Chemistry 20	Unit 4
Lesson 7 - Chemical Analysis	84 mins

Chemical Analysis

- **Quantitative Analysis**	- analysis by colour, which uses light emitted, absorbed, or transmitted by the chemical (Section 8.1)
- **Gravimetric Analysis**	- which uses stoichiometric calculations from a measured mass of a reagent (Section 8.2)
- **Titration Analysis**,	- which uses stoichiometric calculations from a measured solution volume of a reagent (Section 8.4)

Colorimetry

Colours of Solutions - some chemicals make specific colours in solution	Pg. 11 of Data Booklet - Groups 1, 2, 17 - No colour - Copper (II) - Blue - Copper (I) - Blue Green - MnO_3^- - Purple
Flame Colours - some chemicals burn with a specific flame colour	Pg. 6 of Data Booklet - Copper (II) - Green - Sodium - Yellow - Potassium - Purple (Violet) - Strontium - Scarlet Red

Chemical Analysis Using a Graph

- Chemists read the required quantity of a chemical from a graph that has been prepared in advance. This saves the time and trouble of doing a separate stoichiometric calculation for each analysis performed.	Graph the following Data **Table 1** Reaction of Lead(II) Nitrate and Potassium Iodide

Mass of PbI_2 produced (g)	Mass of $Pb(NO_3)_2$ reacting (g)
1.39	1.00
2.78	2.00
4.18	3.00
5.57	4.00
6.96	5.00

Interpolate the Mass of $Pb(NO_3)_2$ reacted from the following data

Table 2 Two Different $Pb(NO_3)_2$ Solutions

	Solution 1	Solution 2
Volume used (mL)	20.0	20.0
Mass of filter paper (g)	0.99	1.02
Mass of dried paper plus precipitate (g)	5.39	8.57

Precipitation Completeness

In a gravimetric analysis where a precipitation reaction is used, it is not possible to predict the quantity of excess reagent required, because you do not initially know the amount of the limiting reagent; that is why you are doing an analysis. For such reactions, use the following trial-and-error procedure to verify that a sample of limiting reagent has completely reacted:

1) Precisely measure a sample volume of the solution containing the limiting reagent.
2) Add (while stirring) an approximately equal volume of the excess reagent solution.
3) Allow the precipitate that forms to settle, until the top layer of solution is clear.
4) With a medicine dropper, add a few more drops of excess reagent solution. Allow the drops to run down the side of the container, and watch for any cloudiness that may appear when the drops mix with the clear surface layer
5) If any new cloudiness is visible, the reaction of the limiting reagent sample is not yet complete. Repeat steps 2 to 4 of this procedure as many times as necessary, until no new precipitate forms during the test in step 4.
6) When no new cloudiness is visible (the test does not form any further precipitate),the reaction of the sample of limiting reagent is complete.

Separating Ions

Sometimes you need to remove toxic or unwanted ions from a solution, such as Pb^{2+} or Hg^{+}. To do this you would need to precipitate the ions with a solution that will react ONLY with those Ions making a precipitate.
Steps:

1. Check your solubility chart for a anion that would dissolve in water but once in water would react with the ion of choice creating a precipitate.
2. Filter the precipitate.
3. Repeat until all unwanted ions are precipitated out.

If you had a mixture of Pb^{2+} and Hg^{+} in a solution. What would you need to add so that you separated the unwanted ions from the solution?

1. *Check your solubility chart for a anion that would dissolve in water but once in water would react with the ion of choice creating a precipitate.*

   Most Halogens and SO_4^{2+} with react with both ions making a precipitate… but we won't be able to ensure that one out the other has been fully precipitated…

   BUT CH_3COO^- ONLY will react with Hg^{+} (Hg_2^{2+} is the same thing) NOT Pb^{2+}

   So we will need to add CH_3COO^- until Precipitation Completeness (Vinegar would work)
2. *Filter the precipitate.*
3. *Repeat until all unwanted ions are precipitated out.*
   Using any halogen or SO_4^{2+} (H_2SO_4 or NaCl etc.)

Chemistry 20 - Unit D - Intro to Chemical Analysis

Name: _____

1) Artificial fire logs for home fireplaces are commonly available in supermarkets and hardware stores. Along with the combustible ingredients, the fire logs often have chemicals deliberately added to colour the flames. If such a fire log has copper(II) chloride near its core, sodium nitrate in layers farther out from the centre, and strontium chloride near the surface, describe how the flames will look over the normal three-hour burning period.

2) A student wants to precipitate all the toxic lead(II) ions from 2.0 L of solution containing 0.34 mol/L $Pb(NO_3)_{2(aq)}$. The purpose of this reaction is to make the filtrate solution nontoxic. If the student intends to precipitate lead(II) sulfate, suggest an appropriate solute, and calculate the minimum required mass of this solute.

3) A chemical analyst wants to determine the concentration of a solution of copper(II) sulfate that is used for treating wood, to prevent decay. A large strip of zinc metal is placed in a 200 mL sample of this solution. When the reaction shows no further change, much of the zinc strip remains. The originally blue solution is now colourless. A brownish layer of fine copper particles has formed, which when filtered and dried, has a mass of 1.72 g. What is the amount concentration of the sample solution?

4) Many industries recycle valuable byproducts, such as silver nitrate solution. You are an industry technician who needs to determine the amount concentration of a solution. Complete the Analysis of the investigation report.

Purpose

The purpose of this investigation is to use the stoichiometric method to analyze a solution for its amount concentration.

Problem

What is the amount concentration of silver nitrate in the solution to be recycled?

Design

A sample of the silver nitrate solution reacts with an excess of sodium sulfate in solution. The precipitate is filtered and the mass of dried precipitate is measured.

Evidence

A white precipitate formed in the reaction.

No further precipitate formed when a few extra drops of sodium sulfate were added to the clear solution layer above the settled precipitate.

volume of silver nitrate solution = 100 mL

mass of filter paper = 1.27 g

mass of dried filter paper plus precipitate = 6.74 g

Analysis

5) Identifying ions in an aqueous solution can be very important. Nitrate ions in well water, for example, must be identified because they may be harmful to health (especially for children) if the concentration is too high. Assume you have a solution containing several common cations and anions, which may or may not contain strontium ions. Write an experimental design for an analysis to determine whether strontium ions are present. Use two precipitation reactions followed by filtrations, and then a flame test. Use your Solubility of Ionic Compounds table (inside back cover) to decide what solutions you might use for the precipitation reactions. You may assume that no ions are present that are not listed in this table. Hint: Plan your first precipitation to remove most cations that are not strontium ions from the solution. Explain the logic you apply to each step of your design, in particular, why a flame test is required as a final step.