DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY
CHEMISTRY 3411, FALL 2020
AQUATIC CHEMISTRY

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Office Hours: https://udenver.zoom.us/my/brianjmajestic
Mon: 11:00 – 12:30
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Course Description: This is a course in *aquatic chemistry*. We will examine the chemical processes which dominate natural waters in oxic and anoxic environments in the earth system. We will discuss basic properties such as alkalinity and then move to advanced topics such as red-ox equilibria, chemical equilibria of multiple components, and solubility as a function of pH. A common theme of this course will be to understand how the chemistry of the system can help to dictate water quality, as well as water treatment for drinking water.

It is assumed that you have a sound knowledge of general chemistry and a good understanding of the concepts of equilibrium. Of most importance is a good handle on General Chemistry II or Quantitative Chemical Analysis (CHEM 2270), as Aquatic Chemistry is a direct extension of many of the concepts covered there.

Textbooks: There is one textbook listed for this course. There are required readings from this textbook, and I highly suggest obtaining a copy. This is a relatively basic textbook, and I will provide supplementation as needed.

- Manahan SE; *Water Chemistry,* 2011, CRC Press, ISBN: 978-1-4398-3068-0

I will also be drawing off of the following textbook, although it is not necessary to purchase:

- Stumm W and Morgan JL; *Aquatic Chemistry: Chemical equilibria and rates in natural waters*, 3rd Ed, 1996, John Wiley & Sons, ISBN: 978-0-471-51185-4

Other Resources: In addition to the textbook, lecture presentations, and handouts, you will have the opportunity (and requirement) to consult other resources. These will consist of websites (laboratories, trade associations, government sites, user groups, and list-servers), electronically available journals, and paper-based journals. Most journal articles published 1970-present are available in electronic format and may be printed and/or stored in journal publication format as *.pdf format. Two examples of where to look are as follows: A) the ACS journals (pubs.acs.org) are available from any DU-based URL; and B) many other journals are available free of charge from several databases available at the DU Library website (www.library.du.edu/). The most

useful databases are A) www.sciencedirect.com, "Sciencedirect", a service with > 1000 full-text journals which the DU library subscribes to, and B) the Web of Science, which can be accessed directly from the Penrose Library webpage (search the Databases at http://library.du.edu/site/). All of the library databases are available without a personal account from any campus-based URL; however, you can access them from off-campus through the DU library's website with proxy identification.

The University Libraries Research Center answers research questions seven days a week by phone, email, in-person, chat/IM or text. One-on-one research consultations in the Anderson Academic Commons are also available on a drop-in basis or by appointment. Consultations help students at any stage of the research process, from refining a topic, to finding books and articles, to creating a bibliography with RefWorks. Ask a question or make an appointment at 303-871-2905 or research-help@du.edu.

Course Topics

I. Introduction / bulk properties (~ 1 week)

- *Hydrological cycle*
- *Importance and anomalies of water*
- *Bulk properties of water – alkalinity and acidity*
- *Charge balance*
- *Activity*

II. Acid-base chemistry (~ 2 weeks)

- *Carbonate Equilibria*
- *Multiple components*
- *pC – pH diagrams*

III. Red-ox equilibria (~ 2 weeks)

- *Importance of oxidative and reductive environments in aquatic waters*
- *Free energy and its relation to red-ox reactions*
- *The "power" of an electron: metal speciation and pE-pH diagrams (Pourbaix diagrams)*

IV. Water Treatment Processes (~ 1 week)

V. Student Presentations (see details at the end of the syllabus) (1 week)

Note that this class is not a prerequisite for any further classes. Therefore, this schedule is ***extremely*** flexible. If you want to go deeper into a topic currently under discussion or if there is a general consensus that we should skip something so we can get into other topics, then say so!

Evaluation Methods

Over the 10 week quarter, you will be evaluated by several criteria. Specifically, you will be expected to complete the following:

- 2 in-class exams – the 2nd will be during the Final Exam period and is cumulative.
- Sporadic homework (4-5)
- One **paired** presentation 20-22 min (+3-5 min questions), including a written summary, OR an individual paper, described in detail at the end of the syllabus.

In the event that you must miss an exam, please let me know ASAP (in advance if possible) and a makeup will be scheduled. I am generally reasonable, but reserve the right to deny makeup exams for confabulated reasons, in which case your missed exam will be counted as a zero.

The breakdowns, immediately below, reflect the "default" grading distribution. As with everything in life, **this is negotiable.** If you believe that you would perform better with different weightings, then we can meet virtually to discuss this by **Monday, Sept 21**.

