Chemistry Lab

By Lin Wozniewski

lwoz@iu.edu

Disclaimer

- This presentation was prepared using draft rules. There may be some changes in the final copy of the Rules.
- The Rules released in September 2024 will be the official Rules and should be used for all competitions.

Safety

- Students must wear:
  - Closed shoes
  - All skin from neck to toes covered (loose fitting pants)
  - Lab coat or lab apron
  - Indirect vent or unvented chemical splash proof goggles.
  - All skin from neck to wrists covered
  - Long hair (shoulder length or longer) must be tied back.

What the Students Should Bring

- One non-image capable calculator per student.
- One unique 8.5 X 11” sheet of paper, two sided containing information in any form from any source per team member
- A writing instrument
- Chemistry “C” lab kit

Students can bring Chemistry C kit consisting of:

- Spot plate or something to do reactions in
- Microspatula or something to get powders out
- Forceps/ Metal Tongs
- Hydron paper
- Hand lens

Chemistry C kit

- Test Tubes
- Test Tube rack
- Test Tube holder
- Eye droppers
- Funnel
- Filter Paper
- Battery Conductivity meter
- Flame loop/cobalt blue glass
- Ruler
- Nail, Zn, & Cu metals

Chemistry C kit

- Stirring rods or something to stir with
- Slide & cover slip
- Pencil
- Paper towels
- A test tube brush
- Thermometer
- Petri Dish

Chemistry C kit

- Graduated Cylinders
- Erlenmeyer Flasks
- Battery multimeter
- Alligator clip wires
- Calipers
- Will all of this be any good to Chemist?
- No, but we are going for one kit
- Nothing else is allowed!!!!!!

What the Supervisor Provides

- Everything the student will need
  - This may include:
    - Glassware
    - Reagents
    - Balances
    - Hot plates
    - Thermometers
    - Probes
    - Magnets
    - Stirrers

What do they need to be able to do every year every year?

- Interpretation of experimental data (tabular and/or graphic)
- Observation of an experiment set up and running
- Computer or calculator sensors/probes
- Stoichiometry : mole conversions and percentage yield
- Nomenclature and formula writing - symbols and charges for the following ions by memory: nitrate, carbonate, phosphate, acetate, sulfate, ammonium, bicarbonate, and hydroxide (“ite” forms of “ates” listed)

How to prepare participants

- Make sure students read the directions and pay particular attention to the description of the event (The Competition)
- Have them do many experiments together
- Have them determine their individual strengths
- Divide (and conquer) tasks during competition
- Check each other's work

How to prepare participants

- Get as many lab books from your chemistry teacher as possible & have students explore labs by topic and do the ones that appear consistently

Changes for 2024

- 1 new topic & 1 old topic:
  - Stoichiometry and Chemical Reactions
  - Equilibrium

Equilibrium Activities

- Students should be able to write equilibrium reactions
- Predict the direction of a reaction using Le Châtelier's Principle.
- Calculate an equilibrium constant.
- Use equilibrium constants to determine concentrations
- At the state and national levels knowledge and application, knowledge/application of equilibrium to separate chemicals may be included

Stoichiometry and Reactions

- Students will complete experimental tasks and answer questions related to classification of reaction type, balancing reactions (including predicting products of double replacement reactions, solubility, oxidation-reduction, total ionic and net ionic equations), and reaction prediction.

Equilibrium Activities

- Use a titration/data of a weak acid/base with a strong acid/base to calculate an equilibrium constant.
- Investigate an equilibrium reaction and determine what happens when it is stressed.
- Stoichiometry of equilibrium reactions.

Equilibrium Activities

- Construct/use a standard absorption curve to determine an equilibrium constant.
- Use a calorimeter to predict a curve.
- Use a syringe to verify gas laws.

Equilibrium Activities

- http://education.ti.com/educationportal/activityexchange/activity_list.do?cid=us
- http://chemtutor.com/redox.htm

Chemical Equations-Stoichiometry Activities

- Students can perform composition, decomposition, single replacement, and double replacement reactions
- Students can be asked to determine the stoichiometry of the reaction based on data collected.
- Students can determine the net ionic equation of a reaction based on data colected.

Chemical Equations-Stoichiometry Activities

- Students can predict products of reactions based on solubility rules
- Students can predict theoretical yields of reactions based on stoichiometries

Resources: TI Activity Exchange

- http://education.ti.com/calculators/downloads/US/Activities/Search/Subject?s=5023&sa=5028&t=5099

Scoring

- 50% Equilibrium
- 50% Chemical Reactions and Stoichiometry

Resources

- ://mypage.iu.edu/~lwoz/socrime/index.htm
- For Lesson Plans for classroom use
  - http://mypage.iu.edu/~ For Event Supervisors
  - http lwoz/socrime/index.htm

Questions???

- Thank you

Time to play!

- 4 basic problems to solve
  - Stoichiometry-Acid/Base
  - Equilibrium-Colorimetric Determination of an Equilibrium Constant & Le Châtelier's Principle
  - Stoichiometry-Biggest Bang
  - Equilibrium-Determine the Equilibrium constant of a weak acid.

Stoichiometry-Acid Base

- Put 10 ml $Ba(OH)_2$ solution in a 50 ml beaker. Put the conductivity probe attached to a working TI and CBL into the beaker
- Draw up .1M H_2SO_4 into a Berrel Pipette.
- Count the number of drops it takes to make 1 ml by dropping the acid into a 10 ml graduated cylinder
- Measure the conductivity of the base.

