화학 General Chemistry
034.020-005

2018 Spring Semester

Tue/Thr 9:30~10:45
Building 028-302

송윤주 woonjusong@snu.ac.kr

034.020-005 General Chemistry

출석: 10%
과제: 5%
중간: 35%
기말: 45%
태도: 5%

합계: 100%

- 출석는 1회 무단 결석시 -1점; 지각시 -0.5 점
- 출석 및 지각 체크는 랜덤하게 실시할 예정
- 피치 못할 사정으로 결석/지각시 반드시 하루 전에 메일로 연락하고, 승인 답장 이메일을 받아야만 용인됨
- 과제는 각 chapter 끝나고 일주일 내에 수업 시작 전까지 제출
- 미제출시에 -1점, (시간 엄수: 수업 시작 전까지), 지각시 수업시간 끝날 때까지만 받음. 결석시에는 이메일로 스캔/사진으로 제출할 것
- 손으로 직접 써서 제출
- 수업중에 핸드폰 사용 및 부적절한 행동시에 태도 점수 차감 (-1점씩)

Textbook: Chemical Principles by Atkins (any edition)
Slides for the class will be uploaded a day prior to the class.

034.020-005 General Chemistry

휴강: 4월 19일 (목요일)-대한화학회 (보강필요)
5월 22일 (화요일)-부처님오신날

중간고사: 4월 21일 토요일 13:30-15:30 (보강으로 간주)
기말고사: 6월 16일 토요일 13:30-15:30

Before Starting…

1. Take out your cellular phone.
2. Type the following address: https://kahoot.it/
3. Please enter the pin number.
4. You have to use your real name; no nickname allowed.

Start

「기초화학1」강좌

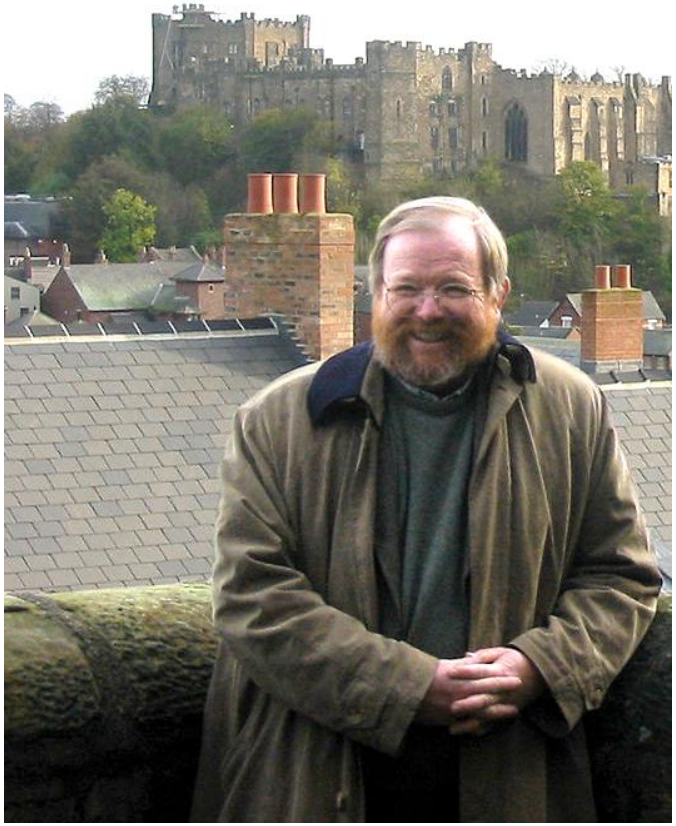
위 교과목은 일반화학 강좌 수강생을 대상으로 우수한 학부생 조교가 매 주 1회 2시간씩 각 주 강의 진도에 맞게 스터디 형식으로 미진한 부분을 가르치는 교과목입니다.
고등학교 재학 당시 화학에 자신이 없는 학생을 위한 과목입니다.

1. 신청기간: **수강신청 변경기간**

2. 신청방법: 서울대학교 수강신청사이트 (http://sugang.snu.ac.kr/)
   기초화학1【034.025(001)】

3. 운영방식: 각 강좌당 1~3개의 조로 편성됨. 1개 조당 1명의 조교와 3~5명 정도의 학생들이 참여하며 **매주 1회 저녁 6시부터 2시간 진행됨.**

