CHEM 252 - PHYSICAL CHEMISTRY I

FALL TERM, 2009

Instructor: Ed Thorne
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Office Hours: One hour before class each week or by appointment

A. COURSE OBJECTIVES/DESCRIPTION

This is a 3 credit course covering selected topics from classical thermodynamics. Emphasis will be on gas properties and the Laws of Classical Thermodynamics.

B. PREREQUISITES MATH 200 and either CHEM 102 or (CHEM 162 and CHEM 164) or TDEC 121

C. REQUIRED TEXTBOOK

Physical Chemistry, 8th Edition by Peter Atkins and Julio de Paula, W.H. Freeman and Company (2006)

D. CLASS MEETINGS

Monday Evenings from 7:00 P.M. to 9:40 P.M. in LeBow, Room 241

E. COURSE LEARNER OBJECTIVES

Upon completion of this course the student should be able to:

- accurately predict gas behavior under both ideal and non-ideal conditions
- have a fundamental understanding and appreciation of the thermal energy requirements and consequences of chemical reactions and transformations
- predict from purely thermodynamic data whether a reaction is expected to proceed under both standard and non-standard state conditions
- understand the effect of conditions on the behavior and states of pure materials based on their phase diagrams

F. GRADE BREAKDOWN

20% of your grade will come from Exam I covering the material from Chapters 1 and 2 and will be given on October 26 (tentative date)

20% of your grade will come from Exam II covering the material from Chapter 3 and will be given on November 16 (tentative date)

30% of your grade will come from the Final Exam on December 7, which will be comprehensive

30% of your grade will come from problem sets (10% each) to correspond to each exam

NOTE: NO EXAMS OR PROBLEM SETS WILL BE GRADED OR RETURNED TO ANY STUDENT NOT ENROLLED IN THE CLASS. GRADES WILL BE DETERMINED FROM EXAMINATIONS AND PROBLEM SETS ONLY--EXTRA CREDIT ASSIGNMENTS ARE NOT AVAILABLE.

NOTE: EXAM DATES ARE TENTATIVE AND SUBJECT TO CHANGE AS THE TERM PROGRESSES. ANY CHANGES WILL BE ANNOUNCED IN CLASS.

During then exams you will be permitted to use one 4 inch by 6 inch index card as a reference. This is not designed to be a comprehensive summary of all topics but rather as an aid in helping you to recall some of the more fundamental equations. The process of preparing this card is part of

studying for the exam because you will have to decide what you feel is important enough to include on it. If you find that there is not enough room to record all you need, that is a good indication that you may not understand the material very well. NOTHING OTHER THAN THIS ONE CARD MAY BE USED DURING THE EXAM. IF YOU ARE FOUND USING ANYTHING ELSE IT WILL BE CONFISCATED AND YOU WILL RECEIVE A GRADE OF ZERO FOR THE EXAM.

G. ACADEMIC HONESTY POLICY

Drexel University is committed to a learning environment that embraces academic honesty. In order to protect members of our community from results of dishonest conduct, the University has adopted policies to deal with cases of academic dishonesty. Please read, understand, and follow the "Academic Honesty Policy" as written in the official student handbook. Instances of academic dishonesty, such as cheating and plagiarism will be dealt with appropriately.

H. PROBLEM SETS AND HOMEWORK ASSIGNMENTS

Homework assignments, as a general rule, will not be collected or subject to grading. The main reason for this is that the homework assignments are designed to serve as a learning tool and they are where you begin to really grab a stronghold on the material. Verification of that understanding will come from an in-class solution to some of these assigned problems. The exams are designed to show how well you have mastered this material within a certain timeframe. In place of homework assignments being graded, each exam will have its own problem set, due at the beginning of the respective exam. These problem sets are based on material that is included in the exam and are principally problems that are less appropriate for an in-class exam with a well-defined time limit. These problems set assignments are typically more easily suited to solution with computer software and/or are more time consuming than would be appropriate for the in-class exam. Successful completion of the problem set is an excellent preparation for the in-class exam. **ALL STUDENTS ARE REQUIRED TO COMPLETE AND SUBMIT THEIR OWN WORK. ANY INSTANCES OF DUPLICATE WORK BEING SUBMITTED (INCLUDING SPREADSHEETS AND/OR GRAPHS) WILL RESULT IN A SIGNIFICANTLY REDUCED GRADE FOR ALL PERSONS INVOLVED.** This is not to discourage comparing your answers with others in the class (I fully support that) but you must work them out independently before comparing. Simply stating, "we did them together so that is why our submissions are the same" will not be accepted. **NOTE: Because this is a take-home assignment and you will have one week to complete it, there are no make up options for the problem sets. You will forfeit that portion of your grade if it is not completed and submitted on time.**

I. MAKING UP MISSED EXAMS

A single make-up exam will be given to replace either Exam I or Exam II. This exam will be given ***after the second exam*** and will cover material from both exams. This means that if you miss either Exam I or Exam II the make-up exam you take will cover material from both exams. The make-up exam will replace one exam only, so that if you miss both exams you will forfeit 20% of your grade. To do this, you first have to make an appointment with Marge Fritsche (215-895-2164) at the Goodwin College of Evening and Professional Studies, located at One Drexel Plaza at 30th and Market Streets. All make-up exams will be administered through the Goodwin College of Evening and Professional Studies. **If you do not complete the make-up exam by Friday November 20, your grade for the missed exam will be zero. No make-up exams will be permitted after November 20. THE MAKE-UP EXAM IS TO REPLACE A MISSED EXAM, NOT TO REPLACE A POOR GRADE. THERE IS A TWO HOUR TIME LIMIT ON THE MAKE-UP EXAM SO YOU WILL HAVE TO ARRIVE EARLY ENOUGH TO RECEIVE THE FULL TIME ALLOWED. THE OFFICE WILL NOT REMAIN OPEN PAST THEIR REGULAR HOURS FOR YOU TO COMPLETE THE EXAM IF YOU ARRIVE LATE. IT IS YOUR RESPONSIBILITY TO MAKE A SUITABLE APPOINTMENT TO TAKE THE EXAM.**

J. ATTENDANCE POLICY

Considering the needs of part time students occasionally having to miss class because of employment commitments, attendance will not affect your grade. If you miss a class for any reason, it is your responsibility to call me to determine what work you missed.