Stoichiometry-Acid Base

- Set the TI to record with prompt.
- Add a drop of acid. Record the conductivity.
- Continue to add drops of acid one at a time and record the conductivity after each drop.
- Continue until the conductivity starts to decrease.
- Plot the number of drops vs. the conductivity.

Stoichiometry-Acid Base

- Determine the volume of acid required to exactly neutralize the base.
- Determine the number of moles of acid and number of moles of base
- What is the stoichiometry of the reaction?

Equilibirum

- Pipette 5 ml of .002 M $Fe(NO_2)_3$ into a 10 ml graduated cylinder
- Pipette 1 ml of .002 M KSCN into the cylinder.
- Fill to 10 ml with DI, put in a container
- Pour into a cuvette
- Pipette 5 ml of .002 M $Fe(NO_2)_3$ into a 10 ml graduated cylinder
- Pipette 2 ml of .002 M KSCN into the cylinder.
- Fill to 10 ml with DI, put into container
- Pour into a cuvette

Equilibrium Cont.

- Pipette 5 ml of .002 M $Fe(NO_2)_3$ into a 10 ml graduated cylinder
- Pipette 3 ml of .002 M KSCN into the cylinder.
- Fill to 10 ml with DI, put in container
- Pour into a cuvette
- Pipette 5 ml of .002 M $Fe(NO_2)_3$ into a 10 ml graduated cylinder
- Pipette 5 ml of .002 M KSCN into the cylinder.
- Put in container
- Pour into a cuvette
- Fill one cuvette with DI

Equilibrium Con't.

- Attach colorimeter to TI using EasyLink.
- Set colorimeter to 470 nm (if necessary) by pushing blue buttons on colorimeter right or left until light under 470 nm lit.
- Put the cuvette of DI in and hit the "calibrate" button on the colorimeter
- Hit "Menu" button on the calculator
- Click on "Experiment"
- Arrow down to "Collection Mode" & click
- Arrow down to "Events with Entry" & click

Equilibrium Con't

- Title it Concentration
- Tab to Units
- Put down molarity for units
- Determine your initial unreacted SCN^- molarity
- Put 1st cuvette in and click on icon in lower left hand corner. Click on Start in lower left hand corner. When reading stabilizes, click on camera icon. Put in the concentration you have determined in whole numbers.

Equilibrium Continued

- Put in 2nd cuvette & repeat
- Put in 3rd cuvette and repeat
- Click on stop collecting
- Click on the blue ctrl button and the save button.
- Name your graph something
- Click on the menu button and arrow down to analyze
- Arrow over and down to curve fit.
- Click on linear

Equilibrium con’t

- Determine slope of the line. Since according to the Beer Lambert law A=abc, bc=slope of the line. (we are deliberately attempting to force equilibrium to completion by making concentration of Iron(III) much higher that thiocyanate, thus the concentration of the thiocyanate = the concentration of the complex.
- Since we entered whole numbers instead of the actual concentrations, we need to divide by 0.0001 to get the real slope.

Equilibrium con't

- Put in the 4th cuvette and determine the absorbance. Write it down.
- Pour the contents of the cuvette into a test tube and put in either a hot water or a cold water bath. After 5 minutes determine the Absorbance.
- Repeat in the other bath or exchange data with someone who did the other one.
- We can use this information to determine if the reaction is endothermic or exothermic

Equilibrium con't

- $k=[FeSCN^{+2}[/[Fe^{+3}][SCN^{-}]$ (all at equilibrium)
- We know can determine the original concentrations of the unreacted reagents
- We can determine the concentration of the complex at equilibrium by dividing the absorbance of the 4^{th} tube be the slope of the line
- We can subtract the concentration of the complex from the concentrations of the original reagents and find K.

Stoichiometry – Biggest Bang

- Calibrate a pipette into 6 equal sections and mark it
- Fill the pipette with water
- Add zinc and HCl to the hydrogen generator
- Add yeast and hydrogen peroxide to the oxygen generator.
- Put the filled pipette over the hydrogen generator and allow the bulb to fill with hydrogen.

Stoichiometry-Biggest Bang

- Light a match and bring it close to the opening of the pipette. How big is the sound?
- Repeat using 5/6 hydrogen and 1/6 oxygen. Any difference in the sound?
- At what ratio of oxygen to hydrogen do you get the loudest sound?

Equilibrium

- Measure 10 ml of the unknown acid into a beaker.
- Determine the volume of a drop of water from the pipette by counting how many drops it takes to make up a ml in the graduated cylinder.
- Attach a pH probe to the TI calculator. Hit “Menu” button
- Click on “Experiment”
- Arrow down to “Collection Mode” & click
- Arrow down to “Events with Entry” & click
- Title it pH.
- Use units of drops or ml.
- Click on “Start” button

Equilibrium con't.

- When pH stabilizes click on camera
- Enter 0 drops or ml.
- Add 1 drop .100 M NaOH & take a reading
- Continue adding NaOH and taking a reading after each 5 drops.
- How many drops (ml) did it take to get to the endpoint?
- What is half that volume?

Equilibrium con't.

- What is the pH at the half way point?
- Since the $k_a=[H^+][An^-]/[HAn]$ (yes I am only using monoprotic acids for this level), at the half way point the $[An^-]=[HAn]$
- Taking the negative log of both sides, $pH=pK_a$.
- We then take the antilog of the negative of the pH at the half-way point to find the K_a.