* Summary of evaluation:

Exams (2 x 25)	= 50 %
Homework	= 25 %
Project	= 25 %

A	≥ 93 %	C	≥ 69 %
A-	≥ 90 %	C-	≥ 65 %
B+	≥ 87 %	D+	≥ 62 %
B	≥ 83 %	D	≥ 58 %
B-	≥ 80 %	D-	≥ 54 %
C+	≥ 74 %	F	≤ 54 %

I reserve the right to make downward adjustments to this scale (i.e. adjustments in the direction of leniency). In no event will the actual scale used be adjusted upward from that described above.

Important Dates:
Sept 14: Classes begin
Sept 21: Last day to drop for 100% refund and drop deleted from record
Oct 25: Last day to drop without approval (W assigned)
Nov 9: Last day to drop with approval
Nov 20: Last day of classes
Dec 1 Final Exam (online)

Group Project:

In the last week of this course, you will lead a 20-22 min (+ ~3 min Q/A) discussion. In addition, a **< 1 page Executive Summary** (title page and references excluded) report of your findings will be turned in on the date of your presentation. Alternatively, an **individual paper** (4-6 pages) can be used instead of an oral presentation. Either way, the technical details of the written sections of the report are below:

- Double spaced
- 12 pt Times New Roman **or** 11 pt Arial
- 1" x 1" margins (this is NOT the default in MS Word).
- Need **at least** five references, only **two** of which can be from reputable web sites. The others must be primary research articles. In general, a ".gov" site is OK (EPA, USGS), in addition to some international agencies such as UNEP and the WHO. Some ".com" sites may be OK, but talk to me if you have questions about the integrity of a specific site. For those in the presentation route, the references can be listed in the presentation, rather than the Executive Summary.

Please be prepared to lead the class for your presentation. Here are some tips for a successful discussion:

1. You are free to use slides, powerpoints, demonstrations, skits, or anything else which will help the class learn the material. Feel free to have an interactive portion, as well.
2. This is not a trivial task – I suggest that you start your research at the beginning of the quarter.
3. I am happy to meet with you as much as you'd like for consultation. However, you are **required** to meet with me (virtually) at least **twice** during the quarter.

Relevant Dates for the Special Project (either paper or presentation):

- Monday, Sept 21: Email Dr. Majestic (see below). This email should contain 1) your name and 2) your preferred topic + one back-up topic.
- Wed, Sept 23: I will approve your choice or suggest an alternative (in class).
- Friday, Oct 9: Deadline for Meeting #1: progress of research and obtaining references
- **Thurs, Oct 29: Rough draft of paper due with bibliography (Paper only, optional)**
- Thurs, Nov 5: Deadline for Meeting #2: will discuss rough draft and/or upcoming presentation progress
- Fri, Nov 20 Presentations / Paper due

Ideas for topics (there are many others and *original ideas are certainly encouraged*!!)

- Water quality and treatment in underdeveloped countries
- Isotope dating and tracing of aquatic organisms
- Ocean acidification
- Iron ocean fertilization
- Pharmaceuticals in drinking water – source and treatment
- Engineered metallic nanoparticles in drinking water
- Desalination of seawater
- Mercury pollution and poisoning
- Fluoride removal
- Microplastics
- Coastal algae blooms
- Phytoremediation (i.e., plants and trees to clean water)
- Other (specify)

Project grade break-down (100 pts total):

1) **Presentation Route:**

Preparation (*5 pts*)
- Meeting #1 (prior to October 9) (2.*5 pts*)
- Meeting #2 (prior to November 5) (2.*5 pts*)

Content (*30 pts*)
- Appropriate scope (*5 pts*)
- Background and motivation (*5 pts*)
- Relevant and correct chemistry/concepts (*10 pts*)
- Summary/Conclusions (*5 pts*)
- Answers to questions (*5 pts*)

Form and style (*30 pts*)
- Slide quality (uncluttered, clear) (*10 pts*)
- Clear explanations (5 pts)
- Verbal quality, eye-contact, body-language (*5 pts*)
- Team balance (*5 pts*)
- Timing (*5 pts*)

Executive Summary (*15 pts*)

Three multiple choice questions (with answers) for use on the Final Exam (5 pts)

Peer and partner grade (*15 pts*)

2) **Paper Route (4-6 pages):**

Preparation (5 *pts*)
- Meeting #1 (prior to end of October 9) (2.5 *pts*)
- Meeting #2 (prior to end of November 5) (2.5 *pts*)

Three multiple choice questions (with answers) for Exam II (5 pts)

Written report (*90 pts*)
- Overall Scope (10 pts)
- Focus (10 pts)
- Relevant and correct chemistry/concepts (15 pts)
- Appropriate **introduction** of the problem/topic (10 pts)
- Appropriate **level of research** into the problem/topic (15 pts)
- Independent **conclusions** based on research (15 pts)
- Clear figures and formatting (5 pts)
- Grammar/spelling (5 pts)
- References (5 pts)