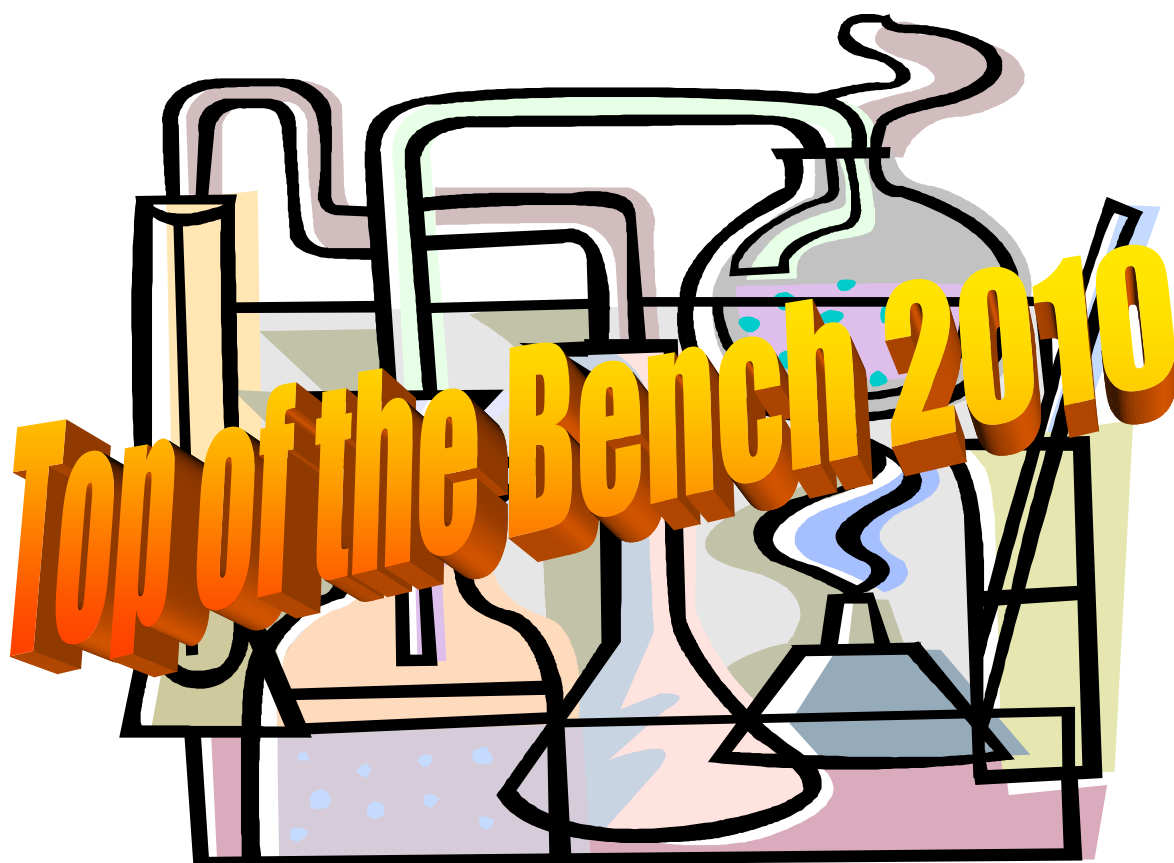


RSC | Advancing the
Chemical Sciences

Mid Scotland Section Trust



FORTH VALLEY COLLEGE, FALKIRK CAMPUS

WEDNESDAY 17th NOVEMBER 2010

18:45

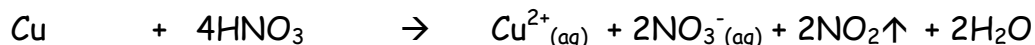
The Mission

Copper is a widely used metal both as the metal and as compounds. Eg modern water pipes and door handles. Your mission should you take it on, is to investigate some of the chemistry of copper plus find the amount of copper in a coin of the realm.

