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Aero Thermo Hydro Engineers Nuclear Application

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Lecture: 09:30~10:45, Mon & Wed, 032-108

Problem Set 1

1. Avogadro Constant **20%**

The Avogadro constant denotes the number of units in one mole of any substance defined as its molecular weight in grams, equaling 6.022×10^{23}. The units may be electrons, atoms, ions, or molecules, depending on the nature of the substance and the character of the reaction, if any. The Avogadro law stipulates that under the same conditions of temperature and pressure, equal volumes of gases contain an equal number of molecules. The empirical relation can be derived from the kinetic theory of gases under the assumption of a perfect (ideal) gas. The law is approximately valid for real gases at sufficiently low pressures and high temperatures. The molecular weight of oxygen is 32, so that one gram-mole of oxygen has a mass of 32 g and contains 6.022×10^{23} molecules. The volume occupied by one gram-mole of gas is about 22.4 liters at 0 ℃ and 1 atm and is the same for all gases, according to the law. We are interested to experimentally measure Avogadro's number. This experiment is based on the mass loss of the copper anode, but it is also possible to collect the hydrogen gas that is evolved and use it to calculate Avogadro's number. You may wish to review the working of electrochemical cells before attempting to understand this experiment. You are supposed to obtain two copper electrodes. Clean the electrode to be used as the anode by immersing it in 6 M HNO_3 in a fume hood for 2~3 seconds. Remove the electrode promptly or the acid will destroy it. Do not touch the electrode with your fingers. Rinse the electrode with clean tap water. Dip the electrode into a beaker of alcohol. Place the electrode onto a paper towel. When the electrode is dry, weigh it on an analytical balance to the nearest 0.0001 g. Remember that 1 A = 1 C/s and charge of one electron is 1.602×10^{-19} C. Now let's say that the following measurements were made: anode mass lost: 0.3554 g; average current: 0.601 A; time of electrolysis: 1802 s.

A. Find the total charge passed through the circuit.
B. Calculate the number of electrons in the electrolysis.
C. Determine the number of copper atoms lost from the anode.
D. Calculate the number of copper ions per gram of copper from the number of copper ions above and the mass of copper ions produced.
E. Calculate the number of copper atoms in a mole of copper, 63.546 grams.
F. Calculate the percentile error.

2. Avogadro Constant on Video **20%**

View https://www.youtube.com/watch?v=74-X94OP2XI. This video tutorial focuses on Avogadro's number and how it is used to convert moles to atoms. This video also shows you how to calculate the molar mass of a compound and how to convert from grams to moles. Summarize the lessons you've learned from this clip. Do you have any other idea(s) to determine the Avogadro constant in the 21st century?

3. Physics Tricks with Water **20%**

View https://www.youtube.com/watch?v=yUQHyhYCuwI to check on the three physics tricks with water. The first is turning a glass of water upside down, using a playing card to hold the water. The second is turning a soda bottle upside down with no card, without spilling the water. The third is turning a soda bottle into a booby trap squirting practical joke. Elaborate the physics seemingly hidden behind.

4. More Tricks with Water **20%**

View https://www.youtube.com/watch?v=wXwSpcfYBD4 to enjoy more awesome water tricks and experiments you didn't know before. They are so simple and easy that you can do them at home like water freeze, cooking oil and water trick with food color, etc. Provide with as detailed physical explanations as you possibly can.

5. Water Freezes from Top to Bottom **20%**

Warm water generally gets denser as it gets colder, and therefore sinks. This fact may lead you to deem that ice should form on the bottom of a lake first. But a funny thing happens to water as it gets even colder. In deep lakes, water pressure may also play a role. Watch closely https://www.youtube.com/watch?v=JFwa9MwCaXg to figure out why ponds, lakes and rivers freeze from top to bottom. We drink water, we swim in it, we wash with it, and we cool things down with it. Because water is so common, many of us indeed fail to notice just how strange it is compared to other fluids. When we plop an ice cube or two into our drink during the warmer months, we watch it float above the liquid in our glass without a second thought. But why does ice do this, and why does water freeze from the top to the bottom, when most other substances freeze from the bottom up? Water freezes from the top down because of a strange quirk in how water's density behaves at falling temperatures. Density is the mass of a unit volume of a material substance. It is essentially a measure of how tightly packed the atoms and molecules of a substance are. What will be happening to the sea water with salt in it?