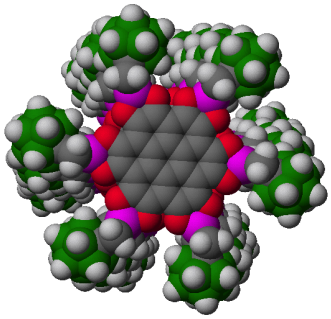
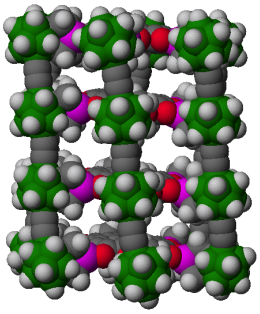


SYRACUSE UNIVERSITY
PROJECT ADVANCE
General Chemistry
CHEMISTRY 106/107/ 116/117
TEACHER ORIENTATION



Course Website at http://supa.syr.edu/Subjects/

2022 WORKSHOP SCHEDULE FOR SUPA CHEMISTRY (CHE)

Sunday, July 10, 5:00pm – 6:30pm – Reception (Optional)**,** Sheraton Syracuse University Hotel.

	Morning	Lunch	Afternoon
Mon. (7/11)	**8 AM**; **CHE and URP:** (Sheraton University Restaurant) Breakfast, Registration, Orientation and Welcome Breakfast (**Attendance Required**) Syracuse University Sheraton Hotel & Conference Center, 801 University Ave. **10:00-10:45**: **CHE and URP:** (Room LSB 001) Introductions and background info (*Prof. Jim Spencer and Mike Sponsler*), SU Chemistry and Forensics) **11:00 AM – 1:00 PM, CHE and URP:**(Bird Library) Gen. overview of Syracuse University Libraries (*Patrick Williams, SU Librarian*)	**1:15-2:15**: OPEN LUNCH	**2:30 PM – 4:30**; **CHE**: (LSB 004) Gen. Chem. Laboratory Discussion, (*Mike Revenson*), *Tyna Meeks* (virtually) and *Prof. Jim Spencer*. **2:30 PM – 4:30**; **URP:** (Room LSB 001) Research and materials for URP (*Prof. Mike Marciano*)
Tues. (7/12)	**8:30 AM – 10:00 AM: CHE and URP** (LSB 001), *Emily Beck* SUPA Registration and *Dr. Melanie Nappa Carroll*. Admin. Issues and Overview of SUPA Course, Syllabus, Textbooks, Exams, Grading, and Procedures. **10:15 AM – 11:45** - **CHE and URP,** (LSB 001) Brief Overview of SUPA URP and Chemistry Programs (*Profs. Jim Spence and Mike Sponsler*). LSC 001	**12:00 PM-1:45**: REU Chemistry Program Talks and lunch, CST 1-019	**2:00 – 4:00** PM: **CHE and URP**: (LSB 001) Melissa Whipps: Grant Writing. **4 PM**: **CHE and URP:** SUPA "Picnic" (Schine Student Center, Panasci Lounge).

SCHEDULE (Continued)

	Morning	Lunch	Afternoon
Wed. (7/13)	**9:00 AM – 9:45**; **CHE and URP** (Room LSB 001) Continue Program Summary. Textbooks, Exams, Grading, Procedures, General Overview; methods, and concepts; Powerpoint slides; etc. (*Prof. Jim Spencer*) **CHE and URP: 10:00 AM – noon:** (LSB 001) Panel presentations by SUPA HS Teachers: *Sarah Maine* (ESM HS) *Ed Oliver* (1000 Islands HS) *Beth Burns* (Fairport HS) *Todd Hilt* (CNY HS)	**12:00-1:30 PM**: OPEN LUNCH	**1:45 – 3:45 PM – URP**: (LSB 001) Establishing URP in HS (*Dr. Matt Schuchman, Clarkstown N HS, SUPA URP Faculty*) **1:45 – 3:45: CHE: Chemical Demonstrations** and related items (LSB 004) (*Prof. Sponsler*). Demonstrations, Q/A, general discussions. **Departures from Campus (4 PM)**
URP ONLY Thurs. (7/14)	***URP ONLY*** (Note: This session is Virtual *via* Zoom) **9:00 AM – 9:45**; (Virtual *via* Zoom) Other URP Program Information and Introduction to Teachers Panel (*Prof. Jim Spencer and Mike Sponsler*) **10:00 AM – 12:00**; **Teachers panel**: (Virtual *via* Zoom) *Hannah O'Leary* (Rachel Carson HS) *Daniel Layer* (Pelham Lab HS) *Elizabeth Stephens (Mahopac HS)*		

Dr. James T. Spencer	**Dr. Michael Sponsler**	**Dr. Melanie Carroll**
Laura J. and L. Douglas Meredith Professor, Professor of Chemistry, Founding Exec. Dir. FNSSI, SUPA Faculty Chem/Foren. Program Coordinator Department of Chemistry, Syracuse University Syracuse, New York 13244 (315) 443-3436 (Office) (315) 443-4070 (FAX) (315) 420-5233 (cell) jtspence@syr.edu	Prof. of Chemistry Director of FNSSI Curriculum SUPA Faculty Chem/Forensics Department of Chemistry, Syracuse University Syracuse, New York 13244-4100 (315) 443-4880 (Office) (315) 443-4070 (FAX) (315) 480-5276 (cell) sponsler@syr.edu	Associate Director SUPA Program Administrator Forensic Science Program Admin., Project Advance Syracuse University Syracuse, New York 13244 (315) 443-5709 (315) 863-3899 (cell) msnappa@syr.edu

Prof. James T. Spencer, Ph.D., Syracuse University 	Professor. PhD. Iowa State University 1984, Postdoctoral Fellow, University of Virginia 1984-1986; Chancellor's Citation for Excellence, Distinguished Achievement Award in Boron Science, 2000; Laura J. and L. Douglas Meredith Professor and Exec. Dir., Forensic and National Security Science Institute (FNSSI). Research directed toward aspects of main group cluster chemistry including nanoscale molecular systems, photochemistry, Forensic Science and solid-state chemistry.	Phone: 315-443-3436 FAX: 315-443-4070 Email: jtspence@syr.edu web: http://as-cascade.syr.edu/profiles/pages/chem-dev/Spencer-James.html
Prof. Michael Sponsler, Ph.D., Syracuse University 	Professor. Organic and Organometallic Chemistry, Ph.D. California Institute of Technology, 1987, Postdoctoral Fellow, Univ. California Berkeley. Dir. of Curriculum, Forensic and National Security Science Institute (FNSSI). Research is aimed toward new and useful materials, including optical and electronic materials and components for molecular electronic devices. Investigations into the synthesis and electronic properties of new types of conjugated organometallic complexes.	Phone: 315-443-4880 FAX: 315-443-4070 Email: sponsler@syr.edu Web: http://as-cascade.syr.edu/profiles/pages/chem-dev/Sponsler-Michael.html
Melanie Nappa-Carroll Syracuse University	Dr. Melanie Nappa-Carroll Associate Director SUPA Program Administrator	400 Ostrom Avenue Syracuse, NY 13244 (315) 443-5709 msnappa@syr.edu

SYRACUSE UNIVERSITY PROJECT ADVANCE
GENERAL CHEMISTRY

HANDOUT MATERIALS

- SCHEDULE OF SESSIONS
- SUPA ADMINISTRATIVE INFORMATION
- "WHY SUPA CHEMISTRY"
- CHEMISTRY DEPARTMENT INFORMATION
- TEXTBOOK (BROWN AND LEMAY)
- TEXTBOOK INSTRUCTORS MANUAL
- CHE 106 AND 116 SYLLABUS
- CHE 106 AND 116 SAMPLE EXAM QUESTIONS
- LABORATORY SUMMARY (CHE 107 AND CHE 117)
- LABORATORY EXPERIMENTS

Syracuse University Project Advance Chemistry Course Offerings: Forensic Science (CHE 113) and General Chemistry (CHE 106/107 and 116/117)

Why SUPA? - Syracuse University's Project Advance (SUPA) is a cooperative effort between Syracuse University and high schools throughout the Northeast that provides qualified high school students with the opportunity to enroll in challenging Syracuse University courses that are offered in their own schools. We strongly believe that our chemistry departmental courses through Project Advance (General Chemistry and Forensic Science) provide an enormous advantage to college-bound students. In an effort to let you know about this program, some of the primary reasons why we feel that our offerings through Project Advance are so valuable to both teachers and students are briefly summarized below;

Student Credit Acceptance and Transfer Rate – Students who successfully complete SUPA courses receive a regular Syracuse University transcript recording their credit that is identical to that of a main campus student. Importantly, students enrolled at over 500 institutions nationally have reported that Project Advance has a greater than 92% actual success rate in transferring credit to other colleges and universities. This is in marked contrast with other programs, such as AP, where the reported success rate is approximately 49%. In the relatively unusual cases where students have trouble transferring SUPA credit, the Project Advance office can often effectively help students in obtaining credit.

Full Credit Transfer – The Project Advance General Chemistry course provides a full 8 credits and the Forensic Science course provides a full 4 credits. Students with these SUPA credits typically receive the complete compliment of credits when they transfer. This is in contrast to AP and similar programs in which a student typically must receive a 4 or 5 in order to transfer *at most* half of the credits (usually the maximum allowed is 3-4 credits for chemistry). Transferring fewer than the full compliment of credits often does not significantly enhance the students college program. This is especially true in chemistry, where students usually find that they need to retake the first semester in order to compete effectively in second semester coursework (for which they did not receive transfer credit). Additionally, success in the SUPA course is determined over an entire year of testing and evaluation, rather that based solely upon a single examination.

Teacher Seminars – Each semester, Project Advance runs a unique course-specific seminar for teachers in the program at both upstate and downstate sites. These seminars typically involve presentations by forefront researchers in the field. Recent presentations in Chemistry have focused on topics including "Teaching with Microscale Lab Techniques" [Mark Langella], "The Chemistry and Biology of Protein Post-translational Modification" [Prof. James Hougland], "Hands-on experience with new modular chemistry lab instrumentation." [Sally Mitchell], and "Bottom-Up Nanotechnology: recent research advances, and how to integrate them and other materials chemistry topics into the general chemistry lecture" [Prof. Mathew Maye], among many others. Forensics topics have included "Firearms Investigations: Hands-on experience in developing curricular materials in firearms investigations" [Matt Kurimsky] and "Justice from the Public Defender Perspective" [Stephen Mercer, State of Maryland Public Defender Office]. Importantly, these seminars also provide a unique forum within disciplines for teaching professionals from both high school and university settings to discuss common concerns and ideas.

Training and Support – New teachers of the SUPA chemistry and forensics courses are provided with detailed training in the summer to facilitate their offering of the course.

Complete instructional materials and course information, along with in-depth discussions, are provided at these training sessions. [Teachers may also take this training, at reduced rate, for Syracuse University graduate credit.]

Inexpensive Credit - Project Advance courses are probably the least expensive credits a student will ever receive. Currently, Project Advance students pay ca. $112 per credit (in comparison with over $1,500 per credit on campus and with community colleges well over $150 per credit). In addition, limited emergency tuition assistance is available for eligible students who are unable to manage even these costs.

Administrative Support – Project Advance has a large, full time support staff of professional administrators and faculty to administer and oversee the program. Currently, about 6,600 students are enrolled in SUPA classes annually involving approximately 500 teachers in 140 high schools.

Classroom Visitations – Each semester that a course is offered, faculty visit each and every high school classroom and interact directly with the students to answer their questions and to provide insights into forefront research in the field. Additionally, SUPA program administrators meet with the teachers and high school administrators to address any questions or concerns during these visits.

University Curriculum and Exams – Each semester, materials are provided to ensure the close tie between the high school offering and the main campus course. For example, in Chemistry, Syracuse University faculty prepare a complete set of exam questions comparable to those used in our main campus classes. These questions are sent to the teachers at the beginning of each semester. The curriculum for the courses are completely comparable to similar courses offered at universities nationwide.

Project Advance "History" – Project Advance recently celebrated its 40th anniversary, making it one of the oldest national co-enrollment programs. Importantly, it is also one of the most honored programs and has received awards from the National Commission of Excellence in Education, the National Institute of Education, the Carnegie Foundation for the Advancement of Teaching, and the American Association of Higher Education. Project Advance has also served as a model for similar programs at such institutions as Indiana University, the University of North Carolina, Pittsburgh University and the University of Wisconsin, among many others.

As mentioned above, Project Advance provides many important services to the high schools including in-service training for high school instructors, a continuing forum for communication between educators from both school and university settings, and extensive ongoing research and evaluation in an effort to systematically improve instruction. As an aside, Project Advance is a not-for-profit auxiliary unit of Syracuse University and is neither used as a profit making center nor a recruiting tool for Syracuse University. Project Advance primarily serves New York, New England and the Mid-Atlantic States.

Both teachers and students that have participated in SUPA have very high regard for the program. For example, in a recent study, 95% of Project Advance graduates highly recommended SU courses offered through the SUPA program and 96% of principals felt SUPA helped students develop more realistic expectations of college work. Furthermore, 92% of teachers reported they have significantly benefited from exposure to new ideas and developments in their discipline because of their SUPA involvement.

For additional information, please contact either Prof. Jim Spencer, Chemistry Department, at (315) 443-3436 [jtspence@syr.edu] or Mr. John Fiset, SUPA Program Administrator, at (315) 443-2404 [jcfiset@syr.edu] or visit the website at www.supa.syr.edu.

Why SUPA for Students?

(Syracuse University Project Advance)

By taking a SUPA course, a student can earn college credit while still in high school!

The SUPA course sounds expensive – why should I pay that?

At only $112 per credit, it's actually a great value!

Consider:

- The same credit earned on the SU campus costs >10 times more!
- Even analogous credits taken at a community college cost more – about 50% more!

But can I use SUPA credit at the colleges I am considering?

Yes! The success rate for transferring the credit is >90%!

- Your chances are even higher if you ask for help if needed.
- A student's chance of getting credit from an AP course is much lower, <50%!

But I think my chances with AP are good. I'm sure I'll get a 4 or a 5.

A score of 4 or even 5 is not a guarantee that you will get credit.

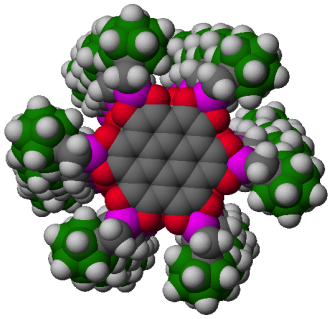
- Even if you get credit, it is often less than the full credit for the course – or it may be credit for a lower level, similar course.
- With SUPA, the credit is for the entire course.
- And with SUPA, your success does not depend on a single exam!

But I have never heard of SUPA before – I want something established.

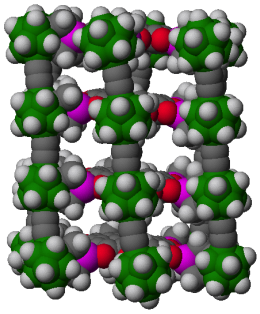
SUPA has been a leader in concurrent enrollment for >40 years!

Consider:

- 95% of students who have completed a SUPA course recommend the course to other students.
- 96% of principals of schools with SUPA courses believe that the courses help prepare their students to succeed in college.
- Check SUPA out for yourself – go to http://supa.syr.edu!



SYRACUSE UNIVERSITY
PROJECT ADVANCE
CHEMISTRY
106/107 AND 116/117
General Chemistry



Course Website at http://supa.syr.edu/Subjects/Chemistry/syllabi/

INTRODUCTION AND LEARNING GOALS - Whether we like it or not, we live in a dynamic chemical universe. Chemical properties and reactions influence our every action (and reaction). We rely upon chemical properties and reactions to both sustain and cultivate our lives. This course is intended to provide an introduction to understanding on a deeper level the role of chemistry in our world. This will be accomplished by providing a rational basis for interpreting and predicting chemical phenomena through examples of chemical behavior observed in nature. Thus, it is anticipated that students will be able to understand the fundamental chemical processes outlined below and to be able to apply this understanding to solve new problems in chemical behavior.

COURSE DESCRIPTION AND PREREQUISITE SKILLS: Chemistry 106 and 116 are general chemistry courses intended for students with an interest or background in science. No prior chemistry instruction is required or assumed. A general, basic understanding of math and algebra, including an understanding of decimals, exponents, logarithms, quadratics, and algebraic equations, is essential to success in this course (calculus is not required). You should not be taking remedial algebra concurrently with this course. Topics included are atomic structure, electronic structure and chemical bonding, descriptive solution chemistry, and introductions to biochemistry and biopolymer chemistry, nuclear chemistry, and many others.

IN-CLASS MATERIALS: The material covered in class is illustrative rather than exhaustive. *You should read the material in the text assigned **before** the class*. In class, alternate ways of understanding the material will often be presented. The examinations, however, will cover **both the assigned text and in-class materials** (whether or not they are specifically covered in class).

IMPORTANT NOTES:

- Check the Blackboard site frequently for any changes to lecture, recitation and exam schedules.
- This syllabus and the lecture notes will also be posted on Blackboard.
- For each chapter of the text, you should do all of the in-chapter sample exercises as practice. Doing at least the representative exercises from the end of each chapter will be very helpful. The textbook contains the answers to the odd-numbered problems. The Solutions Manual contains detailed solutions to these problems and several copies are held on reserve in the Science and Technology Library (Carnegie Library Building). If you are having difficulty, refer to the Solutions Manual and Student Guide to support your learning.

GRADING AND EXAMINATIONS: Exams will cover material covered in the text, in the lectures, and in the MasteringChemistry homework. Bring a calculator to all exams; however, graphing calculators and cell phone calculators are **NOT** allowed. A key to success is to practice problems to get good at them and then to practice more. Practice makes you efficient in answering problems such that you will have sufficient time on the exams to complete your work. Forming a study group to practice problems is strongly encouraged.

Final grades will be assigned based upon the four hourly exams given during the regularly scheduled classes (60%), the final examination (30 %) and the MasteringChemistry homework (10%). The breakdown is as follows;

Four Hourly Examinations: 4 exams @ 15% each	=	60 %
Final Examination	=	30 %
Mastering Chemistry	=	10 %
Total		100%

There will be NO MAKE-UP Examinations. *Approximate* grade cutoffs from the past, to provide guidance, are: A ≥ 90, A- ≥ 88, B+ ≥ 85, B ≥ 80, B- ≥75, C+ ≥ 70, C ≥ 60, C- ≥ 55, D ≥ 45, F<45. NOTE: the final grade cutoffs for the course, however, are likely to be near these but **not exactly the same**.

Exam Schedule:

Exam I: **Wed., Sept. 30th (in class)**
Exam II: **Wed., Oct. 21st (in class)**
Exam III: **Wed., Nov. 18th (in class)**
Exam IV: **Wed., Dec. 9th (in class)**
Final Exam: **Mon., Dec 14th, 12:45pm to 2:45pm**

The four hourly (in class) exams will include the course material covered listed in the schedule given later in this syllabus. The final will be cumulative.

Exam attendance: A grade of zero will be assigned for an exam if a student is absent. If you know in advance that you will be absent for an exam, that absence must be discussed with Prof. Spencer, at least a week before the exam. To be excused from an exam in the case of a medical emergency, A WRITTEN EXCUSE signed by the Health Center or a health-care provider must be obtained. No verbal, phone or email excuses will be accepted. All excuses will be verified by Chemistry Department staff. Excuses from class for medical reasons will only be given if such absences are advised by a health care provider or the Health Center based upon clinical findings and prescribed treatment recommendations. Verification must be made in writing by the provider. Excused notes will not be given solely to confirm a visit to the Health Center. For complete details on excuse notes, visit: http://health.syr.edu/students/policies.html. MAKE YOUR TRAVEL PLANS NOW. NO ACCOMMODATIONS FOR STUDENT TRAVEL/EXAM CONFLICTS WILL BE MADE.

