

QUALITATIVE ANALYSIS OF AQUEOUS SOLUTIONS



As you arrive:

- Goggles on.
- Open notebook to prelab.
- Get a pair of gloves
- Begin setting up your test tubes with labels and get a waste beaker out (labeled).
- Get a piece of paper towel and lay it out in the hood.

What is Qualitative Analysis?

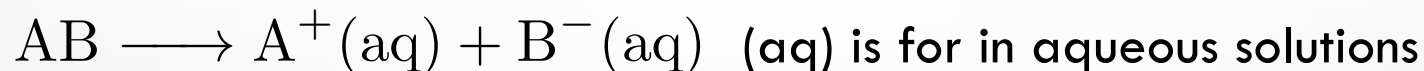
Tests to help identify **presence** of properties rather than size or amount.

Data are *observations* not *quantities*.

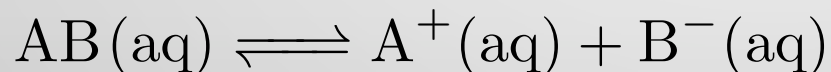
What property will we be using to qualitatively identify the absence or presence of the metal cations?

STRONG VS. WEAK ELECTROLYTES

- **Dissociation** – process of compounds separating in solution:



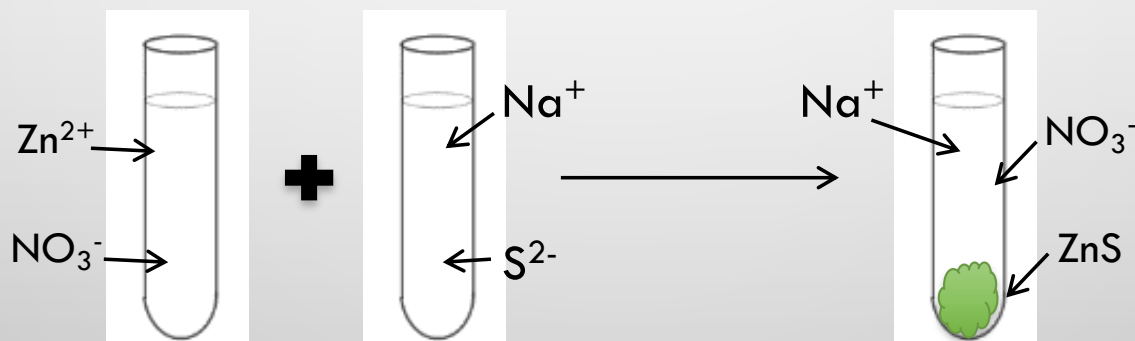
- **Strong electrolyte** –present **almost entirely** as ions in solution
- **Weak electrolyte** –**incompletely ionized** in solution (mostly intact)
 - Impact on writing ionic reaction equations?



DOUBLE DISPLACEMENT REACTIONS

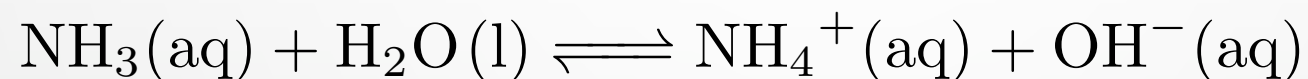
- GENERAL EQUATION: $AB + CD \longrightarrow AD + CB$
- SOME ELECTROLYTE SOLUTIONS FORM INSOLUBLE PRODUCTS (**PRECIPITATE**) TO BE ISOLATED FROM SOLUTION.

- **EXAMPLE:**



NH₃ – WEAK ELECTROLYTE

- ALL COMPOUNDS TODAY ARE STRONG ELECTROLYTES.
- **EXCEPTION: NH₃.** IN H₂O:



WHAT DOES THIS MEAN?

