Laboratory Content, Consumables, and Experiment Specific Equipment Cost Correlations:

(for 25 students)

Small-Scale Experiments Based on Chemtrek: *Small-Scale Experiments for General Chemistry* by Stephen Thompson	**Traditional Experiments based on Chemistry: *The Molecular Science* by Olmsted/Williams**
Spectroscopy	**Spectroscopy**

• Spectroscopy: The Interaction of Light and Matter (ch. 2)
  ◦ Characterization of a Transmission Diffraction Grating
  ◦ Exploring Spectroscope Specifications
  ◦ Wavelength Calibration of the Spectroscope
  ◦ A Comparison of Continuous Emission Spectra
  ◦ Atomic Line Spectra and Electronic Transitions; Electrical Emission Tubes
  ◦ Flame Emission Spectra
	• Visible Absorption Measurements (ch. 6)
	• The Visible Atomic Spectrum of Hydrogen (ch. 17)
	• A Colorimetric Determination of Aspirin in Commercial Preparations (ch. 20)

`Consumables: $6.44` `Experiment Specific Equipment: $540.43`	`Consumables: $592.33` `Experiment Specific Equipment: $9588.60`
Techniques in Mass & Volume Transfer & Measurement	**Techniques in Mass & Volume Transfer & Measurement**

• Small-Scale Techniques and the Absorption of Light (ch. 3)
  ◦ An Introduction to Small-Scale Scientific Apparatus
  ◦ Making a Microburner
  ◦ Making Microburets
  ◦ General Microburet Techniques
  ◦ Microburet Calibration for Quantitative Volumetric Work
  ◦ Quantitative Dilution of Solutions
  ◦ Standard Color Solutions and Colorimetry
  ◦ The Factors that Govern the Absorption of Light
  ◦ Colorimetric Analysis of a Beverage
  ◦ Solution Absorption Spectrophotometry
	• Mass Measurements (ch. 3)
	• Volume Measurements of Liquids (ch. 4)

`Consumables: $0.11` `Experiment Specific Equipment: $0.00`	`Consumables: $80.69` `Experiment Specific Equipment: $2423.75`
Instruments-The Gas Laws	**Instruments-The Gas Laws**

• Instruments: What They Do and What They Don't (ch. 5)
  ◦ Basic Electronics
  ◦ The Operation of a Digital/Analog Multimeter as a Measurement Instrument
  ◦ A Semiconductor Silicon Temperature Sensor System
  ◦ The Constuction and Calibration of a Gas Thermometer
  ◦ An Extended Range Gas Thermometer	

◦ A Novel Pressure Gauge Balance	
Consumables: $10.23 Experiment Specific Equipment: $204.50	Consumables: $119.10 Experiment Specific Equipment: $1596.50
Thermochemistry	**Thermochemistry**
• Thermochemistry and Solar Energy Storage (ch. 6) ◦ Calibration of a Styrofoam Microcalorimeter ◦ Determination of the Specific Energy of Granite Rock Used for Solar Energy Storage ◦ Determination of the Heat of Crystallization of Sodium Thiosulfate Pentahydrate ◦ An Assessment of the Microcalorimetric Methodology and the Storage Information Obtained	• Enthalpy of Hydration (ch. 24) • Enthalpy of Neutralization (ch. 25) • Enthalpy of Formation of Ammonium Salts (ch. 26)
Consumables: $1.15 Experiment Specific Equipment: $26.97	Consumables: $228.13 Experiment Specific Equipment: $888.19
Chemical Reactions in Aqueous Solutions	**Chemical Reactions in Aqueous Solutions**
• Solutions and Reactions (ch. 7) ◦ Naming and Making Solutions ◦ Solubility and Solutions ◦ Solutions and Reactions ◦ Four Major Types of Chemical Reaction in Aqueous Solution ◦ A Chemical Reaction Survey: The Ion Reaction Chart ◦ Identification of Three Unknowns ◦ Five Unknowns: Solo ◦ Finding General Solubility Rules	• Detecting Signs of Chemical Change (ch. 8) • Studying Chemical Reactions and Writing Chemical Equations (ch. 9) • A Sequence of Chemical Reactions (ch. 13) • Stiochiometry of the Reaction of Magnesium with Hydrochloric Acid (ch. 14) • The Chemistry and Qualitative Analysis of Anions (ch. 36)
Consumables: $13.20 Experiment Specific Equipment: $20.00	Consumables: $262.68 Experiment Specific Equipment: $2522.34
Introduction to Acids and Bases	**Introduction to Acids and Bases**
• An Introduction to Acids and Bases (ch. 8) ◦ Common Laboratory Acids and Bases: Necessary Facts and Some Questions ◦ Indicator Color Probes for Acids and Bases ◦ Microburet Construction ◦ Acid-Base Titrations; Stoichiometry and Molarity ◦ Eggshell and Seashell Analysis ◦ Acid Concentration in Fruits: Pucker Order	• Standardizing a Hydrochloric Acid Solution (ch. 29) • Standardizing a Sodium Hydroxide Solution (ch. 30) • Evaluations of Commercial Antacids (ch. 31)
Consumables: $2.69 Experiment Specific Equipment: $0.00	Consumables: $196.14 Experiment Specific Equipment: $3598.00
Halogens and Their Compounds	**Halogens and Their Compounds**
• Halogens and Their Compounds (ch. 9) ◦ From Fluorine to Astatine: A Basic Introduction to the Halogens ◦ The Synthesis and Reactions of Chlorine ◦ A Small-Scale Pilot Plant for the Manufacture	• Determining the Percent Sodium Hypochlorite in Commercial Bleach (ch. 32)