Any and all problems involving registration, scheduling, grade reporting or other clerical issues are best handled by seeing the undergraduate chemistry secretary, located in the Chemistry Office, Room 120, 1st Floor, CST Building (adjacent to Life Sciences).

REQUIRED TEXTBOOKS: Chemistry, The Central Science, 13th ed. (Syracuse University Edition) by Brown, LeMay, Bursten, Murphy, and Woodward (Pearson-Prentice Hall, 2015)

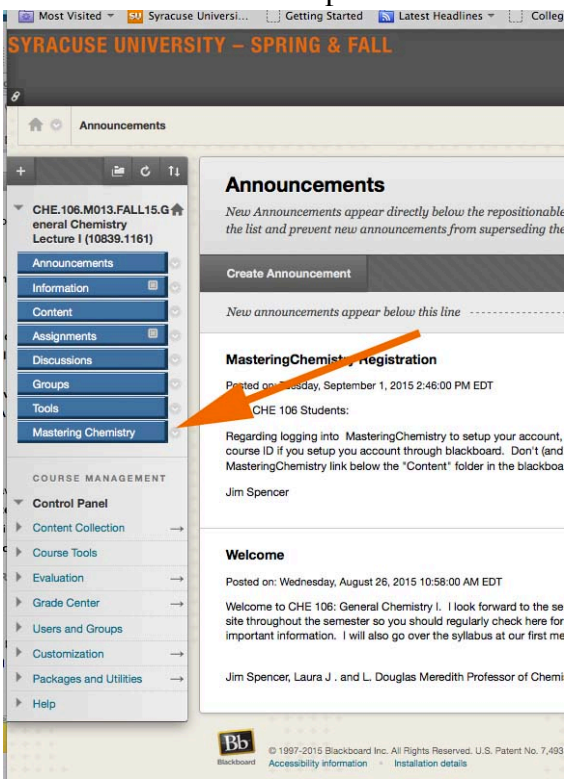
Online Homework: MasteringChemistry login information (http://www.masteringchemistry.com/)

The textbook and MasteringChemistry access code can be purchased as a package from the SU Bookstore. You can choose to buy only the electronic textbook and the MasteringChemistry access code from Pearson at http://www.masteringchemistry.com/. If you already have the textbook, the access code can be purchased for at the same website. Textbook prices from the SU Bookstore (hard copy, e-text, MasteringChemistry access): $200; Etext and MasteringChemistry access: $111.50; MasteringChemistry access: $66.

STUDENT RESPONSIBILITIES:

- Attend lectures, and read and watch the assigned material prior to class time.
- Participate in class through questions.
- Study your lecture notes and assigned text reading.
- Attend recitations to help reinforce your learning.
- Do assigned homework on time and review assignments before exams. Do not fall behind!
- Do additional problems as needed to ensure mastery of the material.
- **Bring a calculator to all lectures, recitations, and exams!**
- Take all of the examinations.

BLACKBOARD: Extensive use of SU's *Blackboard* course program will be made so you should become familiar with and routinely check the site for the course. The lecture notes are posted. Additional materials, such as the syllabus, announcements, interesting articles and any required supplemental materials will also posted on the *Blackboard* site for the course. The lecture powerpoints/notes are provided so that you can get the most out of lectures. I recommend that you copy the notes by hand later, because people tend to remember material that they write far better than material that they only read or hear. The notes are not, however, exhaustive and are meant to be used in conjunction with lectures, the text and MasteringChemistry.



EMAIL POLICY: Syracuse University has established email as a primary vehicle for official communication with students, faculty, and staff. Emergency notifications, educational dialogue, research, and general business correspondence are all consistently enhanced in institutions of higher learning where email policies exist and are supported by procedures, practice, and culture.

REQUIRED HOMEWORK: Consult the MasteringChemistry website for the assigned problems and due dates – note: completion of each week's homework is due at midnight on Friday of that week. The site will be operational by the end of the first week of classes. More information is provided at the end of this syllabus. The required MasteringChemistry homework will provide valuable practice since there is *no substitute* for practice in the learning of chemical concepts. The MasteringChemistry site, accessed through Blackboard (see the screen shot at right), has resources that you may wish to use that go beyond the assigned homework, including the e-text with hyperlinks and other features and a study area that allows self-testing and exploration of animations, videos, dynamic study modules, and more. You can also use the assigned homework for self-study even after you have submitted answers. The Student Guide is another resource for organizing your study and for additional problems. If you scored below 95% in a homework exercise, you will be required to complete a short follow-up problem set within the following two days (called the adaptive followup).

LABORATORY: CHE 107 (1 credit), General Chemistry Laboratory I, is the laboratory course associated with CHE 106. However, it is a *separate course* with separate staff and *separate grading*. The first labs occur two weeks into the semester. Check your course schedule for the time and place where your lab meets.

ACADEMIC INTEGRITY: Syracuse University's Academic Integrity Policy reflects the high value that we, as a university community, place on honesty in academic work. The policy defines our expectations for academic honesty and holds students accountable for the integrity of all work they submit. Students should understand that it is their responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. The policy governs appropriate citation and use of sources, the integrity of work submitted in exams and assignments, and the veracity of signatures on attendance sheets and other verification of participation in class activities. The policy also prohibits students from submitting the same work in more than one class without receiving written authorization in advance from both instructors. Under the policy, students found in violation are subject to grade sanctions determined by the course instructor and non-grade sanctions determined by the School or College where the course is offered as described in the Violation and Sanction Classification Rubric. SU students are required to read an online summary of the University's academic integrity expectations and provide a signature agreeing to abide by them. For more information about the policy, see http://academicintegrity.syr.edu.

DISABILITY STATEMENT REGARDING DISABILITY-RELATED ACCOMMODATIONS

Our community values diversity and seeks to promote meaningful access to educational opportunities for all students. Syracuse University and I are committed to your success and to supporting Section 504 of the Rehabilitation Act of 1973 as amended and the Americans with Disabilities Act (1990). This means that in general no individual who is otherwise qualified shall be excluded from participation in, be denied benefits of, or be subjected to discrimination under any program or activity, solely by reason of having a disability.

If you believe that you need accommodations for a disability, please contact the Office of Disability Services (ODS), http://disabilityservices.syr.edu, located at 804 University Avenue, room 309, or call 315-443-4498 for an appointment to discuss your needs and the process for requesting accommodations. ODS is responsible for coordinating disability-related

accommodations and will issue "Accommodation Authorization Letters" to students with documented disabilities as appropriate. Since accommodations may require early planning and generally are not provided retroactively, please contact ODS as soon as possible.

Religious Policies: Syracuse University does not have non-instructional days for any religious holiday and students must notify instructors by the end of the second week of classes when they will be observing their religious holiday(s). SU's religious observances policy, found at http://supolicies.syr.edu/emp_ben/religious_observance.htm, recognizes the diversity of faiths represented among the campus community and protects the rights of students, faculty, and staff to observe religious holy days according to their tradition. Under the policy, students are provided an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance **provided they notify their instructors before the end of the second week of classes**. For fall and spring semesters, an online notification process is available through MySlice/Student Services/Enrollment/My Religious Observances from the first day of class until the end of the second week of class.

Accommodations only include the holiday itself and **do not** cover travel days. Accommodations and related support services such as exam administration are not provided retroactively and must be requested in advance.

MISCELLANEOUS:

(1) Students who may need special consideration due to a physical or learning disability should see the instructor as soon as possible. **No provisions** will be made if notified **after** examinations.

(2) No student will be refused admission because he or she is unable to participate in a course requirement because of his or her religious holy day requirements. Again, you must make provisions **before** such absences. According to University policy, "an opportunity to make up examinations and other class work [due to religious observances] will be provided...if the **instructor is notified in writing one week before the absence**."

Note:

Just as a very rough guideline, the grade distribution below is approximately what has been used in a number of CHE 106 sections in the past. We have no set grade breakdowns and it varies on campus from instructor to instructor and from year to year. Also please note, that you should not be compelled to use these guidelines. Nonetheless, hopefully, this might be helpful.

SUPA Grading Guidelines:

A= 81-100
A-=72-80
B+=67-71
B= 64-66
B-=61-63
C+=55-60
C= 46-54
C-=36-45
D= 25-35
F= below

General Chemistry, CHE 106 and 116
Project Advance, Syracuse University

Course Syllabus
Fall 2016 and Spring 2017 Semesters

Syllabus on web:
http://supa.syr.edu/Subjects/Chemistry/chemistry.htm (PA Site)

Fall Semester Covers Chapters 1 thru 13 (excluding 12)
Spring Semester Covers Chapters 14 thru 26 (excluding 18 and 23-25)

Fall Semester
Chemistry 106

Note: The Chapters and items within each chapter listed below are not the same in all editions of the Brown and LeMay textbook. The listing below is simply to give a representative compilation of the topics usually covered in the course.

Chapter 1. Introduction: Some Basic Concepts

1.1 Matter
- Substances
- Chemical and Physical Properties
- Chemical and Physical Changes
- Mixtures

1.2 Elements and Compounds
- Elements
  - (Learn names and symbols of some common elements)
- Compounds

1.3 Measurement Units
  - (Study Table 1.4 SI Base Units 12)
  - (Study Table 1.5 Selected Prefixes Used in the SI System 12)
- Length and Mass
- Temperature
- Celsius, Fahrenheit, Kelvin scales
- Volume
- Density
- Intensive and Extensive Properties

1.4 Uncertainty in Measurement
- Precision and Accuracy

Significant Figures
(See rules for determining the number of significant figures in a measured quantity)
Significant Figures in Calculations
(See rules for rounding off numbers)

1.5 Dimensional Analysis
Summary of Dimensional Analysis

Chapter 2. Atoms, Molecules, and Ions

2.1 The Atomic Theory
Basic Postulates of the Dalton Theory

2.2 The Discovery of Atomic Structure
Cathode Rays and Electrons
Radioactivity
The Nuclear Atom

2.3 The Modern View of Atomic Structure
Protons, neutrons and electrons
(See Table 2.1 Comparing the proton, neutron, and electron)
Isotopes, Atomic Numbers, and Mass Numbers

2.4 The Periodic Table
(Study figure showing the division of elements into metals, metalloids, and nonmetals)
(Learn the family names for some of the groups in the periodic table)

2.5 Molecules and Ions
Molecules and Chemical Formulas
(Study figure - Common elements that exist as diatomic molecules at room temperature)
Molecular, Empirical, and Structural Formulas
Ions
(Study Figure - Charges of some common ions)

2.6 Naming Inorganic Compounds
Ionic Compounds: Cations
Ionic Compounds: Anions
(Learn the names of common ions. See Table - Common ions)
Acids
Molecular Compounds

Chapter 3. Stoichiometry: Calculations with Chemical Formulas and Equations

3.1 Chemical Equations

3.2 Patterns of Chemical Reactivity
Using the Periodic Table to predict reactivity
Combustion in Air: Combustion Reactions
Combination and Decomposition Reactions

3.3 Atomic and Molecular Weights
The Atomic Mass Scale

Average Atomic Masses (mixtures of isotopes)
Formula and Molecular Weights
Percentage Composition from Formulas

3.4 The Mass Spectrometer

3.5 The Mole

Molar Mass
Interconverting Masses, Moles, and Numbers of Particles

3.6 Empirical Formulas from Analyses

Molecular Formula from Empirical Formula
Empirical formula calculation from Combustion Analyses

3.7 Quantitative Information from Balanced Equations

3.8 Limiting Reactant

Theoretical Yield

Chapter 4. Aqueous Reactions and Solution Stoichiometry

4.1 Solution Composition

Molarity
Dilution

4.2 Electrolytes

Strong and Weak Electrolytes

4.3 Acids, Bases, and Salts

Bases
Salts
(Table - Common strong acids and bases)
Identifying Strong and Weak Electrolytes
(Guidelines for recognizing substances as strong or weak electrolytes)
Neutralization Reactions

4.4 Ionic Equations

4.5 Metathesis Reactions

(Study guidelines for determining what is the driving force for metathesis reactions to occur)
Precipitation Reactions
Solubility Rules
(Study table - Solubility rules for common ionic compounds in water)
Reactions in Which H_2O or a Weak Electrolyte Forms
Reactions in Which a Gas Forms

4.6 Reactions of Metals

Oxidation and Reduction
Oxidation of Metals by Acids and Salts
The Activity Series
(Table - Activity series of metals)

4.7 Solution Stoichiometry

Titrations

Chapter 5. Energy Relationships in Chemistry: Thermochemistry

5.1 The Nature of Energy
Kinetic and Potential Energy
Energy Units
Joule and Calorie
Systems and Surroundings
5.2 The First Law of Thermodynamics
Internal Energy
Relating E to Heat and Work
State Functions
5.3 Heat and Enthalpy Changes
5.4 Enthalpies of Reaction
(Three important characteristics of enthalpy)
5.5 Calorimetry
Heat Capacity and Specific Heat
Constant-Pressure Calorimetry
Constant-Volume Calorimetry (Bomb Calorimetry)
5.6 Hess's Law
5.7 Enthalpies of Formation
Using Heats of Formation to Calculate Heats of Reaction
(Study table - Specific heats of selected substances)
5.8 Foods and Fuels
Foods
Fuels
Other Energy Sources

Chapter 6. Electron Structures of Atoms

6.1 The Wave Nature of Light
(Figure - The electromagnetic spectrum)
(Table - Common wavelength units for electromagnetic radiation)
6.2 Quantum Effects and Photons
The Photoelectric Effect
6.3 Bohr Model of the Hydrogen Atom
Line Spectra
Bohr's Model
6.4 The Dual Nature of the Electron
The Uncertainty Principle
6.5 Quantum Mechanics and Atomic Orbitals
Orbitals and Quantum Numbers
(Letters used to label atomic orbitals)
(Table- Relationships among values of n, l, and m_l)
6.6 Representations of Orbitals
The s Orbitals
The p Orbitals
The d and f Orbitals
(Figures showing contour representations of orbitals)
6.7 Orbitals in Many-Electron Atoms

Effective Nuclear Charge
Energies of Orbitals
6.8 Electron Spin and the Pauli Exclusion Principle
6.9 Electron Configurations
Writing Electron Configurations of the Elements
6.10 Electron Configurations and the Periodic Table
(Table - Electron configuration of the elements)

Chapter 7. Periodic Properties of the Elements

7.1 Development of the Periodic Table
7.2 Electron Shells in Atoms
7.3 Sizes of Atoms
7.4 Ionization Energy
Periodic Trends in Ionization Energies
7.5 Electron Affinities
7.6 Metals, Nonmetals, and Metalloids
Metals
Nonmetals
Metalloids
Trends in Metallic and Nonmetallic Character
(See Figure - Trends in metallic and nonmetallic character.)
(Also study guidelines on predicting metallic character for a given element in the periodic table)
7.7 Group Trends: The Active Metals
Group 1A: The Alkali Metals
Group 2A: The Alkaline Earth Metals
7.8 Group Trends: Selected Nonmetals
Hydrogen
Group 6A: The Oxygen Family
Group 7A: The Halogens
Group 8A: The Noble Gases

Chapter 8. Basic Concepts of Chemical Bonding

8.1 Lewis Symbols and the Octet Rule
(Table - Electron-dot symbols)
8.2 Ionic Bonding
Energetics of Ionic Bond Formation
Electron Configurations of Ions
Polyatomic Ions
8.3 Sizes of Ions
(Figure - Relative sizes of atoms and ions)
8.4 Covalent Bonding
Multiple Bonds
8.5 Bond Polarity and Electronegativity

Electronegativity
(Study figure - Electronegativities of the elements)
Electronegativity and Bond Polarity
8.6 Drawing Lewis Structures
(Learn rules for writing Lewis structures)
8.7 Resonance Structures
8.8 Exceptions to the Octet Rule
Odd Number of Electrons
Less Than an Octet
More Than an Octet
8.9 Strengths of Covalent Bonds
(Study table Average bond energies)
Bond Energies and the Enthalpy of Reactions
Bond Strength and Bond Length
8.10 Oxidation Numbers
(Rules for determining oxidation numbers)
Oxidation Numbers and Nomenclature

Chapter 9. Molecular Geometry and Bonding Theories

9.1 Molecular Geometries
The Valence-Shell Electron Pair Repulsion (VSEPR) Model
AXE Notation (handout)
Predicting Molecular Geometries
(Study Table - Electron-pair geometries as a function of the number of electron pairs)
(Steps used to predict molecular geometries using the VSEPR model)
Four or Fewer Valence-Shell Electron Pairs Around a Central Atom 290
(Table - Electron-pair geometries for molecules with two, three, and four electron pairs about the central atom)
The Effect of Nonbonding Electrons and Multiple Bonds on Bond Angles
Geometries of Molecules with Expanded Valence Shells
(Table - Electron-pair geometries for molecules with five and six electron pairs about the central atom)
Molecules with No Single Central Atom
9.2 Polarity of Molecules
The Polarity of Polyatomic Molecules
9.3 Covalent Bonding and Orbital Overlap
9.4 Hybrid Orbitals
sp Hybrid Orbitals
(Figure - Formation of sp hybrid orbitals)
sp^2 and sp^3 Hybrid Orbitals
(Figure - Formation of sp^2 hybrid orbitals)
(Figure - Formation of sp^3 hybrid orbitals)
Hybridization Involving d Orbitals
9.5 Multiple Bonds
Delocalized Bonding
(Figure - Formation of delocalized bonds)

General conclusions on hybrid orbitals in determining molecular structure

9.6 Molecular Orbitals

The Hydrogen Molecule

Bond Order

(Definition of bond order)

9.7 Second-Period Diatomic Molecules

(Rules for assigning electrons to molecular orbitals)

Molecular Orbitals for Li_2 and Be_2

Molecular Orbitals from 2p Atomic Orbitals

Electron Configurations for B_2 through F_2

(Figure General energy-level diagram for molecular orbitals of second-row diatomic molecules)

Electron Configurations and Molecular Properties

Chapter 10. Gases

10.1 Characteristics of Gases

10.2 Pressure

Atmospheric Pressure and the Barometer

Pressure of Enclosed Gases and Manometers

10.3 The Gas Laws

Pressure-Volume Relationship: Boyle's Law

Temperature-Volume Relationship: Charles Law

Quantity-Volume Relationship: Avogadro's Law

10.4 The Ideal-Gas Equation

(Table - Numerical values of the gas constant, R)

Relationship Between the Ideal-Gas Equation and the Gas Laws

10.5 Molar Mass and Gas Densities

10.6 Gas Mixtures and Partial Pressures

Partial Pressures and Mole Fractions

10.7 Volumes of Gases in Chemical Reactions

Collecting Gases Over Water (Correcting for the vapor pressure of water)

10.8 Kinetic-Molecular Theory

Basic assumptions of Kinetic-Molecular Theory

Application to the Gas Laws

10.9 Molecular Effusion and Diffusion

Graham's Law of Effusion

Diffusion and Mean Free Path

10.10 Deviations from Ideal Behavior

(Figure - PV/RT versus pressure)

The van der Waals Equation

Chapter 11. Intermolecular Forces, Liquids, and Solids

11.1 The Kinetic-Molecular Description of Liquids and Solids

(Table - Some characteristic properties of the states of matter)

11.2 Intermolecular Forces
Ion-Dipole Forces
Dipole-Dipole Forces
London Dispersion Forces
Hydrogen Bonding
(Figure - Boiling points of the group 4A and 6A hydrides as a function of molecular weight)
11.3 Properties of Liquids: Viscosity and Surface Tension
11.4 Changes of State
Heating Curves
(Figure - Enthalpy of water between -25°C and 125°C)
Critical Temperature and Pressure
11.5 Vapor Pressure
Explaining Vapor Pressure on the Molecular Level
Volatility, Vapor Pressure, and Temperature
Vapor Pressure and Boiling Point
11.6 Phase Diagrams
(Figure - Phase diagram for a system exhibiting gas, liquid, and solid phases)
The Phase Diagrams of H_2O and CO_2
(Figure 11.24 Phase diagram of (a) H_2O and (b) CO_2)
11.7 Structures of Solids
Unit Cells
The Crystal Structure of Sodium Chloride
Close Packing of Spheres
11.8 Bonding in Solids
Molecular Solids
Covalent-Network Solids
Ionic Solids
Metallic Solids

