Avogadro's Constant (N_A): Where it Comes From ? What it Means? And Who has Measured it?

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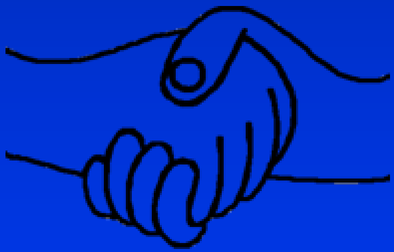

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North Shore Senior High
CULLEN COLLEGE
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High School Outreach Program

Spring 2009

Spring 2010

Fall 2010

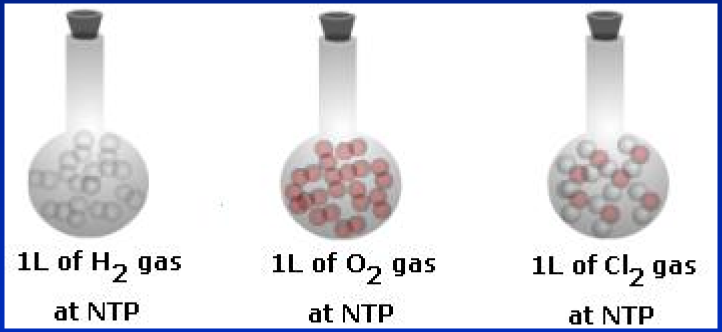
Education Material Available at:

www2.egr.uh.edu/~ecnfg/outreach

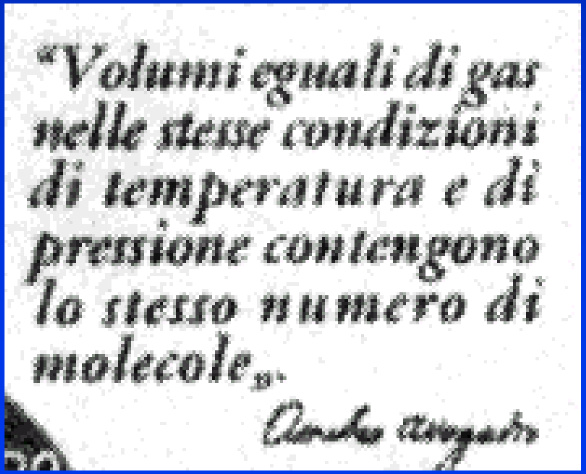
Who is This Funny Looking Italian Guy

Amadeo Avogadro
1776-1856

Avogadro’s Law



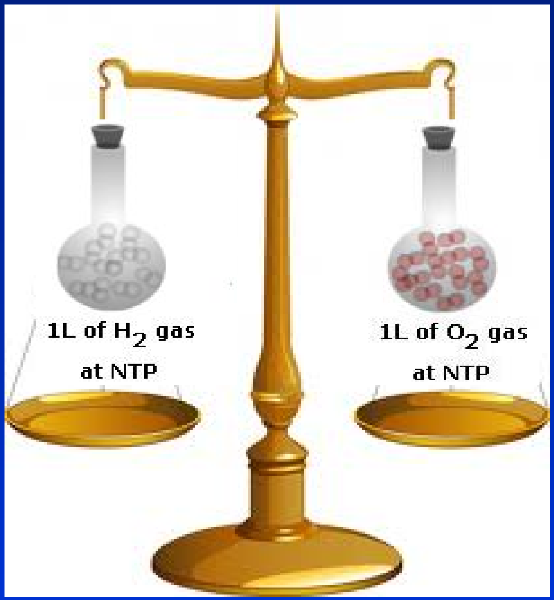
Equal volumes of gasses under the same conditions of pressure and temperature contain the same number of molecules



“Volumi eguali di gas nelle stesse condizioni di temperatura e di pressione contengono lo stesso numero di molecole”.

