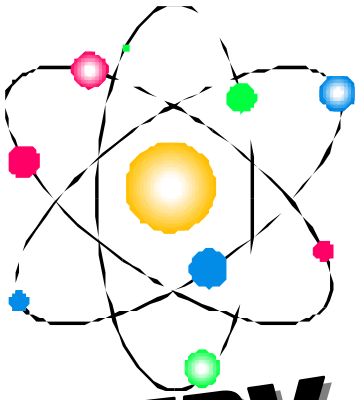
CHEMISTRY DEPARTMENT
MORRISVILLE STATE COLLEGE
MORRISVILLE, NY 13408



CHEMISTRY 121L

GENERAL INSTRUCTIONS

AND

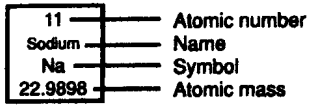
LABORATORY MANUAL

A. HABER, Editor

FALL/SPRING

Name_____

Lab Section_____



PERIODIC TABLE OF THE ELEMENTS

Atomic masses are based on Carbon-12.
Atomic masses in parentheses indicate the most stable or best-known isotope.

Periods	Groups 1A	2A	3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A	8A Rare Gases
1	1 Hydrogen H 1.0079																	2 Helium He 4.0026
2	3 Lithium Li 6.941	4 Beryllium Be 9.0128											5 Boron B 10.811	6 Carbon C 12.011	7 Nitrogen N 14.0067	8 Oxygen O 15.9994	9 Fluorine F 18.9984	10 Neon Ne 20.180
3	11 Sodium Na 22.9898	12 Magnesium Mg 24.305											13 Aluminum Al 26.9815	14 Silicon Si 28.086	15 Phosphorus P 30.9738	16 Sulfur S 32.067	17 Chlorine Cl 35.453	18 Argon Ar 39.948
4	19 Potassium K 39.098	20 Calcium Ca 40.08	21 Scandium Sc 44.956	22 Titanium Ti 47.88	23 Vanadium V 50.942	24 Chromium Cr 51.996	25 Manganese Mn 54.938	26 Iron Fe 55.847	27 Cobalt Co 58.933	28 Nickel Ni 58.69	29 Copper Cu 63.546	30 Zinc Zn 65.39	31 Gallium Ga 69.72	32 Germanium Ge 72.61	33 Arsenic As 74.922	34 Selenium Se 78.96	35 Bromine Br 79.904	36 Krypton Kr 83.80
5	37 Rubidium Rb 85.468	38 Strontium Sr 87.62	39 Yttrium Y 88.906	40 Zirconium Zr 91.22	41 Niobium Nb 92.906	42 Molybdenum Mo 95.94	43 Technetium Tc (99)	44 Ruthenium Ru 101.07	45 Rhodium Rh 102.905	46 Palladium Pd 106.4	47 Silver Ag 107.868	48 Cadmium Cd 112.412	49 Indium In 114.82	50 Tin Sn 118.71	51 Antimony Sb 121.75	52 Tellurium Te 127.60	53 Iodine I 126.904	54 Xenon Xe 131.29
6	55 Cesium Cs 132.905	56 Barium Ba 137.33	*57 Lanthanum La 138.91	72 Hafnium Hf 178.49	73 Tantalum Ta 180.948	74 Tungsten W 183.85	75 Rhenium Re 186.21	76 Osmium Os 190.2	77 Iridium Ir 192.21	78 Platinum Pt 195.08	79 Gold Au 196.967	80 Mercury Hg 200.59	81 Thallium Tl 204.38	82 Lead Pb 207.2	83 Bismuth Bi 208.980	84 Polonium Po (210)	85 Astatine At (210)	86 Radon Rn (222)
7	87 Francium Fr (223)	88 Radium Ra (226)	**89 Actinium Ac (227)	104 — — (261)	105 — — (263)	106 — — (263)	107 — — (261)	108 — —	109 — — (266)									