Chapter 13. Properties of Solutions

13.1 The Solution Process
(Table - Examples of solutions)
Energy Changes and Solution Formation
Solution Formation, Spontaneity, and Disorder
13.2 Ways of Expressing Concentration
Molarity, Mole Fraction, and Molality
13.3 Saturated Solutions and Solubility
13.4 Factors Affecting Solubility
Solute-Solvent Interactions
Pressure Effects
Temperature Effects
13.5 Colligative Properties
Vapor Pressure Lowering
Raoult's Law
Boiling-Point Elevation

Freezing-Point Depression

(Table - Molal boiling-point-elevation and freezing-point-depression constants)

Osmosis

Determination of Molar Mass

13.6 Colloids

Hydrophilic and Hydrophobic Colloids

Removal of Colloidal Particles

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Chapter 14. Chemical Kinetics

14.1 Reaction Rates
- Concepts of Instantaneous and Average Rates (Figure and text material)
- Reaction Rates and Stoichiometry

14.2 The Dependence of Rate on Concentration
- Rate Constant Units
- Using Initial Rates to Determine Rate Laws

14.3 Change of Concentration with Time
- First-Order Reactions
- Half-life
- Second-Order Reactions

14.4 Temperature and Rate
- The Collision Model
- Activation Energy
- The Arrhenius Equation

14.5 Reaction Mechanisms
- Elementary Processes
- Rate Laws of Elementary Processes
  - (Study table - Elementary steps and their rate laws)
- Rate Laws of Multistep Mechanisms
- Mechanisms with an Initial Fast Step

14.6 Catalysis
- Homogeneous Catalysis
- Heterogeneous Catalysis
- Enzyme Catalysts

Chapter 21. Nuclear Chemistry

21.1 Radioactivity
- Nuclear Equations
- Types of Radioactive Decay

21.2 Patterns of Nuclear Stability
- Neutron-to-Proton Ratio
- Radioactive Series

21.3 Nuclear Transmutations
- Using Charged Particles
- Using Neutrons
- Transuranium Elements

21.4 Rates of Radioactive Decay
Radioactive Dating
Calculations Based on Half-Life
21.5 Detection of Radioactivity
21.6 Energy Changes in Nuclear Reactions
Nuclear Binding Energies
21.7 Nuclear Fission
Nuclear Reactors
21.8 Nuclear Fusion
21.9 Biological Effects of Radiation

Chapter 22. Chemistry of Hydrogen, Oxygen, Nitrogen, and Carbon

22.1 Periodic Trends
22.2 Chemical Reactions
22.3 Hydrogen
Isotopes
Properties
Preparation
Compounds
22.4 Oxygen
Properties
Ozone
Oxides, Peroxides and Superoxides
22.5 Nitrogen
Properties
Hydrogen Compounds
22.6 Carbon
Elemental Forms
Oxides
XXX The Noble-Gas Elements
Noble gas compounds
XXX The Halogens
Occurrence
Properties and Preparation of the Halogens
Uses of the Halogens
The Hydrogen Halides
Interhalogen Compounds
Oxyacids and Oxyanions
XXX The Group 6A Elements
General Characteristics
Oxides, Oxyacids and Oxyanions of Sulfur

Chapter 15. Chemical Equilibrium

15.1 The Concept of Equilibrium

15.2 The Equilibrium Constant
Expressing Equilibrium Constants in Pressure Units, Kp
Magnitude of Equilibrium Constants
15.3 Heterogeneous Equilibria
15.4 Calculating Equilibrium Constants
Relationship Between Kc and Kp
15.5 Applications of Equilibrium Constants
Predicting the Direction of Reactions
Calculation of Equilibrium Concentrations
15.6 Factors Affecting Equilibrium: Le Chatelier's Principle
Change in Reactant or Product Concentrations
Effect of Volume and Pressure Changes
Effect of Temperature Changes
Effect of Catalysts

Chapter 16. Acid-Base Equilibria

16.1 The Dissociation of Water
The Proton in Water
16.2 Bronsted-Lowry Acids and Bases
Proton-Transfer Reactions
Conjugate Acid-Base Pairs
Conjugate Acid-Base Strengths
16.3 The pH Scale
Measurement of pH
16.4 Strong Acids and Bases
Strong Acids
Strong Bases
16.5 Weak Acids
Calculating pH for Solutions of Weak Acids
Polyprotic Acids
16.6 Weak Bases
Types of Weak Bases
16.7 Relation Between Ka and Kb
16.8 Acid-Base Properties of Salt Solutions
16.9 Acid-Base Behavior and Chemical Structure
Effect of Bond Polarity and Bond Strength
Oxyacids
Carboxylic Acids
16.10 Lewis Acids and Bases
Hydrolysis of Metal Ions

Chapter 17. Additional Aspects of Aqueous Equilibria

17.1 The Common-Ion Effect
17.2 Acid-Base Titrations

Strong Acid-Strong Base Titrations
Addition of a Strong Base to a Weak Acid
Titration Curves for Weak Acids or Weak Bases
Titrations of Polyprotic Acids

17.3 Buffered Solutions
Composition and Action of Buffered Solutions
Buffer Capacity and pH
Actions of Strong Acids or Bases to Buffers

17.4 Solubility Equilibria
The Solubility-Product Constant, Ksp
Solubility and Ksp
The Common-Ion Effect

17.5 Criteria for Precipitation or Dissolution
Solubility and pH
Selective Precipitation of Ions
Effect of Complex Formation on Solubility
Amphoterism

17.6 Qualitative Analysis for Metallic Elements

Chapter 19. Chemical Thermodynamics

19.1 Spontaneous Processes

19.2 Spontaneity, Enthalpy, and Entropy
Spontaneity and Entropy Change
The Second Law of Thermodynamics

19.3 Molecular Interpretation of Entropy

19.4 Calculation of Entropy Changes

19.5 Gibbs Free Energy
Standard Free-Energy Changes

19.6 Free Energy and Temperature

19.7 Free Energy and the Equilibrium Constant

Chapter 20. Electrochemistry

20.1 Oxidation-Reduction Reactions

20.2 Balancing Oxidation-Reduction Equations
Half-Reactions
Balancing Equations by the Method of Half-Reactions
Balancing Equations for Reactions in Basic Solution

20.3 Voltaic Cells

20.4 Cell EMF
Standard Electrode Potentials
Oxidizing and Reducing Agents

20.5 Spontaneity of Redox Reactions
EMF and Free Energy Change

20.6 Effect of Concentration on Cell EMF

The Nernst Equation

20.8 Electrolysis

Electrolysis of Aqueous Solutions

Electrolysis with Active Electrodes

20.9 Quantitative Aspects of Electrolysis

Electrical Work

Chapter 26. The Chemistry of Life: Organic and Biological Chemistry

26.1 Alkanes

Structures of Alkanes

Structural Isomers

Nomenclature of Alkanes

Cycloalkanes

Reactions of Alkanes

26.2 Unsaturated Hydrocarbons

Alkenes and Alkynes

Addition Reactions of Alkenes and Alkynes

Aromatic Hydrocarbons

26.3 Hydrocarbon Derivatives

Alcohols

Ethers

Aldehydes and Ketones

Carboxylic Acids

Esters

Amines and Amides

26.4 Introduction to Biochemistry

26.5 Proteins

Amino Acids

Polypeptides and Proteins

Protein Structure

The asymmetric carbon atom, chiral (optically active) molecules

Chapter 12. Modern Materials

12.2 Polymers

Addition polymerization, condensation polymerization

Types of Polymers

Thermoplastic, thermosetting

Structures and Physical Properties of Polymers

Crosslinking

12.3 Ceramics

12.4 Thin Films

Typical Laboratory Experiments for Syracuse University Project Advance General Chemistry

Typical Experiments and Schedule for Chemistry Lab CHE 107 (Fall)

Week	Experiment	Description	CER No.
1	**Check-in and safety review**	*An overview of laboratory safety practices, including a discussion of material safety data sheets, suggestions for actions in case of laboratory accidents, a page to record safety equipment locations, a chemical laboratory safety agreement.*	TECH 380
2	**Preparing Soap and Determining its Properties**	*A soap is prepared from an oil and a fat. Some of the properties of soaps and detergents are determined and compared.*	PROP 319
3	**Studying the Rate of the Reaction of Potassium Permanganate and Oxalic Acid**	*The order of the reaction of potassium permanganate and oxalic acid is determined with respect to permanganate ion and oxalic acid concentration*	KINE 505
4	**The Chemistry and Qualitative Analysis of Cations: Group Separations and Separation of Croup I Cations**	*The chemistry of cation Groups I, II, and III is developed. The separation of Group I, II and III is demonstrated using Ag^+, Cu^{2+}, qnd Fe^{3+} ions. A procedure is established for quantitatively verifying the presence of Ag^+, Hg_2^{2+}, and Pb^{2+} ions in an unknown solution.*	ANAL 364
5	**The Chemistry and Qualitative Analysis of Anions**	*The chemistry of selected anions (Cl^-, Br^-, I^-, SO_4^{2-}, CO_3^{2-}, SO_3^{2-}, PO_4^{3-}, NO_2^-, and NO_3^- ions) is developed.*	ANAL 367
6	**Estimating the Calorie Content of Nuts**	*The connection between food calories and chemical calories is determined by estimating the calorie content of peanuts, walnuts, and other nuts using a simple calorimeter.*	THER 428

Typical Experiments and Schedule for Chemistry Lab
CHE 117 (Spring)

Week	Experiment	Description	CER No.
1	**Check-in and safety review**	*An overview of laboratory safety practices, including a discussion of material safety data sheets, suggestions for actions in case of laboratory accidents, a page to record safety equipment locations, a chemical laboratory safety agreement.*	TECH 380
2	**The Empirical Formula of an Oxide**	*From gravimetric data, the empirical formula of an oxide of magnesium is determined.*	STOI 388
3	**Studying Chemical Reactions and Writing Chemical Equations**	*Chemical Reactions are described by writing chemical equations based on laboratory observations and information about reactions of different substances. Reactions are classified as combination, decomposition, single displacement, or double displacement.*	REAC 422
4	**Writing Lewis Symbols and Lewis Structures**	*Lewis symbols and structures are developed for elements, ions, compounds, and equations. Empirical formulas are predicted*	STRC 434
5	**Analyzing Food Products for Vitamin C**	*Juice and solid food samples are analyzed for ascorbic acid content by oxidation-reduction titration. The amount of Vitamin C per serving and the % RDA for each sample are calculated*	ANAL 442
6	**Separating and Determining the Mass of Calcium Ion in a Calcium-Enriched Tablet**	*A Calcium-enriched tablet is dissolved and the calcium ion precipitated as calcium carbonate. The masses of calcium carbonate and calcium are determined. The mass percent of calcium ion in the tablet is calculated and compared with that listed on the label. The filtrate is treated for disposal.*	ANAL 455
7	**Dimensional Analysis**	*Dimensional analysis if used to solve general chemistry problems using clues*	MISC 486

		such as units or dimensions associated with the measurements.	
8	**Separating and Identifying Food Dyes by Paper Chromatography**	*The retention factors of seven pure food dyes are determined in three different solvent systems. The most effective solvent for separating all seven dyes is determined. Dyes in unknown mixtures and selected commercial products are separated and identified, using paper chromatography.*	ANAL 492
9	**Determining the Percent Water in an Unknown Hydrate**	*The percent water in an unknown hydrate is determined*	ANAL 605
10	**Estimating a Heat of Neutralization**	*Heat of neutralization is estimated for the reaction of HCl and NaOH by plotting the temperature-time data collected for measured volumes of solutions of the two compounds, before and after mixing.*	THER 609

Other Favorites Used in Recent Years
(Many are currently used in CHE 109/119 and CHE 103/113)

Week	Experiment	Description	CER No.
1	**Separating a Ternary Mixture**	*The percent composition of the mixture and the percent recovery of the components are calculated*	PROP 375
2	**Evaluation of Vinegar Samples**	*The percent acetic acid in a group of commercial vinegar samples is determined by titrimetry and the data are used to evaluate the vinegar samples.*	ANAL 304
3	**Approximating Avagadro's Number**	*Avogadro's number is approximated from measurements made on a collection of glass beads and a film of oleic acid on water*	STOI 496
4	**Enthalpy of Hydration**	*From experimental data, the enthalpy of solution of $MgSO_4$ and of $MgSO_4 \cdot H_2O$ are calculated and used to calculate enthalpy of hydration of $MgSO_4$.*	THER 370

SUPA Chemistry 107 and 117: General Chemistry Laboratory

Instructor: Prof. James T. Spencer (443-3436)
Department of Chemistry

Instructor sheets can be gotten online at:
http://www.custom.thomsonlearning.com/cer/default.htm
Name – chemistry
Password - cerlabs

Chemical Education Resources
(now part of Brooks/Cole-Thompson Learning)
www.cerlabs.com
1-617-757-8137

Misc. Information:

(Separating and Identifying Food Dyes by Paper Chromatography) - Dye kits, containing 2 g of each of the seven F, D, & C dyes, can be obtained from Rainbow Colors, 286 Baxter St., Tolland, CT 06084. ph: 860-871-2033 fax: 860-871-8330. Price: $18.50, plus $3.50 shipping and handling. Rainbow Colors also accepts special orders for FD&C dyes.

Possible Laboratory Experiments for SUPA Workshop

1) Calorimetry
2) Molecular Weight of Carbon Dioxide
3) REDOX titration, Vitamin C

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Chemistry 106: General Chemistry
Syracuse University Project Advance
Exam Questions, Fall 2001

Name_____ ID No._____

Enter your name above and put your name and ID number in the appropriate places on the answer sheet with a No. 2 pencil (NO PENS!). Sign your name on the answer sheet. Choose the best answer to each question.

Note To Instructors:
Choose questions for the "hourly" exams from the provided pool of questions. Feel free, however, to also use other questions of your design in place of any provided here.

The last page of each examination should be a periodic table.

Chapter 1: Introduction: Some Basic Concepts

(1) Which of the following statements is (are) true?

A. The properties of a single sample are the same everywhere in the sample.
B. The properties of a single sample are different at different points in the sample.
C. The composition of different samples may be different.
D. A sample can only be separated into its components by a chemical reaction.
E. A sample may be separated into its components by physical means.

(a) A, C, and E
(b) B and D
(c) C and E
(d) B, C, and E
(e) all of the above.

(2) A health food store was advertising vitamin C in tablet form, each containing 100 mg of pure vitamin C. The only difference between the advertised brands of vitamin C was the source of the vitamin. Which choice is the healthiest choice?

(a) rose hips
(b) broccoli

(c) laboratory synthesis
(d) oranges
(e) all of the above

(3) Which one of the following is often easily separated into its components by simple techniques such as filtering or decanting?

(a) heterogeneous mixture
(b) compounds
(c) homogeneous mixture
(d) elements
(e) isotopes

(4) Which one of the following is an extensive property?

(a) density
(b) mass
(c) boiling point
(d) freezing point
(e) all are extensive properties

(5) The output of a plant is 4335 pounds of ball bearings per work week (5 days). If each ball bearing weighs 0.0113 g, how many ball bearings does the plant make in a single day?

(a) 3.84×10^5
(b) 7.67×10^4
(c) 867
(d) 3.48×10^7
(e) 2.91×10^6

(6) Alcohol has a density of 0.78 g/mL. How many grams of alcohol would it take to fill a 2 fluid ounce glass (1 fl. oz. = 29.57 mL)?

(a) 59 g
(b) 368 g
(c) 46 g
(d) 122 g
(e) 78 g

Chapter 2: Atoms, Molecules, and Ions

(7) The element oxygen exists in two primary forms in nature called dioxygen and ozone. These two forms are examples of

(a) isotopes
(b) allotropes

(c) isomers
(d) metalloids
(e) enantiomers

(8) Gallium reacts with a certain nonmetallic element to form a compound with the general formula GaX. Element X is a diatomic gas at room temperature. Element X must be

(a) O_2
(b) N_2
(c) Cl_2
(d) F_2
(e) B_2

(9) _____ rays are a stream of fast moving electrons.

(a) alpha
(b) beta
(c) gamma
(d) X
(e) neutron

(10) Methane and ethane are both made up of carbon and hydrogen. In methane, there are 12.0 g of carbon for every 4.00 g of hydrogen, a ratio of 3:1 by mass. In ethane, there are 24.0 g of carbon for every 6.00 g of hydrogen, a ratio of 4:1 by mass. This is a statement of the law of

(a) constant composition
(b) multiple proportions
(c) conservation of matter
(d) conservation of mass
(e) natural selection

(11) An atom of the most common isotope of gold, ^{197}Au, has

(a) 197 protons, 79 neutrons, and 118 electrons
(b) 118 protons, 79 neutrons, and 39 electrons
(c) 79 protons, 197 neutrons, and 197 electrons
(d) 79 protons, 118 neutrons, and 118 electrons
(e) 79 protons, 118 neutrons, and 79 electrons

(12) Which one of the following is a nonmetal?

(a) W
(b) Sr
(c) Os
(d) Ir
(e) Br

(13) The formula of the salt formed from Ca^{2+} and PO_4^{3-} is

(a) $CaPO_4$
(b) $Ca_2(PO_4)_3$
(c) Ca_2PO_4
(d) $Ca(PO_4)_2$
(e) $Ca_3(PO_4)_2$

(14) The correct formula of iron(III) bromide is

(a) $FeBr_2$
(b) $FeBr_3$
(c) FeBr
(d) Fe_3Br_3
(e) Fe_3Br

(15) The element M reacts with fluorine to form an ionic compound with the general formula MF_3. The M ion has 18 electrons. Element M is

(a) P
(b) Sc
(c) Ar
(d) Ca
(e) S

Chapter 3: Stoichiometry: Calculations with Chemical Formulas and Equations

(16) A sample having a mass of 0.01532 g was burned in pure oxygen and 0.00565 g of CO_2 and 0.00116 g of H_2O were obtained. What is the percent C and the percent H in the compound?

(a) 11.0% C and 0.424% H
(b) 11.0% C and 0.847% H
(c) 11.0% C and 89.0% H
(d) 15.8% C and 0.424% H
(e) 15.8% C and 0.847% H

(17) A sample of nickel(II) phosphate heptahydrate [$Ni_3(PO_4)_2 - 7H_2O$], Formula mass = 492.12 amu} contains 0.125 mol of phosphorus. How many moles of water does the sample contain?

(a) 0.0357 mol
(b) 0.438 mol
(c) 0.875 mol
(d) 1.75 mol
(e) 7.00 mol

(18) Chlorine can be prepared by the following reaction:

$MnO_2(s) + 4\ HCl(aq) \text{ ------> } Cl_2(g) + MnCl_2(g) + 2H_2O(l)$

How many moles of manganese(II) chloride can be produced when 1.83 g of HCl gas completely reacts with manganese(IV) dioxide?

