SCH3U – Practical Lab Exam: Qualitative Analysis of an Unknown Ionic Compound

Overview

The purpose of the lab exam is to evaluate your lab skills – do you act safely, do you use equipment properly, can you follow simple instructions, and do you communicate effectively?

The Task

You will be given a sample of an unknown ionic compound to identify. Procedures are based on the scanned text at the bottom of this document. Go over the steps you will take to identify your unknown.

Procedures Available to You

1. The scanned text, in the Procedures, says "add x ion to a sample of the test [unknown] solution". To do this,
   a) Prepare a dilute solution of the unknown by adding a spatula-tip of the unknown to a clean test-tube with 2-3 cm of dH_2O. Swirl to dissolve.
   b) Add 1-2 drops of the solution containing the ion to the test-tube (dropper bottles of each will be available).
   c) Record your observations.
   d) Discard the test-tube contents, and rinse the test-tube with dH_2O.

2. The flame test
   a) Clean nichrome (a nickel-chromium alloy) wire by dipping it into concentrated hydrochloric acid and then holding it in a hot Bunsen flame. Repeat this until the wire doesn't produce any colour in the flame (there will always be a trace of orange in the flame from the nichrome – ignore this).
   b) Dip the wire again into some of the acid, and then dip it into a small amount of the solid you are testing so that some sticks to the wire. (Do *not* dip it into the original unkown vial, to avoid contamination).
   c) Place the wire back in the flame again. Observe the colour. Repeat if necessary.

Evaluation

Category	**Level 1 (50-65%)**	**Level 2 (65-75%)**	**Level 3 (75-85%)**	**Level 4 (85%+)**
Safety – Wears goggles and behaves appropriately	rarely	when prompted	usually	always
Handles equipment safely and correctly	rarely	when prompted	usually	always
Is able to follow procedures properly	rarely	when prompted	usually	always
Disposes of wastes properly and cleans up work area/materials	rarely	when prompted	usually	always
Communicates results	with confusion	with some clarity	with clarity and completeness	clearly, completely, and concisely
Demonstrates _____ knowledge of chemistry in written part	little	some	good	excellent
Identifies unknown substance	no	close – some mistakes	either anion or cation is correctly identified	both anion and cation are correctly identified

Name: _____ . **(Submit this paper with your lab).**

Your Report – written on this sheet of paper

1. Identify your unknown here: Unknown # _____ Identity: _____
2. Include any test you performed and the results of each test.
3. For every positive test (except flame tests), include the corresponding balanced net ionic equation.

How to Identify Anions in Solution

To identify an anion, you need to find a cation with which it will give a characteristic reaction. To illustrate, suppose you have a solution that you know contains one of the following colourless anions: carbonate, chloride, bromide, or sulfate. Then you can perform the following test sequence:

Procedure 1:	add hydrogen ion (dilute hydrochloric acid) to a sample of the test solution
Observation:	gas produced
Deduction:	carbonate ion

Procedure 2a):	add silver ion (silver nitrate solution) to a sample of the test solution
Observation:	white or cream-coloured precipitate
Deduction:	chloride ion or bromide ion

Procedure 3:	add barium ion (barium chloride solution) to a sample of the test solution
Observation:	white precipitate
Deduction:	sulfate ion

To distinguish between chloride and bromide ions, you can use a single displacement reaction involving the halogen activity series.

Procedure 2b):	add aqueous chlorine (also known as chlorine water, $Cl_{2}(aq)$)
Observation:	brown colour
Deduction:	bromide ion (no colour change would have indicated chloride ion)

For each positive test, you should always write a corresponding balanced net ionic equation.

How to Identify Cations in Solution

To identify a cation, you need to find an anion with which it will give a characteristic reaction. To illustrate, suppose you have a solution that you know contains one of the following colourless cations: barium, magnesium, silver, or sodium. Then you can perform the following test sequence:

Procedure 1:	add chloride ion (sodium chloride solution) to a sample of the test solution
Observation:	white precipitate
Deduction:	silver ion

Procedure 2:	add sulfate ion (sodium sulfate solution) to a sample of the test solution
Observation:	white precipitate
Deduction:	barium ion

Procedure 3:	add carbonate ion (sodium carbonate solution) to a sample of the test solution
Observation:	white precipitate
Deduction:	magnesium ion

Procedure 4:	to distinguish between sodium and potassium ion, take a concentrated solution of the unknown ion and perform the flame test (dip the end of a wooden stick or piece of wire into the solution, then place the tip into a burner flame and observe any colour produced). This test only works for pure K^{+} ions that are not contaminated with Na^{+} ions.
Observation:	yellow or lilac colour to flame
Deduction:	sodium ion (yellow) or potassium ion (lilac)

For each positive test, you should always write a corresponding balanced net ionic equation.

Discovering Chemistry — *Mystery Solutions*

In this activity, you are to identify an unknown solution using the anion and cation flowcharts.

Materials

dropper bottles of the following solutions:
dilute hydrochloric acid, silver nitrate, barium nitrate, sodium chloride, sodium carbonate, and sodium sulfate
blue glass
splints
spot plate
wash bottle (to rinse the spot plate into a waste container provided by your teacher)

1. Using the tests given, design flowcharts for the identification of an anion (from a choice of CO_3^{2-}, Cl^{-}, Br^{-}, or SO_4^{2-}) and for a cation (from a choice of Ag^{+}, Ba^{2+}, Mg^{2+}, K^{+}, or Na^{+}). Your teacher will provide you with a mystery solution containing one anion and one cation from these choices.
2. Design an efficient way to record your observations. Using your flowcharts, perform the tests necessary to identify the solution. If you are performing Procedure 4, the splint should be wet first. Use a blue glass to check for potassium ions.

- Write net ionic equations for all reactions you performed.