* Lanthanide series 6	58 Cerium Ce 140.12	59 Praseodymium Pr 140.908	60 Neodymium Nd 144.24	61 Promethium Pm (147)	62 Samarium Sm 150.36	63 Europium Eu 151.96	64 Gadolinium Gd 157.25	65 Terbium Tb 158.925	66 Dysprosium Dy 162.50	67 Holmium Ho 164.930	68 Erbium Er 167.26	69 Thulium Tm 168.934	70 Ytterbium Yb 173.04	71 Lutetium Lu 174.97
** Actinide series 7	90 Thorium Th 232.038	91 Protactinium Pa (231)	92 Uranium U 238.03	93 Neptunium Np (237)	94 Plutonium Pu (242)	95 Americium Am (243)	96 Curium Cm (247)	97 Berkelium Bk (247)	98 Californium Cf (251)	99 Einsteinium Es (254)	100 Fermium Fm (253)	101 Mendelevium Md (256)	102 Nobelium No (254)	103 Lawrencium Lr (257)

LABORATORY SCHEDULE

CHEM 121L SPRING 2020

Date	Experiment	Page
1/28/20	1. Check-In/Safety and Balances	13
2/4/20	2. Measurement and Significant Figures	17
2/11/20	3. Separation of a Mixture	25
2/18/20	4. Physical Properties and Measurement: Density	33
2/25/20	5. Water of Hydration	43
3/3/20	6. Calculation the Atomic Mass of Magnesium	53
3/10/20	7. Double Replacement Reactions	61
3/17/20	***NO EXPERIMENT SCHEDULED***	
3/24/20	8. Acid-Base I: Titration Techniques	75
3/31/20	9. Chemical Reactivity	85
4/7/20	10. Acid-Base II: Standardization of a Basic Solution	97
4/14/20	11. Determining the Molar Mass of a Volatile Liquid	107
4/21/20	12. Specific Heat and Heat Capacity	115
4/28/20	13. Lewis Structures and Molecular Geometry	127
5/5/20	14. Clean-up and Check-Out	141

All students must have safety goggles and laboratory coat.

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

T.S. Eliot "Little Gidding"

Science without religion is lame,
religion without science is blind.

A. Einstein

GENERAL INFORMATION ABOUT CHEMISTRY 121L

- Please sign and date the **CHEMISTRY LABORATORY SAFETY AGREEMENT**, which can be found on page 11. Submit this page to your instructor before the start of the second laboratory period. Violation of any laboratory regulation or safety rule will result in expulsion form the laboratory and a recorded grade of **F** for the scheduled experiment. You will not be permitted to work in the laboratory until you submit a signed copy of the **CHEMISTRY LABORATORY SAFETY AGREEMENT** to your instructor.

- A full-length laboratory coat must be worn at all times in the laboratory. You will not be permitted to work without wearing one.

- Shorts are not acceptable clothing for the laboratory. You will not be permitted to work while wearing them.

- Sandals are not appropriate footwear in the chemistry laboratory. You will not be permitted to work without wearing proper footwear.

- Only safety goggles similar or identical to the type available at the bookstore are acceptable for laboratory work. You will not be permitted to work without wearing them. If any student, after warning, persists in not properly wearing the safety goggles, he or she will be excused from the laboratory with a grade of **F**.

- **READ THE EXPERIMENT BEFORE COMING TO THE LABORATORY.**

- **LABORATORY EXERCISES MUST BE COMPLETED DURING THE SCHEDULED TIME. READ THE EXPERIMENT BEFORE COMING TO LAB AND ORGANIZE YOUR TIME EFFICIENTLY.**

- The only acceptable excuse for missing a laboratory experiment is illness. Make-ups for valid reasons (decided by consulting with your instructor) may be possible only during the week the experiment is scheduled. You must schedule a make-up time with your instructor.

- If you come late to lab and miss the introduction and safety information, you will not be permitted to work in the lab.

- Clean-up is part of each laboratory exercise, and it is **THE** assignment for the last week of class. Proper dress, in addition to lab coats and safety goggles, are required for clean-up and check-out. Failure to participate in clean-up will result in a 15-point decrease in your laboratory point total.

- Return keys at the end of each laboratory period. Failure to return you key will result in a 1-point decrease in your laboratory experiment grade.

- Each lab report is worth 15 points. This includes 10 points for the actual laboratory work and 5 points for questions to be answered before and/or after lab. Your grade for lab will be determined from the following percentage scale and based on total points.