※ 담당대학원생(조교) 정선경 magnifiquej@snu.ac.kr

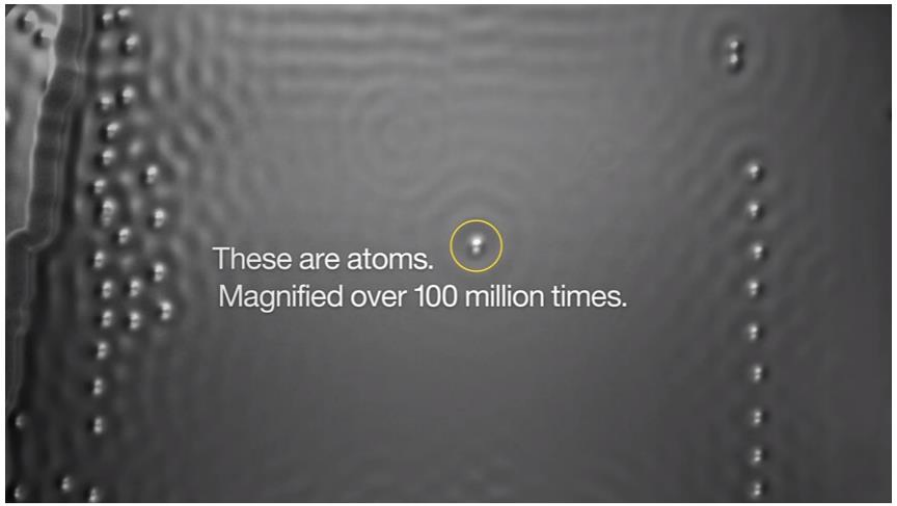


William McGuire "Bill" Bryson
" 거의 모든 것의 역사 " 에서…

"Every atom you possess has almost certainly passed through several stars and been part of millions of organisms on its way to becoming you. We are each so atomically numberous and so vigorously recycled at death that a significant number of our atoms-up to a billion for each of us, it has been suggested-probably once belonged to Shakespeare. A billion more each came from Buddha and Genghis Khan and Beethoven, and any other historical figure you care to name."

His/Her atoms are not enough to make even one brain cell.

The World's Smallest Movie

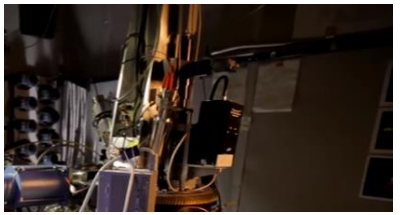


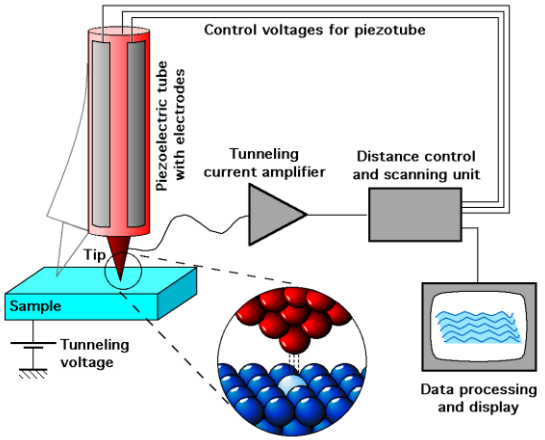
A Boy And His Atom: The World's Smallest Movie

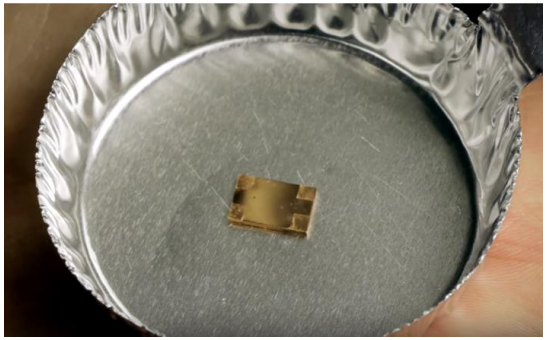
IBM: Published on Apr 30, 2013

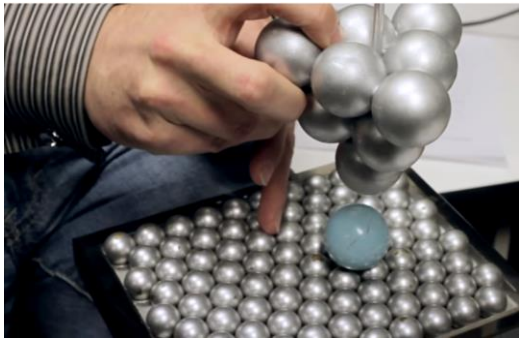
Carbon monoxide (CO)

