Announcements

Mid-Term Exam

When and Where

• Saturday, November 3, 7:00 – 9:00 PM. Since we will start setting up about half an hour prior to the exam, please remain outside of the rooms, as they cannot be used for studying while we set up.

• Assigned rooms are based on the lecture section of registration and the **last five digits of the student number**. You ***must*** write in the assigned room, as space is limited. Those who arrive at the incorrect room will be asked to leave.

Section 003 (Lipson)	Room
04620 – 14942	SH 2355
15176 – 21129	SH 3315
21169 – 27343	SH 3317
27350 – 40575	TH 3101
40576 – 99554	TH 3102

Section 006 (Lipson)	Room
01806 – 15307	HSB 236
15315 – 27190	HSB 240
27250 – 98264	HSB 35

TH = Thames Hall
HSB = Health Sciences Building
SH = Sommerville House

Exam Content

- Format: 25 multiple-choice questions of equal value. There is no penalty for wrong answers, so it is to your advantage to make an informed guess if you cannot answer a question.

- Two questions will be derived from Experiments A and B (Synthesis and Acid/Base Titration, respectively). These questions will be based on lab theory or procedure. Essentially, if you have used a procedure, calculation, apparatus, or reagent, it is expected that you know what it does, how it works, why you used it, etc. No lab questions will be based directly on your own data, so the lab reports are not needed to study for the test.

- The remaining 23 questions will be derived from material covered in class and in the tutorial manual. The *approximate* question breakdown is provided below

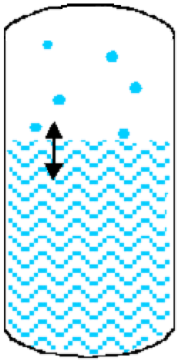
Topic	Questions
Fundamentals and Stoichiometry	10
Strong Acids and Bases	8
Redox	5

I have been told that the biochem instructor said that he has made an announcement multiple times about an early 280a write on Thursday for those with conflicts with C020. Therefore, this conflict will no longer be used as a valid reason to miss the Chemistry midterm.

This is the week of October 29th – November 2nd.

- Group 1 is doing the tutorial on Atoms and Periodicity
- Group 2 is doing the Redox lab.

Vapour-Liquid Equilibrium



Consider the arrangement shown to the right, filled with a liquid and say N_2

Any liquid in a closed container will reach an equilibrium state where the molecules enter the liquid (condense) and leave the liquid (evaporate) at the same rate

The total pressure of the gas phase will be equal to the pressure of N_2 plus the pressure caused by the gas molecules that originated from the liquid (say water)

$$P_{TOT} = P_{Nitrogen} + P_{Water}$$

The partial pressure of the water vapour is referred to as the **vapour pressure** of water.

Its value is fixed at any given temperature, and is independent of the amount of liquid or the presence of any other gases

At higher temperatures the vapour pressure increases because more energy is given to liquid molecules, allowing them to escape into the gas phase
(See Table in lab manual)

Solvents that are more volatile (lower boiling points) have higher vapour pressures

Interesting and proper definition of boiling point: the temperature at which the vapour pressure of a solvent is equal to atmospheric pressure.

Water boils at a lower temperature at higher altitudes. It is really hard to have a hot cup of tea on top of Mt. Everest!

Example:

Some nitrogen is collected over water at 293 K. If 500 mL of gas is collected at 101.3 kPa, what mass of N_2 is present?

P_{Water} at 293 K = 2.34 kPa (from data tables)

$$n_{TOT} = \frac{P_{TOT}V}{RT}$$ = (1.013 bar)(0.5L)/(0.0831 L-bar K^{-1} mol^{-1})(293)

= 2.08×10^{-2} mol

Similarly: $n_{Water} = \frac{P_{Water}V}{RT}$ $= (2.34 \times 10^{-2}$ bar)(0.5 L)/(0.0831L-bar mol^{-1} K^{-1})(293 K)
$= 4.81 \times 10^{-4}$ mol

$$\therefore n_{N_2} = n_{TOT} - n_{Water}$$ $= 2.08 \times 10^{-2} - 4.81 \times 10^{-4} = 2.03 \times 10^{-2}$ mol

$\therefore$ #g $N_2 = 2.03 \times 10^{-2}$ mol x 28 g mol^{-1} = 0.57 g

Electrochemistry

C020

Electrochemistry is the study of the interconversion of electrical and chemical energy