HOMEWORK PROBLEMS

NOTE: EXERCISE NUMBERS REFER TO THE "B" SET OF EXERCISES IN EACH CHAPTER UNLESS OTHERWISE INDICATED

CHAPTER 1

Exercises 1.1, 1.4, 1.8, 1.10, 1.11, 1.15, 1.16, 1.18, 1.19
NOTE: In Exercise 1.8, the pressure is 16.0 kPa (not 1.60 kPa)

Problems 1.2, 1.6, 1.7, 1.19

CHAPTER 2

Exercises 2.1, 2.2, 2.5, 2.15, 2.16, 2.18, 2.19, 2.22

Problems 2.8, 2.20a,c, 2.21c, 2.41
NOTE: In Problem 2.41, assume a mass of 65 kg

CHAPTER 3

Exercises 3.1, 3.2, 3.5, 3.6, 3.7, 3.8, 3.9, 3.10, 3.12, 3.15, 3.16, 3.17, 3.19

Problems 3.2, 3.7, 3.42
NOTE: In Exercise 3.12 the products of combustion are CO_2, N_2, and H_2O

CHAPTER 4

Discussion 4.4

Exercises 4.1, 4.3, 4.4, 4.7 (both a and b), 4.8, 4.9

Problems 4.9

TOPICS TO BE COVERED DURING THE QUARTER

CHAPTER 1 - GAS PROPERTIES

State of A System - Ideal Gas Temperature Scale - Combined Gas Laws - Ideal Gas Law - Compressibility Factor - Real Gases vs. Ideal Gases - van der Waals Equation and Other Equations of State - Critical Phenomena

CHAPTER 2 - FIRST LAW OF THERMODYNAMICS

Work and Heat - Statement of First Law - Exact and Inexact Differentials and the Test for Exactness - Pressure/Volume Work - Reversible, Irreversible, Isothermal, and Adiabatic Processes - Enthalpy - State Functions - Thermochemistry - Heat Capacities at Constant Volume/Pressure - Calorimetry - Joule-Thompson Effect - Temperature Dependence of ΔH

CHAPTER 3 - SECOND AND THIRD LAWS OF THERMODYNAMICS

Entropy and Spontaneity - Statement of Second Law - Carnot Cycle, Carnot Refrigerator, Carnot Heat Pump - Entropy Calculations for Isothermal (reversible and irreversible) Processes - Temperature Dependence of Entropy - Molecular Interpretation of Entropy - Evaluation of Absolute Entropies - Statement of Third Law - Entropy Changes for Chemical Reactions - Criteria of Equilibria in Closed Systems with only P-V Work - Helmholtz Energy and Gibbs Energy - Thermodynamic Derivatives of Closed Systems - Maxwell Relations - Thermodynamic Equations of State - Effect of Temperature and/or Pressure on Gibbs Energy

CHAPTER 4 - PHYSICAL TRANSFORMATIONS OF PURE SUBSTANCES

Stabilities of Phases - Phase Boundaries - Typical Phase Diagrams for Pure Substances - Phase Stability and Phase Transitions - Location of Phase Boundaries - Surface Tension - Capillary Action

MATHEMATICAL EXERCISES

Successful completion of this course requires a level of mathematical ability that includes evaluation of derivatives, partial derivatives, and definite integrals of the power series variety. The exercises below are typical of the type we shall encounter in this course. You should look them over and make certain you are familiar (and comfortable) with each one.

1. Determine where the function $y = 6x^2 + 3x - 2$ has its minimum value (that is, where its first derivative is equal to zero) ***(ANSWER: x = -0.25)***

2. The density, d, of a gas is a function of temperature (T), pressure (P), and volume (V), all related through the gas law constant (R)

$$d = \frac{PM}{RT}$$

Generate an expression for the total differential of d in terms of the variables of the equation of state only. This problem does not require a numerical answer, only the generation of an appropriate mathematical expression.

3. Evaluate the following definite integrals:

a) $\int_1^3 5 + 4T - 0.025T^2 \, dT$ ***(ANSWER = 25.78)***

b) $\int_1^3 5 + 4T - \frac{0.33}{T^2} \, dT$ ***(ANSWER = 25.78)***

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I have read and understand the course requirements that are detailed in this course syllabus. By my signature below I am indicating that I understand each of the following:

- **When exams will be given (at least tentative dates)**
- **The procedure for making up any missed exams and the fact that no make-up exams will be permitted after November 20. Also, it is understood that there will be a single make-up exam to replace both Exam I and Exam II so I may be tested twice on some topics. The make-up exam will replace ONE EXAM ONLY so if I miss both Exam I and Exam II, 20% of my grade will be forfeited.**
- **The policy regarding submission of problem sets and the understanding that they are to be done <u>independently</u> and not in small groups. Also, there is no make-up option for a missed problem set: that portion of the grade will be forfeited if the problem set is not submitted on time.**
- **The contribution each factor has in determining the overall course grade.**
- **That it is my responsibility to find out what was missed if I should miss a class.**

NAME (printed) _____

SIGNATURE _____

DATE_____