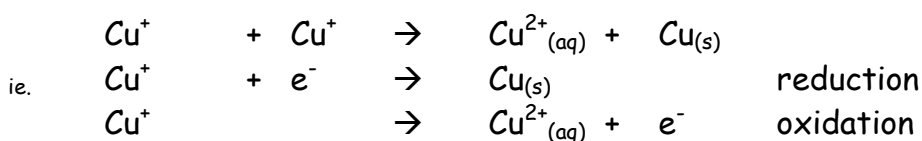
Copper has two common oxidation states; namely copper +1 and copper +2.

Copper metal does not oxidise very readily in air hence its use as copper piping by plumbers.

Copper metal can be oxidised to its +2 oxidation state by reaction with nitric acid.

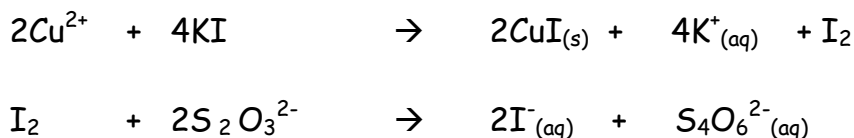


Copper +1 can only be stabilised by the formation of certain insoluble compounds or complexes. In solution copper +1 undergoes a self oxidation reduction reaction:



Copper containing coins can be reacted with nitric acid in order to form solutions of copper II ions; as above.

The copper content can be obtained by firstly reacting with potassium iodide solution which releases free iodine; the iodine produced can be estimated by reaction with standard sodium thiosulphate solution using starch solution as an indicator:



Safe use **MUST** be made of all laboratory equipment.

In order to ensure compliance with safe working practices, teachers will be on hand to supervise all experimental activity.

General Information for all Teams

1 The following **SAFETY WEAR** must be worn at ALL times in your designated **LABORATORY**:

Lab. **Coat [buttoned]** **Safety Specs/Goggles** **Protective Gloves**

2 Your team will be given 1 hour 30 minutes to complete all the work

3 Work will begin at about 6.45pm and finish by about 8.15pm

4 **The work must be carried out by the whole TEAM.**

5 Your **TEAM** will be assessed and awarded points using the following criteria:

- | | | |
|------|---|------------------|
| i | Team working [5 per team member] | 20 points |
| ii | Planning / organisation of experimental Activities | 20 points |
| iii | Safe working | 20 points |
| iv | Tidiness | 10 points |
| v | Recording all of the experimental data | 20 points |
| vi | Reactions of Cu^{2+} with various reagents [Task 1] | 24 points |
| vii | Colour changes [Task 2(i)] | 4 points |
| viii | Volume of $\text{S}_2\text{O}_3^{2-}$ (aq) solution required for known Cu content [Task 2(ii)] | 20 points |
| ix | Production of graph | 20 points |
| x | Volume of $\text{S}_2\text{O}_3^{2-}$ (aq) solution required for unknown Cu content | 10 points |
| xi | Estimation of copper content in a coin of the realm | 8 points |
- Marks will be deducted for any discrepancy in the targeted tasks

Total Points Possible **176 points**

6 The winner will be the **TEAM** with the most points.

7 In the event of a tie, then, the **TEAM** with the best safety mark and/or recording mark, will be deemed the winners.

8 After 8.15pm refreshments will be provided in **Room 206** while the judges are adding up the points.

9 Teams who have submitted a presentation will be asked to deliver it during this time and marks will be awarded for the standard of the delivery. These marks will be added to those previously awarded by the judges for the presentation as submitted. A separate prize will be awarded for the winning presentation.

10 **TEAM** points will be presented sequentially by area until the final scores are calculated in order to identify the winners.