- ➢Using chemistry to generate electricity involves using a **Voltaic Cell** or **Galvanic Cell** (battery)

- ➢Conversely, using electricity to cause chemical changes involves using an **Electrolytic Cell**

Both Voltaic and Electrolytic Cells have the same underlying theory but they will be considered separately

1.) Voltaic Cells

Consider the following reaction that can be done in the lab

Add Zn metal to a solution of CuSO4
The following then happens simultaneously:

- The blue color of Cu^{2+} disappears
- The Zn metal slowly dissolves
- Solid Cu metal (reddish brown) precipitates

The reaction for this is:

$$CuSO_4(aq) + Zn(s) \rightarrow Cu(s) + ZnSO_4(aq)$$

Zn(s) is a reducing agent and is oxidized to Zn^{2+}(aq)

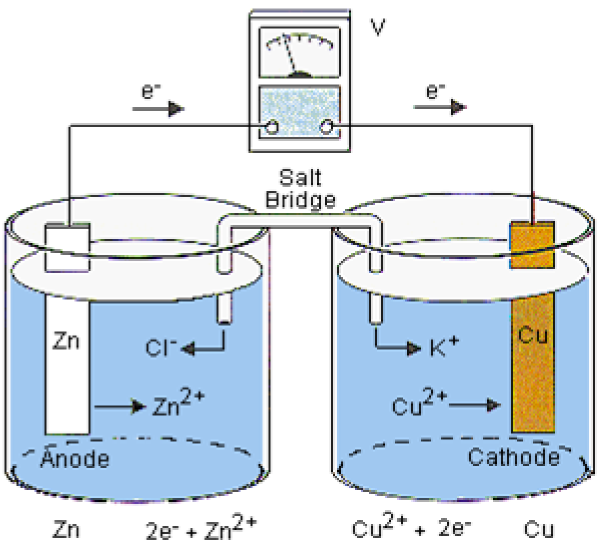
Cu^{2+}(aq) is an oxidizing agent and is reduced to Cu(s)

The corresponding half-reactions, leaving out the spectator SO_4^{2-} ion, are:

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

$$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$$

This is a redox reaction, which occurs spontaneously by itself.
If the reaction is allowed to proceed in a beaker, the liberated energy would appear as heat



However, if each half-reaction took place in separate but electrically connected beakers, the 2 e^- can be made to travel along a wire and do electrical work.
The liberated energy would then appear as light (passing through a light bulb) or as shown in the picture, a signal on a volt meter

Definitions

Oxidation occurs at the anode (an ox)

Reduction occurs at the cathode (red cat)

Thus, cations (positively charged species) travel to the cathode;
anions (negatively charged species) travel to the anode

The e^-s travel through the wire because there is an unbalanced electrical force known as the electromotive force (***EMF***) which pushes electrons generated from the oxidation half-reaction towards the electrode where reduction occurs

EMF is measured in Volts, V (potential difference).
The greater the difference in potential energy between the two electrodes the greater the ***EMF***

To generate the largest ***EMF*** one requires a metal that really wants to be oxidized and ion that really wants to be reduced

A potential difference of 1 Volt causes a charge of 1 Coulomb to acquire an energy of 1 Joule

$\therefore \quad 1\ V = 1\ J\ C^{-1}$

One mole of electrons corresponds to 96480 C ≡ Faraday Constant

Who was Faraday?

•Michael Faraday was an Englishman born in 1791 and died in 1867.

• Is most famous for his work on electromagnetism and electrochemistry. Among his many accomplishments he discovered electromagnetic induction, diamagnetism Electrolysis, and the invention of the electric motor.

• He also discovered benzene, invented an early form of the bunsen burner and a system of oxidation numbers.

• He is considered by many to be the best experimentalist of the 19th century.

EMF is measured using a voltmeter.
The potential energy difference is commonly called the cell potential, E_{cell}

In the cell diagram before there is a salt bridge. Why?

- The salt bridge, which connects the two beakers, is typically some inert solution that does not take place in the redox reaction (sodium sulfate, potassium nitrate, etc)

- As the reaction occurs, there is a build up of cation concentration at the Zn anode, and a decrease in cation concentration at the Cu electrode

- Therefore, anions migrate through the salt bridge from the Cu side to the Zn side, and cations pass in the opposite direction, to preserve charge balance