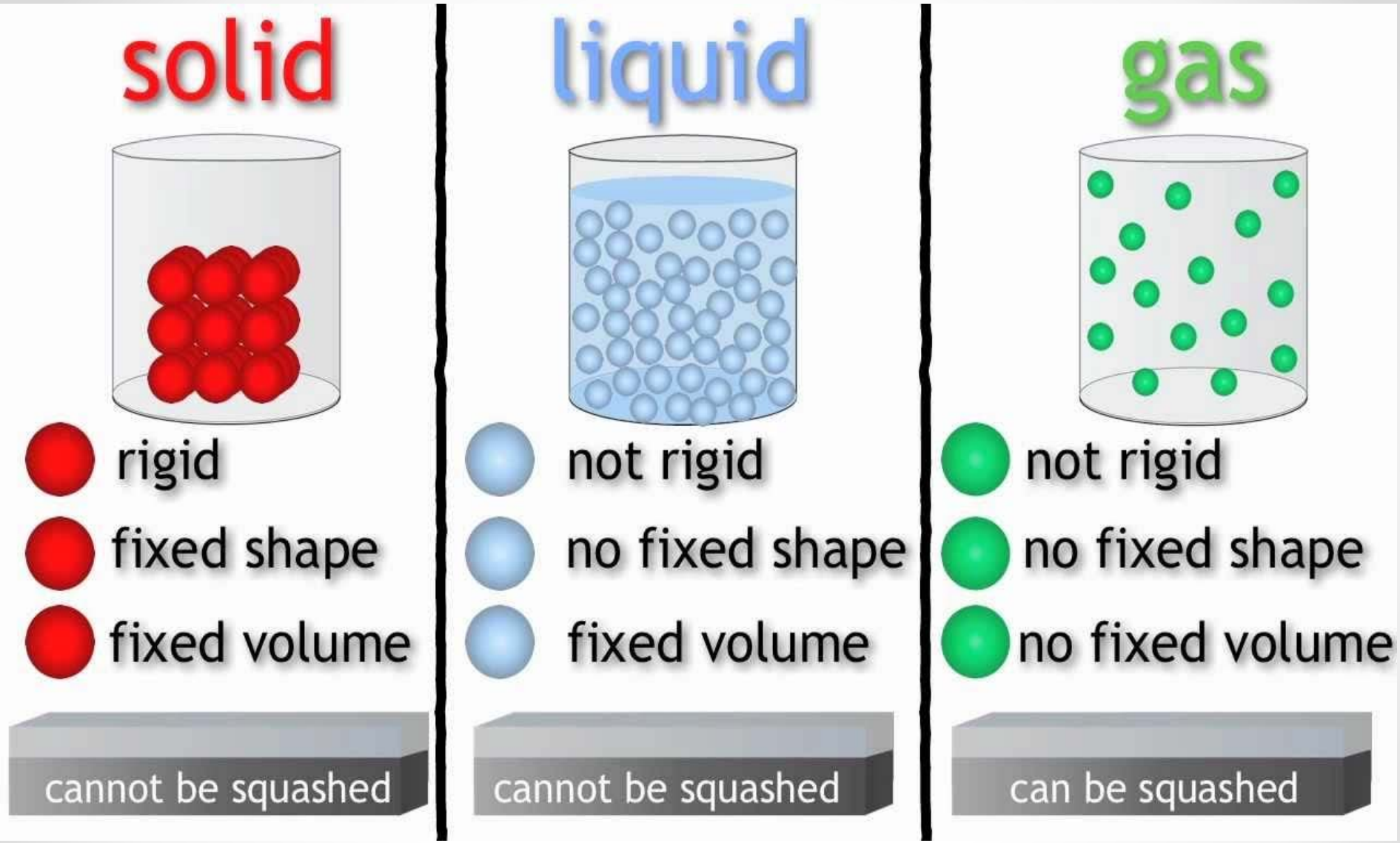