11 The presentation of the **Top of the Bench Trophy** and prizes will take place around 8.55pm in **Room 206**.

Available Laboratory Equipment

- 1 All essential Laboratory Safety Wear including Safety Spectacles, Goggles, Laboratory Coats and Protective Gloves
- 2 A range of glass beakers ~ 100ml + 250ml + 400ml
- 3 A reagent bottle containing standard solution of sodium thiosulphate
- 4 Measuring cylinders ~ (5ml + 10ml + 25ml) x 2
- 5 A set of graduated syringes ~ (5ml + 10ml + 20ml) – 2 of each
- 6 A set of test tubes and 2 test tube racks
- 7 The following 5 Cu^{2+} (aq) solutions:
From coin containing 25% copper From coin containing 50% copper
From coin containing 60% copper From coin containing 90% copper
From coin containing an **unknown %age** of copper
- 8 Reagent bottle of starch solution
- 9 Reagent bottle containing potassium iodide solution
- 10 A series of hand bottles containing named chemical reagents for reacting with Cu^{2+} solution
- 11 A set of Labels
- 12 A set of stirring rods
- 13 Tissue paper for the base of the test tube racks.
- 14 Set of general purpose dropping pipettes
- 15 Pencils and 2 Calculators
- 16 Paper towels
- 17 A solution of Cu^{2+} for reacting with named chemical reagents
- 18 2 Wash bottles containing pure water that can be refilled from a plentiful supply of pure water available at the main sink.

Specific Team Tasks

TASK 1

Carry out a set of reactions between Cu^{2+} solution and the supplied named chemical reagents and record your observations.

TASK 2

- i To investigate the colour changes when $\text{Cu}^{2+}_{(\text{aq})}$ is reacted with $\text{I}^{-}_{(\text{aq})}$ followed by addition of starch as indicator then $\text{S}_2\text{O}_3^{2-}_{(\text{aq})}$ dropwise.
- ii To construct a graph showing %age copper content (x-axis) against volume of thiosulphate ion solution used to bring about a change of colour within the solution (y-axis).
- iii To estimation the copper content in a coin of the realm.