Scanning tunneling microscope



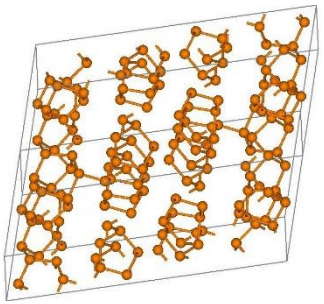


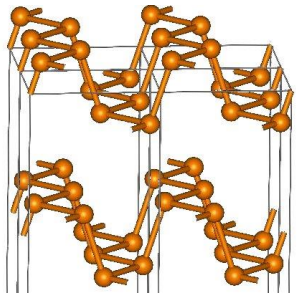


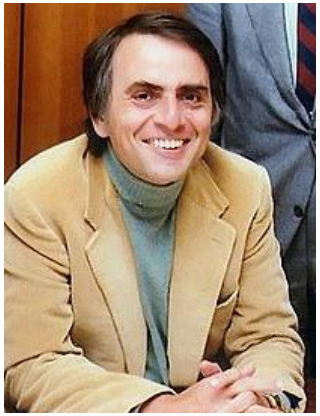


- Magnetic properties of atoms on the surfaces: how small can you make the magnetic smaller and use it for data storage.
- 100 million times magnified: If the atom is the size of orange, then, the orange is the size of the Planet Earth.

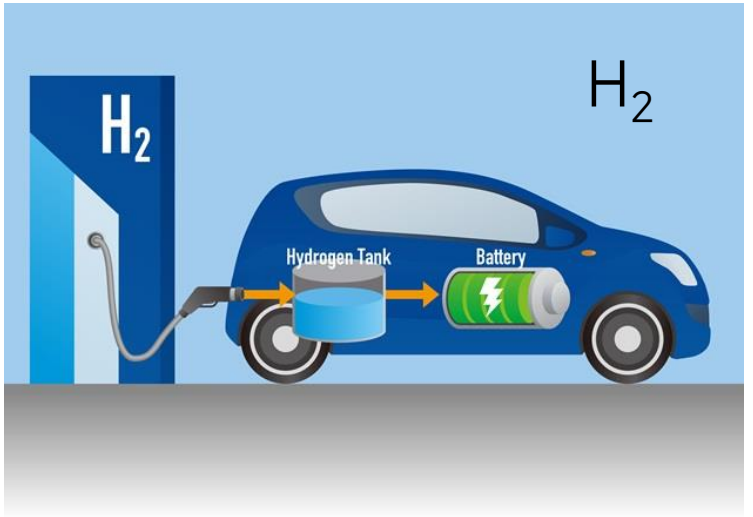
Phosphorus, $_{15}P$ allotropes







"생명의 아름다움은 그것을 구성하는 원자들에 있지 않고 원자들이 어떻게 배열되었는지에 있다." – 칼 세이건 (Carl Sagan: known for COSMOS)



H_2O

Outline of General Chemistry

Chapter 0. Fundamentals
Chapter 1. Atom
Chapter 2. Chemical Bond between Atoms
Chapter 3. Shape and Structure of Molecules

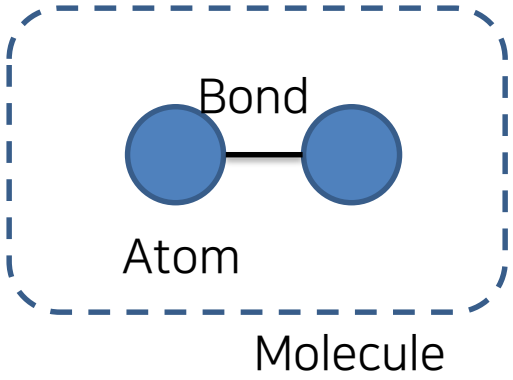
Basic properties of matter

Chapter 4. Gas
Chapter 5. Liquid and Solid
Chapter 6. Inorganic Materials

Chapter 7. Thermodynamics: The First Principle
Chapter 8. Thermodynamics: The Second and Third Principles

Midterm Exam

Whether reactions will happen,
Direction of reactions



Outline of General Chemistry

Chapter 9. Physical Equilibrium
Chapter 10. Chemical Equilibrium
Chapter 11. Acid and Base
Chapter 12. Aqueous Equilibrium
Chapter 13. Electrochemistry

Whether reactions will happen,
Direction of reactions

Chapter 14. Kinetics

How fast a reaction will happen

Chapter 15. Main Group Chemistry
Chapter 16. d-block Transition Elements
Chapter 17. Nuclear Chemistry
Chapter 18. Organic Chemistry
Chapter 19. Polymers and Biological Chemicals

Final Exam

What is Chemistry?

