Lab Glassware (Search the specific glassware online for an image!)

- **Non-calibrated glassware** are used for containing, mixing, and reacting without specifically measuring the experimental materials.
  - **Test tubes** are relatively small and allow a larger number of samples to be analyzed in a rack for easy processing.
  - **Beakers** are wide-mouthed cylinders with lip to allow for pouring.
  - **Erlenmeyer flasks** are tapered and thus minimize accidental spills. Can be sealed easily with rubber, cork, or a stopper.
  - **Round bottom flasks** are good for heating.
  - A **retort** is a round vacuum flask that is used for distillation.
  - **Separatory funnels** are used for extractions.
  - **Transfer pipets** are made up of a plastic bulb at the top.
  - **Pasteur pipets** are made of glass require a second bulb.
- **Calibrated glassware** are used for any lab measurement that requires accuracy and precision. Measures volume.
  - **Graduated cylinders** are useful for measuring liquid to volumes within about 1%. Used for general purpose but not for quantitative measures.
  - **Burets** are used to deliver precisely-measured variable volumes. Used mostly for titrations and to make solutions.
  - **Graduated pipets** can deliver a variable amount of liquid precisely.
  - A **volumetric pipet** can deliver a single volume with great precision and accuracy.
  - **Volumetric flasks** are used to make solutions that require a specific volume of solution, such as molar solutions.

Precision vs Accuracy

- **Accuracy** is how close a measured value is to the actual (true) value.
- **Precision** is how close the measured values are to each other.
- Example problem:

  An experiment was performed to find the number of moles of hydrochloric acid in a sample with the following results:

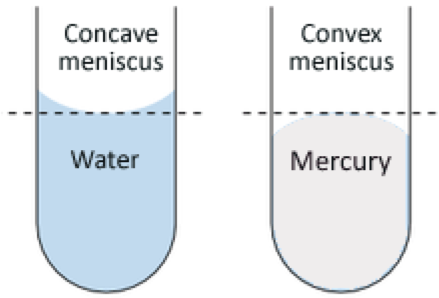
Trial	Moles
1	1.51
2	1.49
3	1.50

  The actual number of moles was later determined to be 1.00. The above results are:

  a) both accurate and precise
  b) accurate but imprecise
  c) precise but inaccurate
  d) both inaccurate and imprecise
- How to approach this type of problem and answer to example problem:
  - Look at the recorded results for each trial. Ask yourself if the value of each measurement close to each other. If yes, then the results are precise. If no, then the results are imprecise. In the example problem, they are all very close to each other as each value differs from the others by 0.01 to 0.02. Therefore, they are precise.
  - Now compare the recorded values for each trial to the actual value. If the recorded values are close to the actual value, then the values are accurate. If they are not, then they are inaccurate. In the example problem, they are all not close to the actual value (in these types of problems, it is usually obvious if the values are close to the actual value or not). Therefore, the values are inaccurate and the correct answer choice is C.

Meniscus

- A meniscus is the observed curved surface of a liquid at its interface with water. Two types:
  - A **concave meniscus** is observed if we placed water in a small-diameter tube. This type of meniscus results when the forces between the glass and the liquid molecules (adhesion) is greater than the forces between the liquid molecules themselves (cohesion).
  - A **convex meniscus** is observed if we placed mercury in a small-diameter tube. This type of meniscus results when the forces between the liquid molecules (cohesion) is greater than the force between the glass and the liquid molecule (adhesion).
    - http://www.tutorvista.com/content/physics/physics-iii/solids-and-fluids/shape-meniscus.php provides an in-depth physics style explanation as to why each meniscus forms. I think it does an excellent job of explaining this phenomenon. If you would like the full explanation, check this out!



  - **Parallax error** results when you view a meniscus from the incorrect line of sight (not head on). This will cause an incorrect measurement to be recorded.

Random vs. Systematic Error

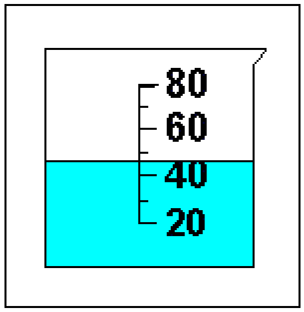
- **Random errors** are caused by unknown and unpredictable changes in the experiment. These changes may occur in the measuring instruments or in the environmental conditions.
- **Systematic errors** usually come from the measuring instruments. They may occur because: there is something wrong with the instrument or its data handling system, or because the instrument is wrongly used by the experimenter.

Heating a hydrated salt

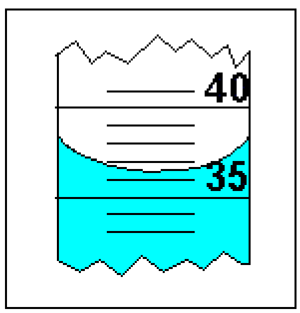
- % change = $\frac{mass\ of\ salt\ after\ heating - mass\ of\ salt\ before\ heating}{mass\ of\ salt\ before\ heating} * 100$
  - Note that this percent will always be negative!
- How to find the formula of the hydrate:
  - (mass before heating) – (mass after heating) = mass H_2O
  - convert mass H_2O → moles of H_2O
  - convert mass of anhydrous solid → moles of anhydrous solid
  - $n = \frac{mol\ H_2O}{mol\ anhydrous\ solid}$
  - http://ap-chem-resources.weebly.com/uploads/3/5/5/2/3552772/hydrates_practice.pdf is an excellent resource for practice problems (yes use a calculator to do these). Comes with answer key!
- Heating a hydrated salt must be controlled to prevent decomposition of the salt.
- If the % of the anhydrous salt was calculated to be lower than expected, a possible reason would be the loss of gas from an anhydrous salt.
- If salt binds tightly to water, it is possible for decomposition to occur.

Significant figures

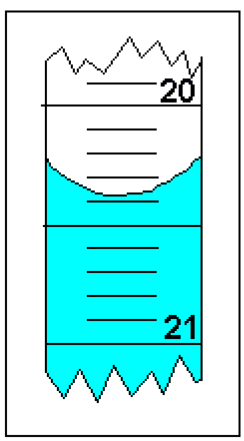
- Significant figure rules
  - Non-zero digits are always significant.
  - Any zeros between two significant digits are significant.
  - A final zero or trailing zeros in the decimal portion ONLY are significant. Any zero that come before the first significant digit is not significant!
  - HINT: change the number to scientific notation. It makes it easier to see how many significant figures there are.
  - http://chemed.chem.purdue.edu/genchem/topicreview/bp/ch1/sigfigs.html is a great resource to learn significant figure rules. If you have time, also go into how to perform common math operations with significant figures and rounding!
- Beaker = 2 significant figures (round to the nearest 1). Note that there is no meniscus. An acceptable value for the beaker below would be 47 mL



- Graduated cylinder = 3 significant figures (round to the nearest 0.1). Because there is a meniscus, when we read the volume, we read it at the bottom of the meniscus. An acceptable value for the graduated cylinder below would be 36.4 mL.



- Buret = 4 significant figures (round to the nearest 0.01). Because there is a meniscus, when we read the volume, we read it at the bottom of the meniscus. An acceptable value for the buret below would be 20.37 mL.



Beer's law

- Go to the following website: http://www.chem.ucla.edu/~gchemlab/colorimetric_web.htm. This page does an excellent job on explaining how to find the concentration of a solution from using a spectrophotometer. Learn how to do all 3 types of these problems as they will show up on the DAT!