

## Analytical Tools

### Analytical Balances

An modern analytical balance uses a magnetic force to balance the pan and determine the mass of the sample (Figure 2-3)

Analytical balances can measure to a precision of 0.0001 g (0.1 mg)

#### Precaution to use when weighing

- Do not touch sample or container with fingers —the balance is precise enough to weigh finger prints

### Analytical Balances

#### Precaution to use when weighing

- Close the doors on the balance to prevent air drafts from affecting results
- Correction for buoyancy—upward force by air under pan of balance

$$m = \frac{m' \left( 1 - \frac{d_a}{d_w} \right)}{\left( 1 - \frac{d_a}{d_s} \right)}$$

$m$  = true mass of object  
 $m'$  = mass reading from balance  
 $d_a$  = density of air  
 $d_w$  = density of weights (8.0 g/mL)  
 $d_s$  = density of sample

### Analytical Balances

#### Buoyancy Correction

Determine true mass of a  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  sample with a mass reading of 0.5672 g

$$d_s = 2.284 \text{ g/mL} \quad d_w = 8.0 \text{ g/mL}$$

$$d_a = (P \cdot MW)/(RT)$$

$$= (1 \text{ atm})(29 \text{ g/mol}) / (.08205 \text{ Latm/molK})(298\text{K}) = 1.186 \text{ g/L}$$

$$m = \frac{0.5672 \text{ g} \left( 1 - \frac{1.19 \times 10^{-3} \text{ g/mL}}{8.0 \text{ g/mL}} \right)}{\left( 1 - \frac{1.19 \times 10^{-3} \text{ g/mL}}{2.284 \text{ g/mL}} \right)} = 0.5668 \text{ g}$$

### Burets

Burets are used to precisely measure the volume of a liquid, usually when performing a titration. The liquid in a buret will always form a meniscus, usually concave (higher on the sides than in the middle)

- It is customary to read the bottom of the meniscus
- Parallax—a false reading when your eye is not at the same level as the meniscus

### Burets

#### Precautions for use of burets

- Run some liquid through the tip to remove all air bubbles before making measurements
- Clean your buret so the liquid drains completely from the walls, leaving no drops
- Near the endpoint, spin the stopcock quickly to deliver a fraction of a drop
- You can read a 50 mL buret to 0.01 mL precision



## Pipets

Pipets come in several flavors:

- Volumetric
- Graduated
- Micropipets

When using a rubber bulb with a pipet, ***do not*** place the end of the pipet in the stem of the bulb—use the bulb simply to fill the pipet, and then use your thumb to drain to the desired volume

## Calibration of Volumetric Glassware

For the most accurate results possible, volumetric glassware should be calibrated

This is done by filling the glassware to the mark with distilled water at a known temperature, draining the water into a flask of known mass, and weighing the water and flask to determine the mass of water

Volume is then determined using the density of water at the specified temperature

## Calibration of Volumetric Glassware

### Example

Your 100 mL volumetric flask weighs 26.3428 g when cleaned and dried. You then add water to the mark, and the flask with water weighs 125.3149 g with  $T = 22.0\text{ }^{\circ}\text{C}$ . Determine the volume of your flask.

$$m_{\text{H}_2\text{O}} = 125.3149 - 26.3428 = 98.9721\text{ g}$$

$$d_{\text{H}_2\text{O}}(22.0\text{ }^{\circ}\text{C}) = 0.997774\text{ g/mL}$$

$$V_{\text{flask}} = (98.9721\text{ g}) / (0.997774\text{ g/mL}) = 99.193\text{ mL}$$