Similar to how Sheldon describes physics in the tv program, big bang theory (0:45'-1:45)

The word **chemistry** comes from the word *alchemy*, which is often seen as linked to the quest to turn lead or another common starting material into gold.

1000 B.C.

-processing of metals for ornaments and weapons

-use of embalming fluid (for preservation of dead bodies)

400 B.C.

"All matter is composed of indivisible small particles called atomos"

atomos = a (not) + tomos (cut)

in- divisible

Hennig Brand (1630 –1692 or 1710)

"philosopher's stone" into gold

Urine: 5700 L!

Discovery of phosphorus! (accepted in 1770s)

Fundamentals in Chemistry

1. is a branch of physical science that studies the composition, structure, properties and **change** of **matter.**
; **화학**(chemistry): 물질과 물질의 변화를 다루는 과학

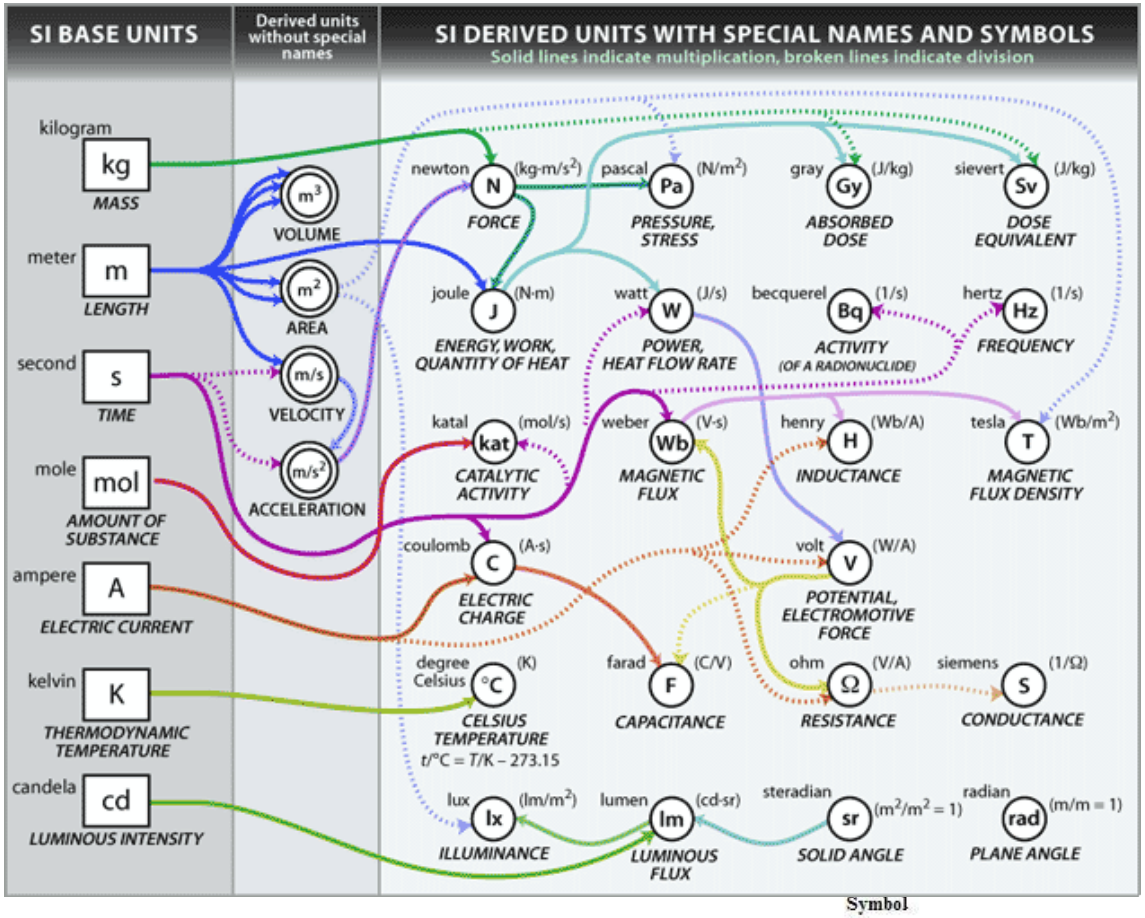
Chemistry is sometimes called the central science because it bridges other natural sciences, including physics, geology, and biology.

2. : 질량을 가지고 공간을 차지하는 모든 것 (혼합물+순물질 포함)
vs 순물질(substance): 물질의 단일하고 정제된 형태

- 물질의 **상태**(state of matter): 고체(solid), 액체(liquid), 기체(gas)

- 물질의 **성질**(property)
  물리적 성질(physical property ex) 질량, 온도)
  화학적 성질(chemical property= 물질의 정체성: 물질이 반응시 함)

- 물리량의 측정/**단위**(unit): m, kg, s; Unit conversion!



