**Chemistry of Chromium**

**Detecting chromium triple ion (Cr3+)**

Chromium triple solution can be prepared by dissolving CrCl3.6H2O in water to form green solution resulted from the complex ion [Cr(H2O)6]3+

**CrCl3.6H2O + H2O → [Cr(H2O)6]3+**

**Dark green solid Green clear solution**

This aqueous ion has an acidic characteristic in water:

**[Cr(H2O)6]3+ + H2O ↔ [Cr(H2O)5OH]2+ + H2O+ pKa= 4**

This ion can be abbreviated into (Cr3+) to carry out the following detections:

1. Put (10) drops of [Cr(H2O)6]3+ solution in a test tube, add (2) drops of NaOH, and observe the change, then add more of the detector and observe the change. then add (2) drops of H2O2 , observe the change, and heat the solution for 5 mints. and observe the change and write down your notices after each addition.
2. Put (10) drops of [Cr(H2O)6]3+ in a second test tube, add (2) drops of NH4OH, then add more of the a ammoni conc. and observe the change. Write down your notices in both cases.
3. Put (10) drops of [Cr(H2O)6]3+ in a third test tube, add (2) drops of Na2CO3 or K2CO3, observe the change and write down your notices.

|  |
| --- |
| C:\Users\enas\Pictures\nh3crcols.gif |

**Question:**

What is the distinguishable detection of Cr(III) Ion?

**Detecting** $CrO\_{4}^{2-} and Cr\_{2}O\_{7}^{2-}$ **anions :**

|  |
| --- |
|  |

A balance happens for the both anions Chromate (yellow) and Dichromate (orange) when a quantity of K2CrO4 and K2Cr2O7 is dissolved in water, according to the following equation:

|  |  |
| --- | --- |
| **CrO42–(aq) + 2H+ ↔ Cr2O72– (aq) + H2O (L)** |  |

Chromate and dichromate solutions are prepared by dissolving Na2CrO4, Na2Cr2O7, K2CrO4, or K2Cr2O7 in water to compose a yellow or orange solution, respectively. It can be abbreviated into ($CrO\_{4}^{2-}$ and $Cr\_{2}O\_{7}^{2-}$) to perform the following detections:

1. Put (10) drops of $CrO\_{4}^{2-}$ in a test tube and add (2) drops of NaOH, observe the change and write down your notices.
2. Put (10) drops of $CrO\_{4}^{2-}$ in a second test tube, add (2) drops of HCl, observe the change and write down your notices.
3. Put (10) drops of $CrO\_{4}^{2-}$ in a third test tube, add (2) drops of Pb(NO3)2 or Ba(NO3)2, observe the change and write down your notices.
4. Put (10) drops of $Cr\_{2}O\_{7}^{2-}$ in a test tube, add (2) drops of NaOH, observe the change and write down your notices.
5. Put (10) drops of $Cr\_{2}O\_{7}^{2-}$ in a second test tube, add (2) drops of HCl, observe the change and write down your notices.
6. Put (10) drops of $Cr\_{2}O\_{7}^{2-}$ in a third test tube, add (2) drops of Pb(NO3)2 or Ba(NO3)2, observe the change and write down your notices.

**Questions:**

1. What happen when HCl is added?
2. What happen when NaOH is added?
3. What happen when Pb(NO3)2 or Ba(NO3)2 is added?

**Preparation of Chromic Oxide (Cr2O3) :**

1. Gradually put (1) gr of the orange ammonium dichromate (NH4)2Cr2O7 in a crucible on flame, very soon you will see flash at each addition.

Cr2O3

1. Pull the flame away from the bowl when the flashing happens.
2. Return the flame again after flash end until the dichromate quantity is decomposed.

**Reaction Equation:**

**(NH4)2Cr2O7 ⎯ φ→ N2 ↑ + Cr2O3 + 4H2O**

**Questions:**

1. What the flash means?
2. Calculate the product percentage.
3. Why dichromate is gradually added?
4. What is the principle of this reaction?

