

## Experiment 3: Gravimetric Analysis of a Sulfate Mixture

### Materials

#### Apparatus

milligram balance

100-mm test tube

small hotplate

Desiccator

Centrifuge

#### Reagents

solid mixture of potassium sulfate,  $K_2SO_4$  and sodium sulfate,  $Na_2SO_4$

1.0 M HCl

1.0 M  $BaCl_2$

Sulfate unknown; a sample of an unknown sulfate salt

## Experiment 11: Rate Law Determination

### Materials

#### Apparatus

Cuvette with lid (at least 1, up to 3)

Colorimeter sensor or spectrophotometer with recording capability

Computer interface system (LabPro or similar)

Computer or calculator for data collection

Data collection software (e.g., LoggerPro™)

Tissues or lens paper, lint-free

Pipets for measuring solutions – See note 3, below.

#### Reagents

Phenolphthalein (Ph) solution,  $5.0 \times 10^{-4} M$

Sodium hydroxide, NaOH, 0.20 M

Wash bottle and distilled water

## Experiment 10: Reaction Rates

### Materials

#### Apparatus

Test tubes, 18 x 150 mm or similar<sup>1</sup> (18, if possible)

Graduated cylinders, 10-mL (2)

Plastic transfer pipets (3)

Beakers, 150- or 200-mL, for holding reagent solutions and distilled water

Test tube rack, ideally one that can hold 12 tubes (or more) at one time

Stopwatch<sup>2</sup>

Thermometer

#### Reagents

Potassium iodate solution,  $KIO_3(aq)$ , 0.024 M

Sodium bisulfite solution,  $NaHSO_3(aq)$ , 0.016 M

Distilled water

## Experiment 5: Thin Layer Chromatography

### Materials

#### Apparatus

Beakers, 200 mL or larger (6)  
Plastic TLC slides (~4 x 10 cm)  
Latex surgical gloves  
Ruler  
Pencil  
Plastic wrap or Parafilm®  
10-microliter (10  $\mu$ L) micropipets<sup>2</sup>

#### Reagents

Ethanol solutions of the indicator dyes:  
methyl red  
malachite green  
bromocresol green  
Solvent mixtures: various combinations of:  
Acetone,  $\text{CH}_3\text{COCH}_3$   
Ethanol,  $\text{CH}_3\text{CH}_2\text{OH}$   
Ethyl acetate,  $\text{CH}_3\text{COOCH}_2\text{CH}_3$   
Hexane,  $\text{C}_6\text{H}_{14}$

## Experiment 6: Intermolecular Forces

### Materials

#### Apparatus

Balance  
Hot plate  
Sand bath (optional)  
Flask, Erlenmeyer or filtering  
Beakers: 200- or 250-mL (2)  
50-mL (2)  
Funnel  
Filter paper (2)  
Interfaced temperature probes or thermometers (3)  
Hand lens (magnifying glass)  
Digital interface (CBL2, LabPro, LabQuest, etc.)  
Paper towel  
Sublimation apparatus (see Figures 6.1a and 6.1b, next page)

#### Reagents

Orange mixture for Part A  
Gray mixture for Part B  
Ethanol  
Acetone  
Hexane or petroleum ether

## Experiment 13: Lechatelier's Principle

### Materials

#### Apparatus

50-mL beaker  
Shell vials, 1 dram (5)  
Hot plate  
Ice bath  
Eyedroppers or thin-stem transfer pipets (8-10)  
24-well test plate  
Microtip transfer pipet or Pasteur pipet (1)  
Toothpick (for stirring)

#### Reagents

cobalt chloride hexahydrate,  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$   
ethanol (or methanol, or 2-propanol)  
12 *M* hydrochloric acid,  $\text{HCl}(\text{aq})$   
calcium chloride pellets,  $\text{CaCl}_2(\text{s})$   
silver nitrate solution,  $\text{AgNO}_3(\text{aq})$ , 0.10 *M*  
Ammonia solution,  $\text{NH}_3(\text{aq})$ , 3 *M*  
Sodium bromide solution,  $\text{NaBr}(\text{aq})$ , 0.10 *M*  
Sodium chloride solution,  $\text{NaCl}(\text{aq})$ , 0.10 *M*  
Sodium thiosulfate solution,  $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$ , 0.20 *M*

## Experiment 14: Titration Curves

### Materials

#### Apparatus

Erlenmeyer flasks, 125-mL (3)  
Buret, 50-mL  
pH meter with pH electrode or other  
interface with pH probe  
beaker, 150-mL (3 or 4)<sup>1</sup>  
magnetic stirrer and stirring bar(s) (optional)<sup>2</sup>  
400-mL (or larger) beaker for rinsing, waste

#### Reagents

solid potassium hydrogen phthalate, KHP  
nitric acid,  $\text{HNO}_3(\text{aq})$ , 0.10 *M*  
sodium hydroxide,  $\text{NaOH}(\text{aq})$ , 0.10 *M*  
  
acetic acid,  $\text{HC}_2\text{H}_3\text{O}_2(\text{aq})$ , 0.10 *M*  
solid unknown diprotic acid  
distilled or deionized water (wash bottle)

## Experiment 15: Buffered Systems

### Materials

#### Apparatus

Beaker, 200-mL (4)  
pH meter or interfaced pH probe  
Balance, preferably with milligram sensitivity

#### Reagents

Sodium acetate,  $\text{NaC}_2\text{H}_3\text{O}_2(\text{s})$ <sup>1</sup>  
Acetic acid,  $\text{HC}_2\text{H}_3\text{O}_2(\text{aq})$ , 1.0 *M*  
Acetic acid,  $\text{HC}_2\text{H}_3\text{O}_2(\text{aq})$ , 0.10 *M*<sup>2</sup>  
Sodium phosphate,  $\text{Na}_3\text{PO}_4 \cdot 12\text{H}_2\text{O}(\text{s})$   
Phosphoric acid<sup>3</sup>,  $\text{H}_3\text{PO}_4(\text{aq})$ , 1.0 *M*  
Sodium hydroxide,  $\text{NaOH}(\text{aq})$ , 1.0 *M*

## Experiment 16: Acids, Bases and Buffers

### Materials

#### Apparatus

buret, 50-mL

pH meter with pH probe or other  
interface with pH probe

beaker, 150-mL (2)

magnetic stirrer and stirring bar (optional)<sup>1</sup>

250-mL (or larger) beaker, for rinsing

safety goggles

#### Reagents

acetic acid,  $\text{HC}_2\text{H}_3\text{O}_2$ , 0.10 *M*

sodium hydroxide,  $\text{NaOH}$ , 0.10 *M*

sodium acetate,  $\text{NaC}_2\text{H}_3\text{O}_2$ , solid

distilled water (wash bottle)

hydrochloric acid,  $\text{HCl}$ , 0.10 *M*