Chemistry Lab

By Lin Wozniewski
lwoz@iun.edu

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)

Safety

- Students must wear:
  - Closed shoes
  - All skin from neck to toes covered
  - 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.
  - Visorgogs now permitted

What the Students Should Bring

- Safety gear
- Something to write with
- Five 8.5 X 11” sheets of paper, two sided containing information in any form from any source per team
- One non image capable calculator per student.

What the Supervisor Provides

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

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 2016

- 1 new topic & 1 old topic:
  - Gases
  - Thermodynamics

Thermodynamic Activities

- Students should understand the following concepts: direction of heat flow; endothermic and exothermic processes; units of heat measurement (Joules, calories, etc); heat capacity; calorimetry; enthalpy change; thermochemical equations; heat of fusion & solidification; heats of vaporization & condensation; phase diagrams; heat of solution; heat of combustion; heats of reaction; standard heat of formation & heat of reaction; and associated calculations. Gibbs free energy and entropy may be included at the State or National level. Activities may include: Determine specific heat of metal (coffee cup calorimeter) ΔH of a reaction (acid/ base) (endo/exo), determine specific heat of liquid, experiment based on heat exchange between water samples, heat of fusion of ice, heat of combustion of a candle, Hess Law (calorimetry adding hydrate and nonhydrate) at the State or National level.

Gases

- Students will complete experimental tasks and answer questions related to the physical properties of gases, effect of greenhouse gases and ozone depletion on our climate, behavior of gases described by the following: Avogadro's law, Boyle's Law, Charles' Law, Dalton's law, Gay-Lussac's law, Graham's Law, and the ideal gas law. Students may be expected to complete labs/activities such as: Determine the: density of a gas, partial pressure of a gas, molar mass of a gas, relative rates of diffusion. Examine the relationship between: Pressure and volume, Pressure and temperature, Temperature and volume

Thermodynamic Activities

- Students can look at the stoichiometry of a reaction using temperature to monitor the optimum reaction
- Students can look at dissolving solids or liquids in a solvent to determine if it is an endothermic or exothermic reaction
- Students can look at heating/cooling curves
- For State and National's Students can look at Hess's law

Thermodynamic Activities con't.

- Students can reproduce phase diagrams.
- Students can determine the Caloric value of various foods

Thermodyanmic Activities

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

Gas Activities

- Students can perform Boyle's Law labs to determine the relationship between pressure and volume
- Students can be asked to determine the number of moles or molecules in a given volume of a gas at a given pressure & temp.
- Students can determine the solubility of a gas.

Gas Activities con't.

- Students can determine the relative rate of diffusion of two gasses
- Students can predict theoretical yields of reactions based on stoichiometry's
- Students can determine R by reacting a known volume of solid (Mg, $NaNO_2$) with an excess acid (HCl, Sulfamic) and determining the amount of gas produced by displacement of water.

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

Time to play!

- 4 basic problems to solve
  - Ideal Gas/Boyles Law
  - Stoichiometry of an acid/base reaction
  - Solubility of a gas
  - Solubility of a salt-Cooling Curve

Ideal Gas/Boyles law

- Set the volume of the gas in the syringe to ~ 10 ml & attach to pressure sensor
- Attach a pressure sensor to a TI calculator
- Hit Menu
- Click on Experiment
- Arrow down to Collection Mode
- Arrow down to Events with Entry
- Change the name to Volume
- Arrow down to units & type “ml”
- Click on OK

Boyle's Law con't.

- Click the green button in the lower left hand corner to start recording data
- Click the button with the picture of a camera just to the right of where you just clicked
- Put 10 in the dialog box and click OK
- Press on the syringe until it is 9 ml & click on the camera button again. Put 9 in the box & click OK.
- Repeat every ml until you can no longer compress the syringe. (This is best done in partners because you have to hold the syringe.)

Ideal Gas/Boyles Law Con't.

- Pull on the syringe until the volume is 11 ml.
- Repeat procedures until you get to 20 ml
- Press the red Stop collection button in the lower left hand corner
- Hit Menu
- Arrow down to data
- Arrow right, and then down to new calculated column & click
- Name it 1/v
- Arrow down to short name & type 1/v
- Arrow down until the curser is in Expression

Boyles Law con't.

- Type 1/volume & click on OK
- Click on the graph mode
- Hit menu
- Arrow down to graph, arrow right, & down to select X axis column
- Arrow right & then down to 1/v & click
- Looks a little weird huh?
- You would think Boyles law would be linear
- It IS linear when air behaves as an ideal gas.
- So where is the air not behaving ideally?
- Why is it not behaving ideally?

Boyle's Law con't.

- We need to highlight the part of the graph where the gas is behaving like an ideal gas
- Click on the lower left data. Move & highlight the graph as long as the data points appear to be linear
- Click again to highlight the area of interest
- Hit menu
- Arrow down to analyze and right and then down to curve fit and finally right. Linear comes up as default, so click. Then click OK
- You have your Boyle's Law constant

Ideal Gas Law

- Attach a thermometer to the TI
- Record the temperature
- Calculate the number of moles/molecules of gas in the syringe based on the original 10 ml of gas in the syringe
- Remember that we only are measuring the temperature at atmospheric pressure.
- It is the temperature of the gas that will change, not the # of moles/molecules

Thermodynamics-Stoichiometry

- Measure 3 ml of HCl.
- Put in 50 ml beaker.
- Measure the temperature of the HCl.
- Start adding NaOH a few drops at a time, but quickly, stirring with the temperature probe.
- Record the volume when adding another drop of NaOH, does not cause the temperature to go up at all.
- Determine the stoichiometry of the reaction
- Repeat using H_2SO_4

Solubility of a Gas

- Determine the mass of $NaHCO_3$ in an Alka-Seltzer tablet
- Put a tablet in a 500 ml Erlenmeyer Flask
- Put a 2 hole stopper in the top so it completely seals the cylinder
- Insert a syringe in one whole filled with 20 ml of water
- Insert a gas probe into the other hole
- Squirt the water into the cylinder and record the maximum pressure (Hold the syringe down).

Solubility of a Gas con't.

- Determine the volume of the total cylinder up to the bottom of the stopper.
- Determine the number of moles of gas that would have been produced from the reaction
- Determine the number of moles of gas in the cylinder
- Determine the solubility of the carbon dioxide

Thermodynamics-Solubility

- Measure the temperature of 10 ml of distilled water.
- Add .5 gram of Ammonium Chloride (NH_4Cl)
- Stir with probe until dissolved. Note max./min. temperature attained
- Repeat with Sodium Chloride (NaCl).
- Repeat with Calcium Chloride ($CaCl_2$)

Thermodynamics-Cooling Curve

1. Attach 3 temperature probes to the TI
2. Wrap 1 piece of filter paper around each probe & secure with a rubber band
3. Dip each probe in a different solvent.
4. Record cooling curves – answer questions