SI Derived Units

Derived Quantity	Name	Symbol	Equivalent SI units
Frequency	hertz	Hz	s^{-1}
Force	newton	N	$m \cdot kg \cdot s^{-2}$
Pressure	pascal	Pa	N/m^2
Energy	joule	J	N·m
Power	watt	W	J/s
Electric charge	coulomb	C	s·A
Electric potential	volt	V	W/A
Electric resistance	ohm	Ω	V/A
Celsius temperature	degree Celsius	°C	K*

Prefix	Symbol for Prefix		Scientific Notation
exa	E	1 000 000 000 000 000 000	10^{18}
peta	P	1 000 000 000 000 000	10^{15}
tera	T	1 000 000 000 000	10^{12}
giga	G	1 000 000 000	10^{9}
mega	M	1 000 000	10^{6}
kilo	k	1 000	10^{3}
hecto	h	100	10^{2}
deka	da	10	10^{1}
----	--	1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000 001	10^{-6}
nano	n	0.000 000 001	10^{-9}
pico	p	0.000 000 000 001	10^{-12}
femto	f	0.000 000 000 000 001	10^{-15}
atto	a	0.000 000 000 000 000 001	10^{-18}

3. : 원소(element)의 가장 작은 **입자**

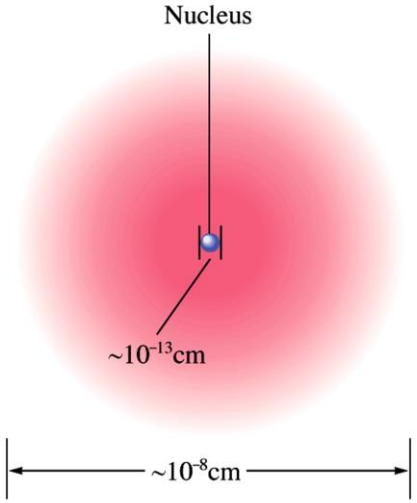
- vs 원소: 한 종류의 원자로 구성된 물질

We will learn the nuclear model in greater details in chapter 1.

Atom= 핵자(Nucleon)+전자(electron)
= 양성자(proton)+중성자(neutron) +전자(electron)

Particle	Symbol	Charge*	Mass, kg
electron	e^-	−1	9.109×10^{-31}
proton	p	+1	1.673×10^{-27}
neutron	n	0	1.675×10^{-27}

: 핵안의 양성자+중성자 개수=



Atomic Symbol

Mass number
Atomic number
$^{A}_{Z}X$ ← Element symbol

Z: number of protons

A: number of protons + number of neutrons

$^{23}_{11}Na$ 11 electrons, 11 protons, 12 neutrons

: 같은 원자번호를 가지나, 질량수가 다른 원자 $^{16}_{8}O$ $^{17}_{8}O$ $^{18}_{8}O$

Average Atomic Mass

Take into account the of carbon isotopes:

98.89% ^{12}C (12 amu)

1.11% ^{13}C (13.0034 amu)