**Preparation of Potassium Chromate:**

1. Melt a mixture of (3g) of KNO3 and (2g) of K2CO3 in porcelain crucible.
2. Add (0.5g) of Cr2O3 (prepared in step 1) gradually to the molten mixture.
3. Leave the mixture to melt on a Binzin lamp until it change from green to yellow.
4. Leave the bowl to cool down, then add (15 ml) of distilled water.
5. Heat and filter (neglect the precipitate).
6. Reduce the filtered solution by evaporating into 2/3 of the original volume.
7. Cool down and filter again to get K2CrO4.

**Reaction Equation:**

**2K2CO3 + KNO3 + Cr2O3 → 2K2CrO4 + 2CO ↑ + KNO2**

|  |  |
| --- | --- |
| Image result for crucibles chemistry | F:\Pictures\200px-Potassium-chromate-sample.jpg |

**Questions:**

1. What is the purpose behind using a mixture of K2CO3 and KNO3?
2. Calculate the ratio of K2CrO4.

**Preparation of Potassium trioxalatochromate (III) trihydrate K3[Cr(C2O4)3].3H2O :**

1. Dissolve (2.5g) of H2C2O4 in (10ml) of hot distilled water.
2. Gradually add (0.5g) of K2Cr2O7.
3. Heat the mixture until boiling to complete reaction.
4. Dissolve (1.25g) of K2C2O4 in the hot mixture, then cool it down to room temperature.
5. Add (2ml) of ethanol and cool down using ice, you will notice separation of greenish blue crystals.
6. Filter the solution and collect the crystals using Büchner funnel.
7. Dry the resulted crystals at 60oC.
8. Measure the resulted material weight and calculate its ratio.

|  |  |
| --- | --- |
|  |  |

The color-change from red cubic crystals to dark blue under fluorescent light, and to reddish violet under incandescent light.

**Questions:**

1. Why the Oxalic acid coordinates with the central metal in alkaline medium? What happen if the medium was acidic?
2. Why ethanol is added?
3. Why K2C2O4 is added? What happens if KOH was added?
4. Write down the reaction equation.

Notes: The student must write the following for each complex attended information

1. **Electronic configuration for the metal and its ion:**

For example:

Electronic configurationof Cr atom is

|  |
| --- |
| 24Cr: [18Ar] 3d54s1 |
| $$↿$$ | $$↿$$ | $$↿$$ | $$↿$$ | $$↿$$ |  | $$↿$$ |  |  |  |  |  |
| 3d |  | 4s |  | 4p |  |

Whereas the electronic configuration **of** Cr (III) ion is

|  |
| --- |
| Cr3+ [18Ar] 3d3 4s0 |
| $$↿$$ | $$↿$$ | $$↿$$ |  |  |  |  |  |  |  |  |  |
| 3d |  | 4s |  | 4p |  |

1. **Type of hybridization of the central atom in the complex [Cr (C2O4)3]3- is d2sp3**

|  |
| --- |
| Cr3+ [Ar]18 3d3 4s0 |
| $$↿$$ | $$↿$$ | $$↿$$ | ×× | *××* |  | ×× |  | ×× | ×× | ×× |  |
|  $\uparrow \uparrow $ |  | $$\uparrow $$ |  |  $\uparrow \uparrow \uparrow $ |  |
|  ox |  |  |  ox |  Ox |  |

Where ox= (C2O4=), which is bidentate oxalate ligand

1. **Orbital type (d):**

Whether the given complex ion is inner orbital octahedral or outer or orbital octahedral?

This complex is inner orbital octahedral.

1. **Magnetic properties:**

The metal in this complex is paramagnetic because of the existence of three single electrons.

1. **Geometry of complex:**

It is octahedral, where the oxalate ion (the ligand) connected with Cr(III) ion by both anionic donor atoms (o-,o-) according to the following structure:

