CHEM-204 Physical Chemistry for Biological Sciences Fall 2022

Classes: Mon/Wed 12:35 pm-01:25 pm in SADB 2/36

Problem-solving sessions/Tutorials: Fri 12:35 pm-01:25 pm in SADB 2/36 or on Zoom

Instructor: Prof. Lena Simine (lena.simine@mcgill.ca)

Teaching Assistants: Ben Weiser (benjamin.weiser@mail.mcgill.ca) before the midterm, and Jérôme Genzling (jerome.genzling@mail.mcgill.ca) after the midterm.

Brief course description: Basic concepts and problems in Thermodynamics and Chemical Kinetics with an emphasis on biological examples to illustrate Gas Laws and Kinetic theory of gas; Work, Enthalpy, Heat Capacity, the 1st Law of Thermodynamics; Entropy and 2nd Law of Thermodynamics; Gibbs and Helmholtz Free Energies; Electrolyte & Non-electrolyte solutions and Chemical potential; Chemical equilibrium and Ligand binding; Chemical kinetics and Enzyme kinetics.

Delivery. This class is ***partially flipped***. The content will be delivered ***in part in live lectures and in part in pre-recorded videos*** (see schedule). Videos will be discussed during live meetings twice a week by a panel of students. Problem solving sessions lead by TA's will take place during tutorials on Fridays. A Slack workspace will be set-up for informal discussions: please join https://join.slack.com/t/chem204workspace/shared_invite/zt-1eog9uexz-8a4xpHWFAF1mSnz8KusMlQ

Communication: Please use direct messages on Slack or email (less effective!) with subject line: "**CHEM204**".

Office Hours: Mondays and Wednesdays immediately after class.

Goals: Learn physical chemistry concepts and apply them to solve problems.

Evaluation:

20 asynchronous quizzes* 20% (teamwork is encouraged, no plagiarism)

Panel debate: 10%

Virtual Reality lab: 10%

HW Assignment = 10% (teamwork is encouraged, no plagiarism)

Mid-term test 20%

Final exam 30 %

* Three-four questions will accompany each assigned video. They will be available for the entire semester and solutions may be locked in at any time on or before the last day of the semester. Group discussions of

these questions are allowed and encouraged but plagiarism, i.e., copying solutions from others is forbidden (honor code).

Textbook: *"Physical Chemistry for the Chemical and Biological Sciences"*, by Raymond Chang, year: 2000, Publisher: University Science Books, ISBN: 1891389068 (the same used in previous years)
Recommended: "Problems and Solutions to Accompany Physical Chemistry for the Chemical and Biological Sciences" by Helen Leung and Mark Marshall, year: 2000, Publisher: University Science Books, ISBN: 1891389114
Optional broader perspective reading: '*Critical Mass: How One Thing Leads to Another*' - a non-fiction book by a chemist and physicist Philip Ball (2004) that discusses "physics of society".

Tips: This is a partially ***flipped class***, watching the assigned videos and/or reading the relevant sections in the textbook ***before meetings*** is strongly recommended. Ask questions on Slack's general channel, tune in during office hours, start/join a study group on or off our Slack workspace: you are encouraged to collaborate on your quizzes (note that sharing and copying answers from others falls under plagiarism which is a serious academic offense). Doing so will significantly enhance your understanding of the material.

Academic Integrity: *McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/integrity for more information).*
Lecture topics and tentative schedule