An Important Conclusion

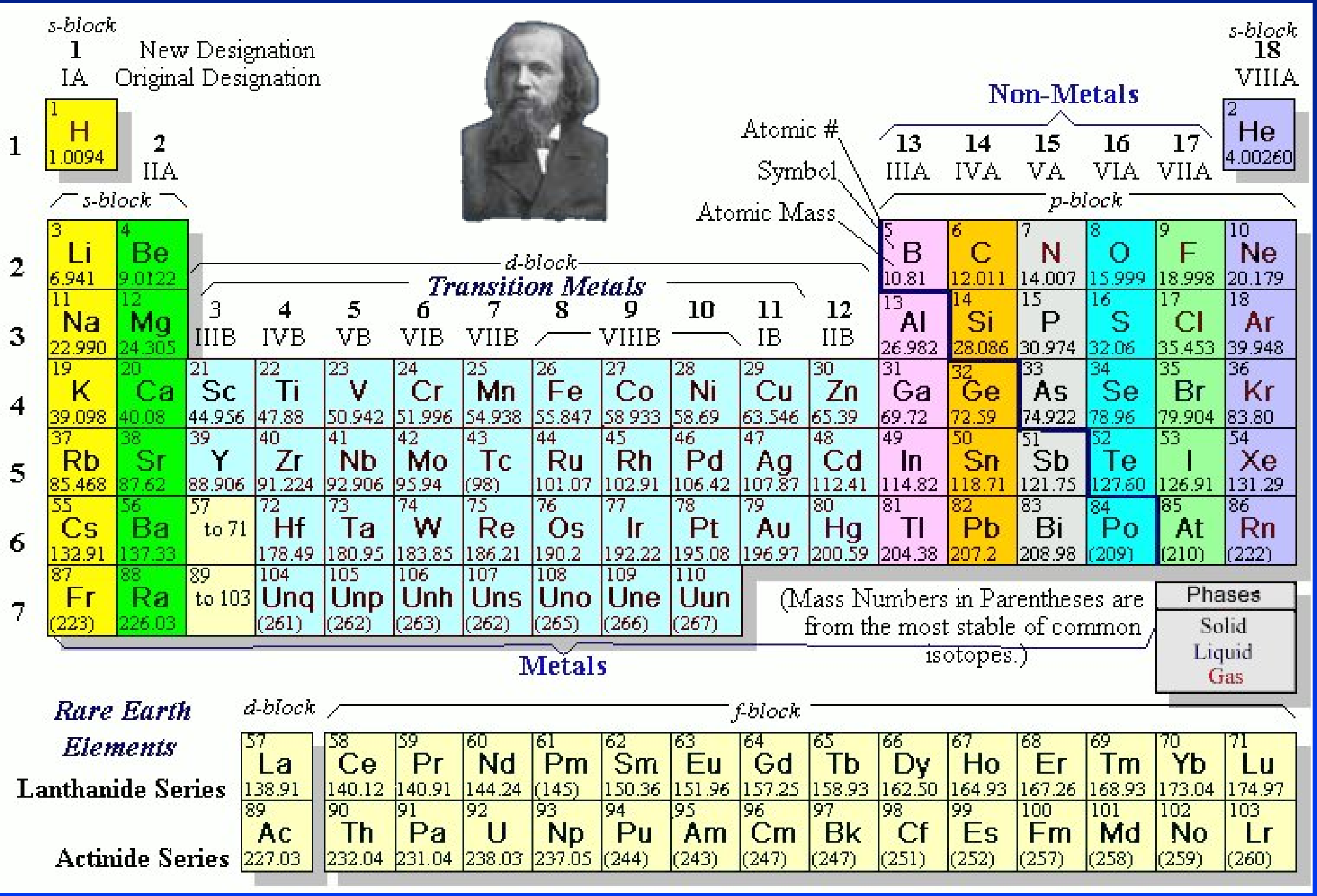
Measuring the weight of equal volumes of different gasses we can get the relative weight ration of their atoms/molecules



This fact establishes a fundamental property of different elements and that is their atomic weight or i.e. molar mass

Some hippie Russian guy took this idea further and made the life of all chemists easier

An Epic Agreement:
1 mole of H_2 is 2 g, and 1 mole of O_2 is 32 g



Mole is Measure of Quantity of Matter
Mole ; [mol]

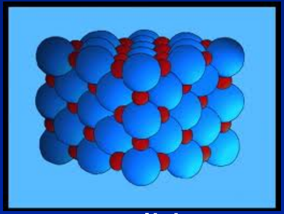
Hydrogen is the lightest element in the periodic table. So it was decided that one mole of this element has 1 g of mass. The molar masses of other elements were established by simple comparison i.e. using the ratio between the mass of I mol of H (C) and mass of 1 mol of other elements.

*One mole of matter is the certain amount /weight, that contains an arbitrary number of elementary particles (**this number we have to agree on**) having the same property as the bulk of this matter (compounds=molecules, elements=atoms)*

*One mole of any matter has the **same number** of elementary particles (molecules or atoms)*

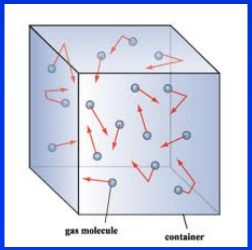
What is this number ?

