Chemical Separations CHEM621 Spring 2011

10/19/10 .

COURSE DESCRIPTION: Fundamental examination of chemical separation methods and principles. Mathematical modeling of the thermodynamic and steady state principles governing zone broadening and separation efficiency in chemical separations. Investigation of fundamental chemical separation principles applied to chromatographic instrumentation including traditional and newly emerging chromatographic techniques.

• Instructor: (wingrave@udel.edu)

- Dr. J. A. Wingrave; Office (204 BRL); Phone (831-1676); e-mail

• CHEM621-010 Lecture

- Section 010 T,R, from 3:30-4:45 pm in 116BRL

• Required Course Supplies (Available at University Bookstore - sometimes!)

- **Textbook**: "Unified Separation Science", J. Calvin Giddings, John Wiley & Sons, NY (1991).
- **Lecture Manual** Lecture Manual for CHEM621, Wingrave 2011

• Exams

- Two (2) in-class exams of 100 points each will be given.
- No make-up exams
  - Final exam score will count in place of any EXCUSED missed exam.
  - Missed exams excused if note describing legitimate cause for exam absence is presented to professor prior to the next exam date.
- Exams Cover: textbook, lecture, and Lecture Manual material.

* Exam corrections must be made prior to the next exam date.

• Grading Schedule for CHEM621-010

- **Examinations (200 points, 50 %) = 2 x 100 points**
- **Final Examination (100 points, 25 %) = 1 x 100 points**
- **Paper/Presentation (75 points, 18.75%) = Students(25 pts)+ Prof(50 pts)**
- **Homework (25 points, 6.25%) = 5 x 5 points**

TTL POINTS (%)	GRADE	TTL POINTS (%)	GRADE	TTL POINTS (%)	GRADE
400-340 (85)	A	260-240 (60)	B -	160-140 (35)	D +
340-320 (80)	A -	240-220 (55)	C +	140-120 (30)	D
320-300 (75)	B +	220-180 (45)	C	120-100 (25)	D -
300-260 (65)	B	180-160 (40)	C -	100-0	F

- **Office Hours**
  - Location (204 BRL)
  - Time (**T,R,** 9:30 am -10:30 am & **W**, 9:00 am-10:00 am)

- **Presentation (75 pts)**
  - Presentations done in class in May (date TBA)
  - Prepare a POWERPOINT presentation on an 'external field' chromatographic method. Choose from the list below.

    - Temperature Gradient Chromatography
    - Thermogravitational Chromatography
    - Capillary Electrophoresis Chromatography
    - Capillary Gel Electrophoresis
    - Foam Fractionation Separations
    - Magnetic Gradient Chromatography
    - Electromagnetic Radiation Gradient Chromatography
    - Concentration Gradient Chromatography
    - Supercritical Fluid Chromatography
    - Two-Dimensional Chromatography
    - Hydrophobic Interaction Chromatography
    - Pressure Gradient Chromatography
    - Micellar Electrokinetic Chromatography
    - Chiral Chromatography
    - Zone Melting Chromatography
    - Other (Obtain permission for a method not on the list above.)

  - Presentation should include but not be limited to the following.
    - History of method development
    - Rigorous mathematical description of theory of operation
    - Strengths and weakness of method versus other chromatographic methods including analysis sensitivity for several different types of analyte systems.
    - Description of instrument design, operation and costs.

- **Homework (25 pts)**
  - Five Due Dates: 3/3, 3/17, 4/7, 4/21 and 5/5
  - List of Assigned Problems on website for chem621S11

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12/31/10 .

SCHEDULE OF LECTURES, EXAMS AND HOMEWORK

Date	wk	Chap	Lecture Number & Topics	Home work
2/8 T 2/10 R	1	None 2	0. Introduction & Syllabus 1. Integral and Differential Calculus	
2/15 T 2/17 R	2	2	1a. Mathematics of Thermodynamics	
2/22 T 2/24 R	3	2 4	2. Thermodynamics in Chemical Separations 3. Bulk Fluid Phase Flow Processes	
3/1/ T 3/3 R	4	3,4 5,6	4. Solute Steady State Transport 5. Zone Migration Processes - HOMEWORK #1 DUE - 3/3	#1
3/8 T 3/10 R	5	7,9 7,9	6. Counter-current Separation 7. Simple Extractions	
3/15 T 3/17 R	6	7,9 7, 8,9	8. pH Dependent Extraction 9. Complexation Separation Processes (10. Ext. Field Chromat.)	#2
3/22 T 3/24 R	7	7, 10-12	**EXAM 1 - 3/22 M** 11. Chromatography Fundamentals	
3/26 Sa - 4/3 Su	8		**** SPRING BREAK ** (March 26 – April 3)**	
4/5 T 4/7 R	9	7, 10-12	11. Chromatography Fundamentals	#3
4/12 T 4/14 R	10	10	12. GC	
4/19 T 4/21 R	11	10	12. GC 13. LC	#4
4/26 T 4/28 R	12	10	13. LC	
5/3 T 5/5 R	13	10	**EXAM 2 - 5/3 M** 14. IEC	#5
5/10 T 5/12 R	14	10	14. IEC Presentations	
5/15 T	15	- - -	Presentations	
5/16 W	15		**READING DAY**	
			FINAL EXAM	