EXPERIMENTAL DETAILS

1. **WATCH** DEMONSTRATION OF Centrifuge, pH testing, mixing, DI Water
2. **Test** each reagent/known cation combination & **record observations**.
 - Should have own **procedure** prepared for this in your notebooks
3. Prepare **flow chart** to use to find cations **present** or **absent** from unknown solution.
4. **Test** flowchart on **known cation solutions** & record all results, **positive** and **negative**.
5. **Use** flow chart on assigned **unknown**.
 - *Write down letter of your unknown! No unknown letter = no grade!!!*
6. Identify cations (1-4) in unknown.

EXPERIMENTAL DETAILS

- **CLEAN** TEST Tubes with acids ($\text{HCl} + \text{HNO}_3$), rinse with DI H_2O . Shake/blow air to dry.
- **Label** all test tubes with wax pencil/small tape labels. Organize by row, column (template in notebook!)
- 25 drops cation to test tubes, then 5 drops of 1st anion reagent. Mix by **flicking bottom of tube** (demo!). Next anion in next tube, mix, etc.
 - **Note:** if expect ppt with nh_3 & don't see one, add ≤ 20 drops, 1 drop at a time
- Test pH with **stir rod** and **small pH strip**. Rinse well in between uses.
- Collect rinse, sample waste in large beaker in your hood. Dispose **at end** of lab period.
- Again, make sure all these suggestions are **incorporated** into your previously prepared **procedural outline**.

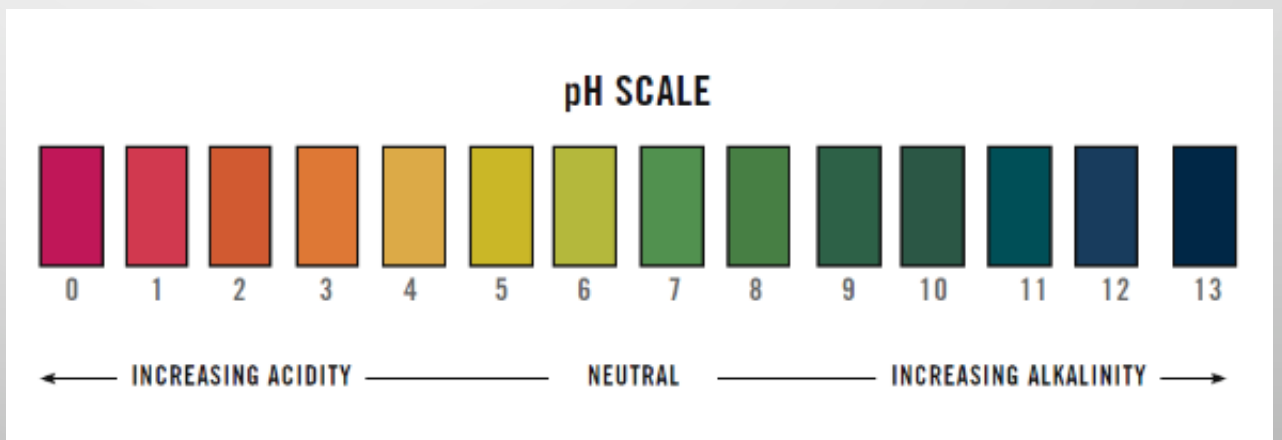
DEMO: MIXING REAGENTS

- Each test: 25 drops cation solution!
- Add right amount of reagent, mix by gently flicking test tube
- When adding reagents to test tubes, make sure to NOT touch dropper to test tube



DEMO: TESTING pH

- DO **NOT** put pH paper directly in solution!
- Instead **dip glass stirring rod** in solution + place on pH paper.
- pH paper is expensive! Multiple pH tests on one piece.
- Rip it up and put it across a piece of paper towel



