

SYLLABUS
Chem 531
Fall 2017

Advanced Physical Chemistry: Classical physical chemistry including basic thermodynamics and an introductory discussion of surface chemistry and electrochemistry.

INSTRUCTOR: Prof. K W Hipps (N116B) 335-3033 hipps@wsu.edu. Office Hours by appointment.

TEXTBOOKS: **Physical Chemistry 6th edn.** I. N. Levine. Additional material will be provided.

TOPICS:

- Chapter 1. Thermodynamics, Introduction.
- Chapter 2. The First Law of Thermodynamics
- Chapter 3. The Second Law of Thermodynamics
- Chapter 4. Material Equilibrium

EXAM 1

- Chapter 5. Standard Thermodynamic Functions of Reactions
- Chapter 6. Ideal gas reaction equilibrium
- Chapter 7. One component Phase Equilibrium

EXAM 2

- Chapter 9 & 10. Selected Topics on Solutions (including activity) and Coligative Properties
- Hand Outs. Surface Chemistry

EXAM 3 (take home)

EXAMS: Three exams.

HOMEWORK: Graded, assigned by chapter or parts of a chapter.

FINAL GRADE: Homework.....25%
Class Participation 5%
Exams.....70 %

TOTAL.....100%

Homework 1: Chapter 1: 1.1, 1.13, 1.16, 1.21, 1.25, 1.41, 1.45, 1.50, 1.52, 1.55, 1.60, 1.67 AND

I) Using $V=V(P,T)$

a) Find the total derivative (dV) of V

b) Showing ALL STEP, prove that $\left(\frac{\partial T}{\partial P}\right)_V = \kappa/\alpha$

II) USING the ideal gas law and $U=U(T,P)$ show that

$$\left(\frac{\partial U}{\partial V}\right)_T = -\left(\frac{\partial U}{\partial P}\right)_T \left(\frac{P}{V}\right)$$

III) LET δ be a small positive number on the order of 0.01, and defined for all x as: $F = xy$ for $y \leq -\delta$ and $F = x^2y^2$ for $y \geq \delta$ and F is undefined otherwise.

Evaluste and discuss $\left(\frac{\partial^2 Z}{\partial x \partial y}\right)$ and $\left(\frac{\partial^2 Z}{\partial y \partial x}\right)$ on the interval between $(-\delta$ and $+\delta)$.

GENERAL: All of you have seen most of the material in this course before. The problem is that almost none of you really understand all that you saw. I would like to fix that with this class. It has been shown that in a simple lecture setting students only learn about 10% of what they are told. If the students stay active in participating in class, that can be pushed to about 50% but the amount of material covered decreases considerably. Moreover, in the time we have for lecture, I will only be able to talk about 25 to 30% of what is in the text. Bottom line is that I am not going to be able to pour knowledge into your head – you are going to have to pack it in. So, read the chapter BEFORE coming to class and be prepared to ask questions. Do the homework until you can do it with the book closed. Stay awake and ask questions in class. Participate in the classroom exercises. And remember, you are not learning the material for my exams, you are learning it for prelims and for life!

Homework: Homework assignments will be assigned almost every Tuesday and will usually be due the Tuesday of the following week (i.e., you will have about 7 days to complete each homework. **You are encouraged to work in groups.** I hope that you will use the group homeworks as a vehicle for cooperative teaching and learning as well as a time-saving device. However, I do not want to see ‘carbon copies’ of the homework. Some students fall into a trap of letting other members of their group do the hard intellectual work and think that they can catch up in time to take the exams. Of course, this is not only a mistake and not an effective way to learn—it is also bad manners.

You will be allowed **one and only one** late homework.

Final Grade: The grade will be determined by:

Homework (25%):

Homework will tend to test problem solving ability. I will hand grade two or three of the assigned problems and your grade will be based on those problems. Not because they are the most important, but because I don't have time to hand grade all the problems you need to do to learn the material.

Homework is VERY important. Ideally you would do each problem until you can do them all with the book closed.

Class Participation (5%)

At the start of most classes, students will be selected to demonstrate and discuss the solution of a problem. Scores will be awarded based on your contributions to this effort.

Exam 1, 2, and 3 (70%)

All exams have equal value. One of the three exams will be takehome. Please do not become complacent that you can find solutions to the questions without actually having to learn the material. Takehome exams tend to be longer and more difficult than in class exams. Thermodynamics is a subject that must be digested slowly. Please try to keep up and work at a constant rate. Last minute studying for a thermodynamics exam is usually a recipe for poor performance. All exams are cumulative.

Time Management: This is a 3 credit course. You are expected to spend 3 waking hours a week in lecture. You should be spending a minimum of nine hours a week reviewing lecture material, reading text book(s), doing homework, and studying for exams. My advice to you is that you spend at least 3 of those 9 hours reviewing lecture material each week—and that you set aside a regular time to study.