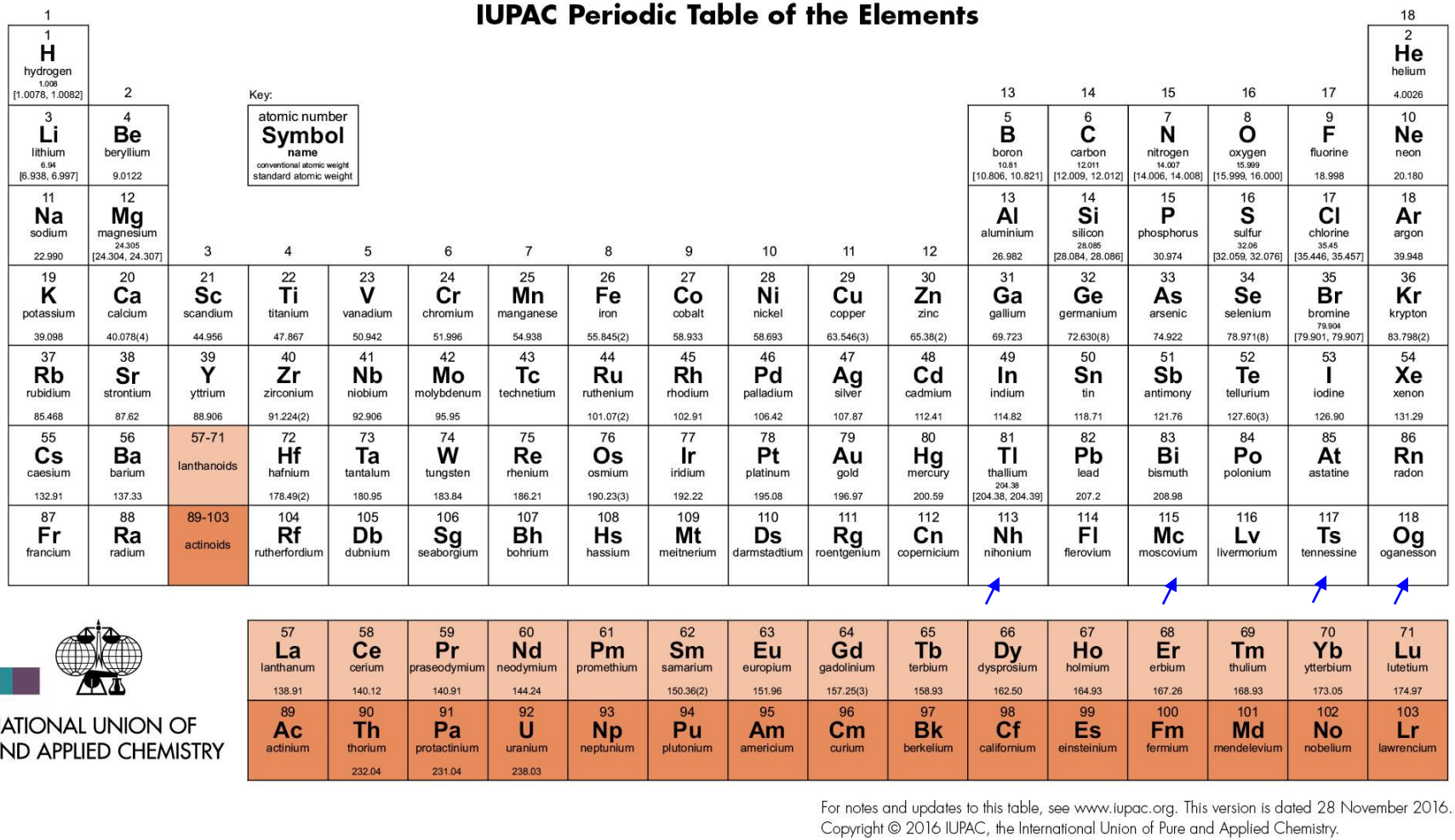
(Average) Carbon atomic mass

= 0.9889 x 12 amu + 0.0111 x 13.0034 amu

= 12.01 amu

4. Periodic Table (주기율표)

- Updated on 28 November 2016
- Includes the recently added elements 113, 115, 117, and 118 with their names and symbols



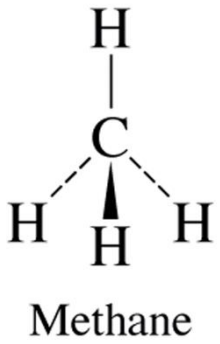
- Named after a place or geographical region, or a scientist.
- Nh: Nihon which is one of the two ways to say “Japan” in Japanese; Mc: Moscovium is in recognition of the Moscow region; Ts: Tennessee region of the United States; Og: Professor Yuri Oganessian

5. 두개 이상 **원소**의 **원자**들이 특정한 비율로 **결합(bond)**되어 만들어진 전기적으로 중성인 물질

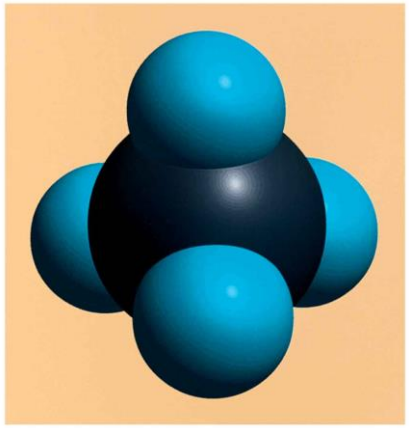
-**분자**(molecule): A collection of covalently-bonded atoms.

Covalent bonds: result from atoms sharing electrons.

CH_4



Methane



Chemical formula

Structural formula

Space-filling model

Ball-and-stick model

-**이온** (ion): 양전하 또는 음전하를 띠는 원자나 분자: 양이온(cation), 음이온(anion)
ex) NaCl

Ionic Bonding: Force of attraction between oppositely charged ions.

