**SECTION A: (46 MARKS)**

*Answer* **all** *questions from this section.*

1. (a) Complete the following equations for **nuclear reactions**.

(i) …………………… *(01 mark)*

(ii) ……… (*01 marks)*

(b) When a radioactive isotope was left to stand, it decayed by **12.5%** of its original value in **45 days**. Calculate the **half-life** of the radioactive isotope. *(2½ marks)*

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2. (a) State **three** factors that can affect electron affinity. *(1½ marks)*

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(b) Write **equation** for the first electron affinity of sulphur. *(01 mark)*

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(c) The first and second electron affinities of sulphur are and respectively. Explain the difference in the electron affinities of sulphur. *(04 marks)*

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3. Polystyrene is formed by polymerization of phenylethene.

(a) (i) Write the structural formula of polystyrene. *(01 mark)*

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(ii) Name the type of polymerization involved in the formation of polystyrene. *(½ mark)*

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(b) The osmotic pressure of a solution containing **5.5g** of polystyrene in **1** **dm3** of benzene is **1.0 x atmospheres** at **200C**.

(i) Calculate the relative molecular mass of polystyrene.*(R = 0.082 atm dm3 )*  *(02 marks)*

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(ii) Determine the number of monomers that formed the polystyrene. *(1½ marks)*

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4. (a) The figure below shows the energy diagram for the reaction between nitrogen monoxide and oxygen.

Reaction co-ordinate

2NO+O2

L

2NO2

Energy (kJmol-1)

K

1. Identify K and L.

K…………………………………………… *(½ mark)*

L…………………………………………… *(½ mark)*

1. State whether the reaction is endothermic or exothermic. *(½ mark)*

…………………………………………………………………………..………..

1. Give a reason for your answer in (a) (ii). *(½ mark)*

……………………………………………………………………………………

(b) The experimental results in the table below were obtained for the reaction in (a).

|  |  |  |
| --- | --- | --- |
| **Initial concentration**  ***(mol d)*** | | **Rate of reaction**  ***(mol d)*** |
| NO | O2 |
|  |  |  |

1. Deduce the order of the reaction with respect to;

nitrogen monoxide. *(01 mark)*

…………………………………………………………………………………………………………………………………………………………………………

Oxygen. *(01 mark)*

……………………………………………………………………………………………………………………………………………………………….………...

1. Write the rate equation for the reaction. *(01 mark)*

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(c) Calculate the

(i) rate constant (k) for the reaction and state its units. *(1½ marks)*

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

5. When compound **Q** was steam distilled at 950C and at 760mmHg, the distillate contained 77.1% by mass of **Q**. Calculate the molecular formula of **Q***. [The vapourpressure of water at 950C is 526mmHg] (04 marks)*

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6. Draw the structures and name the shapes for the following species.

*(4½ marks)*

|  |  |  |
| --- | --- | --- |
| **species** | **Structure** | **Name** |
| (i) |  |  |
| (ii) |  |  |
| (iv) |  |  |

7. (a) Explain what is meant by the term an **ideal solution**. *(1½ marks)*

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(b) A mixture of liquids **A** and **B** behaves as an ideal solution. The vapour pressures of A and B are 473.2Pa and 139.8Pa respectively at 200C. Calculate the composition of the vapour from a mixture containing 0.6 mole fraction of liquid **A** at 200C. *(03 marks)*

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8. State what would be observed and write equation(s) for the reaction(s) that would take place when sodium hydroxide solution is added drop-wise until in excess to;

(a) Lead nitrate solution. *(03 marks)*

Observation.

…………………………………………………………………………………………………………………………………………………………………………

Equation(s).

…………………………………………………………………………………………………………………………………………………………………………

(b) Iron () chloride solution. *(02 marks)*

Observation.

…………………………………………………………………………………………………………………………………………………………………………

Equation.

…………………………………………………………………………………………………………………………………………………………………………

9. (a) (i) State the conditions for the reaction between benzene and sulphuric acid. *(01 mark)*

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(ii) Outline a mechanism for the reaction in (a) (i). *(03marks)*

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

(b) Write equation(s) to show how the products in (a) (ii) can be converted to hydroxybenzene. *(1½ marks)*

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**SECTION B (54 MARKS)**

*Answer* **six** *questions from this section.*

10. (a) State what is meant by the term **enthalpy of solution**. *(01 marks)*

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(b) The table below shows the heats of hydration and lattice energies of lithium chloride and sodium chloride.

|  |  |  |
| --- | --- | --- |
| Salt | Enthalpy of hydration  (kJ ) | Lattice energy  (kJ ) |
| LiCl |  | +848 |
| NaCl |  | +788 |

Calculate the heat of solution of

(i) Lithium chloride *(1½ marks)*

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(ii) Sodium chloride.  *(01 marks)*

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(iii) State how you would expect the solubility of the two salts to vary with temperature and give reasons for your answers. *(2½ marks)*

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(c) Explain how hydration energy affects the solubility of salts in water. *(03 marks)*

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11. Complete the following equations and in each case write the accepted mechanism.

(a)  *(04 marks)*

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*HI*

CH=CH2

(b) ……………………… *(03 marks)*

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

NaOH(aq)

NaOH(aq)

Cl

NaOH(aq)

(c)  *(02 marks)*

Heat

…………………………………………………………………………………… …………………………………………………………………………………… …………………………………………………………………………………… ……………………………………………………………………………………

12. (a) State how the following anhydrous chlorides can be prepared.

(i) Aluminium chloride. *(01mark)*

……………………………………………………………………………………

(ii) Phosphorous () chloride. *(01 mark)*

……………………………………………………………………………………

(b) Write equations for the reaction between water and the chlorides in (a).

(i) Aluminium chloride. *(1½ marks)*

……………………………………………………………………………………

(ii) Phosphorous () chloride. *(1½ marks)*

……………………………………………………………………………………

(c) Dilute sodium hydroxide solution was added drop-wise until in excess to a solution of aluminium chloride in water.

(i) State what was observed. *(1½ mark)*

………………………………………………………………………………...

(ii) Write equation(s) for the reaction (s) that took place. *(2½ marks)*

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13. A hydrocarbon **Y** contains **85.7%** carbon and has a density of at s.t.p.

(a) Calculate the empirical formula of **Y**. *(02 marks)*

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(b) Determine the molecular formula of **Y**. *(02 marks)*

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(c) Write the structural formulae of all the possible open chain isomers of **Y**. *(1½ marks)*

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(d) (i) Ozonolysis of **Y** and subsequent work-up gave one compound. Identify **Y**. *(½ marks)*

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(ii) Write an equation to show how **Y** can be synthesized from butan-2-ol and indicate a mechanism for the reaction. *(03 marks)*

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14. (a) Define the term **partition coefficient**.  *(01 mark)*

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(b) Copper (II) ions forms a complex with ammonia. The table below shows the results of partition of ammonia between 0.1M copper(II) ions and trichloromethane.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| [NH3] (0.1M Cu2+(aq)) | 0.88 | 1.08 | 1.34 | 1.56 | 1.80 |
| [NH3] (CHCl3) | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 |

(i) Plot a graph of [NH3] (0.1M Cu2+ (aq)) against [NH3] (CHCl3).  *(03 marks)*

(ii) Determine the value of in the complex. *(2½ marks)*

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(c) (i) Determine the partition coefficient, KD of ammonia between aqueous copper (II) ions and trichloromethane. *(1½ marks)*

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(ii) State how the value of KD you have determined indicates about the distribution of ammonia.  *(01 mark)*

…………………………………………………………………………………… ……………………………………………………………………………………

15. Name the reagent(s) that can be used to distinguish between the following compounds. In each case state what would be observed when each compound is separately treated with the reagent.

(a) 

*(03 marks)*

*Reagent(s)*

………………………………………………………………………………………………………………………………………………………………………....

*Observation:*

…………………………………………………………………………………… …………………………………………………………………………………… ……………………………………………………………………………………



*(03 marks)*

(b)

*Reagent(s)*

…………………………………………………………………………………………………………………………………………………………………………

*Observation:*

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

(c) and *(03 marks)*

*OH*

*OH*

*Reagent(s)*

…………………………………………………………………………………………………………………………………………………………………… *Observation:*

………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

16. The table below shows the atomic radius and the first ionization energy of some elements in period () of the Periodic Table.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Element | Na | Mg | Al | Si | P | S | Cl |
| Atom radius (nm) | 0.186 | 0.160 | 0.143 | 0.117 | 0.110 | 0.104 | 0.099 |
| First ionization energy  (kj ) | 496 | 738 | 577 | 787 | 1060 | 1000 | 1251 |

1. (i) State how atomic radius of the elements varies across the period. *(01 mark)*

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(ii) Explain your answers in (a) (i). *(03 marks)*

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1. (i) Explain how atomic radius affects the first ionization energy. *(02marks)*

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(ii) Why is the first ionization energy of aluminium lower than that of magnesium? *(03 marks)*

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This is the last page of the printed paper, Page 14

