MGS 2024:

In another experiment, the solubility of the organic acid, **C**, in different solvents, water, ethanol and acetone is investigated.

Plan an investigation to find the effect of the nature of solvent on the solubility of the organic acid, **C**.

You may assume the apparatus normally found in the school laboratory is available for the investigation.

Outline:

Variables / Conditions to be controlled: 1m
Volume of solvent, temperature, speed of stirring, dry beaker

Independent variable: type of solvent: 1m

Dependent variable: maximum mass of the organic acid that has dissolved: 1m

Add a known mass of the solid organic acid + stir to dissolve completely: 1m

Continue adding until no more of the solid organic acid dissolves: 1m

SST 2024:

Iron nails rust in the presence of air and water. Iron nails can be coated with more reactive metals to protect them from rusting, through sacrificial protection.

You have been given two unknown metals, **A** and **B**. These metals are either more or less reactive than iron.

You are to outline a method to determine which metal **A** or **B** is more suitable to be used as a coating for the iron nails.

You can assume that all apparatus and reagents normally found in a school laboratory are available.

In your method you should note any assumptions that you make, include the observations you would record and explain how you would use your results to determine the metal to be used as a coating for the iron nails.

Outline:

1. **Set up two test tubes each with 25.0 cm3 of water inside.**
2. **Put one nail in each test tube, with metal A in the first test tube and metal B in the second test tube.**
3. **Leave both test tubes overnight and observe if each nail had any presence of rust.**
4. **Should there be a presence of rust in the nail, the metal coating protecting the nail is less reactive than iron. If there is no rust on the nail, the metal is more reactive than iron.**

Independent variable: metals A and B
Dependent variable: presence of rust on nails

Assumptions:

Each nail was rust-free before the start of the experiment.
There are no impurities in metal coating provided.

Nan Hua 2024

When an iron(III) sulfate sample crystallises from aqueous solution, it forms a trihydrated solid, $Fe_2(SO_4)_3.3H_2O$, which contains three molecules of water of crystallization per formula.

Describe a method to show by experiment that the crystallised solid is a trihydrated solid. This method must not involve titration.

You can assume all the apparatus and reagents normally found in a school laboratory are available. You should include any measurements you would take and explain how you would use your results to confirm that it is a trihydrated solid.

[Ar: Fe, 56; S, 32; O, 16; H, 1]

1. **Measure 1 g of the trihydrated solid ($Fe_2(SO_4)_3.3H_2O$) using an electronic balance.**
2. **Heat the trihydrated salt in a boiling tube until no change in mass.**
3. **Measure the mass of the anhydrous salt using the electronic balance and let this mass be x g.**
4. **Calculate the difference/change in mass to find the mass of water of crystallization, (1-x) g.**
5. **Find the number of moles of water, [(1-x) / 18] mol.**
6. **Find the number of moles of anhydrous salt, (x / 400) mol.**
7. **If $Fe_2(SO_4)_3$ is a trihydrated solid, $Fe_2(SO_4)_3.3H_2O \rightarrow Fe_2(SO_4)_3 + 3H_2O$, hence after heating, 1 mole of $Fe_2(SO_4)_3$ and 3 moles of H_2O will be obtained.**
8. **By comparing the mole ratio of $Fe_2(SO_4)_3$ and H_2O, if (x/400) : [(1-x) / 18] is 1 : 3, it is confirmed that the crystallized $Fe_2(SO_4)_3$ is a trihydrated solid.**

OPSS 2024:

The diagram shows two bottles of artwork solvent, E**1** and E**2**.

The solvents contain iron(III) chloride solution. A solution of iron(III) chloride is useful for etching copper according to the following equation:

$$2FeCl_3\ (aq) + Cu\ (s) \rightarrow 2FeCl_2\ (aq) + CuCl_2\ (aq)$$

Fe^{2+} produced can be tested with potassium ferricyanide, $K_3Fe(CN)_6$, solution. If Fe^{2+} is present, a dark blue precipitate of $Fe_3[Fe(CN)_6]_2$ will form.