Cation: A positive ion Mg^{2+}, NH_4^+

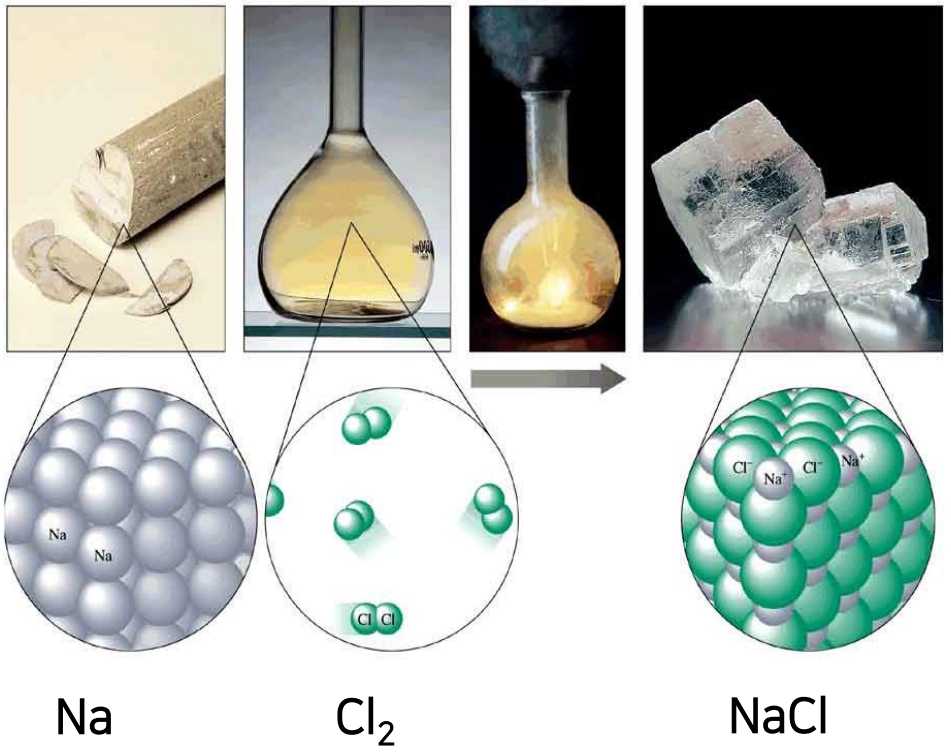
Anion: A negative ion Cl^-, SO_4^{2-}

Ionic solid (salt): a solid consisting of oppositely charged ions

sodium chloride (NaCl): Na^+ and Cl^-

-cation: $Na \rightarrow Na^+ + e^-$

-anion: $Cl + e^- \rightarrow Cl^-$



Molecular Weight (or molar mass)

Add all of the atomic mass of the atoms in a molecule:

ex)
Molecular weight of a H_2O molecule
= 2 x 1 + 16 = 18 amu (or gram/mole)

Molecular weight of a C_6H_6
= 6 x 12 + 6 x 1 = 78 amu

6. Mole

Mass of a ^{12}C atom = 12 atomic mass unit
= 12 amu
= 1.660538×10^{-27} kg

ex) Mass of a ^{13}C = 13.003355 amu

6.022×10^{23} = Avogadro's number

One mole of ^{12}C weighs 12 gram
One mole of ^{1}H weighs 1 gram
One mole of H_2O weighs 18 gram

Two moles of ^{12}C weighs 2 x 12 gram = 24 gram,
1.2 gram of ^{12}C corresponds to 0.1 mole.

6. Mole

One mole of ANYTHING contains 6.022×10^{23} entities.

One mole of donuts contains 6.022×10^{23} donuts

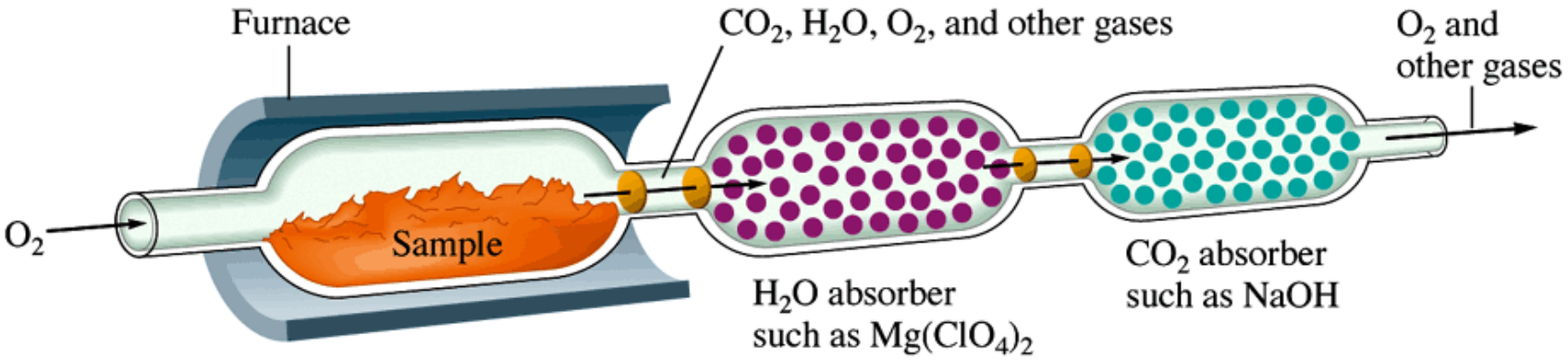
One mole of H_2O contains 6.022×10^{23} H_2O molecules