A	**100-92**	**C+**	**76-74**		
A-	**91-88**	**C**	**73-70**		
B+	**87-85**	**C-**	**69-66**		
B	**84-81**	**D+**	**65-63**		
B-	**80-77**	**D**	**62-60**	**F**	**<60%**

IF YOU ARE NOT PROPERLY PREPARED, YOU MAY RUN OUT OF TIME TO COMPLETE THE EXPERIMENT. FINISHING PAST THE SCHEDULED LAB TIME WILL RESULT IN POINT LOSS ON YOUR LAB REPORT.

SHOW ALL WORK CLEARLY ON EACH LAB REPORT. FOR NUMERICAL PROBLEMS, SHOW HOW THE ANSWERS ARE DERIVED. ANSWERS WITHOUT WORK WILL NOT RECEIVE CREDIT.

LAB REPORTS ARE DUE AT THE NEXT SCHEDULED EXPERIMENT. LATE LAB REPORTS WILL RECEIVE POINT DEDUCTIONS.

LAB REPORTS WILL NOT BE ACCEPTED LATER THAN TWO WEEKS FROM THE DATE THE EXPERIMENT WAS PERFORMED. THE LAST EXPERIMENT IS DUE BY NOON ON THE LAST DAY OF CLASS.

IF YOU NEED HELP WITH COMPLETING YOU LAB REPORT, CONSULT WITH YOU INSTRUCTOR.

THE SCHEDULED LABORATORY EXPERIMENT TAKES PRECEDENCE OVER OTHER ACTIVITIES. LAB TIME IS NOT FOR *CATCHING-UP* ON ANY OTHER ASSIGNMENTS.

BEFORE LEAVING THE LAB AT THE COMPLETION OF AN EXPERIMENT, YOU MUST CHECK-OUT WITH THE INSTRUCTOR TO INSURE THAT YOUR LAB SPACE IS CLEAN AND EQUIPMENT HAS BEEN PROPERLY STORED.

SHOULD YOU DECIDE TO DROP THE LAB, YOU MUST FIRST PERFORM THE CLEAN-UP EXPERIMENT AND RETURN THE DRAWER KEY BEFORE THE DROP FORM WILL BE SIGNED BY YOUR LABORATORY INSTRUCTOR.

LABORATORY SAFETY

Laboratory work is essential to understanding and practicing chemistry. As instructive, challenging, and interesting as it may be, the chemistry laboratory is also hazardous. When you are in the lab you must conduct yourself as though you are in a dangerous place: **you are**. What follows summarizes some of the practices and restrictions necessary for our mutual welfare. Please read this material carefully. When you check into the lab, you will be asked to sign and submit the **CHEMISTRY LABORATORY SAFETY AGREEMENT** page of this manual to show that you have read and understood the safety guidelines in this material and that you agree to comply with them. You will not be permitted to do any of the laboratory experiments until you have signed and handed in page 11.

The guidelines are summarized as follows.

1. **APPROPRIATE EYE PROTECTION MUST BE WORN AT ALL TIMES IN THE LABORATORY.**
2. Report all fires, accidents, or injuries to your instructor at once.
3. Wear appropriate clothing. Bare feet, open-faced shoes, sandals, bare midriffs, and shorts are prohibited.
4. Horseplay will not be tolerated.
5. If you make a mess, clean it up immediately. This includes spilled water, chemicals, and/or broken glass. Properly dispose of all clean-up materials.
6. Do not work alone in any lab at any time.
7. Smoking is prohibited in all chemistry classrooms and labs.
8. Do not eat, bring, or store food or drink in a lab.
9. Always assume that any chemical you are working with is toxic and dangerous. Treat chemicals with care.
10. The laboratory, as is any other space within the walls of this College, is academically hallowed ground. Behavior and language use appropriate to this setting is expected and demanded. Inappropriate behavior will result in expulsion from the laboratory for that day with a grade of **F**.

These rules are explained below in greater detail.