This is the number of atoms that the weight of 12 g of C_{12} carbon contains (this is an agreement). Historically, first element to serve as an etalon in definition of mole was oxygen



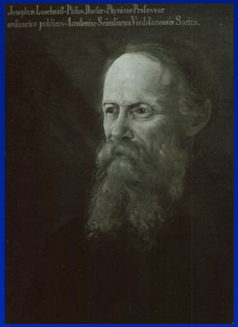
Solid
NaCl

Liquid
H_2O

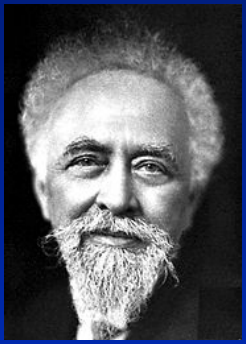


Gas
N_2

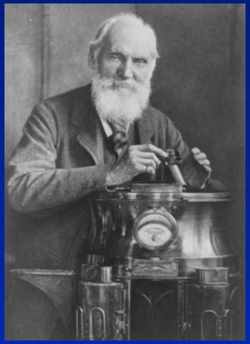
Who Has Measured the N_A First?



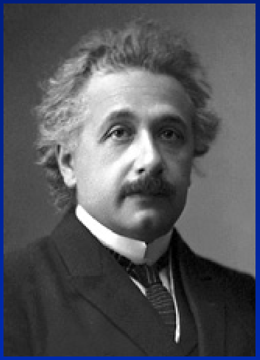
Johann Josef Loschmidt
1821-1895



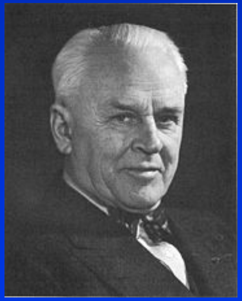
Jean Perrin
1870-1942



Lord William B. Kelvin
1824-1907



Albert Einstein
1879-1955



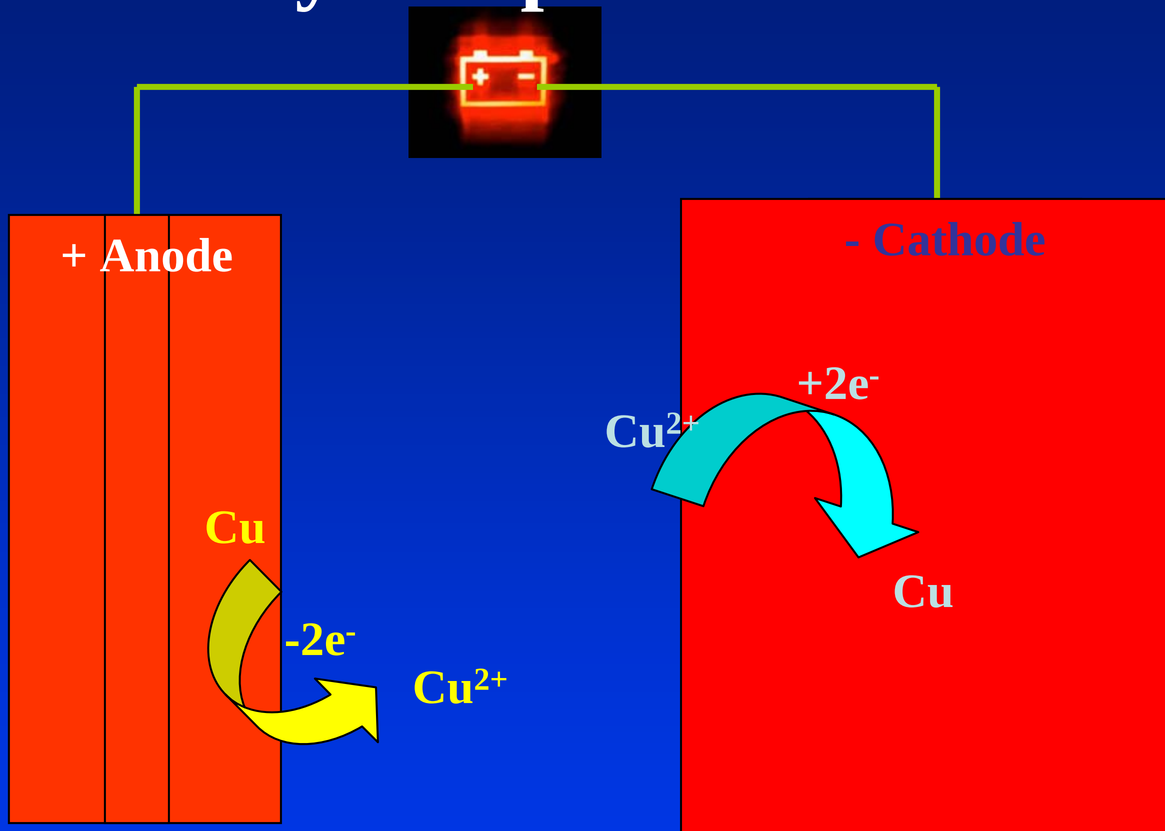
Robert Millikan
1868-1953

Currently Accepted Consensus for Accurate Value of N_A
(NIST 1971)
$N_A = 6.0221499 \times 10^{23}$