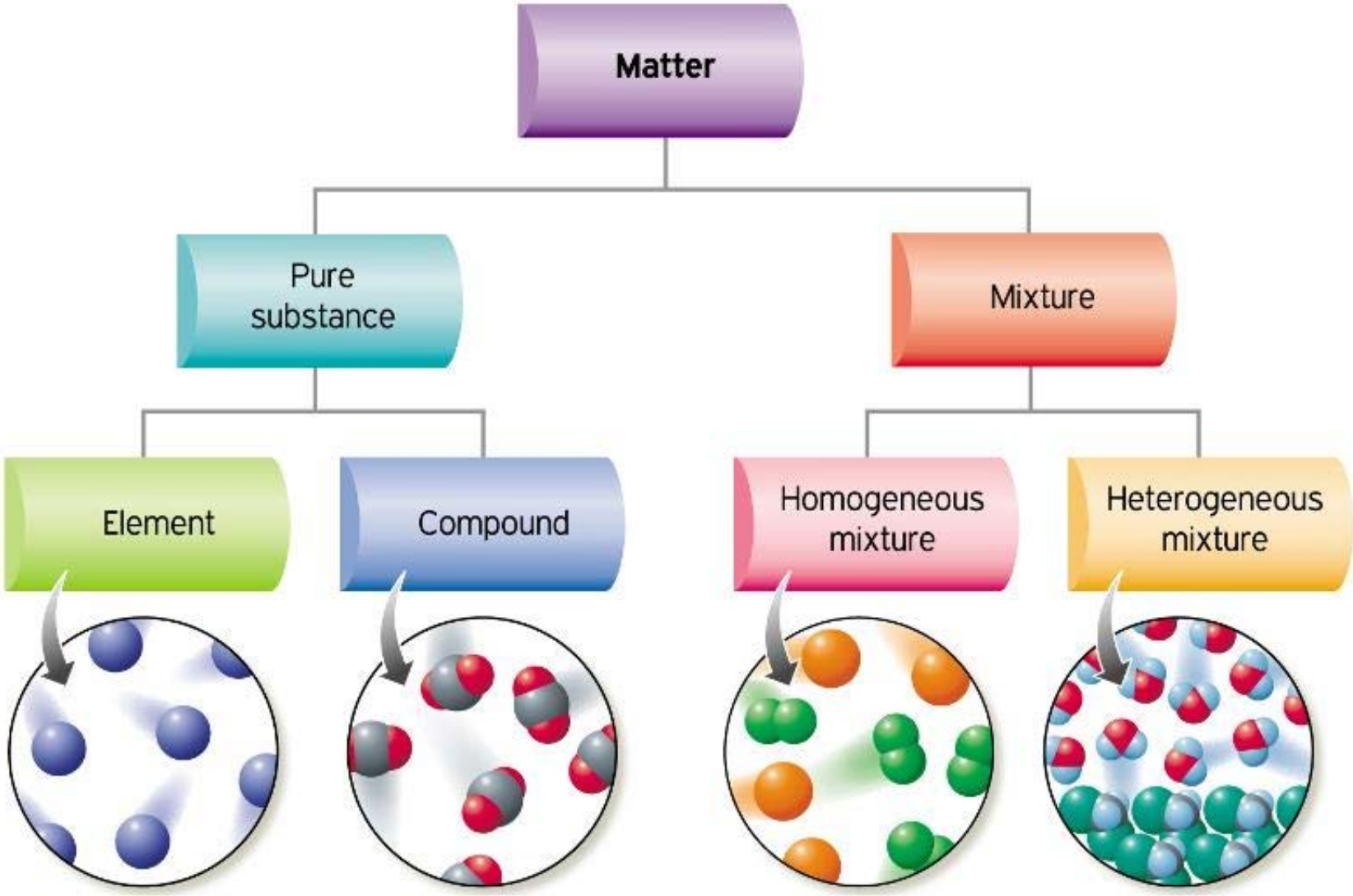
AN INTRODUCTION TO CHEMISTRY