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8	W	31	Live lecture	Video #1A	Introduction, basic probability theory	
9	F	2	Live lecture		Technical skills: Python, Basic Physics and Math (velocity, Newton's second law, derivatives, integrals, etc…)	
9	M	5	**Labor Day**	**Labor Day**	**Labor Day**	**Labor Day**
9	W	7	Live lecture		Problem solving skills: the scientific principle, best practices	
9	F	9	**Tutorial**	HW-type problems		
9	M	12	Panel #1	Video #1B	Ideal gas law Ch. 2.3-2.6, Ch 3.1-3.3	
9	W	14	Panel #2	Video #2	Equipartition of energy. Ch. 3.4 and 3.8	
9	F	16	**Tutorial**	**CH 2-3**		HW is due at 5pm (10%)
9	M	19	Panel #3	Video #3	Heat Capacity Ch. 3.8	VR labs (10%)
9	T	20	----	----	----	VR labs (10%)
9	W	21	Panel #4	Video #4	First Law, Heat and Work Ch. 4.1-4.2	VR labs (10%)
9	R	22	----	----	----	VR labs (10%)
9	F	23	**Tutorial**	**CH 3-4**		VR labs (10%)
9	M	26	Panel #5	Video #5	Enthalpy Ch. 4.3,4.4, 4.6	
9	W	28	Panel #6	Video #6	The 2nd Law Part I Ch. 5.2	
9	F	30	**Tutorial**	**CH 4-5**		
10	M	3	**Election day**			
10	W	5	Panel #7	Video #7	The 2nd Law Part II 5.1	
10	F	7	Panel #8	Video #8	Carnot Engine Ch. 5.3, 4.5	
10	M	10	**Thanksgiving**	**Thanksgiving**	**Thanksgiving**	**Thanksgiving**
10	W	12	Reading break			
10	**R**	**13**	Tutorial	**CH 5**		**Make-up day**
10	M	17	Live (Review)	CH 2-5		
10	W	19	Live (Review)	CH 2-5		
10	R	20	**Midterm**		**Location: Otto Maass 112; 6-9pm**	
10	F	21	**No Tutorial**		**Grading day**	
10	M	24	Panel #9	Video #9	Free Energies Ch 6.1-6.4	
10	T	25			Withdrawal without refund deadline	
10	W	26	Panel #10	Video #10	RXNs, Phase equilibria Ch. 6.5	
10	F	28	**Tutorial**	**CH 6**		
10	M	31	Panel #11	Video #11	Rubber elasticity Ch. 6.6	
11	W	2	Panel #12	Video #12	Protein folding (no textbook)	
11	F	4	**Tutorial**	**CH 6**		
11	M	7	Panel #13	Video #13	Non-electrolyte Solutions Ch 7	
11	W	9	Panel #14	Video #14	Electrolyte Solutions Ch. 8.1-8.5	
11	F	11	**Tutorial**	**CH 7-8**		
11	M	14	Panel #15	Video #15	Transport Through Cell Membranes Ch.8.7	
11	W	16	Panel #16	Video #16	Chemical Equil. and Ligand Binding Ch. 9	
11	F	18	**Tutorial**	**CH 8-9**		
11	M	21	Panel #17	Video #17	Kinetics: Reaction Rates Laws Ch 12	
11	W	23	Panel #18	Video #18	Kinetics: Arrhenius Equation Ch 12	
11	F	25	**Tutorial**	**CH 12**		
11	M	28	Panel #19	Video #19	Kinetics: Enzymes and catalysis Ch 12	
11	W	30	Panel #20	Video #20	Conclusion	
12	R	2	**Tutorial**	Review		
12	M	5	**Live lecture**	Last day	Asynchronous quizzes are due at 5pm.	

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Content tested in HW		
Content tested on the Mid-Term exam		
Content tested on the Final Exam		

Panel debates:

Be it resolved: 'Physical chemistry is useful and easy to learn'

Group:

1 moderator

Affirmative team: argue in favor of importance and utility of concepts presented in the assigned video by explaining what they are and how they work.

Opposing team: argue against importance and utility of concepts presented in the assigned video by explaining what is confusing about them, how they are difficult to use, and how it's possible to get by without them.

The basic flow of a debate:

0. **The moderator** gives a quick introduction by presenting the concepts that will be discussed in the debate, and the debating teams.

1. **Affirmative team** A. presents a concept and B. demonstrates its utility in two ways (either or both, whichever is fitting**)**: 1. By giving examples from broader science where the concept is useful, 2. By solving a sample problem on the board.

2. **Opposing team** does either or both**:** 1. Argue the same broader impact could be achieved without invoking the concept, and 2. Solve a problem that appears to be confusing: present *an incorrect but arguably plausible solution* and the *correct solution*.

3. Steps 1 and 2 are repeated until everyone had a turn and all concepts have been discussed.
4. The audience votes for or against the resolution.

Grading scheme: 5% (team mark) for an overall successful debate that runs smoothly from introduction to audience vote. 5% for individual performance: 3% clarity of presentation, 2% ingenuity of arguments.

Teams should work on their debate preparation collaboratively and organize the debate in a way that would deliver the best educational (and possibly entertainment) value to the audience.

Virtual reality lab:

Each group will get 1 hour access to the VR interactive simulation infrastructure. Each student in the group will get 5-7 minutes to explore the docking of the 'Tamiflu' drug onto the target protein; evaluation will be based on preparation (5%, a short quiz), and on a ***group report*** *(1 report for the entire group, 5%)* ***prepared and handed in*** by the group members ***during the lab***. VR hygiene products (head-set masks and gloves) will be provided, and the headset will be sanitized before being passed on to the next user.

Note that participation in the lab is **possible** even without using the VR headset – if you are not comfortable with putting it on for any reason, you will be able to get a good view by watching the simulation on the screen and interacting with the person in the simulation.

Instructors reserve the right to discontinue an experiment at any time if the equipment is not being used appropriately or if health safety protocols are not being followed - the turn will be transferred to the next student in line with 0% assigned for the entire component of the grade (including the quiz) to the individual whose experiment had to be discontinued.