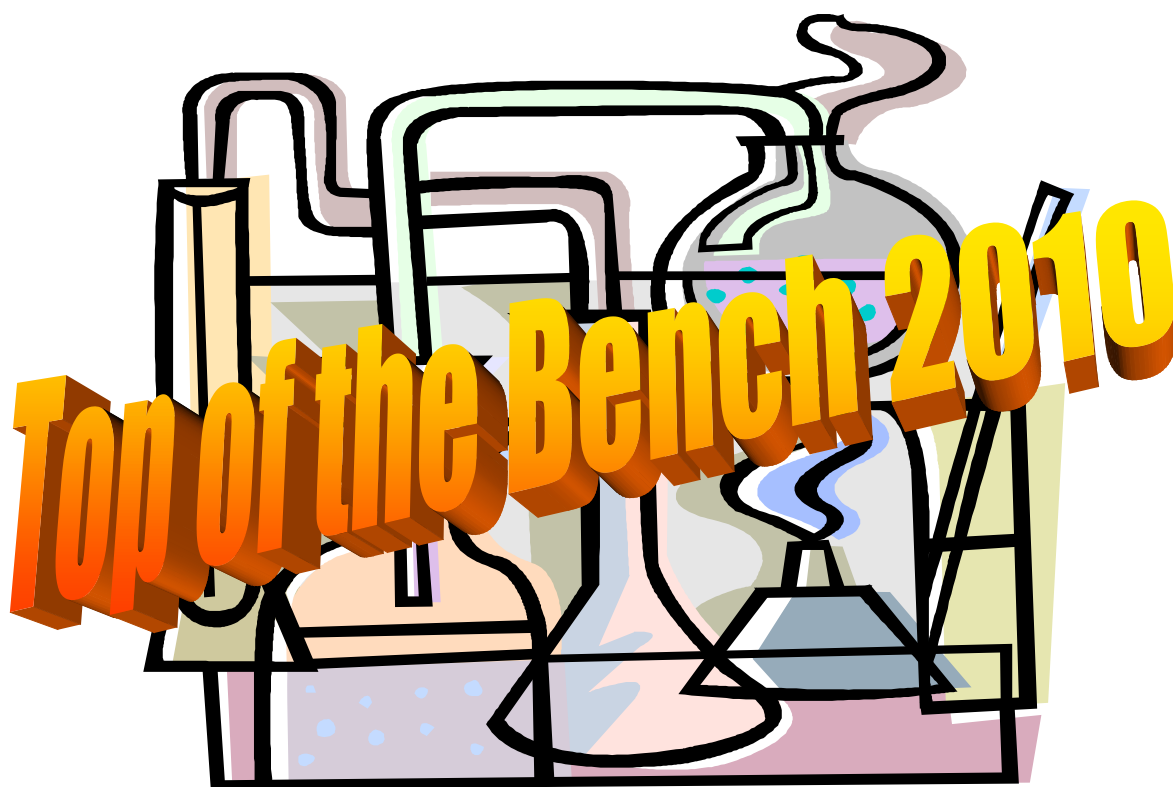
The Report

You have been given a laboratory report book to write up your experimental work. The first set of pages gives ample space to include all of your experimental data and calculations.

In the book there are a number Sections that must be completed. These are indicated in *italics*.

School Name:

Laboratory Report



Laboratory Report

Task 1 - Carry out a set of reactions between Cu^{2+} solution and the supplied named chemical reagents and record your observations.

Using a measuring cylinder take about 2ml quantities of the stock copper II solution and add the following solutions of chemical reagents dropwise.

Note: the concentrated reagents are located in a fume cupboard and should be added very carefully.

Example reaction of copper II ions with a chemical reagent

CHEMICAL REAGENTS	What did you see?	What do you think happened?
Hydrogen sulphide (colourless reagent) added	Black solid formed and colour of solution changed to clear.	Copper II ions form a black compound with sulphide ions which was not soluble.

CHEMICAL REAGENTS	What did you see?	What do you think happened?
1. Dilute sodium hydroxide solution		
2. Concentrated sodium hydroxide (CARE NEEDED)		
3. sodium carbonate solution		
4. Few drops of dilute ammonia solution		
5. Excess dilute ammonia solution		
6. Concentrated hydrochloric acid (CARE NEEDED)		

Task 2 (i) - To investigate the colour changes when $\text{Cu}^{2+}_{(\text{aq})}$ is reacted with $\text{I}^{-}_{(\text{aq})}$ followed by addition of starch as indicator then $\text{S}_2\text{O}_3^{2-}_{(\text{aq})}$ dropwise.

Add 1 ml of Cu^{2+} solution to a test tube followed by 1 ml of potassium iodide solution.

Observe the colour change.



Original colour New colour

Now add a few drops of starch solution.

Colour with indicator is

Now add, dropwise, sodium thiosulphate solution until a permanent colour change occurs.

Final colour is

Colour changes to to to
(original) (final)

Task 2 (ii) To construct a graph showing %age copper content of coin (x-axis) against volume of thiosulphate ion solution (y-axis).

Using a fixed volume of the prepared solution of the coin, add KI solution followed by starch solution and titrate until a permanent colour change is observed.

- 1 Using a syringe measure out exactly 10 ml of the 25% copper content solution into a small conical flask; use a measuring cylinder to add 10ml of the potassium iodide solution followed by 1 ml of starch solution. Using a syringe, add sodium thiosulphate solution, stepwise, with shaking, until a permanent colour change is observed.
- 2 Read and record the volume of the sodium thiosulphate solution used.
- 3 Repeat 1 and 2 at least twice more.
- 4 **TABULATE** the volumes of sodium thiosulphate used in the experiments and also the accepted volume of sodium thiosulphate solution that your results indicate

NOW Repeat the steps 1,2,3 and 4 with the 50% copper content, then 60% copper content and finally 90% copper content solutions.

Table of Results

Draw a properly annotated and scaled graph from your results for the above four sets of experiments.

Task 2 (iii) - Find the %age copper content of a coin of the realm.

Repeat the steps 1, 2 and 3 with the copper solution of **UNKOWN** copper %age and add these results to your table of data.

From the experimental value of the thiosulphate ion solution required to bring about the colour change find, from your graph, the percentage copper content of the coin of the realm.

Volume of thiosulphate ion solution required was _____ ml.

From the graph this volume corresponds to a copper content, in the coin, of

_____ %