PRESENTATION EVALUATION

CHEM621S11

Presenters Name _____

Your Name _____

Presentation grade should be based on the following.

1) History of method development (**5 pts**) _____

2) Rigorous mathematical description of theory of operation (**5 pts**) _____

3) Strengths and weakness of method versus other chromatographic methods including analysis sensitivity for several different types of analyte systems. (**10 pts**) _____

4) Description of instrument design, operation and costs. (**5 pts**) _____

TOTAL (**25pts**) _____

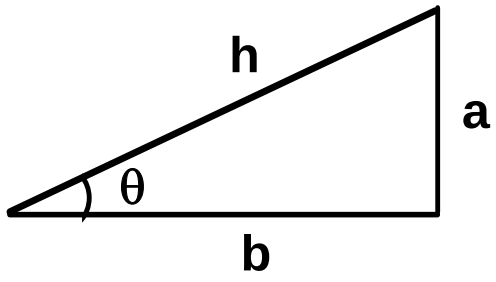
BASIC MATH FUNCTIONS

A. Exponents

1. $x^2 \bullet x^3 = x^{2+3} = x^5$
2. $x^5 \bullet y^5 = (xy)^5$
3. $x^3 \bullet y^4 = x^3 y^4 = y\left(x^3 y^3\right) = y(x\,y)^3$
4. $\left(x^2\right)^5 = x^{(2\bullet 5)} = x^{10}$
5. $\sqrt[3]{x^6} = \left(x^6\right)^{1/3} = x^{(6/3)} = x^2$
6. $\sqrt{x^6} = \left(x^6\right)^{1/2} = x^{(6/2)} = x^3$
7. $x^{-4} = \dfrac{1}{x^4}$
8. $\dfrac{x^5}{x^3} = x^{5-3} = x^2$

B. Logs

1. $\log 1000 = +3.0$ ⋮ $10^{+3} = 10^{\log 1000} = 1000$
2. $\ln 1000 = +6.91$ ⋮ $e^{+6.91} = e^{\ln 1000} = 1000$
3. $pH \equiv -\log\left[H^+\right]$ ⋮ $\left[H^+\right] = 10^{-pH}$
4. $\log x^7 = 7 \bullet \log x$
5. $\ln x^6 = 6 \bullet \ln x$
6. $\ln x = 2.303 \log x$
7. $\log xy = \log x + \log y$
8. $\log \dfrac{y}{x} = \log y - \log x$
9. $\log (x+y) = \log (x+y)$



10. $\sin\theta = \dfrac{\text{opposite}}{\text{hypotenuse}} = \dfrac{a}{h} = \dfrac{1}{\sec\theta}$
11. $\cos\theta = \dfrac{\text{adjacent}}{\text{hypotenuse}} = \dfrac{b}{h} = \dfrac{1}{\csc\theta}$
12. $\tan\theta = \dfrac{\text{opposite}}{\text{adjacent}} = \dfrac{a}{b} = \dfrac{1}{\cot\theta} = \dfrac{\sin\theta}{\cos\theta} = \left(\dfrac{a}{h}\right)\left(\dfrac{h}{b}\right) = \dfrac{a}{b}$
13. $1 = \sin^2\theta + \cos^2\theta$

D. Mensuration:

1. $C = \pi d = 2\pi r$ ⋮ Circumference of circle
2. $A = \pi r^2 = \dfrac{\pi}{4} d^2$ ⋮ Area of circle
3. $A = 2\pi r L$ ⋮ Area of cylinder
4. $A = 4\pi r^2$ ⋮ Area of sphere
5. $A = \dfrac{1}{2} bh$ ⋮ Area of RIGHT triangle
6. $A = 6L^2$ ⋮ Area of cube
7. $V = L^3$ ⋮ Volume of cube
8. $V = \dfrac{4}{3}\pi r^3$ ⋮ Volume of sphere
9. $V = \pi r^2 L$ ⋮ Volume of cylinder

E. Quadratic Equation

$ax^2 + bx + c = 0$ ⋮ $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$