of Chlorine by the Industrial Process ◦ Electrochemical Writing with a Halogen ◦ Precipitation Reactions & Titration of a Halide ◦ Redox Analysis of Commercial Bleach	
Consumables: $4.46 Experiment Specific Equipment: $0.00	Consumables: $113.41 Experiment Specific Equipment: $0.00
Natural Waters	**Natural Waters**
• The Chemistry of Natural Waters (ch. 10) ◦ The Evaporation of Water Samples to Give Total Dissolved Solids ◦ Divalent Cation Analysis by EDTA Titration ◦ The Dissolution of Rocks ◦ Important Ways of Reporting the Hardness of Water ◦ Determination of the Hardness of Ground-, Spring-, and Wellwater ◦ The Reaction of Divalent Cations with Soap; Soap Titrations ◦ Water Softening with Commercial Water-Conditioning Agents ◦ Divalent Cation Removal by Ion Exchange	• Determining Aluminum(III) Concentrations in Natural Waters (ch. 18)
Consumables: $2.77 Experiment Specific Equipment: $13.50	Consumables: $818.97 Experiment Specific Equipment: $2906.24
Nutritional Chemistry	**Nutritional Chemistry**
• Vitamin C Analysis (ch. 11) ◦ Optimizing the Reaction Conditions for the Determination of Vitamin C ◦ Standardization of 2,6-Dichloroindophenol ◦ The Analysis of a Commercial Vitamin C Tablet ◦ Vitamin C Concentration in Fresh Fruit Juices ◦ Analysis of a Breakfast Cereal for Vitamin C ◦ Research Project	• Determining the Acid Content of Fruit Juices (ch. 33)
Consumables: $1.42 Experiment Specific Equipment: $122.02	Consumables: $55.03 Experiment Specific Equipment: $399.75
Chemical Reaction Kinetics	**Chemical Reaction Kinetics**
• Kinetic Blues (ch. 13) ◦ Experimental Evidence: A Review of "The System" ◦ A Possible Reaction Mechanism for "The System" ◦ Further Investigations of the Mechanism and a Comparison of Rates of Reaction ◦ The Rate-Determining Step and the Rate Law for the Overall Reaction ◦ Determination of the Order of Reaction for Fructose and Hydroxide Ion ◦ Determination of the Energy of Activation	• Kinetic Study of a Chemical Reaction (ch. 28)
Consumables: $0.59	Consumables: $37.03

Experiment Specific Equipment: $3.75	Experiment Specific Equipment: $223.04
Acid-Base Equilibria	**Acid-Base Equilibria**

• Acid-Base Equilibria (ch. 14)
  ◦ Conductimetry and the Strength of Acids and Bases
  ◦ Acid-Base Equilibria and Indicator Dyes
  ◦ Determination of the Ka Values of Weak Acid Indicators
  ◦ pH Measurement with Indicator Color Probes
  ◦ The Study of Acid-Base Equilibria by Graphical Interpretation of Titration Data
  ◦ The Titration of Polyprotic Acids
  ◦ Calculations on Diprotic and Triprotic Acids
	• Determining the Dissociation Constant of a Weak Acid Using pH Measurement (ch. 34)
	• A Study of pH, Dissociation, Hydrolysis, and Buffers (ch. 35)

Consumables: $2.72 Experiment Specific Equipment: $20.00	Consumables: $80.68 Experiment Specific Equipment: $990.00
Redox Equilibria and Electrochemistry	**Redox Equilibria and Electrochemistry**

• Redox Equilibria and Electrochemistry (ch. 15)
  ◦ Redox Reaction Investigations
  ◦ A Small-Scale Electrochemical Cell
  ◦ An Electrochemical Series from Cell Data
  ◦ Electrographic Analysis of Metals
  ◦ Nernst's Law and Potentiometric Redox Titrations
  ◦ Lead-Acid Automobile Battery
	• Studying Electrochemistry and Establishing the Relative Reactivities of a Series of Metals (ch. 37)
	• Studying Electrochemical Cells and Reduction Potentials (ch. 38)

Consumables: $35.20 Experiment Specific Equipment: $0.00	Consumables: $100.76 Experiment Specific Equipment: $1397.00
Chromatography	**Chromatography**

