STUDENT PACKET - CHEM 15  
Summer 2006  

PENN STATE UNIVERSITY  
DEPARTMENT OF CHEMISTRY  

CHEMISTRY 15 – EXPERIMENTAL CHEMISTRY  
SYLLABUS  

Your Name  
Teaching Assistant  
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Office Hours  

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Additional administrative information may be found on the Chem 15 web page at  
http://courses.chem.psu.edu/chem15 or at the ANGEL website at https://cms.psu.edu  

Course-Section  
Chem 15-001  

1st Lab Meeting  
Friday, June 9, 2006  
8:00 AM – 12:00 PM  

All of the General Chemistry Lab’s are located on the first floor of the Whitmore Laboratory Building. On the first day you should go there 10 minutes before the start of your lab period and look for the posted lists which will indicate where to go for your introductory lecture. This will last for about an hour. Afterwards, we will proceed to the lab to complete the “Check-In/Orientation” experiment which is contained in this packet.
GETTING STARTED

You MUST have the following 4 items before you can be checked into lab:

1. Lab Manual - "PSU Chemtrek", currently using August 2005 version. The Aug. 2004 version may be used as long as you write in the updated information (available upon request).

2. Chem 15 Student Packet, Summer ‘06 - This is what you have in your hand. This contains the course syllabus and other handouts necessary for the course.

3. Eye Protection - There are 4 or 5 approved styles sold in the Penn State Bookstore. Choose a style you like. More detailed information on eye protection is given elsewhere in this packet.

4. Chem 14/15 Lab Kit.

    If you purchased the kit for a previous semester, then you only need to buy supplies that you have used up. For a typical student this means purchasing (a) a new blank notebook, and (b) perhaps a new package of 50 thin stem pipets. Refills for both of these items are available in the Penn State Bookstore.

It would also be a good idea to buy a Scientific Calculator if you do not already own one. It is not important for it to be programmable, but it should be able to handle logs, exponentials, trigonometric functions and scientific notation.

WEAR APPROPRIATE CLOTHING - Lab is potentially a messy experience. A T-shirt, blue jeans and shoes (or sneakers) would be reasonable. (No open-toed sandals allowed). We reserve the right to send you home to change if you are not dressed appropriately.
THE COURSE VISION

Chem 15 is an introductory chemistry laboratory experience that gives students the opportunity to put into practice the essential principles utilized in a professional chemistry laboratory regarding topics relevant to Chem 13. As such, we assume that you are currently taking Chem 13 or have previously taken this course or a course similar in content to it. You will be expected to use information learned in the lecture for the laboratory.

Essential Principles:

- attention to detail
- proper use of a lab notebook
- writing of a formal laboratory report
- use of the literature
- experimental design
- interpretation of data/statistics
- an awareness of safety issues
- an awareness of environmental issues
- appreciation for what instruments can and cannot do
Dear Chem 15 Students,

Welcome to "Part 2" of our General Chemistry Laboratory Program. Most of you have recently completed Chem 14 and are familiar with the "Small Scale" approach used in this course. For those of you who are new to the General Chemistry Laboratories, you should read Chapter 3 of the lab manual which describes the advantages of this approach compared to the traditional experiments. We are one of the first major universities to adopt this approach in both our General Chemistry and our Organic Chemistry Laboratories. But, there is evidence that this is the wave of the future. For example:

- The Journal of Chemical Education now has an entire section of each issue devoted to small scale chemistry.

- The American Chemical Society (ACS) devoted an entire issue of one of its periodicals to small scale chemistry (ChemUnity News, 1994). The entire issue has been sent to 20,000 chemistry teachers nationwide.

- The State of Massachusetts and the Environmental Protection Agency (EPA) have both funded the National Microscale Chemistry Center at Merrimack College. The goal of this Center is to train teachers in small scale techniques. (Chemical and Engineering News, Aug. 9, 1994, pg. 8)

- An article appeared in Science entitled, "Innovations in Teaching". One of the people featured in this article was Steve Thompson, the author of Chemtrek (Science, Vol. 266(4), pp. 889-90, 1994).

I would also like to point out that this small scale trend in education parallels current developments in research and industry. The same technology which has enabled the computer chip to shrink is enabling the analytical lab to shrink. In fact, scientists are already developing the "chemistry lab on a chip" (e.g., see Chemical and Engineering News: July 25, 1994, pg. 15, and December 12, 1994, pg. 28). A related development involves scaled down equipment used in medicine. An article included in this packet called, “Pocket-Size Medicine” describes some of these trends.

**The day is coming in which you will be able to have an analytical lab in your wrist watch!**

And, as a result, chemical analyses will be faster, safer, cheaper, and involve less waste.... *i.e.*, smaller is better for the 21st Century.

Please feel free to talk to me if you have any questions or comments regarding these developments, or any other matters regarding this course.

Sincerely,

Joseph T. Keiser
Director of the General Chemistry Laboratories
Pocket-Size Medicine

Miniaturized devices let doctors take the E.R. with them—and may even bring back the house call.
By Christine Gorman

Dr. Gresham Bayne practices medicine in some pretty unusual places. Just last month the San Diego physician was worshipping at the Point Loma Community Presbyterian Church when a fellow parishioner collapsed in her pew. Rather than call 911 to rush the 96-year-old woman to the hospital, Bayne asked the users to take her to the church parlor. The doctor, who is something of a gadget freak, was equipped for any contingency. Stashed in his black bag—actually a blue-and-gray fishing-tackle box—was a miniaturized version of every diagnostic tool he needed to assess her symptoms, as well as a full supply of standard emergency-care drugs to treat them. “You’ve got to stop thinking about bricks and mortar,” Bayne says. “Today I am the emergency room.”

Welcome to pocket-size medicine. The revolution in microelectronics that gave us cellular phones and palmtop computers now allows doctors like Bayne to take their healing arts out of the hospital and onto the road. The result: fully functional EKG machines no bigger than a box of chocolates; blood-sample analyzers no larger than a princess phone; portable ultrasound machines that fit in the trunk of a car. There is even a hand-held MRI scanner in the works that is about the size and shape of a catcher’s mitt. And last week the U.S. Food and Drug Administration approved a paperback-size automatic defibrillator that can shock a stopped heart back into a normal rhythm.

Bayne took full advantage of the new technology that Sunday morning in Point Loma. Although he could not feel a pulse at his patient’s wrist, he was able to determine that it had fallen from a normal 80 beats a minute to 38 by placing a digital pulse monitor the size of a lemon on the woman’s finger. He then touched her chest with a portable EKG machine and analyzed her cardiac rhythms. Had there been any indication she was suffering a heart attack, Bayne would immediately have called 911. When he determined that wasn’t the case, he decided to perform a battery of blood tests.

No sooner said then done: from the woman’s wrist the doctor drew a sample, injected it into a tiny cassette and snapped it into a hand-held blood analyzer. Within two minutes, all readings came up normal. There was no sign of dehydration, anemia, insulin shock or kidney failure. “In a standard emergency room, it would have taken me 30 minutes to an hour to get those test results,” Bayne says.

Questioning his patient, Bayne finally deducted that a prescription drug she was taking had caused her heart to slow, decreasing the flow of oxygen to her brain and sending her into a faint. That settled, he administered a stimulant called atropine to strengthen her heartbeat. Total elapsed time from pew to recovery: eight minutes, just about as long as it would have taken to get her to the emergency room in an ambulance.

It would be impractical, of course, to put a doctor in every church—or even on every street corner. But Bayne has an answer for that. He is one of the founders of the Call Doc Medical Group, five well-equipped physicians and three technicians who work through a central dispatcher to bring their high-tech tools to elderly, homebound and disabled patients. San Diegans can just pick up the phone and dial 1-800-call-doc to patch through to one of the group’s physicians. If the symptoms are not so dire that they require a call to 911, one of Call Doc’s physicians can be on the scene within a few hours. Average cost per call is $150, which compares quite favorably to a typical $350 charge for an ambulance and anywhere from $1,000 to $3,000 for a visit to the emergency room.

Call Doc is not the only doctors’ group taking advantage of the new flexibility the miniature equipment affords them. Similar associations are forming in Tampa, Florida and Palm Springs, California. Patients appreciate the service, and the physicians seem to enjoy providing it. “Now that I can make house calls,” says Bayne, “I feel like a doctor again.”

GRADING

Lab Reports
Experiments 9, 13, 14, and 18 will require reports that can usually be completed in lab. Some of the labs will contain short homework assignments. These assignments should be completed in labs if time allows, or completed at home if you run out of time in lab. The reports will be due either at the end of lab, or at a time to be announced, often a day or two after the experiment is completed.

Instead of a report for Experiment 5, a quiz will be given at the beginning of the following lab period. The quiz and a graphing exercise will count as your experiment 5 report grade. (Note: There will not be an Expt. 15 prelab quiz).

Instead of an in-lab report for Experiment 19, you will be asked to submit a formal type-written report.

Late Lab Reports Policy
Significant late penalties will result for lab notebooks that are not handed in on the due date. Reports received one week late have a 25 point penalty.

Reports that are more than one week late will not be accepted.

Quizzes/Test
There will be short quizzes given at the beginning of most lab periods according to the schedule on the inside cover. These cover the major points of the experiment of the day. Students who arrive late for lab (i.e., after the quiz has been collected) will receive a zero on that quiz. Contained in this packet are outlines of what you should know for each quiz.

There will also be a cumulative lab test given on the last day of lab. An outline of what will be covered on this exam is contained in this packet.

Instructor Evaluation
The instructor will assign a grade to each student based on their perception of the student's overall performance in the lab. This will include the use of the laboratory notebook, attitude, independence and technique.

Lab Monitoring
Each student will be assigned one day for which they are responsible for lab monitoring. This will normally entail an end of the period clean up of the shared areas such as the sinks, balances and the chemical supply area.

THE FINAL GRADE:  Lab Reports: 50%
                  Prelab quizzes: 15%
                  Lab Test: 25%
                  Instructor Evaluation: 10%
                  100%

Teaching Assistants
Most of the time you will be working with a Graduate Teaching Assistant (TA). Your TA will supervise your work in the laboratory and grade your reports and quizzes. The final grading decisions, however, will be made by Dr. Keiser.
Misc. Policies

**Attendance** Each student is expected to be present in the laboratory at the beginning of each session and to remain in the laboratory for all the scheduled time unless explicit instructions to the contrary are given. A grade of zero will be assigned for any laboratory missed unless permission for a make-up has been given.

**Make-up Requests** If a student has a legitimate excuse for missing a lab (e.g., family emergencies, a note from your Doctor), then he/she should complete a Make-up Request Form (one is on the next page) and drop it off in the mail slot on the cubicle on the 1st floor of Whitmore ASAP. In most cases you will be asked to attend a special make-up experiment which will be held during your normal laboratory period on the week before the lab test. In this case, you will still be held responsible for the material covered on the missed experiment for the lab test.

**Conflict Exams** (Usually this only effects the evening lab sections)
Many Departments now schedule exams in the evenings. Sometimes these may conflict with a scheduled laboratory meeting. In these cases you are expected to come to lab. The Department which is giving the exam is expected to offer you a suitable make-up opportunity. This will normally involve giving you the same exam at a different time. (Note: most Departments have a cut off date for the scheduling of conflict exams. Be sure to check your entire semester’s schedule now for lab/exam conflicts.)

**The Lab Notebook** You are expected to keep a detailed and legible laboratory notebook in this course. We will use the notebook as a cross between a professional laboratory notebook, and a lab journal (similar to a diary). Some guidelines on how to do this are given in the section of this packet entitled, "How to Keep a Laboratory Notebook". At the end of each day, you must have the lab instructor sign and date your lab notebook. All original data and observations should be recorded in your lab notebook. Your notebook will typically be turned in at the end of each laboratory period.

**Lab Neighbors** You should feel free to discuss the experiments with your neighbors, but, reports must be written up individually. If information in your notebook comes from someone else, then it must be referenced. The presentation of someone else’s work under your name (i.e., without a clear reference) is plagiarism. There are serious penalties for plagiarism, potentially including an “F” in the course, and an academic dishonesty “flag” on your transcript. Note: the facilitation of plagiarism, for example by posting your lab reports to the web, is also considered academically dishonest. You should not give a digital copy of your formal report to anyone, including you lab partners, because this tends to encourage plagiarism. A full listing of all Penn State policies on ethics and honorable behavior that apply to this course is given at [http://www.psu.edu/ufs/policies/](http://www.psu.edu/ufs/policies/).

**Open Office Hours** Each Chem 15 TA is expected to hold a minimum of one hour per week in the Chemistry Resource Center, room 211 Whitmore. These office hours are “open”, in the sense that any Chem 15 student may attend the office hour of any Chem 15 TA. (It is still a good idea to go to your own TAs office hour, if possible, since he/she will be more familiar with your work.)

**Clever Chemist Awards** We are interested in identifying and acknowledging students who go "above and beyond" the normal expectations for their lab work. This could be a clever experimental idea, or an especially impressive lab write up, or the discovery of a significant mistake in the lab manual. TA's will make recommendations to the Lab Director. If selected, the student will receive a “Clever Chemist” award. This consists of a unique pair of safety glasses, and a gift certificate to a local store.
Chem 15 Makeup Request

If this form is incomplete or illegible it may be rejected

This should be dropped off in the mail slot of the door to the Cubicle ASAP, but no later than one week after your absence.

Today's Date________________________  Your Name__________________________
Phone _____________________  Email address_________________________
Local mailing address________________________________
Your student ID __________________________________
TA’s Name______________________________________
Your Normal Lab Day and Time _____________________
Date you missed/will miss lab________________________

Reason (attach any pertinent documentation):

If an assignment was due on the date you missed, what is it's current status? i.e., is it completed?
Has it been handed in?/When do you plan to hand it in?

====================================================================

Makeup Request Approved?     Yes            No

Plan to attend the make-up experiment scheduled during your normal lab period, on the week before the Lab Test.

Note: This will be a different experiment than any that were done during the summer session. The grade you earn on this experiment will replace the grade for the missed experiment. But, you will still be held responsible for the material covered in the missed experiment for the Lab Test. There are only provisions for one make-up during summer session.

Comments:

Approved by                      Date
Information on Eye Protection

There are three types of eye protection acceptable for use in the Penn State undergraduate chemistry labs. These are described below. You should go to the bookstore and try on the various types, and choose the type that is best for you.

1. **Safety Glasses** look similar to prescription glasses, but have side shields and a browbar to prevent extra splashes protection. They are generally considered to be more comfortable, and to offer better peripheral vision compared to goggles. The disadvantages are that they do not fit well (if they fit at all) over prescription glasses, and they offer less protection than goggles since they do not cup completely over the eye. The bookstore carries an excellent type of safety glasses called Panaspec Plus by Bouton. This type features a large single lens with side shields and a brow bar. They have the highest level of splash protection of any of the safety glasses examined.

2. **Visor Goggles** are a type of “half goggle”, the upper half is similar to a goggle, and the lower half is similar to safety glasses. As such, they have some of the advantages and disadvantages of both safety glasses and goggles. They are reasonably comfortable, afford good splash protection, and offer better peripheral vision and have less tendency to fog than goggles. They fit over many types of prescription glasses. They do have a strap around the head which may be somewhat annoying. The PSU Bookstore carries one brand, Visorgogs (Jones and Company).

3. **Goggles** are pliable and form a complete cup around the eyes, and are held in place by a strap that wraps around the head. Goggles offer the highest level of splash protection compared to other types of protective eyewear. The disadvantages are that they may fog up, they limit peripheral vision, and the strap may be uncomfortable to some. There are 4 different kinds of goggles available at the Penn State Bookstore. These vary slightly in terms of their shape, design, venting and price. They should fit over prescription glasses.

**Contact Lens Wearers** In 1994, OSHA concluded that “contact lenses do not pose additional hazards to the wearer, and has determined that additional regulation addressing the use of contact lenses in unnecessary” (1). Other reports support this position (2,3). Therefore, contact lenses will be allowed in the Penn State undergraduate chemistry labs. However, you must wear some type of approved protective eyewear over your contact lenses when you are working in the lab, and you must identify yourself as a contact lens wearer in some manner to be designated by your instructor. This is to alert safety personnel of the presence of your contact lenses in the unlikely event that your eyes would need to be flushed when you are unconscious.

2. Chemical Health and Safety, Published by the American Chemical Society, Jan./Feb., 1995, pp. 16-21.
3. Chemical Health and Safety, Published by the American Chemical Society, May/June, 1997, pp. 33-37
Chem 14/15 Student Information Sheet

Name:

email address:
(How often do you expect to check it?)

Phone number (optional):

Major:

Yr. at Penn State (Fr. So. Jr. Sr.):

Tell me a little about your chemistry background:

Tell me about your expectations/hopes for this course:

Additional Comments:
TERMS THAT YOU SHOULD KNOW FROM HIGH SCHOOL CHEMISTRY

Note: Part of your first quiz will be based on these terms.

Accuracy
The closeness of a measurement to the true value of the quantity that is measured.

Actual yield
The amount of product actually obtained in a reaction.

Anion
An ion with a net negative charge.

Atom
The smallest piece of an element that can enter into chemical combinations.

Avogadro's Number
The number of $^{12}\text{C}$ atoms in exactly 12 g of $^{12}\text{C}$; it equals $6.022 \times 10^{23}$.

Bronsted acid
A substance capable of donating a proton ($\text{H}^+$).

Bronsted base
A substance capable of accepting a proton ($\text{H}^+$).

Catalyst
A substance that increases the rate of a chemical reaction without itself being consumed.

Cation
An ion with a net positive charge.

Chemical reaction
Processes in which one or more substances are converted into other substances. (Also called "chemical changes".)

Chemical kinetics
The area of chemistry concerned with the speeds, or rates, at which chemical reactions occur.

Compound
A substance composed of atoms of two or more elements chemically united in fixed proportions.

Covalent bond
A bond in which two electrons are shared by two atoms.

Density
The mass of a substance divided by its volume.

Diffusion
The gradual mixing of one substance with another due to random molecular motion.

Dilution
A procedure for preparing a less concentrated solution from a more concentrated solution.

Electrolyte
A substance that, when dissolved in water, results in a solution that can conduct electricity.

Electronegativity
The ability of an atom to attract electrons toward itself in a chemical bond.

Element
A substance that cannot be separated into simpler substances by chemical means.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endothermic processes</strong></td>
<td>Processes that absorb heat from the surroundings.</td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td>The capacity to do work or to produce change.</td>
</tr>
<tr>
<td><strong>Enzyme</strong></td>
<td>A biological catalyst.</td>
</tr>
<tr>
<td><strong>Equilibrium</strong></td>
<td>A state in which there are no observable changes as time goes by.</td>
</tr>
<tr>
<td><strong>Excess reagents</strong></td>
<td>One or more reactants present in quantities greater than those needed to</td>
</tr>
<tr>
<td></td>
<td>react with the quantity of the limiting reagent.</td>
</tr>
<tr>
<td><strong>Exothermic processes</strong></td>
<td>Processes that give off heat to the surroundings.</td>
</tr>
<tr>
<td><strong>First Law of Thermodynamics</strong></td>
<td>Energy can be converted from one form to another, but cannot be created</td>
</tr>
<tr>
<td></td>
<td>or destroyed.</td>
</tr>
<tr>
<td><strong>Heat</strong></td>
<td>The transfer of thermal energy (energy associated with the random motion</td>
</tr>
<tr>
<td></td>
<td>of atoms and molecules) between two bodies that are at different</td>
</tr>
<tr>
<td></td>
<td>temperatures.</td>
</tr>
<tr>
<td><strong>Hess's Law</strong></td>
<td>When reactants are converted to products, the change in enthalpy is the</td>
</tr>
<tr>
<td></td>
<td>same whether the reaction takes place in one step or in a series of steps.</td>
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<tr>
<td><strong>Hydrogen bond</strong></td>
<td>A special type of dipole-dipole interaction between containing hydrogen</td>
</tr>
<tr>
<td></td>
<td>bonded to an electronegative element. The most important examples involve</td>
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<td></td>
<td>nitrogen, oxygen and fluorine. For instance, the attraction between a</td>
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<tr>
<td></td>
<td>hydrogen on one water molecule and the oxygen atom on a second water</td>
</tr>
<tr>
<td></td>
<td>molecule would constitute a “hydrogen bond”.</td>
</tr>
<tr>
<td><strong>Inorganic compounds</strong></td>
<td>Compounds other than organic compounds.</td>
</tr>
<tr>
<td><strong>Ion</strong></td>
<td>A charged species.</td>
</tr>
<tr>
<td><strong>Ionic bond</strong></td>
<td>The electrostatic force that holds ions together in an ionic compound.</td>
</tr>
<tr>
<td><strong>Ionization energy</strong></td>
<td>The minimum energy required to remove an electron from an isolated atom</td>
</tr>
<tr>
<td></td>
<td>(or an ion) in its ground state.</td>
</tr>
<tr>
<td><strong>Isotopes</strong></td>
<td>Atoms having the same number of protons but different numbers of neutrons.</td>
</tr>
<tr>
<td><strong>Joule</strong></td>
<td>Unit of energy given by newtons - meters.</td>
</tr>
<tr>
<td><strong>Kinetic energy</strong></td>
<td>Energy available because of the motion of an object.</td>
</tr>
<tr>
<td><strong>Le Chatelier's principle</strong></td>
<td>If an external stress is applied to a system at equilibrium, the system</td>
</tr>
<tr>
<td></td>
<td>will adjust itself in such a way as to partially offset the stress.</td>
</tr>
<tr>
<td><strong>Limiting reagent</strong></td>
<td>The reactant used up first in a reaction.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<td>-------------------------------</td>
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<tr>
<td>Macroscopic properties</td>
<td>Properties that can be measured directly.</td>
</tr>
<tr>
<td>Metals</td>
<td>Elements that are good conductors of heat and electricity and have the tendency to form positive ions in ionic compounds.</td>
</tr>
<tr>
<td>Mixture</td>
<td>A combination of two or more substances in which the substances retain their identity.</td>
</tr>
<tr>
<td>Molar mass</td>
<td>The mass (in grams or kilograms) of one mole of atoms, molecules, or other particles.</td>
</tr>
<tr>
<td>Molarity (M)</td>
<td>The number of moles of solute in one liter of solution.</td>
</tr>
<tr>
<td>Mole</td>
<td>A collection of Avogadro's number (6.022 \times 10^{23}) of objects; for example, a mole of (\text{H}_2\text{O}) is (6.022 \times 10^{23}\ \text{H}_2\text{O}) molecules.</td>
</tr>
<tr>
<td>Molecule</td>
<td>A neutral aggregate of two or more atoms held together by covalent bonds.</td>
</tr>
<tr>
<td>Nonelectrolyte</td>
<td>A substance that, when dissolved in water, gives a solution that is not electrically conducting.</td>
</tr>
<tr>
<td>Nonmetals</td>
<td>Elements that are usually poor conductors of heat and electricity, and have the tendency to gain electrons and form negative ions.</td>
</tr>
<tr>
<td>Nonpolar molecule</td>
<td>A molecule that does not possess a dipole moment.</td>
</tr>
<tr>
<td>Octet rule</td>
<td>An atom other than hydrogen tends to form bonds until it is surrounded by eight valence electrons.</td>
</tr>
<tr>
<td>Organic Chemistry</td>
<td>The branch of chemistry that deals with carbon compounds.</td>
</tr>
<tr>
<td>Oxidation number</td>
<td>The number of charges an atom would have in a molecule if electrons were transferred completely in the direction of the atoms with the higher electronegativity.</td>
</tr>
<tr>
<td>Oxidation reaction</td>
<td>The half-reaction that involves the loss of electrons.</td>
</tr>
<tr>
<td>Oxidizing agent</td>
<td>A substance that can accept electrons from another substance or increase the oxidation number in another substance.</td>
</tr>
<tr>
<td>Percent yield</td>
<td>The ratio of actual yield to theoretical yield, multiplied by 100%.</td>
</tr>
<tr>
<td>pH</td>
<td>The negative logarithm of the hydrogen ion concentration.</td>
</tr>
<tr>
<td>Photon</td>
<td>A particle of light.</td>
</tr>
<tr>
<td>Physical property</td>
<td>Any property of a substance that can be observed without transforming the substance into some other substance.</td>
</tr>
<tr>
<td>Polar molecule</td>
<td>A molecule that possesses a dipole moment.</td>
</tr>
<tr>
<td>Potential energy</td>
<td>Energy available by virtue of an object's position.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Precipitate</td>
<td>An insoluble solid that separates from the solution.</td>
</tr>
<tr>
<td>Precision</td>
<td>The closeness of agreement of two or more measurements of the same quantity.</td>
</tr>
<tr>
<td>Pressure</td>
<td>Force applied per unit area.</td>
</tr>
<tr>
<td>Redox reaction</td>
<td>A reaction in which there is either a transfer of electrons or a change in the oxidation numbers of the substances taking part in the reaction.</td>
</tr>
<tr>
<td>Reduction reaction</td>
<td>The half-reaction that involves the gain of electrons.</td>
</tr>
<tr>
<td>Salt</td>
<td>An ionic compound made up of a cation (other than H&lt;sup&gt;+&lt;/sup&gt;) and an anion (other than OH&lt;sup&gt;-&lt;/sup&gt; or O&lt;sub&gt;2&lt;/sub&gt;sup&gt;-).</td>
</tr>
<tr>
<td>Saturated solution</td>
<td>At a given temperature, the solution that results when the maximum amount of a substance dissolves in a solvent.</td>
</tr>
<tr>
<td>Significant figures</td>
<td>The number of meaningful digits in a measured or calculated quantity.</td>
</tr>
<tr>
<td>Solubility</td>
<td>The maximum amount of solute that can be dissolved in a given quantity of solvent at a specific temperature.</td>
</tr>
<tr>
<td>Solute</td>
<td>The substance present in smaller amount in a solution.</td>
</tr>
<tr>
<td>Solution</td>
<td>A homogeneous mixture of two or more substances.</td>
</tr>
<tr>
<td>Solvent</td>
<td>The substance present in larger amount in a solution.</td>
</tr>
<tr>
<td>Specific heat</td>
<td>The amount of heat energy required to raise the temperature of one gram of the substance by one degree Celsius.</td>
</tr>
<tr>
<td>Spectator ions</td>
<td>Ions that are not involved in the overall reaction.</td>
</tr>
<tr>
<td>Theoretical yield</td>
<td>The amount of product predicted by the balanced equation when all of the limiting reagent has reacted.</td>
</tr>
<tr>
<td>Thermochemistry</td>
<td>The study of heat changes in chemical reactions.</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td>The scientific study of the interconversion of heat and other forms of energy.</td>
</tr>
<tr>
<td>Titration</td>
<td>The gradual addition of a solution of accurately known concentration to another solution of unknown concentration until the chemical reaction between the two solutions is complete.</td>
</tr>
</tbody>
</table>