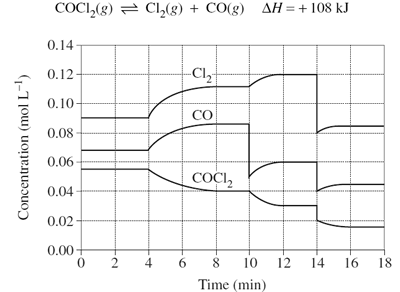
Using the information in the table below, identify the substances A, B, C and D from the ***following list:***

* Zinc
* Calcium carbonate
* Copper
* Copper (II) sulphate
* Heptane
* Graphite
* Iodine
* Mercury
* Nickel (II) chloride
* Silicon dioxide
* Sodium chloride

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Electrical conductivity in the solid state** | **Electrical conductivity in the liquid state** | **Solubility in water** | **Phase at 25°C** | **Colour at 25°C** | **Name of substance** |
| A | nil | conducts | soluble | solid | white |  |
| B | conducts | conducts | insoluble | solid | silver |  |
| C | nil | nil | insoluble | liquid | colourless |  |
| D | nil | nil | insoluble | solid | white |  |

**Question 35 (9 Marks)**

This graph shows the variation in concentration of reactant and products as a function of time for the following system.



Identify and explain each of the changes in conditions that have shaped the curves during the time the system was observed.

1. Change at 4 minutes

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

1. Change at 10 minutes

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

1. Change at 14 minutes

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

**End of Section Two**

**Section three: Extended answer 40% (80 marks)**

This section contains **six (6)** questions. You must answer **all** questions. Write your answers in the spaces provided.

Where questions require an explanation and /or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression.

Final answers to calculations should be expressed to **three (3)** significant figures and include appropriate units.

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.

Suggested working time: 70 minutes

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

**Question 36 (20 marks)**

Part of the Contact Process for the manufacture of sulfuric acid involves the conversion of sulfur dioxide to sulfur trioxide, as shown by the equation

2SO2(g) + O2(g) <==> 2SO3(g)  *ΔH* = –192 kJ mol–1

As part of a laboratory study of this process, a container was filled with an equilibrium mixture of sulfur dioxide, sulfur trioxide and oxygen in the presence of a catalyst. The container was initially at 450oC. The container had a fixed volume and was **thermally well insulated**.

Concentrations during a following experiment are shown on the diagram below.



* 1. What change occurred at the 10 minute point? (2 marks)

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

* 1. Which components of the equilibrium mixture are represented by X and Y?

X = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Y = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(2 marks)

* 1. Give explanations for the changes in concentration that occur in X, Y and O2 between 10 and 20 minutes. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(3 marks)

* 1. Would the temperature of the mixture increase, decrease or remain the same between 10 and 20 minutes? Explain your reasoning. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(3 marks)

* 1. At t = 20 the volume of the system is reduced. Draw on the graph how the amounts of each species will change. A new equilibrium is reached at t = 30 minutes.

(3 marks)

* 1. Give explanations for the changes in concentration that occur in X, Y and O2 between 20 and 30 minutes. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(3 marks)

* 1. A catalyst is added at t = 10 minutes. Draw on the graph how the concentrations of each of the species change between 10 and 20 minutes.

(2 marks)

* 1. Give explanations for the curves you drew in (g). \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(2 marks)

**Question 37 (10 marks)**

In the reaction between ten metal and iodine, tin (IV) iodide is formed.

1. Write an equation for this reaction.

If 0.945 g of tin is added to 3.67 g of iodine.

1. Identify the Limiting reagent;
2. Calculate the mass of tin (IV) iodide formed; and
3. Calculate the mass of excess reactant remaining after the reaction.

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

**Question 38 (7 marks)**

3.00 g of an impure sample of zinc was added to excess dilute hydrochloric acid solution to produce a zinc chloride and hydrogen gas. All of the hydrogen gas produced was collected and dried. The volume of hydrogen produced at 110.3 kPa and 20.0oC was 910.0 mL. Calculate the percentage purity of the zinc.

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

**Question 39 (10 marks)**

Consider the following melting points.

|  |  |
| --- | --- |
| Substance | Melting point (ÖC) |
| SO2 | - 10 |
| NH3 | - 33 |
| CH4 | -162 |
| H2Ö | 100 |

1. Order the substances in terms of increasing strength of intermolecular forces.

(2 marks)

1. Explain the order in terms of the nature of the intermolecular forcesinvolved.

(8 marks)

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**Question 40 (10 marks)**

Explain why NaCl dissolves in water but not in pentane (C5H12) yet pentane dissolves in octane (C8H18).

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**Question 41 (11 marks)**

Five unlabelled solutions are known to be; sodium sulfate, sodium iodide, sodium carbonate, sodium nitrate, barium hydroxide

These 5 solutions are randomly labeled V, W, X, Y, Z and samples are tested with reagents. These tests are described in the table below

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Solutions | | | | |
| Reagents | V | W | X | Y | Z |
| Mg(NO3)2 | no visible reaction | no visible reaction | no visible reaction | white ppte | white ppte |
| Ba(NO3)2 | no visible reaction | no visible reaction | white ppte | white ppte | no visible reaction |
| Pb(NO3)2 | no visible reaction | yellow ppte | white ppte | white ppte | white ppte |

In the space below deduce the information that each reagent added infers and then state the identity of each.

1. Mg(NO3)2:

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

1. Ba(NO3)2

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1. Pb(NO3)2

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1. Conclusion:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| V | W | X | Y | Z |
|  |  |  |  |  |

**Question 42 (12 marks)**

A farmer accidentally empties a 10,000 kg carton of barium chloride BaCl2 into a water tank containing 12000.0 L of rainwater. In order to remove this she decides to precipitate the barium ions by adding 75.0% pure magnesium sulfate MgSO4

2. (a) Write an equation to describe the removal of the barium ions by precipitation with the magnesium sulfate solution
3. (b) Calculate the mass of 75.00% magnesium sulfate MgSO4.that should be added to exactly remove all the barium ions.

The farmer believes that because 10,000 kg of the barium chloride was added then an equal mass of magnesium sulfate MgSO4 should be added to the tank and so 10,000 kg of the 75.00% magnesium sulfate, MgSO4 is added to the tank

1. (c) State whether magnesium sulfate or barium chloride is in excess and provide evidence to support your answer.
2. (d) Calculate the mass of solid that is precipitated when the 10,000 kg of 75.00% magnesium sulfate was added.
4. (e) Calculate the final concentration of Cl1- ions in the tank

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**Additional working space**

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**End of Paper**