Using the information given, plan an investigation to show which solvent contains the higher concentration of iron(III) chloride.

You may assume the apparatus and reagents normally found in a school laboratory are available.

Outline:

1. **Using a measuring cylinder, measure 5 cm^3 of E1 into a test-tube.**
2. **Using a spatula, add excess copper powder into the test-tube, stir and mix well.**
3. **Filter to remove the excess copper.**
4. **Using a measuring cylinder, add 1 cm^3 of potassium ferricyanide solution to the filtrate in step 3.**
5. **Filter to obtain the dark blue residue, $Fe_3[Fe(CN)_6]_2$.**
6. **Air dry the residue.**
7. **Weigh the dried residue using an electronic balance.**
8. **Repeat the experiment with the E2 solvent.**
9.

Solvent	Mass of $Fe_3[Fe(CN)_6]_2$ (g)
E1	m_1
E2	m_2

10. **The solvent which produces more dark blue precipitate, $Fe_3[Fe(CN)_6]_2$ contains a higher concentration of iron(III) chloride.**

ACSBR 2023

Cassiterite is a naturally-occurring form of tin dioxide. Tin can be obtained from tin dioxide and is commonly used in glass production and as coatings for steel containers.

Given a lump of cassiterite, outline a method by which the percentage by mass of tin present in the cassiterite can be determined.

Tin is similar in reactivity to iron.

You can assume that all apparatus and reagents normally found in a school laboratory are available.

In your method you should include the measurements you would take and explain how you would use your results to determine the percentage by mass of tin present in the cassiterite.

[A_r: Sn, 207]

Outline:

1. **Crush a lump of cassiterite with a mortar and pestle.**
2. **Weigh the cassiterite with the electronic balance (let this mass be M_1).**
3. **Heat the cassiterite with excess carbon in a crucible (not covered*) until a constant mass is achieved.**
4. **Allow the crucible to cool and weigh the residue which is Sn (let this mass be M_2).**
5. **Calculate the percentage by mass of Sn in the cassiterite = $(M_2 / M_1) \times 100\%$**

1m: [apparatus] mentioning electronic balance by description or drawing

1m: [reactant/procedure] heat with excess carbon till a constant mass is achieved

1m: [measurement] measure masses before and after heating

1m: [calculation] correct formula

Award 1M for [Apparatus] if student mentioned the use of electronic balance even if subsequent approach is mistaken. Award 1M for [Calculation] (i.e. correct formula) if the approach mentioned is thermal decomposition instead of reduction by carbon.

do not cover crucible to allow excess carbon to be removed/reacted with oxygen to form carbon dioxide gas which will escape from the crucible.

BBSS 2023

A white powder is the carbonate of an element in Group II. Its formula can be written as **X**CO_3.

A student wants to determine the molar mass of **X**CO_3 and hence the identity of **X**. He intends to react **X**CO_3 with dilute hydrochloric acid.

Describe the method the student should use to determine the molar mass of **X**CO_3. The method should include apparatus and the measurements that need to be taken.

You may assume that the apparatus normally found in a school laboratory is available.
You may use a labelled diagram to illustrate your answer.

Outline:
[labelled diagram, step 1 and 2 – 1m]
1. **Weigh 2.0 g of XCO_3 and add to the conical flask.**
2. **Set up apparatus as shown above.**

3. **Add excess dilute hydrochloric acid to carbonate in the flask. [1m]**

4. **Measure volume of carbon dioxide when reaction stops.**
5. **No. of mol of carbon dioxide = volume / 24 dm^3 [step 4 and 5 – 1m]**

6. **No. of mol of carbon dioxide = number of mole of XCO_3**
7. **Molar mass of XCO_3 = 2.0 g / number of mole of XCO_3 [step 6 and 7 – 1m]**