• Paper and Liquid Chromatography
  ◦ Paper Chromatography of Dyes
  ◦ Moist Buffered Phase Chromatography of Nicotine
  ◦ Calculations of the K_b of Nicotine from Chromatographic Data
  ◦ Preparation of a Liquid Chromatography Column
  ◦ Investigations of Column Parameters and Processes
  ◦ Derivatization of the Silica Gel Stationary Phase
  ◦ Chromatography of Selected Synthetic Dyes
  ◦ LC of Beet Pigment
	• Separating and Identifying Food Dyes by Paper Chromatography (ch. 21)

Consumables: $16.34 Experiment Specific Equipment: $29.44	Consumables: $10.71 Experiment Specific Equipment: $40.18
Complexation Equilibria	**Complexation Equilibria**
• Zinc Links: Coordination Chemistry and Nutritional Deficiency (ch. 22) ◦ The Preparation of Calibration Standards for the Quantitative Colorimetric Determination of	• Spectrophotometric Determination of the Formula of a Complex Ion (ch. 19)

Zinc ◦ Zinc Determination in Unknown Samples ◦ The Chelation of Zinc by Phytate and Other Naturally Occurring Substances ◦ A Quantitative Instrumental Colorimeter for the Determination of Zinc ◦ Calculation of Your Daily Zinc Intake	
Consumables: $3.70 Experiment Specific Equipment: $75.48	Consumables: $35.71 Experiment Specific Equipment: $0.00
Total Consumables: $101.02 **Total Experiment Specific Equipment: $1,056.09**	**Total Consumables: $2731.37** **Total Experiment Specific Equipment: $26,573.59**

Additional Small-Scale Experiments Done in Chemtrek: *Small-Scale Experiments for General Chemistry* by Stephen Thompson
The System (ch. 1)
Consumables: $0.87 Experiment Specific Equipment: $8.25
The Use and Abuse of Aluminum and Its Compounds (ch. 4)
◦ The Aluminum Can ◦ Recycling Aluminum: The Synthesis of Alum (Potassium Aluminum Sulfate) ◦ Qualitative Analysis of an Alum Sample ◦ A Pratical Use for the Reaction of Aluminum with a Base
Consumables: $3.25 Experiment Specific Equipment: $5.00
Alcohol Abuse: Chemical Tests for Intoxication (ch. 12)
◦ Preparation of a Set of Colorimetric Standards for the Determination of Ethanol ◦ The Analysis of Unknown Samples Containing Ethanol ◦ An Exploration of the Relationship between Chemical Structure and the Chemical and Physiological Behavior of Alcohols ◦ Drinking and Drivig . . . A Sad Story
Consumables: $2.75 Experiment Specific Equipment: $2.75
Acid Deposition (ch. 16)
◦ Design and Characterization of a Probe System for Acidity and Alkalinity ◦ A Chemical Reaction Source for Nitric Oxide and Exploration of the Atmospheric Transport and Reactions of NO_x with Raindrops

- Cloud Formation and Cloud Scavenging of NO_x
- Redox Chemistry of NO_x
- The Susceptibility of Lakes to Acid Deposition-Model Studies
- Source, Transport, and Deposition Reactions of Sulfur Dioxide (SO_2)
- Heterogeneous Oxidation of SO_2 to Sulfur Trioxide (SO_3) and Sulfuric Acid (H_2SO_4) by Hydrogen Peroxide (H_2O_2) in Raindrops and Cloud Drops
- The Effects of Acid Deposition on Naturally Occurring Minerals and on Construction Materials
- The Effects of SO_2 on Plants
- Putting It All Together: Acid Deposition from NO_x plus SO_x
- Space Shuttle Launches: An Example of Severe Local Hydrochloric Acid Deposition

Consumables: $6.05
Experiment Specific Equipment: $11.24

Gas Chromatography (ch. 19)

- The Construction of a Gas Chromatograph
- Measurements of the Retention Time of Air and the Gas Flow Rate
- Measurements of the Retention Times of Halocarbons
- GC Seperation of Halocarbon Mixtures
- GC Analysis of Industrial Products Optimizing a GC System: The Van Deemter Plot
- Quantitative Analysis by GC with Photodetection

Consumables: $11.88
Experiment Specific Equipment: $169.65

Surface Chemistry: Bubbles and Films (ch. 20)

- The Measurement of Surface Tension by Capillary Rise Techniques
- Langmuir-Blodgett Pockels Techniques and Oil Spill Chemistry
- Some Properties of Soap Films
- Minimum-Distance Networks and Soap Film Computers
- Three-Dimensional Systems: Bubbles and Films on Frames
- Free and Captive Bubbles and So Froth
- Fun with Big Bubbles

Consumables: $3.53
Experiment Specific Equipment: $45.15

Natural Products Chemistry: Anthocyanins as Food

Dyes (ch. 21)
◦ The Extraction of Plant Dyes ◦ Anthocyanin Purification by Chromatography ◦ The Solution Chemistry of Anthocyanins ◦ Spectroscopy of Anthocyanins ◦ Anthocyanin Synthesis ◦ The Evaluation of Anthocyanins and Betacyanins as Food, Drug, and Cosmetic Dyes
Consumables: $3.45 Experiment Specific Equipment: $4819.88

Information last updated on .
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