(a) 0.0125 moles
(b) 1.577 moles
(c) 0.010 moles
(d) 0.00313 moles
(e) none of these

(19) A compound has the percent composition (percent by mass) shown in the table below:

Element	**Atomic Mass**	**Mass Percent Composition**
C	12.01	38.37
H	1.008	1.49
Cl	35.45	52.28

The empirical formula for the compound is

(a) C_2HCl
(b) $C_{6.5}H_3Cl_3O$
(c) $C_{12}H_5Cl_5$
(d) $C_{13}H_6Cl_6O_2$
(e) $C_{26}H_{12}Cl_{12}O_4$

(20) What is the percent yield of a reaction in which 762 g of CH_4 is converted to 2048 g CH_3Cl? The photochemical reaction for this process is:

$CH_4(g) + Cl_2(g) \text{ ------> } CH_3Cl(g) + HCl(g)$

(a) 2.69
(b) 26.9
(c) 37.2
(d) 85.4
(e) none of these

(21) The combustion of 3.42 g of a compound known to contain only nitrogen and hydrogen was burned in oxygen. The result was the formation of 9.82 g of NO_2 and 3.85 g of water. Determine the empirical formula of this compound.

(a) NH
(b) NH_2
(c) N_2H
(d) NH_3

(e) N_2H_4

(22) When the reaction below is correctly balanced, the coefficients are

$NH_3 + O_2$ ------> $NO_2 + H_2O$

(a) 1,1,1,1
(b) 4,7,4,6
(c) 2,3,2,3
(d) 1,3,1,2
(e) none of these

(23) From the information below, calculate the weighted average atomic mass of the element X.

Isotope	**Percent Relative Abundance**	**Exact Mass (amu)**
^{221}X	74.22	220.9
^{220}X	12.78	220.0
^{218}X	13.00	218.1

(a) 219.7 amu
(b) 220.4 amu
(c) 220.2 amu
(d) 218.5 amu
(e) 218.1 amu

(24) How many molecules of CH_3OH are in 32.0 g of CH_3OH?

(a) 5.32×10^{-23}
(b) 1.00
(c) 1.99×10^{22}
(d) 6.00×10^{22}
(e) 6.02×10^{23}

(25) What is the empirical formula of a compound that is 49.4% K, 20.3% S, and 30.3% O?

(a) KSO_2
(b) KSO_3
(c) K_2SO_4
(d) K_2SO_3
(e) KSO

(26) How many grams of SF_6 could be produced by the reaction of 3.5 g of sulfur with 4.5 g of fluorine according to the following equation?

$S + 3\ F_2$ ------> SF_6

(a) 12
(b) 3.2

(c) 5.8
(d) 16
(e) 4.5

Chapter 4: Aqueous Reactions and Solution Stoichiometry

(27) What is the molarity of sodium hydroxide (NaOH, molar mass = 40.01 g) solution made by dissolving 57.2 g of NaOH in about 100 mL of water and then making the solution up to a final volume of 250 mL?

(a) 0.1092 M
(b) 2.80 M
(c) 14.3 M
(d) 6.99 M
(e) 5.72 M

(28) When a 25.0 mL sample of HNO_3(aq) was titrated with 0.101 M NaOH(aq), the stoichiometric point was reached when 41.2 mL of the base had been added. What is the concentration of HNO_3(aq) in the sample?

(a) 0.166 M
(b) 0.00416 M
(c) 0.104 M
(d) 0.101 M
(e) 0.332 M

(29) What is the molarity of sodium ions in 4.57L of a 0.847 M Na_3P solution?

(a) 0.847
(b) 3.87
(c) 0.185
(d) 2.54
(e) 1.69

(30) Which one of the following is not an electrolyte?

(a) HCl
(b) Rb_2SO_4
(c) $C6H_{12}O_6$
(d) KOH
(e) HNO_3

(31) The balanced net ionic equation for the precipitation of $CaCO_3$ when aqueous solutions of Li_2CO_3 and $CaCl_2$ are mixed is

(a) $2\ Li^+(aq) + CO_3^{2-}(aq)$ ------> $Li_2CO_3(aq)$

(b) $2\ Li^+(aq) + 2\ Cl^-(aq) \text{ ------> } 2\ LiCl(aq)$
(c) $Li^+(aq) + Cl^-(aq) \text{ ------> } LiCl(aq)$
(d) $Ca^{2+}(aq) + CO_3^{2-}(aq) \text{ ------> } CaCO_3(s)$
(e) $Li_2CO_3(aq) + CaCl_2(aq) \text{ ------> } 2\ LiCl(aq) + CaCO_3(s)$

(32) One method for removal of metal ions from a solution is to convert the metal to its elemental form so it can be filtered out as a solid. Which metal can be used to remove aluminum ions from solution?

(a) zinc
(b) cobalt
(c) lead
(d) copper
(e) none of these

(33) What volume of 0.827 M KOH is required to completely neutralize 35.00 mL of a 0.737 M H_2SO_4 solution?

(a) 35.0 mL
(b) 1.12 mL
(c) 25.8 mL
(d) 62.4 mL
(e) 39.3 mL

(34) The point in a titration at which the indicator changes is called the

(a) equivalence point
(b) indicator point
(c) standard point
(d) end point
(e) volumetric point

Chapter 5: Energy Relationships in Chemistry: Thermochemistry

(35) Which one of the following conditions would always result in an increase in ΔE for a system?

(a) The system loses heat and does work on the surroundings
(b) The system gains heat and does work on the surroundings
(c) The system loses heat and has work done on it by the surroundings
(d) The system gains heat and has work done on it by the surroundings
(e) Cannot predict what happens because w and q are not state functions

(36) The value of $\Delta H°$ for the following reaction is –126 kJ.

$$2\ Na_2O_2(s) + 2\ H_2O(l) \text{ ------> } 4\ NaOH(s) + O_2(g)$$

Determine the amount of heat (in kJ) that would be evolved by the reaction of 25.0 g of Na_2O_2 with water.

(a) 20.2
(b) 40.4
(c) 67.5
(d) 80.8
(e) 126

(37) Which one of the following reactions has a negative value for ΔH°?

(a) $CO_2(s)$ ------> $CO_2(g)$
(b) $C(s) + O_2(g)$ ------> $CO_2(g)$
(c) $2H_2O(l)$ ------> $2\ H_2(g) + O_2(g)$
(d) $NH_3(l)$ ------> $2H_2(g) + N_2(g)$
(e) none have negative values for ΔH°

(38) The value of ΔH° for the following reaction is –482 kJ. Determine the amount of heat (in kJ) exchanged with the surroundings when 12.0 g of CO(g) completely reacts.

$2\ CO(g) + O_2(g)$ ------> $2\ CO_2(g)$

(a) 2.89×10^3
(b) 207
(c) 103
(d) 65.7
(e) 482

(39) What would ΔH° (in kJ) be for the formation of 75.0 g of Al_2O_3?

$2\ Al(s) + 3\ O_2(g)$ ------> $2\ Al_2O_3(s)$ ΔH° = -3351 kJ

(a) -2.51×10^5
(b) -1.26×10^5
(c) -2464
(d) -1232
(e) -3351

(40) What is the resulting temperature when 35 g of water at 75° C is mixed with 15g of water at 15° C? (Heat capacity of water is 4.184 J/g °C)

(a) 33° C
(b) 48° C
(c) 57° C
(d) 75° C
(e) 120° C

(41) Given the following thermochemical equations:

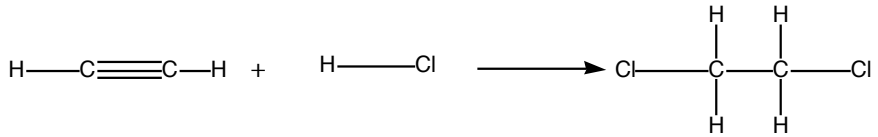
$$Fe_2O_3(s) + 3\ CO(g) \longrightarrow 2\ Fe(s) + 3\ CO_2(g) \qquad \Delta H° = -28.0\ kJ$$
$$3\ Fe(s) + 4\ CO_2(g) \longrightarrow 4\ CO(g) + Fe_3O_4(s) \qquad \Delta H° = +12.5\ kJ$$

What is the value of ΔH° for the reaction

$$3\ Fe_2O_3(s) + CO(g) \longrightarrow CO_2(g) + 2\ Fe_3O_4(s)$$

(a) –59.0 kJ
(b) +40.5 kJ
(c) –15.5 kJ
(d) –109.0 kJ
(e) -85 kJ

(42) Use the table of bond dissociation energies to calculate ΔH (in kJ) for the following gas-phase reaction (balance equation).



Bond	Dissociation Energy (in kJ/mol)
C-C	348
C=C	614
CCtriple bond	839
C-H	413
H-Cl	431
C-Cl	328

(a) -44
(b) 38
(c) -129
(d) 2134
(e) none of the above

(43) Use the information in the table to calculate ΔH° (in kJ) for the following reaction

$$4\ NH_3(g) + 5\ O_2(g) \text{ ------> } 4\ NO(g) + 6\ H_2O(l)$$

Substance	$\Delta H_f°$ (in kJ/mol)
$H_2O(l)$	-286
$NO(g)$	90
$NO_2(g)$	34
HNO_3	-207
$NH_3(g)$	-46

(a) -1172
(b) -150
(c) -1540
(d) -1892
(e) none of the above

(44) Use the information in the table to calculate $\Delta H°$ (in kJ) for the following reaction

$IF_5(g)$ ------> $IF_3(g) + F_2(g)$ $\Delta H° = ?$ kJ

$IF(g) + F_2(g)$ ------> $IF_3(g)$ $\Delta H° = -390$ kJ
$IF(g) + 2\,F_2(g)$ ------> $IF_5(g)$ $\Delta H° = -745$ kJ

(a) +355
(b) -1135
(c) +1135
(d) +35
(e) -35

(45) The heat capacity of copper metal is 0.38 J/g °C. Assume you had a 75 g cube of copper at 25° C. What would the final temperature of the copper be (in °C) if it absorbed 150 J of heat?

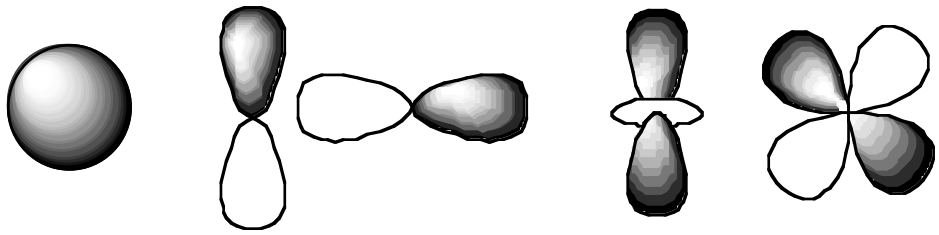
(a) 19.7
(b) 5.3
(c) 30.3
(d) 25.8
(e) 38.2

Chapter 6: Electron Structures of Atoms

(46) Each of the following statements describes the significance of a certain key experiment or idea. Which one is <u>not</u> correct?

(a) Planck's successful explanation of the black-body radiation spectrum introduced the hypothesis that radiation is emitted not continuously but in discrete quanta.
(b) Rutherford's experiment on the scattering of alpha particles showed that the mass of the nucleus is concentrated in a very small volume.
(c) The electron diffraction experiment demonstrated Heisenberg's hypothesis that matter and energy are interconvertable.
(d) The solution to the Schrodinger wave equation for the hydrogen atom does not provide a detailed description of the electron's position but only the probability of finding the electron in a given region of space.
(e) The phenomenon of radioactivity was discovered by Becquerel who observed that uranium salts emitted radiation that penetrated the black paper covering of photographic plates and darkened them as if they had been exposed to light.

(47) Which sketch represents an orbital that can have a azmuthal quantum number of 2?



(1) (2) (3) (4) (5)

(a) 1
(b) 2 and 4
(c) 4 and 5
(d) 2 and 3
(e) 2, 3, 4 and 5

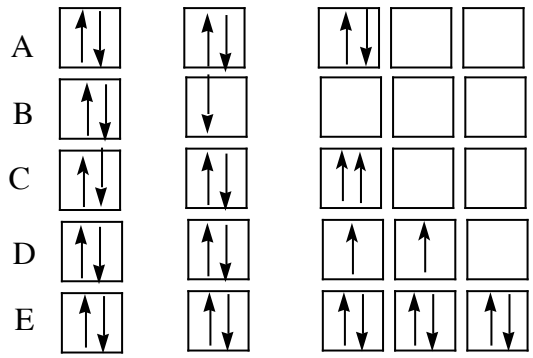
(48) Which of the following statements concerning the Bohr model of the hydrogen atom is <u>not</u> true?

(a) The theory successfully explained the observed emission and absorption spectra of the hydrogen atom.
(b) The theory requires that the greater the energy of the electron in the hydrogen atom, the greater its velocity.
(c) The theory requires that the energy of an electron in the hydrogen atom have only discrete values.
(d) The theory requires that the radii of the circular orbits of the electron have only discrete values.
(e) The theory requires that an electron move only between two discrete orbits.

(49) Which one of the following atoms has two unpaired electrons in the ground state?

(a) Na
(b) Ca
(c) P
(d) O
(e) Al

(50) Which orbital diagram represents a violation of Pauli principle?



(a) A
(b) B
(c) C
(d) D
(e) E

(51) Which of the following combinations of quantum numbers do <u>not</u> represent permissible solutions of the Schrodinger wave equation for the hydrogen atom?

	n	l	m_l	m_s
A.	9	8	-4	-1/2
B.	8	2	-2	-1/2
C.	6	6	-1	-1/2

(a) A
(b) B
(c) C
(d) B and C
(e) none of the above

(52) The places where the value of Ψ^2 is zero are called a(n)

(a) orbital
(b) orbit
(c) node
(d) wavefunction
(e) probability function

(53) Choose the electron configuration that corresponds to an excited state

(a) $[Ar]3d^3 4s^2$
(b) $[Ne]5s^1$
(c) $[Ar]3d^5 4s^1$
(d) $[Ar]3s^1 3p^6$
(e) $[Xe]4f^{14} 5d^{10} 6s^2$

(54) Which of the following transitions in the Bohr hydrogen atom model affords emission of the highest energy photon?

(a) $n_i = 1$ to $n_f = 6$
(b) $n_i = 6$ to $n_f = 1$
(c) $n_i = 6$ to $n_f = 3$
(d) $n_i = 3$ to $n_f = 6$
(e) $n_i = 4$ to $n_f = 1$

Chapter 7: Periodic Properties of the Elements

(55) The equation for the second ionization energy of clhorine is

(a) $Cl_2 + 2e^- \text{------>} 2Cl^-$
(b) $Cl(g) + e^- \text{------>} Cl^-(g)$
(c) $Cl(g) \text{---------->} Cl^+(g) + e^-$
(d) $2Cl^+(g) \text{---------->} Cl_2^+(g) + e^-$
(e) $Cl^{+1}(g) \text{---------->} Cl^{+2}(g) + e^-$

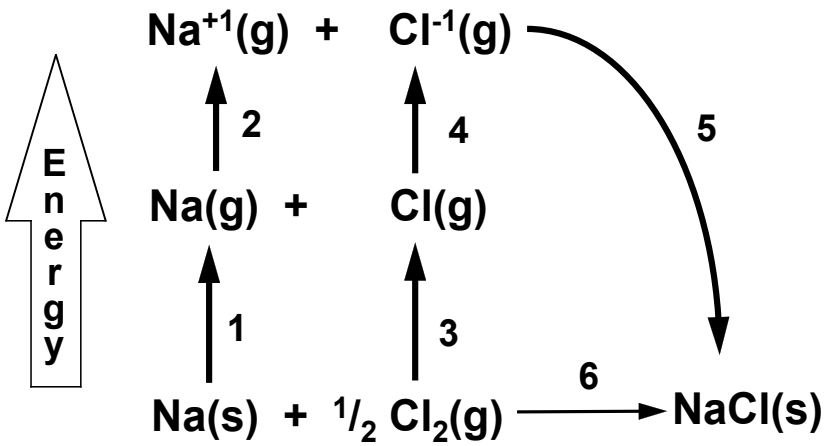
(56) Which of the following elements has the most exothermic electron affinity?

(a) S
(b) Cl
(c) Se
(d) Br
(e) B

(57) In which of the following series are the atoms arranged in order of decreasing first ionization energy?

(a) Sr > Ca > Mg
(b) Li > Be > B
(c) O > F > Ne
(d) Ne > Na > Mg
(e) Cl > Br > I

(58) Below is the Born-Haber cycle for the formation of sodium chloride. Which energy change corresponds to the heat of formation for NaCl?



(a) 1
(b) 2
(c) 4
(d) 5
(e) 6

Chapter 8: Basic Concepts of Chemical Bonding

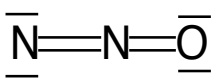
(59) A double bond is

(a) stronger and shorter than a triple bond
(b) weaker and longer than a single bond
(c) weaker and shorter than a triple bond
(d) stronger and longer than a single bond
(e) stronger and shorter than a single bond

(60) The oxidation number of nitrogen in BF_3 is

(a) +2
(b) -2
(c) +1
(d) -1
(e) +3

(61) For the Lewis structure, the formal charges on N, N, and O, respectively (from left to right in the structure) are



(a) -1, +2, -1
(b) -1, +1, 0

(c) 0, 0, 0
(d) 0, +1, -1
(e) -2, +2, 0

(62) Which chloride should exhibit the most covalent (least ionic) type of bonding?

(a) $AlCl_3$
(b) PCl_3
(c) KCl
(d) $MgCl_2$
(e) NaCl

(63) Which species has more than eight electrons around the central atom?

(a) BF_3
(b) BF_4^-
(c) BrF_3
(d) NF_3
(e) PF_3

Chapter 9: Molecular Geometry and Bonding Theories

(64) The electron-pair geometry (parent structure) and molecular geometry of bromine trifluoride are, respectively,

(a) trigonal planar, trigonal planar
(b) tetrahedral, trigonal pyramidal
(c) trigonal bipyramidal, T-shaped
(d) octahedral, trigonal planar
(e) trigonal bipyramidal, trigonal bipyramidal

(65) The approximate adjacent F-Xe-F bond angle in XeF_4 is

(a) 90°
(b) 109°
(c) 120°
(d) 180°
(e) 104.5°

(66) The TOTAL bonding in acetylene (C_2H_2) consists of

(a) one σ and one π bond
(b) two σ and one π bond
(c) two σ and two π bond
(d) three σ and two π bond
(e) three σ and no π bond

(67) Using molecular Orbital Theory, determine the bond order of the O_2 molecule

(a) 0
(b) 1
(c) 1.5
(d) 2
(e) 2.5

(68) Generally, a molecule in which the central atom is sp^3d^2 hybridized will have _____ electron-pair geometry

(a) octahedral
(b) linear
(c) trigonal planar
(d) trigonal bipyramidal
(e) tetrahedral

(69) The molecules shown below all have the general formula AB_3. Which of the following correctly identifies the molecular shape of the corresponding molecule?

	BCl_3	NH_3	ICl_3
(a)	T-shaped	trigonal planar	trigonal pyramidal
(b)	trigonal planar	trigonal pyramidal	T-shaped
(c)	trigonal pyramidal	trigonal planar	T-shaped
(d)	trigonal planar	trigonal planar	trigonal planar
(e)	T-shaped	trigonal pyramidal	trigonal planar

(70) A molecular orbital that is symmetrical for rotation about the internuclear axis is called

(a) a bonding orbital
(b) an anti-bonding orbital
(c) a pi orbital
(d) a sigma orbital
(e) a nonbonding orbital

(71) If a bond has a bond order of three, this means that

(a) the bond has exactly the same number of bonding electrons as antibonding electrons
(b) the bond has 3 more bonding electrons than it has antibonding electrons
(c) the bond has 3 more antibonding electrons than it has bonding electrons
(d) the bond must have considerable ionic character
(e) the bond has 6 more bonding electrons than it has antibonding electrons

Chapter 10: Gases

(72) When 2.34 L of air is released from an automobile tire at 37.5 psi (pounds per square inch), the volume it occupies at 14.7 psi is

(a) 0.427 L
(b) 0.917 L
(c) 2.34 L
(d) 5.97 L
(e) none of these

(73) In the following reaction, 81.2 mL of $O_2(g)$ were collected over water at 23° C and a barometric pressure of 751 torr. What is the mass of $Ag_2O_3(s)$ that was decomposed? (Vapor pressure of water at 23° C is 21.2 torr; molar mass Ag_2O = 231.7 g).