One mole of Fe contains 6.022×10^{23} Fe atoms

One mole of dogs contains 6.022×10^{23} dogs

One mole of electrons contains 6.022×10^{23} electrons

Experimental Methods of Elemental Analysis



(Very) old method → Burn the sample with oxygen:

$$X + lO_2 \rightarrow nCO_2 + mH_2O$$

Number of CO_2 molecules = number of C-atom in compound X
Number of H_2O molecules = ½ of H-atoms in compound X

$$X + lO_2 \rightarrow nCO_2 + mH_2O$$

Amounts of reactants and products

1. Balance the equation.
2. Convert mass to moles.
3. Set up mole ratios.
4. Use mole ratios to calculate moles of desired substituent.
5. Convert moles to grams, if necessary.

Question: What mass of oxygen will react with 96.1 grams of propane?

1. Balance equation

$$C_3H_8\,(g) + 5O_2\,(g) \rightarrow 3CO_2\,(g) + 4H_2O(g)$$

1 mole of C_3H_8 reacts with 5 moles of O_2 to produce 3 moles of CO_2 and 4 moles of H_2O.

2. Convert mass to mole

$$96.1 \text{ g } C_3H_8 \times \frac{1 \text{ mol } C_3H_8}{44.1 \text{ g } C_3H_8} = 2.18 \text{ mol } C_3H_8$$

3. Set up mole ratio and use mole ratios to calculate moles of desired substituent.

$$2.18 \text{ mol } C_3H_8 \times \frac{5 \text{ mol } O_2}{1 \text{ mol } C_3H_8} = 10.9 \text{ mol } O_2$$

4. Calculate mass

$$10.9 \text{ mol } O_2 \times \frac{32.0 \text{ g } O_2}{1 \text{ mol } O_2} = \qquad O_2$$

$$2NH_3(g) + 3CuO(s) \rightarrow N_2(g) + 3Cu(s) + 3H_2O(g)$$

18.1 g 90.4 g How many grams of N_2?

Initially,

1.06 mole 1.14 mole

1.06 mole 1.06 x 3/2 = 1.59 :Limiting Reagents

1.14/3*2=0.76	1.14 mole

Therefore,

1/3 x 1.14 = 0.380 moles of N_2 are produced.

0.380 moles x 28 g/mole = grams of N_2

Describing Reactions in Solution

1. Molecular equation (reactants and products as compounds)

$$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

2. Complete ionic equation (all strong electrolytes shown as ions)

$$Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \rightarrow AgCl(s) + Na^+(aq) + NO_3^-(aq)$$

3. Net ionic equation (show only components that actually react)

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

Na^+ and NO_3^- are spectator ions.

Ex) Determining the Mass of Products Formed II

Calculate the mass of **$PbSO_4$** formed when 1.25 L of 0.0500 M $Pb(NO_3)_2$ and 2.00 L of 0.0250 M Na_2SO_4 are mixed.

Solution

$$Pb^{2+}(aq) + SO_4^{2-}(aq) \longrightarrow PbSO_4(s)$$

$$1.25 \cancel{L} \times \frac{0.0500 \text{ M } Pb^{2+}}{\cancel{L}} = 0.0625 \text{ mol } Pb^{2+}$$

$$2.00 \cancel{L} \times \frac{0.0250 \text{ mol } SO_4^{2-}}{\cancel{L}} = 0.0500 \text{ mol } SO_4^{2-}$$

SO_4^{2-} is limiting.

$$0.0500 \cancel{\text{mol } PbSO_4} \times \frac{303.3 \text{ g } PbSO_4}{1 \cancel{\text{mol } PbSO_4}} = PbSO_4$$

- Problem Set 0 will be uploaded in eTL website today.

- It is due next Tuesday (9:30 PM): 3월 13일

- See you next Thursday!