Electrochemical Measurement of N_A i.e. Faraday's Experiment

Michael Faraday
1791-1867

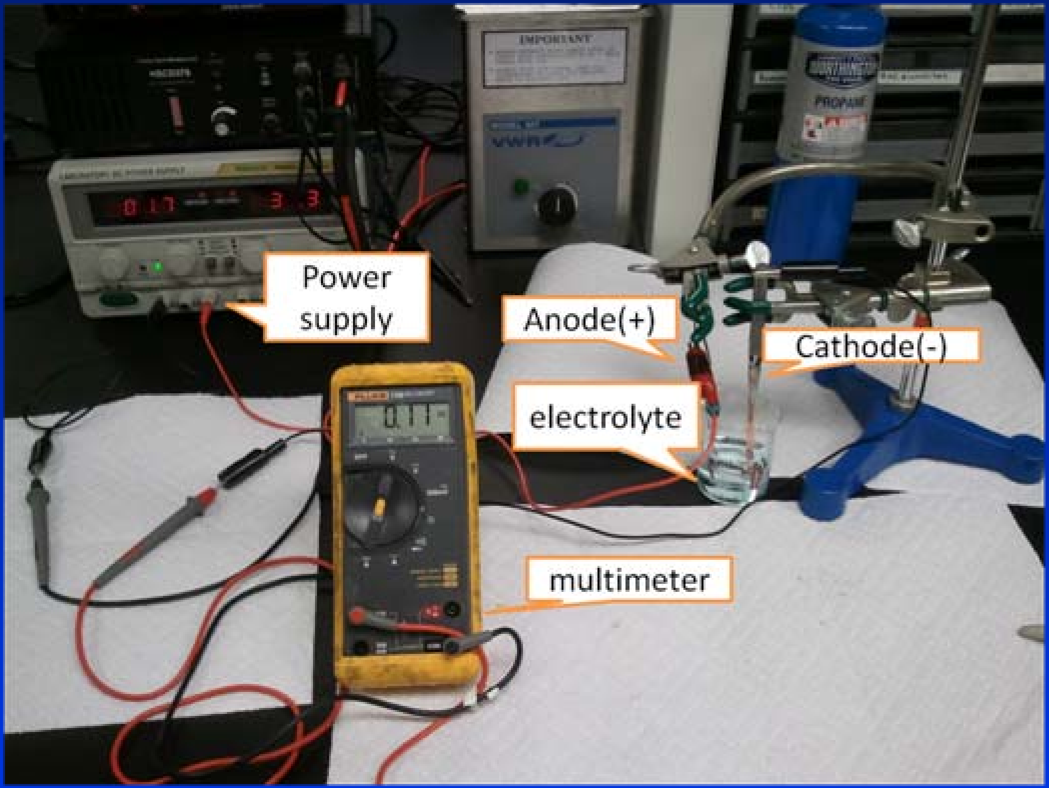
$\Delta m < 0$

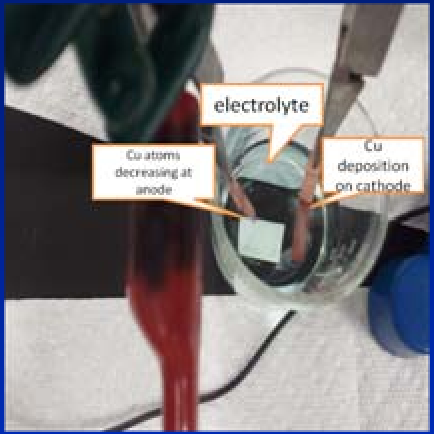


$\Delta m > 0$

Cathode and Anode are Cu
Electrolyte is 0.05 M H_2SO_4

Experimental Set Up





Time / min	1	2	3	4	5	6	7	8	9	10
Current /A										

Let’s Do It, and Let’s Measure N_A

1.Average Current:

exp#1____.165A_____;exp#2___.185A_______

2.-3.Charge = Average Current*time passed (600 sec)

exp#1___99.6C_______;exp#2__111C________

4. # of electrons passed=Charge/$1.6022x10^{-19}$ C

exp#1______6.217E2/____;exp#2___6.928E2/_______

5. Number of Cu Atoms Dissolved = #electrons passed/2 ($Cu = Cu^{2+} + 2e^{-}$)

exp#1___3.1/8E2/_______;exp#2__3.464E2/________

6. Mass of Cu dissolved (Δm)

exp#1___./33g_______;exp#2__./33g________

7. # of Cu atoms per gram= #Cu Atoms dissolved/ Δm

exp#1__9.418E21________;exp#2____1./49E22______

8. N_A=#of Cu atoms per gram*63.5 g/mol

exp#1__5.98E23________;exp#2___6.66E23_______

< N_A >= 6.32E23