**Investigation - Analytical Chemistry /65**

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

What exactly is in the water that you are drinking? How much nitrogen is in the soil on your lawn? These and many other questions can be answered using **analytical chemistry** techniques and methods. Analytical chemistry is the science of determining unidentified compounds, separating them out, and measuring how much of each there is.

The two main methods used are wet chemistry and instrument methods. Wet chemistry is the classical approach to analytical chemistry and has been used for centuries. The instrument method is a recent development.

**Wet Chemistry**

Wet chemistry uses known chemicals to react with unknown chemicals (or known amounts of chemicals with an unknown amount of chemicals) and uses known reaction results to determine what or how much of a chemical is present. These reactions may also isolate the desired compound.

One common wet chemistry technique is the formation of precipitates and measurement of mass. The ions in substance present can be detected by precipitation reactions and the formation of complex ions.

Other wet chemistry techniques such as **chromatography** can isolate specific compounds. This method isolates compounds based on their size, charge, or other properties. Chromatography can isolate by size in the same way that you strain spaghetti from water using a colander; only the 'holes' are much smaller. Column chromatography is an example of this method, it can also isolate compounds by charge or by intermolecular forces.

**Instrument Methods**

The instrument methods are often based upon wet chemistry methods but have been automated or made more precise. These methods use specific instruments to measure, isolate, and identify unknown compounds. They are able to do this quicker and more easily than by using traditional wet chemistry methods. However, these instruments are often very expensive, which is why wet chemistry is often still used.

In this investigation your task is to carry out an individual practical and written activity.

* The practical task will be to identify cations and anions through precipitation reactions.

(35 marks)

* The written task is to complete questions about precipitation reactions, acid reactions and stoichiometry. (30 marks)

Weighting: 7.5%

**Part A Practical tasks - Identifying Ions in Solutions**

Tasks 1 to 5 involve analysis of 5 solutions in which either the anion, cation or both ions must be identified.

For each sample, you must:

* Use the ion identification flow charts to choose suitable reagents and carry out the tests that will allow you to identify the ion present
* Describe the tests carried out and record all observations made
* Identify the ion present
* Write balanced ionic equations for any precipitation reactions. These equations must be linked to the observations recorded.

Task 6 describes tests carried out on another solution so that the anion and cation can be identified. (You do not need to carry out the practical work yourself.)

Based on the observations given:

* identify the anion and cation present using the ion identification flow charts and chemical data sheet
* write balanced equations for the precipitation reactions that occurred.

Write your answers in the spaces provided.

Task One: Identify the cation present in solution A. It is either Ag+(aq) or Fe3+(aq). [4 marks]

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Description of test(s) carried out** | **Observations** | **Equations** |
| Ag+(aq)  **OR**  Fe3+(aq) |  |  |  |

**Ion present is:**

Task Two: Identify the anion present in solution B. It is either SO42−(aq) or Cl−(aq). [6 marks]

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Description of test(s) carried out** | **Observations** | **Equations** |
| SO42−(aq)  **OR**  Cl- (aq) |  |  |  |

**Ion present is: Task Three:** Solution C is an aqueous solution of a metal nitrate. Identify the **cation** present. [6 marks]

|  |  |  |
| --- | --- | --- |
| **Description of test(s) carried out** | **Observations** | **Equations** |
|  |  |  |

**Cation present is:**

Task Four: Solution D is an aqueous solution of a sodium salt. Identify the anion present. [4 marks]

|  |  |  |
| --- | --- | --- |
| **Description of test(s) carried out** | **Observations** | **Equations** |
|  |  |  |

**Anion present is:**

Task Five: Identify the anion and the cation present in solution E. [8 marks]

|  |  |  |
| --- | --- | --- |
| **Description of test(s) carried out** | **Observations** | **Equations** |
| **Test for anion** |  |  |
| **Test for cation** |  |  |

**Anion** present is: **Cation** present is:

**Task Six**

A colourless solution is analysed to determine the cation and anion present. [7 marks]

To separate samples of this solution various tests were carried out and the observations were recorded as follows.

* no effect on red litmus
* no reaction with aqueous silver nitrate
* no reaction with aqueous barium nitrate
* a white precipitate formed when a small volume of aqueous sodium hydroxide was added
* a white precipitate formed with dilute sulfuric acid
* a yellow precipitate formed when a small volume of aqueous sodium iodide was added

Using these observations, the ion identification flow charts and your chemical data sheet to identify the cation and anion present in the solution.

Write balanced equations for the precipitation reactions that occurred and justify your answers.