**NAME: ……………………………… INDEX NUMBER: ………….……………………………………… SCHOOL……………………………. SIGNATURE: …………..................... DATE: ……………….**

**233/3**

**CHEMISTRY**

**PAPER 3**

**FORM 4**

**TIME: (2¼ HOURS)**

**DECEMBER EXAM 2021**

**KENYA CERTIFICATE OF SECONDARY EDUCATION**

**CHEMISTRY**

**PAPER 3**

**INSTRUCTIONS**

* Write your *NAME*, *INDEX NUMBER*, and *SIGNATURE* in the spaces provided.
* Answer *ALL* questions in the spaces provided.
* *SILENT*, *NON-PROGRAMMABLE* scientific calculators may be used.
* Use the first 15 minutes of the time allocated for this paper to crosscheck and *ASCERTAIN* that no pages are missing, the reagents available and all the apparatus are *WORKABLE*
* This paper contains **8** printed pages

**FOR EXAMINERS USE ONLY**

|  |  |  |
| --- | --- | --- |
| **QUESTION** | **MARKS** | **STUDENT’S SCORE** |
|  1 |  22 |  |
|  2 |  12 |  |
|  3  |  6 |  |

**QUESTION ONE (22 MARKS)**

You are provided with:

 - 4.5g of solid A in a boiling tube.

 - Solution B, 0.06M acidified potassium manganate (VII)

You are required to determine:-

1. The solubility of solid A at different temperatures.
2. The number of moles of water of crystallization in solid A.

**Procedure**

1. Using a burette, add 4cm3 of distilled water to solid A in a boiling tube. Heat the mixture while stirring with the thermometer to about 700C. When all the solid has dissolved allow the solution to cool while stirring with the thermometer. Note the temperature at which crystals of solid A first appear. Record this temperature in table I.
2. Using the burette, add 2.0cm3 of distilled water to the contents of the boiling tube. Warm the mixture while stirring with the thermometer until all solid dissolves. Allow the mixture to cool while stirring. Note and record the temperature at which crystals of solid A first appear.
3. Repeat procedure (b) two more times and record the temperatures in the table I. **Retain the** **contents of the boiling tube for use in procedure (e)**
4. (i) Complete table I by calculating the solubility of solid A at different temperatures. *The solubility of a substance is the mass of that substance that dissolves in 100cm3 (100g) of water at a particular temperature.*

**Table I (6mks)**

|  |  |  |
| --- | --- | --- |
| Volume of water in the boiling tube (cm3)  | Temperature at which crystals of solid A first appear  | Solubility of solid A (g/100g water)= 100 x mass of solid  Volume (mass) of water |
| 4 |  |  |
| 6 |  |  |
| 8 |  |  |
| 10 |  |  |

 (i) On the grid provided, plot a graph of solubility of solid A against temperature. (3 marks)

 (iii) Using your graph

* 1. Determine the temperature at which 100g of solid A would dissolve in 100cm3 of water. (1mark)
	2. Calculate the mass of solid A that will crystallize out when a hot solution at 550C cooled to 450C. (1 mark)

(e) (i) Transfer the contents of the boiling tube into 250ml volumetric flask. Rinse both the boiling tube and the thermometer with distilled water and add to the volumetric flask. Add more distilled water to make up to the mark. Label this solution A. Fill burette with solution B. Using a pipette and pipette filler, place 25.0cm3 of solution A into a conical flask. Warm the mixture to about 600C. Titrate the hot solution A with solution B until a permanent pink colour persists. Record your readings in table 2. Repeat the titration two more times and complete table 2.

**Table 2**

|  |  |  |  |
| --- | --- | --- | --- |
|  | I | II | III |
| Final Burette reading |  |  |  |
| Initial Burette reading |  |  |  |
| Volume of solution B used (cm3) |  |  |  |

 (4 marks )

Calculations:-

I) Average volume of solution B used. (1 mark )

II) Number of moles of potassium manganate (VII) used. (1 mark )

III) Number of moles of A in 25.0cm3 of solution A given that 2 moles of potassium

 manganate (VII) react completely with 5 moles of A. (1mark)

IV) Relative formula mass of A. (2marks)

(ii) The formula of A has the form H2C2O4. xH2O. Determine the value of x in the formula (C=12, H=1, O=16) (2marks)

**QUESTION TWO (12 MARKS)**

You are provided with solid, C carry out the following tests and write your observations and inferences in the spaces provided.

1. Place all of solid C in boiling tube. Add about 10 cm3 of distilled water and shake thoroughly. Filter the mixture into another boiling tube. **Retain** the filtrate for use in test 2 (b) below. Dry the residue using pieces of filter papers.
2. Transfer about **half** of the dry residue into a dry test tube. Heat the residue strongly and test any gas produced using a burning splint

|  |  |
| --- | --- |
| Observation | Inference |
|   (1mark)  |  (1mark) |

1. Place the rest of the residue in a dry test tube. Add 3cm3 of 2M Hydrochloric acid. Retain the mixture for test (iii) below.

|  |  |
| --- | --- |
| Observation | Inference |
|   (1 mark)  |   (1mark) |

1. To 2 cm3 of the solution obtained in (ii) above, add few drops of aqueous ammonia until in excess.

|  |  |
| --- | --- |
| Observation | Inference |
|  (1mark) |  (1mark) |

1. To 2 cm3 of the filtrate obtained in (a) above a few drops of aqueous ammonia until in excess

|  |  |
| --- | --- |
| Observation | Inference |
|  (1mark) |  (1mark) |

1. To 2cm3 of the filtrate, add three drops of 2M Hydrochloric acid

|  |  |
| --- | --- |
| Observation | Inference |
|  (1mark) |  (1mark) |

1. To 2cm3 of the filtrate add two drops of Barium nitrate solution

|  |  |
| --- | --- |
| Observation | Inference |
|  (1mark) |  (1mark) |

**QUESTION THREE (6 MARKS)**

* You are provided with liquid K. Carry out the following tests and record your observations and inferences in the spaces provided.
1. Place five drops of liquid K on a clean dry watch glass and ignite it.

|  |  |
| --- | --- |
| Observation  | Inference |
| (1 mark) |  (1 mark) |

1. Place about 2cm3 of K in a clean dry test tube and add sodium hydrogen carbonate provided

|  |  |
| --- | --- |
| Observation | Inference |
|  (1 mark) |  (1 mark) |

1. Place about 2cm3 of liquid K in a test tube, add acidified potassium dichromate (VI) and warm the mixture.

|  |  |
| --- | --- |
| Observation  | Inference |
|  (1 mark) |  (1mark) |