Pre-Class Reading: *You are expected to have read the appropriate chapter in your book PRIOR to coming to class.* You should be doing two to three hours a week of reading. If a concept in Levine is unclear to you, find readings on your own that supplements these hard parts.

About Thermodynamics: Thermodynamics is about developing a rigorous understanding of natural processes. Thermodynamics can become tedious and many useful applications don't begin until a solid foundation is developed. However, I don't think it necessarily has to be boring and I encourage you to keep your minds open about the elegance and beauty of the subject. I also think that it takes many years to master this subject.

Much of what you will learn about chemistry and materials science will rely on your comprehension of thermodynamics. Unfortunately, most of you do not yet know about all the wonderful things you are going to learn over the years or how they depend on this course. So, there will be times when you will be struggling to learn something without knowing why you should bother to learn it. I have tried to distill the thermodynamics you will need to know into 16 weeks of lectures and problems solving sessions - you are going to have to trust that I am trying to teach you something useful.

Thermodynamics is a beautiful and rewarding subject. Here are some excerpts from what others have said about thermodynamics:

A theory is the more impressive the greater the simplicity of its premises, the more different kinds of things it relates, and the more extended its area of applicability. Therefore the deep impression that classical thermodynamics made upon me. It is the only physical theory of universal content which I am convinced will never be overthrown, within the framework of applicability of its basic concepts.
-A. Einstein.

Once or twice I have been provoked and asked the company how many of them could describe the Second Law of Thermodynamics. The response was cold: It was also negative. Yet I was asking something which is about the scientific equivalent of "Have you read a work of Shakespeare's?"
Charles Percy Snow, Baron Snow, [CBE](#) (15 October 1905 – 1 July 1980) was an English [physical chemist](#) and novelist who also served in several important positions in the [British Civil Service](#) and briefly in the [UK government](#).^[1] He is best known for his series of novels known collectively as [Strangers and Brothers](#), and for [The Two Cultures](#), a 1959 lecture in which he laments the gulf between scientists and "literary intellectuals".

The law that entropy always increases—the second law of thermodynamics—holds I think, the supreme position among the laws of Nature. If someone points out to you that your pet theory of the universe is in disagreement with Maxwell's equations—then so much worse for Maxwell equations. If it is found to be contradicted by observation—well these experimentalists do bungle things sometimes. But if your theory is found to be against the second law of Thermodynamics, I can give you no hope; there is nothing for it but to collapse in deepest humiliation. - **Sir Arthur Stanley Eddington**, (born December 28, 1882, [England](#)—died November 22, 1944) English astronomer, physicist, and mathematician who did his greatest work in [astrophysics](#), investigating the motion, internal structure, and evolution of [stars](#). He also was the first expositor of the theory of [relativity](#) in the English language.

Lisa, get in here. In this house we obey the laws of thermodynamics! -**Homer Simpson**.

Additional Reference Material: Will be provided as appropriate.

Academic Integrity: Cheating of any kind is unacceptable. This includes the inappropriate use of solution manuals for homework sets, as well as the usual forms of copying, etc. Cooperative learning is encouraged, but all work submitted for grading must be your own. All instances of cheating will be reported to Student Affairs and the Dean of Students. The assignment in question will receive no credit. Students who violate WSU's Standards of Conduct for Students will receive an F as a final grade in this course, will not have the option to withdraw from the course and will be reported to the Office Student Standards and Accountability. Cheating is defined in the Standards for Student Conduct WAC 504-26-010 (3). It is strongly suggested that you read and understand these definitions.” The standards of Conduct for Students can be found at <http://conduct.wsu.edu>.

Students with Disabilities: Reasonable accommodations are available for students with documented disabilities or chronic medical conditions. If you have a disability and need accommodations to fully participate in this class, please visit the Access Center website to follow published procedures to request accommodations: <http://www.accesscenter.wsu.edu>. Students may also either call or visit the Access Center in person to schedule an appointment with an Access Advisor. Location: Washington Building 217; Phone: 509-335-3417. All disability related accommodations **MUST** be approved through the Access Center. **Please notify the me during the first week of class of any accommodations needed for the course.** Late notification may cause the requested accommodations to be unavailable. .

Safety on Campus: WSU has developed resources for the safety of students, faculty, staff and visitors. These are the Campus Safety Plan at <http://safetyplan.wsu.edu> and the university emergency management at <http://oem.wsu.edu/>. You should also become familiar with the WSU ALERT site at <http://alert.wsu.edu> for information about emergencies affecting WSU. It is recommended that you go to the zzusis portal at <http://zzusis.wsu.edu> and **register your emergency contact information** for the Crisis Communication System (CCS).

Expected outcomes: By the end of the semester you should be able to do at least 60% of the problems in the covered chapters with the book closed.