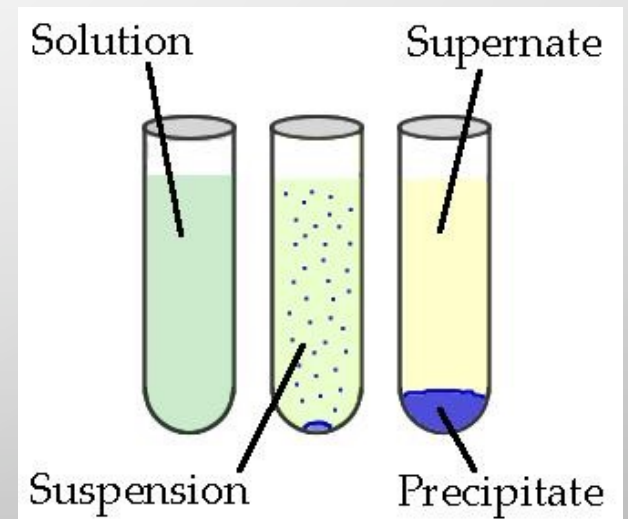
DEMO: USING THE CENTRIFUGE

- **Purpose** of the centrifuge?
- Sample in **labeled** medium test tube.
- **2nd** test tube containing ~same **volume** of liquid in sample holder **directly across** from 1st test tube. Why?
 - A: **counter-balance**.
- Turn on motor. After 30 s, turn off.
- Wait for centrifuge to completely stop. Do not stop the centrifuge with your hand! **When done**, remove test tubes.
- Repeat if necessary. (When?)



DEMO: DECANTING

- **Decant** supernatant and **discard knowns**. Save if supernatant contains unknown for continued ID of unknowns in solution.
- Carefully remove final supernatant fluid using pipet.
- **Record description** of precipitate.



DEMO: CLEANING TEST TUBES

- Clean with mixture of ~ 1 ml 1M HCl and ~ 1 ml 1M HNO₃ (akin to *aqua regia*)
- *Aqua regia* dissolves metal ions in test tube
- Then, rinse with **distilled H₂O**, leave upside down in racks to **dry**.
- Do this **before** experiment if suspect any TT are dirty.



SAFETY & WASTE

Safety:

- Safety glasses and gloves – today & *ALWAYS!* Working with strong acid and toxic metals.
- Don't touch skin, masks, or personal items wearing gloves.
- Ag^+ stains skin.

Clean up:

- ALL waste into **waste container** in front hood!
 - Open the **red** funnel top first!!!
- Reagent bottle < **half full**, then leave **outside** plastic box in your hood; otherwise leave in box.
- Clean all test tubes before leaving; leave upside down in rack.



REMINDERS!

- QUALITATIVE ANALYSIS REPORT IS DUE TODAY BY 7PM!
- USE CLAIM-EVIDENCE-REASONING STATEMENTS.

For each ion's presence or absence, you should construct a *claim-evidence-reasoning sentence*. A claim-evidence-reasoning sentence should include three parts:

- Claim: whether the ion is present or absent.
- Evidence: what *observations* were relevant to making your claim?
- Reasoning: what chemistry knowledge or comparison means that your claim follows from that evidence?

Example (from the flowchart in Figure QA.1): Lead II ion (Pb^{2+}) was present in the unknown sample because a white precipitate was observed upon reaction with HCl, which was observed for the known to be a formation of PbCl_2 .

APPROXIMATE TIMELINE FOR LAB

- 5 MIN - LAB STARTS, NOTEBOOK CHECK, PRE-LAB LESSON, INCLUDING DEMOS
- 45 MIN – STUDENTS START WORKING BY RUNNING CATION PRECIPITATION TESTS ON ALL FOUR DIFFERENT CATIONS & RECORD OBSERVATIONS. WORK AS A CLASS!
- 20 MIN – LESSON ON WRITING FLOWCHARTS; ASSIGN UNKNOWNNS; DEVELOP FLOW CHART BASED ON OBSERVATIONS
- 45 MIN – DO BOTH A KNOWN WITH ALL 3 CATIONS AND YOUR UNKNOWN SIDE-BY-SIDE. ONE PARTNER CAN DO THE KNOWN, ONE CAN DO THE UNKNOWN.
- 15 MIN – CHECK YOUR UNKNOWN, CLEAN UP YOUR STATION
- 45 MIN – WRITE YOUR REPORT AND SUBMIT.
- REPORT IS DUE BY 7PM THE DAY OF LAB.



QUESTIONS?