$2\ Ag_2O(s) \text{ ------> } 4\ Ag(s) + O_2(g)$

(a) 0.00321 g
(b) 0.00330 g
(c) 1.49 g
(d) 0.75 g
(e) none of these

(74) A gas sample containing 0.283 mol of O_2 and 0.942 mol of N_2 at –17.0° C fills a volume of 25.9 L at a pressure of

(a) 0.230 atm
(b) 0.765 atm
(c) 0.994 atm
(d) 1.13 atm
(e) none of these

(75) Cylinders of compressed gases are often filled by mass. Adding enough acetylene, C_2H_2, to a 385 L cylinder to increase the pressure by 18.5 atm at 21.3 ° C would increase the mass of the cylinder by

(a) 3.84 kg
(b) 7.67 kg
(c) 53.1 kg
(d) 106 kg
(e) none of these

Chapter 11: Intermolecular Forces, Liquids, and Solids

(76) One of the assumptions of the kinetic theory of gases is

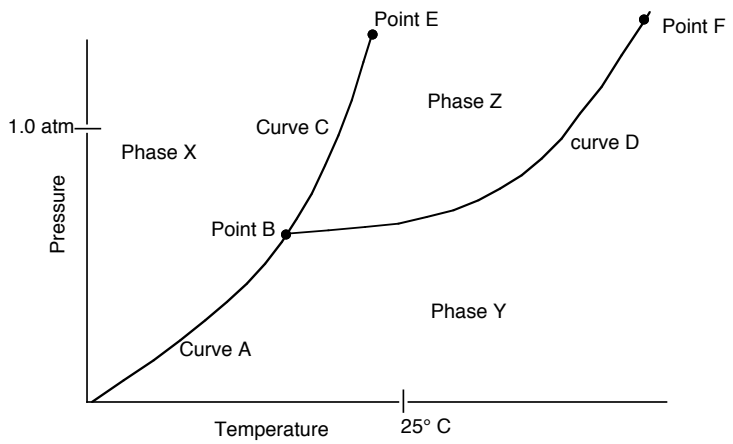
(a) Gas molecules move randomly at nearly fixed velocities.
(b) Gas molecules only exert forces when they move close to one another.
(c) Energy is lost only during collisions with the container.

(d) The average kinetic energy of an ideal gas depends only on the total mass of the molecules of the gas.
(e) None of these are assumptions of the kinetic theory of gases.

(77) The mean square speed of all of the molecules in a gas sample is dependent upon

(a) the number of gas molecules in the sample.
(b) the molecular mass of the gas molecules.
(c) the volume of the container.
(d) all of these.
(e) none of these.

(78) Using the phase diagram shown below, in which phase does this substance exist at room temperature and pressure?



(a) w
(b) x
(c) y
(d) z
(e) not enough information provided

Chapter 13: Properties of Solutions

(79) Which one of the following substances would be the most soluble in water?

(a) $CH_3CH_2CH_3$
(b) NH_3
(c) NaCl
(d) CCl_4
(e) benzene (C_6H_6)

(80) What is the freezing point (in ° C) of a solution prepared by dissolving 11.3 g of $Ca(NO_3)_2$ in 115 g of water? The molal freezing point depression constant for water is 1.86° C/m.

(a) -3.34
(b) -1.11
(c) 3.34
(d) 1.11
(e) 1.86

(81) Which theory best explains the following trend?

Element	**b.p. (K)**
He	4
Ne	25
Ar	95
Kr	125
Xe	170

(a) London dispersion forces
(b) Dipole-dipole interactions
(c) Hyrdogen bonding
(d) Le Chatelier's principle
(e) Ion-ion interactions

(82) Which of the species below would you expect to show the <u>least</u> hydrogen bonding?

(a) NH_3
(b) H_2O
(c) HF
(d) CH_4
(e) All would show the same level of hydrogen bonding

(83) Pure rubidium crystallizes in a body-centered cubic lattice; the edge of the unit cell is equal to 5.62 angstroms (1 angstrom = 1×10^{-8} cm). The density of rubidium is:

(a) $2 \times 85.5 \times 6.02 \times (5.62)^3 \times 10^{-1}$ g/cm^3
(b) $(4 \times 6.01) / (10 \times (5.62)^3)$ g/cm^3
(c) $(2 \times 85.5 \times 10) / (6.02 \times (5.62)^3)$ g/cm^3
(d) $(4 \times 85.5 \times 10) / (6.02 \times (5.62)^3)$ g/cm^3
(e) $(5 \times 85.5 \times 10) / (6.02 \times (5.62)^3)$ g/cm^3

(84) A liquid is in equilibrium with its vapor. If some of the vapor escapes, what is the immediate result?

(a) Vaporization rate decreases
(b) Condensation rate decreases
(c) Vaporization rate increases
(d) Condensation rate increases
(e) None of these is correct

(85) Which of the following is <u>not</u> a colligative property?

(a) freezing point depression
(b) boiling point elevation
(c) osmotic pressure
(d) solubility
(e) None of these

(86) A cucumber is placed in a concentrated salt solution. What will most likely happen?

(a) Water will flow from the cucumber to the solution.
(b) Water will flow from the solution to the cucumber.
(c) Salt will flow into the cucumber.
(d) Salt will precipitate out.
(e) No change will occur.

(87) When a nonvolatile solute is added to a volatile solvent, the solution vapor pressure _____ _____, the boiling point _____, the freezing point _____, and the osmotic pressure across a semipermeable membrane _____.

(a) decreases, increases, decreases, decreases.
(b) increases, increases, decreases, increases.
(c) increases, decreases, increases, decreases.
(d) decreases, decreases, increases, decreases.
(e) decreases, increases, decreases, increases.

EXAM KEY
HOURLY EXAM QUESTIONS
SUPA FALL 2001

1	A	31	D	61	B
2	E	32	E	62	B
3	A	33	D	63	C
4	B	34	D	64	C
5	D	35	D	65	A
6	C	36	A	66	D
7	B	37	B	67	E
8	B	38	C	68	A
9	B	39	D	69	B
10	B	40	C	70	D
11	E	41	A	71	E
12	E	42	C	72	D
13	E	43	A	73	C
14	B	44	A	74	C
15	B	45	C	75	B
16	B	46	C	76	E
17	B	47	D	77	B
18	A	48	B	78	D
19	D	49	D	79	C
20	D	50	C	80	B
21	B	51	C	81	A
22	B	52	C	82	D
23	B	53	D	83	C
24	E	54	B	84	B
25	D	55	E	85	D
26	C	56	B	86	A
27	E	57	E	87	E
28	A	58	E		
29	D	59	E		
30	C	60	E		

Chemistry 106: General Chemistry
Syracuse University Project Advance
Final Exam, Fall 2001

Name_____ ID No._____

Enter your name above and put your name and ID number in the appropriate places on the answer sheet with a No. 2 pencil (NO PENS!). Sign your name on the answer sheet. Choose the best answer to each question.

(1) A sample of matter, found in Australia, was identified as X and was found to consist of 98% silicon and 2% aluminum. Another sample of matter, also identified as X, was found in Texas and was determined to consist of 90% silicon and 10% aluminum. X is a(n)

(a) pure substance
(b) element
(c) mixture
(d) allotrope
(e) cannot determine

Answer: C

(2) The barometric pressue in the eye of a hurricane sometimes dips as low as 27.2 inches of mercury. How many millimeters of mercury is this (1 in. = 2.54 cm)?

(a) 1.1 mm
(b) 6.9 mm
(c) 691 mm
(d) 107 mm
(e) none of these

Answer: C

(3) Which of the following formulas is <u>incorrect</u> for the name given?

(a) potassium bromide	KBr
(b) magnesium phosphate	$Mg_3(PO_4)_2$
(c) sodium sulfate	Na_2SO_4
(d) tin(II) carbonate	$SnCO_3$
(e) iron(III) carbonate	$FeCO_3$

Answer: E

(4) ^{209}Bi has

(a) 209 protons, 126 neutrons, and 83 electrons
(b) 209 protons, 83 neutrons, and 83 electrons
(c) 83 protons, 126 neutrons, and 83 electrons
(d) 83 protons, 83 neutrons, and 83 electrons
(e) 209 protons, 209 neutrons, and 209 electrons

Answer: C

(5) Which one of the following is most likely to lose electrons when forming an ion?

(a) F
(b) P
(c) Rh
(d) S
(e) N

Answer: C

(6) Assume that a new element, SUPAium (SU), consists of three isotopes with the percent abundances and isotopic masses given below:

Isotope	**% Abundance**	**Mass (amu)**
^{151}SU	35.39	150.9377
^{152}SU	35.25	151.9791
^{157}SU	29.36	156.9332

What is the average atomic mass (in amu) of SUPAium?

(a) 153.34
(b) 151.50
(c) 153.07
(d) 153.90
(e) 154.50

Answer: C

(7) The coefficients required to correctly balance the reaction below are

$Al(NO_3)_3 + Na_2S \text{ ------> } Al_2S_3 + NaNO_3$

(a) 2,3,1,6
(b) 2,1,3,2
(c) 1,1,1,1
(d) 4,6,3,2
(e) none of these

Answer: A

(8) A compound with a molecular weight of 110.1 amu that contained only C, H, and O was analyzed by combustion. The combustion of a 5.19 g sample of the compound resulted in the formation of 12.4 g of carbon dioxide and 2.55 g of water. What is the molecular formula of this compound?

(a) $C_6H_6O_2$
(b) C_3H_3O
(c) CH_3O
(d) $C_2H_6O_5$
(e) CH_2O

Answer: A

(9) Calculate the number of grams of Al_2O_3 that could be produced if 2.5 g of aluminum and 2.5 g of oxygen were allowed to react according to the following balanced equation.

$4Al(s) + 3\ O_2(g) \text{ ------> } 2\ Al_2O_3(s)$

(a) 9.4
(b) 7.4
(c) 4.7
(d) 5.3
(e) 2.5

Answer: C

(10) What is the net ionic reaction for the reaction that occurs when aqueous nitric acid is added to aqueous sodium hydroxide?

(a) $H_3O^+(aq) + OH^-(aq) \text{ ------> } 2\ H_2O(l)$
(b) $HNO_3(aq) + NaOH(aq) \text{ ------> } Na^+(aq) + NO_3^-(aq) + H_2O(l)$
(c) $H_3O^+(aq) + NaOH(aq) \text{ ------> } 2\ H_2O(l) + NO_3^-(aq)$
(d) $HNO_3(aq) + OH^-(aq) \text{ ------> } H_2O(l) + Na^+(aq)$
(e) $2H_3O^+(aq) + NaOH(aq) \text{ ----> } 3H_2O(l) + Na^+(aq)$

Answer: A

(11) Aqueous HCl was added to neutralize 400.0 mL of 0.05250 M $Ba(OH)_2$. After the neutralization was complete the volume of the resulting solution was 450.0 mL. What concentrations of the ions are present in the solution?

(a) 0.05250 M Ba^{2+} and 0.1050 M Cl^-
(b) 0.04667 M Ba^{2+} and 0.09333 M Cl^-
(c) 0.05250 M Ba^{2+}, 0.1050 M Cl^-, 0.1050 M H_3O^+, and 0.1050 M Cl^-
(d) 0.4667 M Ba^{2+}, 0.09333 M Cl^-, 0.0933 M H_3O^+, and 0.09333 M Cl^-
(e) 0.04667 M Ba^{2+} and 0.09333 M OH^-

Answer: B

(12) Determine the number of liters of 0.250 M HNO_3 required to neutralize a solution prepared by dissolving 17.5 g of NaOH in 350 mL of solution.

(a) 50.0
(b) 0.44
(c) 1.75
(d) 0.070
(e) none of these

Answer: C

(13) The value of ΔH° for the following reaction is –126 kJ.

$$2\ Na_2O_2(s) + 2\ H_2O(l) \text{ ------> } 4\ NaOH(s) + O_2(g)$$

How much heat will be evolved when 2.00 moles of NaOH(s) are formed in the reaction?

(a) 252 J
(b) 63 J
(c) 3.9 J
(d) 7.8 J
(e) none of these

Answer: B

(14) A 1.96 g sample of titanium was burned in a bomb calorimeter that had a heat capacity if 9.84 kJ/°C. The temperature of the calorimeter increased from 36.84° C to 98.82° C. Calculate the amount of heat that would be released from the combustion of one mole of titanium.

(a) 62.0 kJ
(b) 610 kJ

(c) 1.49×10^4 kJ
(d) 311 kJ
(e) 1200 kJ

Answer: C

(15) The following reactions occur for the hypothetical element E:

$2\ E(l) + O_2(g) \text{ ------> } 2\ EO(g)$ $\Delta H° = -333$ kJ
$EO(g) + O_2(g) \text{ ------> } EO_3(s)$ $\Delta H° = -196$ kJ

What is the $\Delta H°$ in kJ for the reaction

$2E(l) + 3\ O_2(g) \text{ ------> } 2EO_3(s)$

(a) -526
(b) +526
(c) +725
(d) -725
(e) -137

Answer: D

(16) Use the information in the table to calculate $\Delta H°$ (in kJ) for the following reaction.

$IF_7(g) + I_2(g) \text{ ------> } IF_5(g) + 2\ IF(g)$

Substance	$\Delta H_f°$ in kJ/mol)
IF(g)	-95
$IF_5(g)$	-840
IF_7	-941

(a) 89
(b) 311
(c) -1991
(d) -89
(e) none of the above

Answer: D

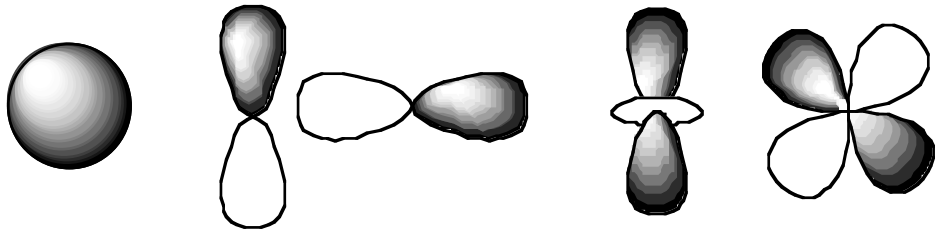
(17) The heat capacity of aluminum metal is 0.900 J/g °C. Assume you had a 0.5 Kg cube of copper at 25° C. What would the final temperature of the copper be (in °C) if it absorbed 250 J of heat?

(a) 19.7
(b) 5.3

(c) 30.3
(d) 25.6
(e) 38.2

Answer: D

(18) Which sketch represents an orbital that can have a azmuthal quantum number of 3?

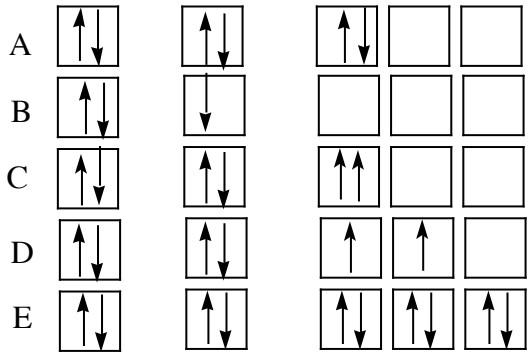


(1) (2) (3) (4) (5)

(a) 1
(b) 2 and 4
(c) 4 and 5
(d) 2 and 3
(e) 2, 3, 4 and 5

Answer: C

(19) Which orbital diagram represents a violation of Hund's rule?



(a) A
(b) B
(c) C
(d) D
(e) E

Answer: A

(20) Which of the following electron configurations is incorrect?

(a) Br $[Ar]5s^2 4d^{10} 5p^5$
(b) Ar $[Ne]3s^2 3p^6$
(c) Ge^{4+} $[Ar]3d^{10}$
(d) Zn^{2+} $[Ar]3d^{10}$
(e) All of the above are correct configurations

Answer: A

(21) Which quntum number defines the energy of an orbital

(a) spin
(b) magnetic
(c) principal
(d) azmuthal
(e) angular momentum

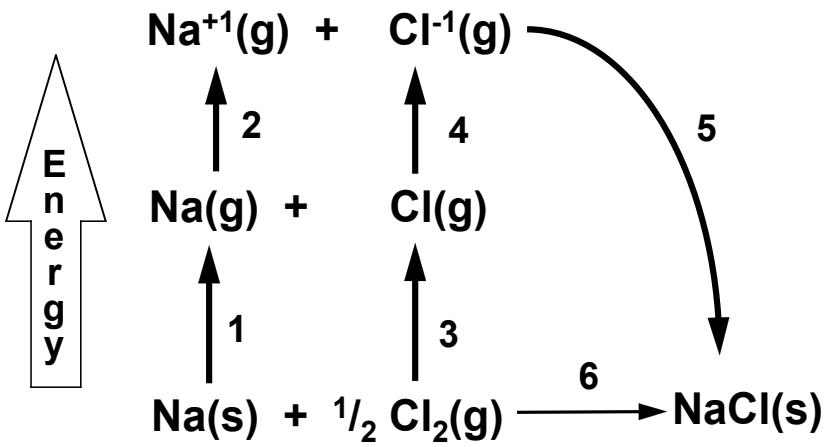
Answer: C

(22) Arrange the following species: K, Mg, Mg^{2+}, and Na in order of decreasing radii.

(a) $Mg^{2+} > Mg > Na > K$
(b) $K > Na > Mg^{2+} > Mg$
(c) $K > Mg > Na > Mg^{2+}$
(d) $K > Na > Mg > Mg^{2+}$
(e) None of the preceeding answers is correct

Answer: D

(23) Below is the Born-Haber cycle for the formation of sodium chloride. Which energy change corresponds to the heat of sublimation for sodium?



(a) 1
(b) 2

(c) 4
(d) 5
(e) 6

Answer: A

(24) The species below which violates the octet rule is

(a) SnF_4
(b) SiF_4
(c) CF_4
(d) SeF_4
(e) GeF_4

Answer: D

(25) For the ClF_4^+ ion, how many valence electrons should be shown in the Lewis structure?

(a) 32
(b) 33
(c) 34
(d) 35
(e) 36

Answer: C

(26) The shape of the xenon tetrafluoride, XeF_4, would be described as

(a) octahedral
(b) square planar
(c) square pyramidal
(d) tetrahedral
(e) trigonal bipyramidal

Answer: B

(27) What type of hybrid orbitals are used for bonding by Xe in the XeF_4 molecule?

(a) sp^2
(b) sp^3
(c) sp^4
(d) sp^3d
(e) sp^3d^2

Answer: E

(28) The electrons in a pi (π) bond which move over three or more atoms are said to be in

(a) bonding orbitals
(b) nonbonding orbitals
(c) delocalized orbitals
(d) hybrid orbitals
(e) resonance

Answer: C

(29) Which one of the following species is paramagnetic?

(a) N_2
(b) C_2^{2+}
(c) F_2
(d) B_2^+
(e) None of the above

Answer: D

(30) If 50 mL of hydrogen, H_2, and 37 mL of oxygen, O_2, at STP are exploded in a closed vessel, which gas remains and what volume of it measured at STP is left?

(a) 13 mL of H_2
(b) 25 mL of O_2
(c) 12 mL of H_2
(d) 12 mL of O_2
(e) 18.5 mL of O_2

Answer: D

(31) Automobile air bags use the decomposition of sodium azide, NaN_3, as their source of gas for rapid inflation:

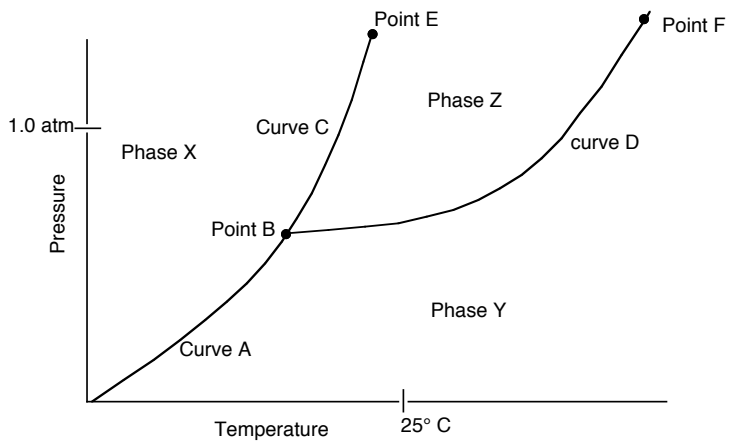
$$2\ NaN_3(s) \text{ ------> } 2\ Na(s) + 3\ N_2(g)$$

How many grams of NaN_3 are required to provide 40.0 L of N_2 at 25° C and 763 mm Hg?

(a) 71.1
(b) 1.64
(c) 1.09
(d) 160
(e) none of these

Answer: A

(32) Using the phase diagram shown below, identify the region that corresponds to the liquid phase.



(a) x
(b) y
(c) z
(d) point B
(e) not enough information provided

Answer: C

(33) Which one of the following substances would be the most soluble in water?

(a) $CH_3CH_2CH_3$
(b) KOH
(c) BF_3
(d) CBr_4
(e) toluene ($CH_3C_6H_6$)

Answer: B

(34) What type of unit cell contains one atom at the center of the cell and atoms at each corner?

(a) simple cubic
(b) body-centered cubic
(c) end-centered cubic
(d) face-centered cubic
(e) cubic close-packed

Answer: B

(35) Which liquid will have the <u>highest</u> boiling point?

(a) aqueous 0.050 M NaI
(b) aqueous 0 050 M glucose
(c) aqueous 0.050 M CoI_2
(d) aqueous 0.025 M AlI_3
(e) aqueous 0.030 M Na_3PO_4

Answer: E

Metal Activity Table
(easiest to oxidize at top)

Lithium
Potassium
Barium
Calcium
Sodium
Magnesium
Aluminum
Manganese
Zinc
Chromium
Iron
Cobalt
Nickel
Tin
Lead
HYDROGEN
Copper
Silver
Mercury
Platinum
Gold

Include Periodic Table

Final Exam
SUPA CHEM Fall 2001

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Chemistry 116: General Chemistry

Syracuse University Project Advance

Hourly Exams, Spring 2002

Name _____ ID No._____

Enter your name and ID number in the appropriate places on the answer sheet with a No. 2 pencil (NO PENS!). Sign your name on the answer sheet. Choose the best answer to each question.

Note To Instructors:

Choose from the Provided Pool of Questions

AND/OR

Substitute Your Own Questions as You See Appropriate

The last page of this examination should be a periodic table

[Gas constant = 0.00831 kJ/mol K; 1 faraday = 96.5 kJ/V mol e^-; Nernst eq. constant = 2.303*RT*/*F* = 0.0592 V mol (*T* = 25 ˚C) R = 8.31 x 10^{-3} kJ/molK]

Chapter 14. Chemical Kinetics

(1) In a kinetic study of the gas-phase reaction of nitric oxide (NO) with oxygen (O_2) to produce nitrogen dioxide (NO_2), the following data were obtained for the initial rates of disappearance of NO(g).

	Initial Concentrations		**Initial Rate of**
	NO	**O_2**	**Reaction of NO**
Exp. 1	0.0125 M	0.0253 M	0.0281 M/s
Exp. 2	0.0250 M	0.0253 M	0.112 M/s
Exp. 3	0.0125	0.0506 M	0.0561 M/s

The experimental rate law is:

(a) rate = $k[NO][O_2]$
(b) rate = $k[NO][O_2]^2$
(c) rate = $k[NO]^2[O_2]$
(d) rate = $k[NO]^2[O_2]^2$
(e) None of the above.

(2) In the reaction above [the gas-phase reaction of nitric oxide (NO) with oxygen (O_2) to produce nitrogen dioxide (NO_2)], how would the rate of the reaction be affected if the initial concentration of O_2 is doubled?

(a) The rate would stay the same.
(b) The rate would halve.
(c) The rate would double.
(d) The rate would increase by a factor of 4.
(e) None of the above.

(3) The main reason for the increase in reaction rates with increasing temperature is that:

(a) the activation energy (E_{act}) increases rapidly with temperature.
(b) typically, reaction rates double for an approximately 10° C rise in temperature.
(c) there is a dramatic increase in the collision frequency with temperature.
(d) the fraction of molecules with energy greater than E_{act} increases exponentially with temperature.
(e) the orientation factor is very strongly dependent on temperature.

(4) Using the Arrhenius equation, we can extract from the slope of a plot of log k vs 1/T the value of

(a) the activation energy.
(b) the first-order rate constant.
(c) the collision frequency.
(d) the activated complex.
(e) the orientation factor.

(5) The main role of the enzyme-substrate complex in catalyzing enzymatic reactions is

(a) to increase the collision frequency.
(b) to increase the orientation factor.
(c) to lower the activation energy.
(d) none of the above.
(e) all of the above.

(6) The experimental rate law for the reaction

$$I^-(aq) + ClO^-(aq) \xrightarrow{OH^-} IO^-(aq) + Cl^-(aq)$$

is rate = $k[I^-][ClO-][OH^-]^{-1}$. The overall reaction order for this reaction is:

(a) 0
(b) 1
(c) 2
(d) 3
(e) none of the above

(7) Which of the following is not a main variable that affects the rate of the gas-phase hydrogenation of ethylene in the presence of solid platinum:

$$C_2H_4(g) + O_2(g) \longrightarrow C_2H_6(g)$$

(a) temperature
(b) pressure of added argon
(c) concentration of reactants
(d) action of catalyst
(e) surface area of solid

(8) If you double the collision frequency, you double the rate constant of a reaction

(a) true
(b) false

(9) If you double the Activation energy, you decrease the rate constant by a factor of two.

(a) true
(b) false

(10) Transition-state theory:

(a) explains the temperature dependence of the rate constant as given by the Arrhenius equation.
(b) explains the molecular basis of the Activation energy as involving the formation of an activated complex.
(c) states that k = Zfp.
(d) predicts that exothermic reactions are more rapid than endothermic ones.
(e) none of the above.

(11) Sunlight produces chlorine and oxygen atoms:

Chlorofluorocarbons + light $\longrightarrow$ Cl(g) + organic residue
O_2 + light $\longrightarrow$ 2 O(g)

The following reactions then occur:

(1) $O_3(g) + Cl(g) \longrightarrow ClO(g) + O_2(g)$
(2) $ClO(g) + O(g) \longrightarrow Cl(g) + O_2(g)$

which can be written as the net chemical equation

(3) $O_3(g) + O(g) \longrightarrow 2\ O_2(g)$

Which of the following is a reaction intermediate?

(a) O_3
(b) Cl
(c) ClO
(d) O
(e) O_2

(12) Sunlight produces chlorine and oxygen atoms:

Chlorofluorocarbons + light --------> Cl(g) + organic residue
O_2 + light --------> 2 O(g)

The following reactions then occur:

(1) $O_3(g) + Cl(g) \longrightarrow ClO(g) + O_2(g)$
(2) $ClO(g) + O(g) \longrightarrow Cl(g) + O_2(g)$

which can be written as the net chemical equation

(3) $O_3(g) + O(g) \longrightarrow 2\ O_2(g)$

Which of the following is a catalyst?

(a) O_3
(b) Cl
(c) ClO
(d) O
(e) O_2

(13) Sunlight produces chlorine and oxygen atoms:

Chlorofluorocarbons + light --------> Cl(g) + organic residue
O_2 + light --------> 2 O(g)

The following reactions then occur:

(1) $O_3(g) + Cl(g) \longrightarrow ClO(g) + O_2(g)$
(2) $ClO(g) + O(g) \longrightarrow Cl(g) + O_2(g)$

which can be written as the net chemical equation

(3) $O_3(g) + O(g) \longrightarrow 2\ O_2(g)$

Which of the following is a reaction mechanism for the damaging of the ozone layer?

(a) reaction (1)
(b) reaction (2)
(c) reaction (3)
(d) reactions (1) and (2)
(e) reactions (2) and (3)

(14) Sunlight produces chlorine and oxygen atoms:

Chlorofluorocarbons + light --------> Cl(g) + organic residue
O_2 + light --------> 2 O(g)

The following reactions then occur:

(1) $O_3(g) + Cl(g) \longrightarrow ClO(g) + O_2(g)$
(2) $ClO(g) + O(g) \longrightarrow Cl(g) + O_2(g)$

which can be written as the net chemical equation

(3) $O_3(g) + O(g) \longrightarrow 2\ O_2(g)$

What is the molecularity of equation (2)?

(a) zero
(b) unimolecular
(c) bimolecular
(d) termolecular
(e) none of the above

(15) Cyclopropane is converted to its isomer propylene in a first-order reaction. The rate constant is $6.0 \times 10^{-4}\ s^{-1}$ at 500° C. If the initial concentration is 0.01 mol/L, it is desired to know the concentration after 1000 seconds. What is the equation needed to solve this problem?

(a) $(1 / [A]_t) - (1 / [A]_0) = kt$
(b) $(1 / [A]_0) - (1 / [A]_t) = kt$
(c) $\log ([A]_t / [A]_0) = -kt / 2.303$
(d) $\log ([A]_t / [A]_0) = -kt$
(e) $([A]_0 / [A]_t) = -kt / 2.303$

(16) NO reacts with bromine according to the following equation:

$$2\ NO(g) + Br_2(g) \text{ --------> } 2\ NOBr(g)$$

The following date were experimentally obtained for this reaction:

Experiment No.	Initial [NO]	Initial [Br_2]	Initial rate of NOBr formation
1	1.0 M	1.0 M	0.80 M/s
2	1.0 M	2.0 M	1.60 M/s
3	2.0 M	2.0 M	6.40 M/s

The overall reaction order for this reaction is:

(a) zero
(b) one
(c) two
(d) three
(e) none of the above

Chapter 15. Chemical Equilibrium

(17) Which of the following is **not** true about catalysts?

(a) A catalyst is a species that speeds up a reaction without itself being used up.
(b) A catalyst does not appear in any rate equation but may appear in the equilibrium constant expression.
(c) A catalyst may work by lining up reactants in an appropriate orientation.
(d) Enzymes are catalysts that typically speed up reactions by lowering their activation energy.
(e) A catalyst has no effect on the equilibrium composition of reactants and products.

(18) Consider the reaction $CO(g) + H_2O(g) \text{ <======> } CO_2(g) + H_2(g)$; $K_c = 3.92$ at 1200 K. If we start with 0.50 mol each of carbon monoxide and water in a 10.0 L reaction vessel, the number of moles of *carbon dioxide gas*, $CO_2(g)$, at equilibrium is:

(a) 0.33
(b) 0.67
(c) 0.80
(d) 0.20
(e) 0.60

(19) Which is the equilibrium constant expression for the dissociation of the weak acid HOCl?

(a) $K = [H^+][OCl^-]/[HOCl]$
(b) $K = [H^+][OCl^-]$
(c) $K = [HOCl]/[H^+][OCl^-]$
(d) $K = [H^+][O^{2-}][Cl^-]/[HOCl]$
(e) none of these

(20) The expression for the equilibrium constant K_c for the following equation is:

$$C(s) + 2\ N_2O(g) \Longleftrightarrow CO_2(g) + 2\ N_2(g)$$

(a) $[CO_2][N_2] / [C][N_2O]^2$
(b) $[CO_2][N_2]^2 / [N_2O]^2$
(c) $[C][N_2O]^2 / [N_2O]^2$
(d) $[N_2O]^2 / [CO_2][N_2]^2$
(e) $[CO_2][N_2] / [C][N_2O]$

(21) For the reaction,

$$CH_4(g) + 2\ H_2S(g) \Longleftrightarrow CS_2(g) + 4H_2(g)$$

the value of K_c is 3.59 at 900° C. Predict the direction of the reaction, given the following initial set of concentrations: $[CH_4] = 1.26$ M, $[H_2S] = 1.32$ M, $[CS_2] = 1.43$ M, $[H_2] = 1.00$ M.

(a) The reaction should proceed to the right (more products).
(b) The reaction should proceed to the left (more reactants).
(c) The reaction is already at equilibrium.
(d) Not enough information is provided to answer the question.

(22) Consider the reaction,

$$I_2(g) + Br_2(g) \Longleftrightarrow 2\ IBr(g) \quad \text{with } K_c = 121 \text{ at } 150° \text{ C.}$$

If 1.00 mol each of $I_2(g)$ and $Br_2(g)$ are initially placed in a 10.0 L reaction vessel, what is the number of moles of $Br_2(g)$ in the flask at equilibrium at 150° C.

(a) 0.22 mol
(b) 0.016 mol
(c) 1.22 mol
(d) 0.15 mol
(e) 1.15 mol

(23) Predict the direction of reaction when the pressure on an equilibrium mixture of $H_2(g)$, $Br_2(g)$, and HBr(g) is reduced.

$$H_2(g) + Br_2(g) \Longleftrightarrow 2\ HBr(g)$$

(a) reaction shifts to the right (more products)
(b) reaction shifts to the left (more reactants)
(c) reaction does not shift
(d) unable to determine from the data given

(24) Consider the reaction at equilibrium

$$2\ H_2O(g) \Longleftrightarrow 2\ H_2(g) + O_2(g) \qquad \Delta H = +484 \text{ kJ}$$

If we increase the temperature:

(a) the reaction shifts to the right (more products)
(b) the reaction shifts to the left (more reactants)
(c) the reaction is unaffected
(d) unable to determine from the data given

(25) Given the following equation:

$$CO_2(g) + C(s) \Longleftrightarrow 2\ CO(g) \qquad \text{with } K_c = 14.0 \text{ at } 800°\ C$$

The equilibrium constant expression for this equation is

(a) $[CO]^2 / [CO_2][C]$
(b) $[CO_2][C] / [CO]^2$
(c) $[CO]^2 / [CO_2]$
(d) $[CO_2] / [CO]^2$
(e) $[CO] / [CO_2]$

(26) Given the following equation:

$$CO_2(g) + C(s) \Longleftrightarrow 2\ CO(g) \qquad \text{with } K_c = 14.0 \text{ at } 800°\ C$$

Suppose you start with a mixture containing [CO] = 1.3 mol/L and $[CO_2]$ = 0.1 mol/L. In which direction will the reaction proceed to achieve equilibrium?

(a) toward more reactant
(b) toward more product
(c) the reaction is already at equilibrium
(d) can't determine from the data given

(27) Given the following equation:

$$CO_2(g) + C(s) \Longleftrightarrow 2\ CO(g) \qquad \text{with } K_c = 14.0 \text{ at } 800°\ C$$

Suppose the reaction is already at equilibrium. If we increase the pressure on the system

(a) the reaction shifts toward more reactant
(b) the reaction shifts toward more product
(c) the reaction is unaffected
(d) can't determine from the data given

(28) Given the following equation:

$$CO_2(g) + C(s) \Longleftrightarrow 2\ CO(g) \qquad \text{with } K_c = 14.0 \text{ at } 800°\ C$$

What is the equilibrium constant for the related reaction (below) at 800° C?

$$1/2\ CO_2(g) + 1/2\ C(s) \Longleftrightarrow CO(g)$$

(a) 196
(b) 0.0714
(c) 3.74
(d) 7.0
(e) 28.0

(29) Which one of the following does **not** correctly describe a reaction mixture in chemical equilibrium?

(a) dynamic equilibrium
(b) constant concentrations of reactants and products
(c) reaction is reversible
(d) atoms do not shift back and forth from reactants to products
(e) forward and reverse reactions occur at the same rate

(30) Consider the following reaction at equilibrium:

$$\underset{\text{pink}}{Co(H_2O)_6^{2+}(aq)} + 4\ Cl^-(aq) \Longleftrightarrow \underset{\text{blue}}{CoCl_4^{2-}(aq)} + 6\ H_2O(l) \quad \Delta H > 0$$

If we add additional chloride ions to the solution:

(a) the reaction shifts to the pink color
(b) the reaction shifts to the blue color
(c) the color is unaffected.
(d) not enough information is provided to answer the question

(31) Consider the gas-phase electrolysis of water, shown below:

$$2\ H_2O(g) \Longleftrightarrow 2\ H_2(g) + O_2(g) \qquad \Delta H = +484\ kJ$$

If we decrease the temperature

(a) the reaction shifts toward more reactant
(b) the reaction shifts toward more product
(c) the reaction is unaffected
(d) can't determine from the data given

Chapter 16. Acid-Base Equilibria

(32) A sample of vinegar has a hydronium ion concentration of 7.5×10^{-3} M. What is the pH of the vinegar?

(a) 7.50
(b) 6.50
(c) 3.00
(d) 3.88
(e) 2.12

(33) Which of the following is/are **not** a true statement?

(1) In the self-ionization of water, H_2O acts as both Bronsted-Lowrey acid and base.
(2) A solution whose pH is 8 is slightly acidic.
(3) A solution of 0.10 M NaOH at 25° C contains $[H_3O^+] = 1.0 \times 10^{-13}$ M.

(a) 1
(b) 2
(c) 3
(d) none of the above
(e) all of the above

(34) Which of the following is/are **not** a true statement?

(1) An aqueous solution of Na_2CO_3 is acidic.
(2) An aqueous solution of $Ca(CN)_2$ is basic.
(3) An aqueous solution of NH_4ClO_4 is acidic.

(a) 1
(b) 2
(c) 3
(d) 1 and 3
(e) 2 and 3

(35) What is the concentration of CN^- in a 0.1 M solution of the weak hydrocyanic acid (HCN) at 25° C? (K_a HCN = 4.9×10^{-10})

(a) 4.8×10^{-12} M
(b) 2.3×10^{-12} M
(c) 4.4×10^{-2} M
(d) 4.4×10^{-4} M
(e) 2.1×10^{-2} M

(36) Label in order, left to right, the Bronsted Lowery acids and bases in the following reaction:

$$NH_3 + HSO_4^- \Longleftrightarrow SO_4^{2-} + NH_4^+$$

(a) acid, base, base, acid
(b) base, acid, base, acid
(c) base, acid, acid, base
(d) acid, base, acid, base
(e) none of the above

(37) The pH of a 0.1 M NH_3 solution in water is approximately

(a) 1
(b) 3
(c) 7
(d) 11
(e) 14

(38) What is the concentration of OH^- in a 1.0 M solution of aniline, $C_6H_5NH_2$? ($k_b = 4.2 \times 10^{-10}$)

(a) 2.0×10^{-5} M
(b) 2.0×10^{-6} M
(c) 4.2×10^{-5} M
(d) 4.2×10^{-6} M
(e) none of the above

(39) An aqueous solution of the salt ammonium nitrate is

(a) neutral
(b) basic
(c) acidic
(d) acidic or basic depending on which ion hydrolyzes more
(e) none of the above

(40) All acidic aqueous solutions contain the ion

(a) H-
(b) NH_4^+
(c) Na^+
(d) OH^-
(e) H_3O^+

(41) The conjugate acid of water is

(a) OH^-
(b) H_3O^+
(c) H
(d) H_2
(e) O_2

(42) A compound which is an electron pair donor is generally classified as a

(a) Lewis base
(b) Lewis acid
(c) Bronsted base
(d) Bronsted acid
(e) none of the above

Chapter 17. Additional Aspects of Aqueous Equilibria

(43) Which of the following is/are **not** a true statement?

(1) If we add NaF at a concentration of 0.1 M NaF in the MgF_2 solution, the molar solubility of MgF_2 decreases.
(2) If we add $MgCl_2$ at a concentration of 0.1 M $MgCl_2$ in the MgF_2 solution, the molar solubility of MgF_2 decreases.
(3) If we add NaCl at a concentration of 0.1 M NaCl in the MgF_2 solution, the molar solubility of MgF_2 decreases.

(a) 1
(b) 2
(c) 3
(d) 1 and 2
(e) 1 and 3

(44) What is the solubility in mol/L of strontium sulfate, $SrSO_4$, in an aqueous solution of 0.50 M sodium sulfate, Na_2SO_4? (K_{sp} of $SrSO_4$ =2.5 x 10^{-7})

(a) 5.0 x 10^{-8} M
(b) 5.0 x 10^{-4} M
(c) 5.0 x 10^{-7} M
(d) 1.3 x 10^{-7} M
(e) none of the above

(45) Consider the titration of 25.0 mL of 0.723 M $HClO_4$ with 0.273 M KOH. Calculate the H_3O^+ concentration after addition of 10.0 mL of KOH.

(a) 0.439 M
(b) 1.00 x 10^{-7} M
(c) 0.723 M
(d) 2.81 x 10^{-13} M
(e) none of these

(46) Calculate the pH of a buffer solution containing 4.0 moles of NaH_2PO_4 and 6.0 moles of Na_2HPO_4. The K_a's for H_3PO_4 are 7.5 x 10^{-3}, 6.2 x 10^{-8}, and 2.2 x 10^{-13}.

(a) 7.38
(b) 4.67
(c) 6.62
(d) 7.03
(e) 4.85

(47) The solubility product for $Pb(OH)_2$ is 2.40 x 10^{-16}. What is the molar solubility of $Pb(OH)_2$ in pure water? (neglect hydrolysis)

(a) 1.55×10^{-8}
(b) 2.40×10^{-16}
(c) 6.2×10^{-6}
(d) 15.6
(e) 3.91×10^{-6}

Chapter 19. Chemical Thermodynamics

(48) Which of the following is/are **not** a true statement?

(1) For a spontaneous process, $\Delta S_{univ.} > 0$.
(2) For a spontaneous process at constant temperature, $\Delta S_{sys} > q/T$.
(3) For a spontaneous process at constant temperature and pressure, $(\Delta H - T\Delta S) > 0$.
(4) For a pure substance that is perfectly crystalline, the entropy at 0 K (absolute zero) is zero.

(a) 1
(b) 2
(c) 3
(d) 4
(e) all are true

(49) Predict the sign of $\Delta S°$, if possible, for the following reaction:

$$2\ NaHCO_3(s) \text{ ------> } Na_2CO_3(s) + 2\ H_2O(g)$$

(a) $\Delta S°$ is positive
(b) $\Delta S°$ is negative
(c) cannot predict the sign
(d) $\Delta S°$ is zero

(50) Given the following information; $\Delta H° = +170$ kJ (25°C) and $\Delta S° = +657$ J/K (25° C) for the following reaction:

$$Ba(OH)_2{\cdot}8H_2O(s) + 2\ NH_4NO_3(s) \text{ ------> } 2\ NH_3(g) + 10\ H_2O(l) + Ba(NO_3)_2(aq)$$

From the magnitude and sign of the calculated $\Delta G°$, you can deduce that:

(a) The reaction proceeds spontaneously from reactants to products.
(b) The reaction, as written, does not produce significant amounts of products.
(c) The reaction produces an equilibrium mixture with significant amounts of both reactants and products.

(51) Calculate $\Delta G°$ for the following reaction from the data given below:

$$SO_2(g) + 2\ H_2S(g) \text{ ------> } 3S(s) + 2H_2O(g)$$

	$\Delta G°f$ (kJ.mol)
$SO_2(g)$	-300.2
$H_2S(g)$	-33
$S(s)$	0
$H_2O(g)$	-228.6

From the magnitude and sign of $\Delta G°$ you can deduce that:

(a) The reaction proceeds spontaneously from reactants to products.
(b) The reaction, as written, does not produce significant anounts of product.
(c) The reaction produces an equilibrium mixture with significant amounts of both reactants and products.
(d) Not enough information is provided to answer the question.

(52) For a certain hypothetical reaction at 300 K, $\Delta H° = 100$ kJ/mol and $\Delta S° = 0.500$ kJ/K. Calculate $\Delta G°$ for this reaction.

(a) 250 kJ/mol
(b) 150 kJ/mol
(c) 50 kJ/mol
(d) –50 kJ/mol
(e) –250 kJ/mol

(53) In a spontaneous process, a certain system, held at the constant temperature 300 K, absorbs 30 J of heat energy. From your knowledge of the various statements of the second Law of Thermodynamics, which of the following is **the most accurate statement** you can make about ΔS_{sys} for this spontaneous process?

(a) $\Delta S_{sys} < -0.1$ J/K
(b) $\Delta S_{sys} > 0.1$ J/K
(c) $\Delta S_{sys} < -10$ J/K
(d) $\Delta S_{sys} > 10$ J/K
(e) n□□□□□□□□□□□□□□□□□□□□

(54) Which of the following statements **best** applies to a **very highly insoluble** ionic solid?

(a) The standard entropy ($\Delta S°$) of solution is very negative
(b) The lattice energy of the ionic solid is very large compared with the energy of hydration of its ions in aqueous solution.
(c) The standard enthalpy ($\Delta H°$) of solution is very negative.
(d) The standard free energy ($\Delta G°$) of solution is very negative
(e) None are correct

Chapter 20. Electrochemistry

(55) How many electrons are involved in the following reaction?

$Cl_2 + 2\ Br^- \text{-------->} 2\ Cl^- + Br_2$

(a) 6
(b) 2
(c) 1
(d) 4
(e) 3

(56) Electrolysis of neutral water produces at the cathode:

(a) OH^-
(b) H_2O_2
(c) O_2
(d) O_3
(e) H^+

(57) Use the following standard reduction potentials in V:

I_2 ------> I^-	+0.54
Br_2 ------> Br^-	+1.07
H^+ ------> H_2	0.00
Cu^{2+} ------> Cu	+0.34
Ni^{2+} ------> Ni	-0.28

Which one of the following species could be used to oxidize Br^- to Br_2?

(a) Br_2
(b) H^+
(c) Cu^{2+}
(d) Ni^{2+}
(e) none of the above

(58) Lithium is produced by the electrolysis of lithium chloride as follows:

$2\ LiCl(l) \text{-------->} 2\ Li(l) + Cl_2(g)$

During passage of a certain current for 45 minutes, 169 gram of Li were produced. How many liters of Cl_2 (measured at STP) were produced concurrently?

(a) (169)(22.4) / (70.9)
(b) (45)(60)(169) / (2)(96,5000)
(c) (169)(22.4) / (6.94)(2)
(d) (45)(60)(22.4) / (96,500)
(e) (169)(70.9) / (6.94)

(59) When the equation for the following reaction in basic solution is balanced, what is the sum of the coefficients?

$MnO_4^-(aq) + CN^-(aq) \text{ ------> } MnO_2(s) + CNO^-(aq)$

(a) 13
(b) 8
(c) 10
(d) 20
(e) 11

(60) Calculate the voltage of a cell in which the following reaction occurs:

$Zn(s) + 2H^+(aq, 0.001\ M) \text{ ------> } Zn^{2+}(aq, 1\ M) + H_2(g, 1\ atm)$

The standard reduction potential for zinc is:

$Zn^{2+} + 2\ e^- \text{ <======> } Zn \qquad E° = -0.763$

(a) +0.73 V
(b) +0.41 V
(c) +0.58 V
(d) +0.70 V
(e) –0.41 V

Chapter 21. Nuclear Chemistry

(61) The radioactive decay of carbon-14 is a first-order reaction with a half-life of 5,715 years. How long will it take for the carbon-14 in an archeological sample to decrease to 50% of its original concentration (radioactivity level)?

(a) 22860 years
(b) 11430 years
(c) 5715 years
(d) 2858 years
(e) 1429 years

(62) Choose the **incorrect** statement concerning gamma rays:

(a) They have no mass.
(b) They have no charge.
(c) They have no energy.
(d) They are emitted by nuclei.
(e) They move with the velocity of light.

(63) The atomic mass of $^{100}Ru_{44}$ is 99.9030. Accordingly, which statement is **incorrect**?

(a) There are 100 massive particles in a nucleus of this isotope.
(b) There are 56 neutrons in this isotope.
(c) The mass number is 100.
(d) This nucleus is stable with respect to the equivalent number of free neutrons and protons.
(e) The nuclear stabilization energy is equivalent to a mass of 100.00 – 99.903 = 0.097 amu

(64) The transuranium element neptunium can be prepared by bombardment of ^{238}U with high energy particles. The reaction is

$$^{238}U_{92} + \text{high energy particle} \text{ -------->} ^{238}Np_{93} + 2\ ^{1}n_{0}$$

What high energy particle is necessary to balance this reaction?

(a) $^{1}H_{1}$
(b) $^{2}H_{1}$
(c) $^{4}He_{2}$
(d) $^{0}e_{1-}$
(e) $^{1}e_{1}$

(65) The nuclear equation:

$$^{14}N_{7} + ^{1}n_{0} \text{ -------->} ^{14}C_{6} + ?$$

can be balanced by adding to the right side

(a) one proton
(b) one gamma
(c) one positron
(d) one electron
(e) one alpha

(66) A piece of steel pipe came out of a nuclear reactor with 1000 curies of ^{59}Fe activity, which has a half-life of 45 days. Calculate how long it will be before the ^{59}Fe activity falls to the level of 10 curies.

(a) 12 1/3 years
(b) 6 years, 2 months
(c) 299 days
(d) 90 days
(e) 45 days

(67) What is the approximate age of an artifact found by an archeologist which has a specific activity due to carbon-14 of 4.14 counts per minute per gram of carbon? [Assume that living matter on the earth had an activity of 15.3 counts per minute per gram of carbon. The half-life of carbon-14 is 5560 years.]

(a) 4590 years

(b) 24300 years
(c) 9480 years
(d) 10600 years
(e) 22600 years

(68) Calculate the amount of energy in MeV liberated in the following nuclear fission reaction, given the information below;

$$^{235}U + \text{neutron} \text{ -------> } ^{88}Kr + ^{144}Ba + 4 \text{ neutrons}$$

conversion factor for $e = mc^2$ is 931 MeV/amu and
mass of neutron = 1.01 amu
mass of ^{235}U = 235.04
mass of ^{88}Kr = 87.91
mass of ^{144}Ba = 143.91

(a) 3.46×10^{-1}
(b) 6.76×10^{4}
(c) 177
(d) 763
(e) 1.77×10^{3}

(69) The radioactive decay of carbon-14 is a first-order reaction with a half-life of 5715 years. How long will it take for the carbon-14 in an archeological sample to decrease to 25% of its original concentration (radioactivity level)?

(a) 1429 years
(b) 2858 years
(c) 5715 years
(d) 11430 years
(e) 22860 years

Chapter 22. Chemistry of the Nonmetals

(70) Which of the following is the correct formula for calcium chlorate?

(a) $CaClO_2$
(b) $CaCO_3$
(c) CCl_4
(d) $Ca(ClO_3)_2$
(e) $CaCl_2$

(71) Bromine can be prepared by

(a) oxidizing Br^- by I_2
(b) reducing I_2 by Br^-
(c) oxidizing Br by Cl_2

(d) reducing Br^- by Cl^-
(e) oxidizing OBr^- by Cl^-

(72) Criticize the logic of the following:

The boiling points of H_2O and HF are higher than the boiling points of other hydrogen compounds of elements in groups VI (16) and VII (17) because of extensive hydrogen bonding in the liquid states of H_2O and HF

(a) Both statement and reason are true and logically related.
(b) Both statement and reason are true but not logically related.
(c) Statement is true but the reason is false.
(d) Statement is false but the reason is true.
(e) Neither statement nor reason is true.

(73) Which one of the following substances will react with oxygen upon exposure to air at room temperature?

(a) silver
(b) argon
(c) yellow phosphorus
(d) chlorine
(e) graphite (a form of carbon)

(74) Some of the differences between oxygen (O_2) and ozone (O_3) are given below. Which is wrong?

	Oxygen	Ozone
(a)	diamagnetic (i.e., not magnetic)	paramagnetic
(b)	less dense at STP	more dense at STP
(c)	standard heat of formation is zero	strd. heat of formation is positive
(d)	zero dipole moment	small dipole moment
(e)	absorbs far ultraviolet only (longer wavelength)	absorbs near ultraviolet (short wave)

(75) Which of the following forms a superoxide upon burning in air?

(a) Li
(b) Na
(c) K
(d) Be
(e) Mg

(76) Which of the following oxides of nitrogen is known to dimerize readily?

(a) N_2O
(b) NO
(c) N_2O_3
(d) NO_2

(e) N_2O_5

(77) Which of the following nitrogen compounds is used as the active ingredient in air bags for automobile front seats?

(a) NO
(b) NO_2
(c) NH_3
(d) NaN_3
(e) K_3N

(78) Boron nitride is isoelectronic with, and closely resembles in structure:

(a) black phosphorus
(b) white phosphorus
(c) graphite
(d) antimony trichloride
(e) calcium carbide

(79) Hydrolysis of PCl_3 results in:

(a) an acid and a base
(b) an acid and a non-reactive by-product
(c) a base and a non-reactive by-product
(d) two acids
(e) two bases

(80) How does the electrical conductivity of a doped semiconductor differ from that of a metal?

(a) only negative carriers are possible; a metal may have either.
(b) only positive carriers are possible; a metal must have negative carriers.
(c) much less conductivity than a metal.
(d) increases with increasing temperature, contrary to metal behavior.
(e) improves as doping decreases; a metal is not affected by impurities.

(81) If a tiny amount of aluminum is added to very pure silicon, its electrical conductivity will

(a) increase due to the metallic nature of aluminum
(b) increase due to the donation of electrons by aluminum
(c) increase due to the donation of holes by aluminum
(d) decrease due to crystal dislocations
(e) decrease due to capture of conduction electrons by the aluminum atoms

(82) Which of the elements in group IV (14) is never found as the central atom in an octahedral structure?

(a) C
(b) Si

(c) Ge
(d) Sn
(e) Pb

(83) The process which returns carbon from the oxidized state in air to the reduced state on earth is:

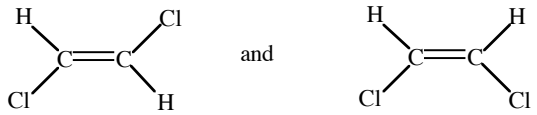
(a) respiration by animals and plants
(b) photosynthesis
(c) dissolving in rain water and reaction with limestone
(d) reaction with sulfur and H_2S from volcanoes and other natural ground sources
(e) biosynthesis by microorganisms in the roots of certain plants (legumes)

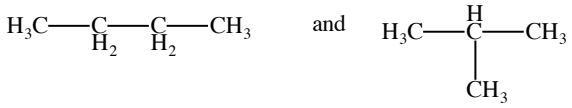
(84) The geometric figure formed by boron atoms in crystals of the pure element has

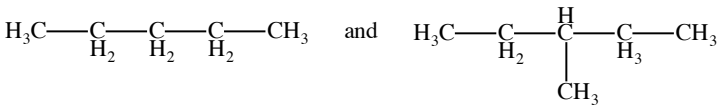
(a) 3 corners
(b) 4 corners
(c) 6 corners
(d) 8 corners
(e) 12 corners

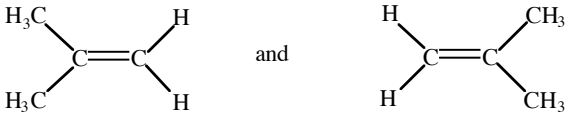
Chapter 26. The Chemistry of Life: Organic and Biological Chemistry

(85) Which of the following is/are neither structural or geometrical isomers

(1) 

(2) 

(3) 

(4) 

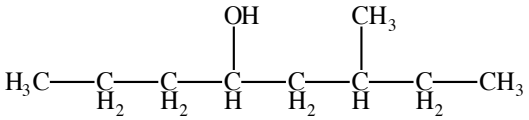
(a) 1
(b) 2
(c) 3
(d) 4

(e) 3 and 4

(86) Which of the following compounds contains carbon atoms with sp^2 hybrid atomic orbitals?

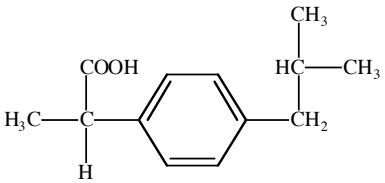
(a) propyne
(b) propene
(c) propane
(d) propanol
(e) none of the above

(87) Give the IUPAC name for the following compound:



(a) 3-ethyl-1-propylbutanol
(b) 5-octanol
(c) 6-methyl-4-octanol
(d) 1-propyl-1-pentanol
(e) 4-monanol

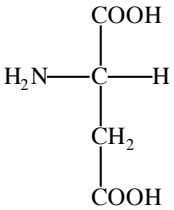
(88) The molecule shown below contains:



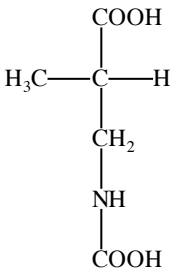
(a) no chiral centers
(b) one chiral center
(c) two chiral centers
(d) three chiral centers
(e) four chiral centers

(89) Which of the following molecules is **not** an amino acid?

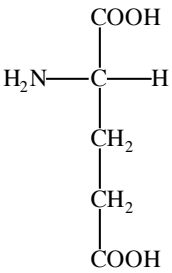
(1)



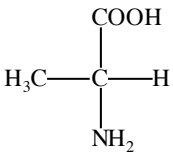
(2)



(3)



(4)



(a) 4
(b) 3
(c) 2
(d) 1
(e) All are amino acids.

(90) For a series of straight-chain alkane hydrocarbon molecules, the higher the molecular weight,

(a) the higher the vapor pressure at room temperature
(b) the more hydrogen bonding is involved
(c) the lower the heat of vaporization
(d) the higher the boiling point
(e) none are correct

(91) For which of the following molecules does hydrogen bonding **not** play an important role as an attractive intermolecular force?

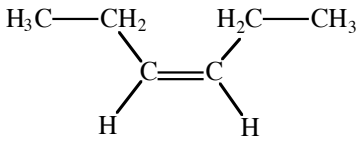
(a) proteins
(b) DNA
(c) HF(l)
(d) NH_3(l)
(e) all participate in hydrogen bonding

(92) Arrange the following three substances in order of increasing solubility in hexane (C_6H_{14}):

A	CH_2OHCH_2OH
B	$C_{10}H_{22}$
C	H_2O

(a) ABC
(b) ACB
(c) CAB
(d) BCA
(e) BAC

(93) The IUPAC name for the compound shown below is:



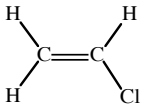
(a) *cis*-3-hexene
(b) *trans*-3-hexene
(c) *trans*-3-hexyne
(d) *cis*-3-hexyne
(e) none of the above

(94) Which of the following is **not** a correct statement?

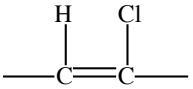
(a) Dimethylacetylene, CH_3CCCH_3, contains sp^3 and sp hybridized carbon atoms.
(b) The IUPAC name for the following compound is 2-ethylpentane,
$(CH_3CH_2)_2CH_2CH_2CH_2CH_3$.
(c) $CH_3CH_2CH_2CH_2CH_2COOH$ is a saturated carboxylic acid.
(d) The *cis-trans* isomerization of 11-retinal is involved in human vision.
(e) All are correct statements.

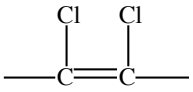
Chapter 12. Materials Chemistry and Polymers

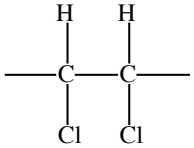
(95) The monomer unit for polyvinylchloride (PVC), used in pipes for plumbing, is vinyl chloride.

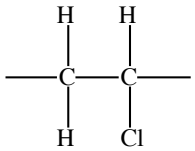


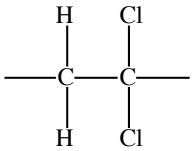
What is the formula for the repeating unit of this polymer?

(a) 

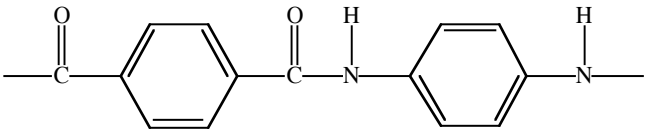
(b) 

(c) 

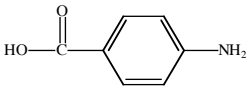
(d) 

(e) 

(96) The polymer Kevlar, which is used in bullet-proof vests, has the repeating unit shown below:



Which of the following is **not** a correct statement?

(1) Kevlar is a condensation polymer.
(2) Kevlar is a co-polymer.
(3) The monomer unit for Kevlar is 

(a) 3
(b) 2

(c) 1
(d) All are correct
(e) None are corret.

(97) Another textbook suggests that were a polyethylene molecule as wide as a piece of spaghetti, it would be about half a mile in length. If the spaghetti is 1 mm in width, calculate the ratio of the length to the width of a polyethylene molecule. (There are 5,280 feet in one mile and 2.54 cm per inch)

(a) 800/1
(b) 8,000/1
(c) 80,000/1
(d) 800,000/1
(e) 8,000,000/1

EXAM KEY
HOURLY EXAM QUESTIONS
SUPA FALL 2002

1	C	34	A	67	D
2	C	35	D	68	C
3	D	36	B	69	D
4	A	37	D	70	D
5	C	38	A	71	C
6	B	39	C	72	A
7	B	40	E	73	C
8	A	41	B	74	A
9	B	42	A	75	C
10	B	43	C	76	D
11	C	44	C	77	D
12	B	45	A	78	C
13	D	46	A	79	D
14	C	47	E	80	C
15	C	48	C	81	C
16	D	49	A	82	A
17	B	50	A	83	B
18	A	51	A	84	E
19	A	52	D	85	E
20	B	53	B	86	B
21	A	54	B	87	C
22	D	55	B	88	B
23	C	56	A	89	C
24	A	57	E	90	D
25	C	58	C	91	E
26	A	59	A	92	C
27	A	60	C	93	A
28	C	61	C	94	B
29	D	62	C	95	D
30	B	63	E	96	A
31	A	64	B	97	D
32	E	65	A		
33	B	66	C		

Chemistry 116: General Chemistry

Syracuse University Project Advance
Final Exam, Spring 2002

Spring Semester Covers Chapters 14 thru 26 (excluding 18 and 23-25)

Name_____ ID No._____

Enter your name and ID number in the appropriate places on the answer sheet with a No. 2 pencil (NO PENS!). Sign your name on the answer sheet. Choose the best answer to each question.

The last page of this examination should be a periodic table

[Gas constant = 0.00831 kJ/mol K; 1 faraday = 96.5 kJ/V mol e^-; Nernst eq. constant = 2.303*RT*/*F* = 0.0592 V mol (*T* = 25 °C).]

Chemical Kinetics

(1) The following is a possible two-step mechanism for a reaction involving hydrogen peroxide in aqueous solution; only a small amount of sodium bromide was added to the reaction mixture.

$$H_2O_2 + Br^- \text{------>} BrO^- + H_2O \qquad (1)$$
$$H_2O_2 + BrO^- \text{------>} Br^- + H_2O + O_2 \qquad (2)$$

List in order: the catalyst, the reaction intermediate, the molecularity of the elementary reaction (2).

(a) Br^-, BrO^-, 3
(b) Br^-, BrO^-, 2
(c) BrO^-, Br^-, 3
(d) BrO^-, Br^-, 2
(e) none of the above

(2) NO reacts with bromine according to the following equation:

$$2\ NO(g) + Br_2(g) \text{-------->} 2\ NOBr(g)$$

The following date were experimentally obtained for this reaction:

Experiment No.	Initial [NO]	Initial [Br_2]	Initial rate of NOBr formation
1	1.0 M	1.0 M	0.80 M/s
2	1.0 M	2.0 M	1.60 M/s

3	2.0 M	2.0 M	6.40 M/s

Determine the rate expression for this reaction.

(a) rate = $k[NO][Br_2]$
(b) rate = $k[NO]^2[Br_2]$
(c) rate = $k[NO][Br_2]^2$
(d) rate = $k[NO]^2[Br_2]^2$
(e) none of the above

(3) Which of the following is/are **not** true about catalysts?

(1) A catalyst is a species that speeds up a reaction without itself being used up.
(2) A catalyst has no effect on the equilibrium composition of reactants and products.
(3) A catalyst may work by lining up reactants in an appropriate orientation.
(4) Enzymes are catalysts that typically speed up reactions by lowering their activation energy.
(5) A catalyst does not appear in any rate equation but may appear in the equilibrium constant expression.

(a) 1
(b) 3
(c) 4
(d) 5
(e) 2 and 5

(4) Sunlight produces chlorine and oxygen atoms:

Chlorofluorocarbons + light --------> Cl(g) + organic residue
O_2 + light --------> 2 O(g)

The following reactions then occur:

(1) $O_3(g) + Cl(g) \longrightarrow ClO(g) + O_2(g)$
(2) $ClO(g) + O(g) \longrightarrow Cl(g) + O_2(g)$

which can be written as the net chemical equation

(4) $O_3(g) + O(g) \longrightarrow 2\ O_2(g)$

According to the above equations, which of the following is a correct expression for the overall rate of depletion of ozone?

(a) $-\Delta[O_3] / \Delta t = k[O_3][Cl]$
(b) $-\Delta[O_3] / \Delta t = k[O_3][O]$
(c) cannot be determined without additional experimental data
(d) $-\Delta[O_3] / \Delta t = k[ClO][O]$
(e) $-\Delta[O_3] / \Delta t = k[O_2][O]$

Chemical Equilibrium

(5) Suppose the reaction 2 CO(g) <======> CO_2(g) + C(s) is already at equilibrium. If we increased the pressure on the system

(a) the reaction shifts to the left (more reactants)
(b) the reaction shifts to the right (more products)
(c) the reaction is unaffected.

(6) Methanol is manufactured using the reaction

$$CO(g) + 2\ H_2(g) \Longleftrightarrow CH_3OH(g)$$

A 1.50 L vessel was filled with 0.150 mol CO and 0.300 mol H_2. When this mixture came to equilibrium at 500 K, the vessel contained 0.119 mol of CO. How many moles of CH_3OH were in this vessel?

(a) 0.191 mol
(b) 0.237 mol
(c) 0.119 mol
(d) 0.269 mol
(e) 0.031 mol

(7) Given the following equation:

$$CO_2(g) + C(s) \Longleftrightarrow 2\ CO(g) \qquad \text{with } K_c = 14.0 \text{ at } 800°\ C$$

The equilibrium constant at 800° C

(a) greatly favors reactants
(b) greatly favors products
(c) greatly favors neither
(d) can't determine from the given data

(8) Consider the gas-phase electrolysis of water, shown below:

$$2\ H_2O(g) \Longleftrightarrow 2\ H_2(g) + O_2(g)$$

When 1.00 mol of H_2O(g) is placed in a 10.00 L reaction vessel and allowed to come to equilibrium, 0.0500 mol of O_2(g) were measured in the equilibrium mixture. How many moles of H_2O and H_2 are found in the equilibrium mixture?

(a) 2.00 mole H_2O and 2.0 mol H_2
(b) 0.0500 mole H_2O and 0.0500 mol H_2
(c) 0.900 mole H_2O and 0.100 mol H_2
(d) 0.950 mole H_2O and 0.0500 mol H_2
(e) none of the above

Acid-Base Equilibria

(9) Which of the following is/are **not** a true statement?

(1) NH_3 is a base according to the Arrhenius, Bronsted-Lowrey and Lewis Concepts of acids and bases.
(2) The Bronsted-Lowrey conjugate acid to OH^- (regarded as base) is H_2O.
(3) In the following reaction: $HPO_4^{2-} + NH_4^+ <=====> H_2PO_4^- + NH_3$, $H_2PO_4^-$ is a Bronsted-Lowrey base.
(4) In the following reaction: $Cr^{3+} + 6\ H_2O <=====> Cr(H_2O)_6^{3+}$, Cr^{3+} acts as a Lewis acid.

(a) 1 and 4
(b) 2
(c) 2 and 3
(d) 1 and 3
(e) 3

(10) What is the concentration of H_3O^+ in a solution of 0.075 M KOH at 25° C?

(a) 0.075 M
(b) 0.150 M
(c) 1.33×10^{-13} M
(d) 6.66×10^{-14} M
(e) none of the above

(11) In each pair below, except one, the stronger acid is written first. Which is wrong?

(a) HCl and H_2S
(b) HBr and HCN
(c) H_2SO_4 and $HC_2H_3O_2$
(d) H_2O and NH_3
(e) HCOOH and HNO_3

Additional Aspects of Aqueous Equilibria

(12) What is the minimum concentration of Mg^{2+} that is needed to begin the formation of a precipitate of $Mg(OH)_2$ in a aqueous solution of pH = 10.0? (K_{sp} of $Mg(OH)_2 = 6 \times 10^{-12}$).

(a) 3×10^{-8} M
(b) 3×10^{-4} M
(c) 1.5×10^{-4} M
(d) 6×10^{-8} M
(e) 6×10^{-4} M

(13) Which of the following mixtures is a buffer solution?

(a) 10 mL of 1 M NaOH + 10 mL of 1 M HCl
(b) 10 mL of 1 M NaOH + 10 mL of 1 M NaCl
(c) 10 mL of 1 M NaOH + 10 mL of 1 M CH_3COONa
(d) 10 mL of 1 M NaOH + 10 mL of 1 M CH_3COOH
(e) 10 mL of 1 M NaOH + 20 mL of 1 M CH_3COOH

(14) What is the solubility of $PbCrO_4$ in a 1.15 M solution of Na_2CrO_4? [Ksp = 1.80×10^{-14}, neglect hydrolysis]

(a) 1.80×10^{-14} molar
(b) 1.34×10^{-7} molar
(c) 1.56×10^{-14} molar
(d) 1.25×10^{-7} molar
(e) 1.15 molar

Chemical Thermodynamics

(15) Given the following information; $\Delta H° = +170$ kJ (25°C) and $\Delta S° = +657$ J/K (25° C) for the following reaction:

$$Ba(OH)_2 \cdot 8H_2O(s) + 2\ NH_4NO_3(s) \text{ ------> } 2\ NH_3(g) + 10\ H_2O(l) + Ba(NO_3)_2(aq)$$

Calculate $\Delta G°$ at 25° C.

(a) –487 kJ
(b) +487 kJ
(c) –25.4 kJ
(d) +25.4 kJ
(e) +154 kJ

(16) Predict the sign of $\Delta S°$, if possible, for the following reaction:

$$C_2H_5OH(l) + 3\ O_2(g) \text{ ------> } 2\ CO_2(g) + 3\ H_2O(l)$$

(a) $\Delta S°$ is positive
(b) $\Delta S°$ is negative
(c) cannot predict the sign of $\Delta S°$

(17) For a reaction with $\Delta H° > 0$ (positive in sign) and $\Delta S° < 0$ (negative in sign), you can deduce that the reaction will be:

(a) Spontaneous at all temperatures.
(b) Nonspontaneous at all temperatures.
(c) Spontaneous at low temperatures; nonspontaneous at high temperature.
(d) Nonspontaneous at low temperature; spontaneous at high temperature.

Electrochemistry

(18) Given the following standard half-cell potentials in 1.00 M basic solution;

REACTION	E°
$2\ H_2O + 2e^- \Longleftrightarrow 2OH^- + H_2(g)$	-1.23
$2\ H_2O + O_2(g) + 4\ e^- \Longleftrightarrow 4\ OH^-$	0.401
$M^{3+} + e^- \Longleftrightarrow M^{2+}$	0.469

Which of the following statements is correct? (assume standard states)

(a) M^{2+} will reduce OH^- to give M^{3+} and O_2 gas.
(b) M^{3+} will oxidize OH^- to give M^{2+} and O_2 gas.
(c) M^{3+} will oxidize OH^- to give M^{2+} and H_2 gas
(d) M^{3+} will reduce OH^- to give M^{2+} and O_2 gas.
(e) M^{2+} will oxidize OH^- to give M^{3+} and O_2 gas.

(19) How many electrons are involved in the following reaction?

$$SO_3^{2-}(aq) + MnO_4^{1-}(aq) \longrightarrow SO_4^{2-}(aq) + Mn^{2+}(aq)$$

(a) 6
(b) 2
(c) 10
(d) 4
(e) 3

(20) Given the following standard electrode potentials:

Reaction	E°
$Li^+ \Longleftrightarrow Li$	-3.05
$Cr^{3+} \Longleftrightarrow Cr$	-0.740
$Cu^{2+} \Longleftrightarrow Cu$	0.337

Which one of the reactions below will proceed spontaneously from left to right? (equations below are not necessarily balanced)

(a) $Cu + Li^+ \longrightarrow Cu^{2+} + Li$
(b) $Cr^{3+} + Cu^{2+} \longrightarrow Cr + Cu$
(c) $Cr + Cu^{2+} \longrightarrow Cr^{3+} + Cu$
(d) $Cu + Cr^{3+} \longrightarrow Cu^{2+} + Cr$
(e) None of the above

Nuclear Chemistry

(21) Which of the following fundamental particles has the largest mass?

(a) beta
(b) gamma

(c) proton
(d) neutron
(e) alpha

(22) What particle is needed to balance the following nuclear equation?

$$^{210}Po_{84} \text{ ------> } ^{206}Pb_{82} + ?$$

(a) positron
(b) electron
(c) neutron
(d) proton
(e) alpha

(23) Neutral argon, atomic mass = 39.45 g/mol, consists of 0.337% ^{36}Ar, 0.065% ^{38}Ar, and 99,600% ^{40}Ar. The atomic masses of ^{36}Ar, ^{38}Ar, and ^{40}Ar are 35.97, 37.96, and 39.96 amu, respectively. Suppose that a sample of natural argon is passed through an "isotope separator" that removes all of the ^{40}Ar from the sample. The average atomic mass of the remaining mixture of ^{36}Ar and ^{38}Ar is (in amu).

(a) 39.95
(b) 37.00
(c) 36.97
(d) 36.26
(e) 37.65

(24) What is the approximate age of an artifact found by an archeologist which has a specific activity due to carbon-14 of 7.64 counts per minute per gram of carbon? [Assume that living matter on the earth had an activity of 15.3 counts per minute per gram of carbon. The half-life of carbon-14 is 5560 years.]

(a) 11100 years
(b) 5600 years
(c) 12900 years
(d) 6180 years
(e) 2430 years

Chemistry of the Nonmetals

(25) In which case is hydrogen present as an anion (a negative ion) called the "hydride" ion?

(a) $LiAlH_4$
(b) B_2H_6
(c) $NaBH_4$
(d) CaH_2
(e) NH_3

(26) Which one of the following is the strongest acid?

(a) $ClCH_2COOH$
(b) $HClO_3$
(c) HBrO
(d) HClO
(e) $HClO_4$

(27) What is the main source of the oxides of sulfur which are such common air pollutants?

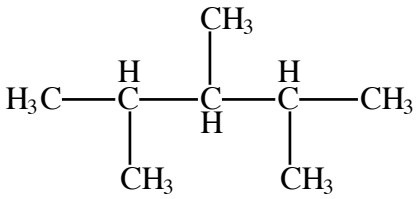
(a) volcanoes
(b) bacterial decay
(c) coal-fired electricity plants
(d) manufacture of sulfuric acid
(e) decomposition of plaster ($CaCO_4$)

(28) In which chemical form is phosphorus mostly found on earth?

(a) P_4O_6
(b) H_3PO_4
(c) P_4
(d) $Ca_3(PO_4)_2$
(e) P_4O_{10}

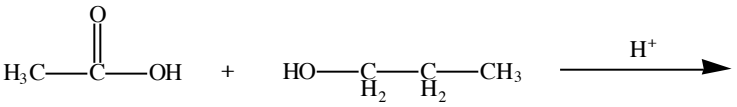
The Chemistry of Life: Organic and Biological Chemistry

(29) What is the IUPAC name for the hydrocarbon whose structural formula is shown below?



(a) 1-isopropyl-1-methyl-2-methylpropane
(b) 2,3,4-trimethylpentene
(c) diisopropyl methane
(d) 2,3,4-trimethylpentane\
(e) none of the above

(30) Which of the following is/are **not** correct statement(s) about the reaction shown below?

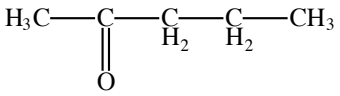


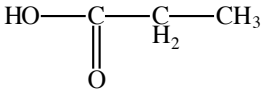
(1) It is an esterification reaction.
(2) It is a condensation reaction, with H_2O as a product.

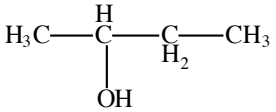
(3) One of the reactants is acetic acid.
(4) The other reactant is a secondary alcohol.

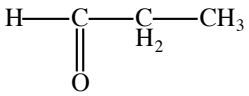
(a) 1 and 3
(b) 1
(c) 2
(d) 3
(e) 4

(31) List, in order (i) through (iv), the functional group for each of the following compounds:

(i) 

(iii) 

(ii) 

(iv) 

(1) alcohol
(2) aldehyde
(3) amide
(4) carboxylic acid
(5) ester
(6) ether
(7) ketone

(a) 2,1,3,7
(b) 7,2,3,6
(c) 7,1,4,2
(d) 5,6,4,2
(e) 3,1,5,2

(32) Which of the following statements is **not** correct?

(a) The primary structure of DNA is a polynucleotide chain.
(b) The structure of DNA is stabilized by hydrogen bonds between the following specific base pairs: adenine-guanine and thymine-cytosine.
(c) Only a small percentage of the DNA chain consists of "genes" that code for specific proteins.
(d) The human genome project recently concluded that the human genome contains 30,000-40,000 genes and not 100,000 as previously believed.
(e) All are correct.

(33) Which of the following statements about proteins in **not** true?

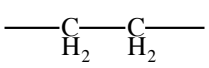
(a) A protein has a polymeric structure, containing typically 100 – 1000 monosaccharide units.
(b) A protein has extensive hydrogen bonding between N-H and C=O groups.
(c) A protein has a characteristic shape depending on the nature of the constituent monomer units.
(d) Some proteins have the ability to form a helical structure.
(e) A certain protein functions as an oxygen carrier in the bloodstream.

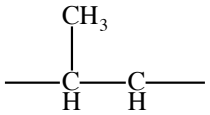
(34) Sugar, like starch, is a carbohydrate, but sugar, unlike starch,

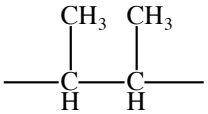
(a) contains OH groups
(b) is not highly polymerized
(c) contains amino groups
(d) is not related to cellulose
(e) contains ether groups

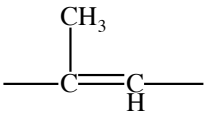
Materials Chemistry and Polymers

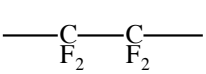
(35) The monomer unit for polypropylene is propene. What is the formula for the repeating unit of this polymer?

(a) 

(b) 

(c) 

(d) 

(e) 

EXAM KEY
FINAL EXAM QUESTIONS
SUPA FALL 2002

1	B
2	B
3	D
4	C
5	B
6	E
7	C
8	C
9	E
10	C
11	E
12	E
13	E
14	C
15	C
16	B
17	B
18	B
19	C
20	C
21	E
22	E
23	D
24	B
25	D
26	E
27	C
28	D
29	D
30	E
31	C
32	B
33	A
34	B
35	B