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Chem10 – Lab #4

FLAME TEST

Background

The flame test is one method used to identify certain unknown substances. Determining the composition of an unknown substance without calculating specific percentages is one form of *qualitative analysis*. When an electron absorbs energy, it travels away from the nucleus to a higher energy level. This increases the potential energy of the electron. When the electron returns to its ground state (or any other lower energy state), energy is released in the form of a photon. Depending on the exact transition made, different amounts of energy may be released. Different quantities of energy yield different wavelengths of light and, often, a visible color that is characteristic of that element. The wavelengths of the photons of light released allow scientists to identify elements present in unknown substances.

Purpose

To observe the atomic spectra of a variety of metal ions and to identify the ion present in an unknown solution.

Equipment and materials

- 250 mL beaker
- Laboratory burner
- Colored drawing pencils
- Chemical splash goggles, aprons, and gloves
- Wooden splints, soaking separately in each of the following solutions: NaCl, KCl, LiCl, $CaCl_2$, $SrCl_2$, $CuCl_2$, and unknown.

Safety notes

- Wear approved chemical splash goggles and chemical-resistant gloves and apron.
- Burned splints should be placed in the 250 mL beaker of water after use.

Procedure

1. Wear aprons and chemical splash goggles.

2. Fill a 250 mL beaker with tap water and place it at your workstation. This will be used to extinguish wooden splints.

3. Obtain a wooden splint from one of the metal chloride solutions.

4. Carefully light laboratory burner and slowly pass the wooden splint back and forth through the hottest part of the flame. Carefully observe the flame that is first produced.

5. After recording observations, immerse the wooden splint in the tap water making sure it is fully extinguished. At the end of the experiment, all splints in the water can be thrown in the trash.

6. Record observations.

7. Repeat steps 1–4 with another salt, until all ions have been tested.

8. Repeat steps 1–4 with the unknown salt. Determine which ion is present in this solution.

9. Once the laboratory work is complete, wash hands with soap and water.

10. Perform calculations and answer all questions.

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Observations and data

Flame Test Observations

Solution	Metal ion Present (include charge)	Color of Flame	Written description of color(s) observed
NaCl			
KCl			
LiCl			
$CaCl_2$			
$SrCl_2$			
$CuCl_2$			
$BaCl_2$			
Unknown			

Calculations and conclusions

1. Discuss some of the limitations of using flame tests to identify ions present in solution.

2. Propose at least one possible method for improving the accuracy of results in this laboratory experiment.

3. A green line of wavelength 486 nm is observed in the emission spectrum of hydrogen. Calculate the energy of one photon of this green light.

Use the mathematical relationships $\nu = c / \lambda$ and $E = h\, \nu$

ν = Frequency

c = speed of light (3.00×10^8 m/s)

λ = wavelength

h = Plank's constant (6.63×10^{-34} J·s)

E = energy

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Figure 1b. Teacher notes and answer key.
Setup

Create saturated solutions of the following salts in 250 mL beakers: NaCl, KCl, LiCl, $CaCl_2$, $SrCl_2$, $CuCl^2$, and an unknown. The unknown should be a second beaker of one of the previously listed salts; however, the teacher should label this beaker “unknown.” Count out enough wooden splints for every beaker to allow all student groups to test each salt. Allow the wooden splints to soak in the saturated solutions overnight.

Data results

Na^+ = yellow
K^+ = lavender
Li^+ = carmine
Ca^{2+} = brick red
Sr^{2+} = red/orange
Cu^{2+} = green/blue
Unknown: Potassium is a good choice for the unknown because its solution looks just like that of sodium, lithium, calcium, and strontium, yet its flame color is easy to differentiate from the other possibilities.

Questions and conclusions

1. One limitation is that some elements have similar flame colors. Also, sodium is present as a contaminant in many compounds, obscuring the sample color with yellow light. Sometimes, elements are viewed through cobalt blue glass to filter out this impurity.
2. One possible improvement would be to view the flame emissions through a spectroscope to improve accuracy.
3. Solution:

É…green = 486 x 10-9m,
ÉÀ = *c*/É…
(3.00 x 108m/s)/(486 x 10-9m) = 6.17 x 10^{14} Hz,
E = *hÉÀ*
= (6.626 x 10-34J·s)(6.17 x 1014Hz)
= (6.626 x10-34J·s)(6.17 x 1014s-1)
= 4.09 x 10^{-19}J