Attire

1. **Appropriate eye protection must be worn by everyone in the lab. This includes students, instructors, visitors, deans, etc.**
2. **Contact lenses should not be worn in the laboratory.**

3. When particularly hazardous operations or substances are involved, face masks, gloves, shields, or other protection may be necessary. These may be obtained from the appropriate location in the laboratory.

4. Clothing is good protection against chemical damage to the skin; shorts, bare midriffs, open-faced shoes, sandals, and bare feet are prohibited in the lab.

5. **Loose or fluffy clothing is likely to catch fire or become entangled in mechanical devices. Please do not wear such clothing in the lab. Long, loose hair is also a hazard. Please keep it tied back.**

6. Clothing or jewelry worn into the laboratory is often damaged or stained, so do not wear your best things to lab. Lab coats are for sale in the college store.

Hygiene

1. **Most laboratory chemicals are toxic. Wash your hands after you handle chemicals; thoroughly wash your hands before leaving the laboratory.**

2. Odors and fumes have no place in the lab. When working with volatile materials or with compounds that fume in the air, work in one of the hoods. Never inhale vapors at short range until you know the intensity or hazard of the vapor.

3. Never smoke in the lab.

Behavior

1. **Horseplay is not permitted in the lab.**

2. Smartphones with or without earphones, electronic devices providing a distraction from laboratory operations, radios, cassette players, mp3 players, or CD players (with or without earphones), and portable TVs are not permitted in the lab.

Apparatus and Equipment

1. **Mouth pipetting is absolutely forbidden in the chemistry lab. Always use a rubber bulb to draw liquids into a pipette or to start a siphon.**

2. If you do not know how to use a given piece of equipment or have not been instructed in its use, do not attempt to use it. Ask for instruction of the apparatus first.

3. Serious injury can result from improperly inserting glass tubing into a rubber stopper. Always use a lubricant (glycerin or vacuum grease), never push the glass toward your hand, and cover your hand with a towel or glove when performing this sort of maneuver.

4. Not all laboratory glass may be safely heated. Find out before you try. (Pyrex brand glassware is resistant to heat.)

5. When you assemble an experimental set-up, be sure it is mechanically secure and cannot fall, collapse, or rupture. If you are in doubt, ask your instructor to check it out.

6. Never use cracked or chipped glassware. Be particularly alert for "star" cracks that form when glass strikes stone or metal. These cracks tend to burst when the glass is heated.

7. Report any damaged or malfunctioning apparatus to your instructor, whether or not you are responsible for the problem.

Chemicals

1. Always assume that any substance with which you are working is dangerous. Treat chemicals with respect.

2. Never use open flames (matches, Bunsen burners, etc.) if you or a neighbor are working with volatile substances.

3. Concentrated nitric, sulfuric, and hydrochloric acids and concentrated ammonia are available in the lab. When any such concentrated substance is diluted, heat is released and the solution may splatter if improperly mixed. Always add the concentrated substance to the water, slowly, with stirring.

4. Sodium hydroxide is also available in the lab in the form of pellets or as 6**M** solutions. Both forms dissolve skin and eye tissue. Clean all spills (of either the solid or the solution) immediately.

5. All chemicals should be clearly labeled. If you store a chemical in a container, label it immediately. The label should include the name of the material, your name, notebook reference, and the date the material was prepared. Never use any chemical which is not clearly labeled. It may not be what you think it is.

6. **Never return excess quantities of chemical reagents to the container. Carefully judge how much you will need before measuring or weighing. You can obtain more reagent, if needed, but excess must be discarded.**

7. Many chemicals are too valuable, dangerous, or toxic to throw down the sink. The Chemistry Department will supply waste jars or special containers for some chemical wastes. Consult your lab instructor before disposing any chemicals. The sink is not a trash can.

Working Conditions

1. You must **NEVER** work alone in a lab; someone must be in the same room with you or another faculty member of the Chemistry Department must be available to check in on you. You are not to work in a laboratory unless supervised by a lab instructor or another member of the Chemistry Department.

2. Pets are not permitted in any lab.

3. Coats, books, papers, etc., should be left in the appropriate location. The only things near your work space should be your lab notebook (which should be open), a calculator, and perhaps your textbook.

4. Your workspace is to be reasonably clean. Spills (liquids and solids) should be cleaned up immediately. Note: Your "work space" includes the area around the analytical balances. You are also to keep this area clean.

5. Equipment may not be removed from the Laboratory Classroom without permission from a Chemistry Department faculty member. Unauthorized removal constitutes theft.

6. You may not conduct an experiment other than the one assigned without permission from the instructor.

Emergencies

1. On the first day in laboratory, you should learn the location and proper use of the safety equipment. This includes the fire extinguishers, fire blanket, eyewash fountain, safety shower, and first-aid kit. Make a habit of rechecking that these pieces of safety equipment are in place whenever you enter the laboratory.

2. If an emergency occurs and you do not know what to do, call for help and then get out of the way of those who are dealing with the problem.

3. **The best treatment for mild burns, small cuts, and chemical spills is to flush the affected area with cold water. Please tell the instructor immediately of any injury in the laboratory.**

4. If a serious injury occurs, the victim must be taken to the Student Health Center for immediate treatment.

5. **If you get something in your eyes, keep your eyes open and flush them immediately with *LOTS* of water. If someone else has been blinded by something in their eyes, quickly guide them to the nearest eyewash station, and help them to thoroughly flush their eyes.**

6. If an extensive chemical spill occurs on your skin or clothing, use the safety shower; that's why it's there. Flood the affected area with water and remove your clothing, if necessary.

7. If you develop any symptoms, which you believe are traceable to chemical exposure, notify your instructor. If you go the Student Health Center, tell them of the specific chemicals to which you have been exposed.

8. If you have a health condition which may be troublesome in the lab (asthma, chemical allergies, etc.), please notify your instructor at the beginning of the term. If you are ill, please go to the Student Health Center and have the condition treated. If you are sick, please don't come to the lab and spread it among the rest of us. If you become ill during a lab, inform the instructor and leave.

9. **Report all fires to the instructor. In case of a fire, keep your wits about you. If the fire is tiny, put it out yourself. If it is more extensive than you can safely handle, leave the area and allow the instructor to deal with the fire.**

10. If your clothing or someone else's catches fire:
    a. get under a safety shower as soon as possible, or
    b. wrap the victim in the fire blanker, or
    c. roll on the floor to extinguish the fire.
    d. Do not use a CO_2 extinguisher on a person; the cold may cause injuries as severe as the burn.
    e. **GET HELP AT ONCE!**

11. If you use an extinguisher or know that one has been used, notify your instructor so that it can be refilled.

These rules cannot replace common sense. Remember that the laboratory can be a dangerous place, and act accordingly. Be aware of what you are doing, and try to anticipate what you would do in case something should go wrong. If you are uncertain of any procedure, consult your instructor. Remember, you are ultimately responsible for you own safety and for the safety of your colleagues.

GUIDE TO SIGNIFICANT DIGITS

1. All non-zero digits are significant.
2. Captive zero's are significant.
3. Leading zero's are not significant.
4. Trailing zero's are significant, if there is a decimal point in the number.
5. When multiplying/dividing a series of numbers, one number has the fewest significant digits. The number of significant digits in the product/quotient corresponds to this.

$$4.1753 \times 5.3 \times 2.71 = 6.0 \times 10^1$$

6. When adding/subtracting a series of numbers, one number is the least precise. The precision of the sum/difference corresponds to this.

$$2.173 + 0.019 + 7.3 = 9.5$$

STATE UNIVERSITY OF NEW YORK
COLLEGE OF AGRICULTURE AND TECHNOLOGY
MORRISVILLE, NEW YORK 13408

CHEMISTRY LABORATORY SAFETY AGREEMENT

I, the undersigned, have read, understood, and will abide by the criteria set forth in **GENERAL INFORMATION ABOUT CHEMISTRY 121L** and **LABORATORY SAFETY**. These criteria govern my conduct and actions in the laboratory.

I understand that I must wear New York State approved eye protection and a full-length laboratory coat at all times while in the laboratory.

Failure to abide by the rules of laboratory safety will result in my expulsion from the laboratory with a grade of **F** for the scheduled experiment.

PLEASE SIGN IN INK

Name (printed) _____

Signature _____ Date _____

Course: CHEM 121L