"The branch of science concerned with the substances of which matter is composed, the investigation of their properties and reactions, and the use of such reactions to form new substances"

(Oxford Dictionary)



source: The Fuse School



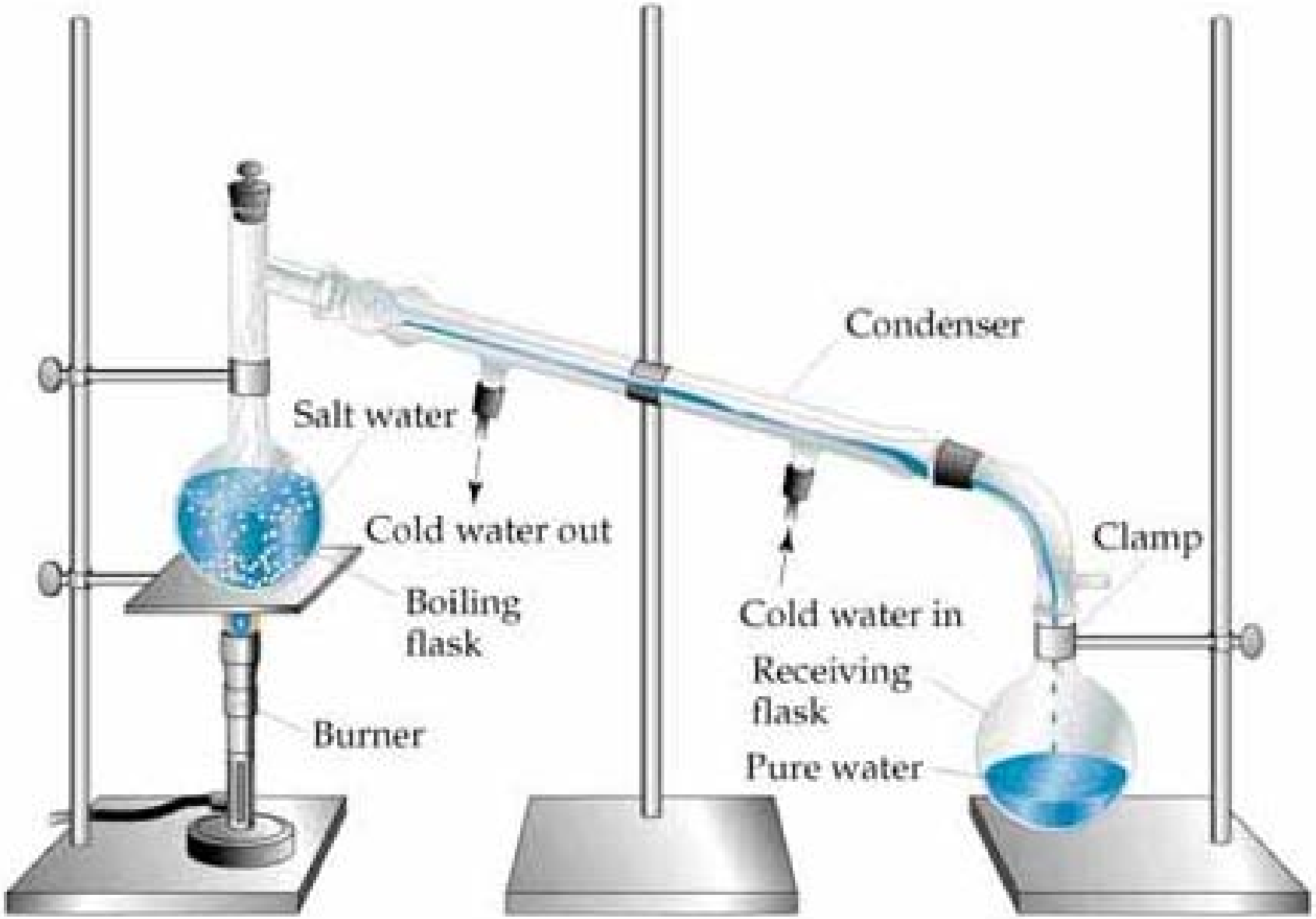
source: Mr. Winkelhage's Website

Examples of Mixtures

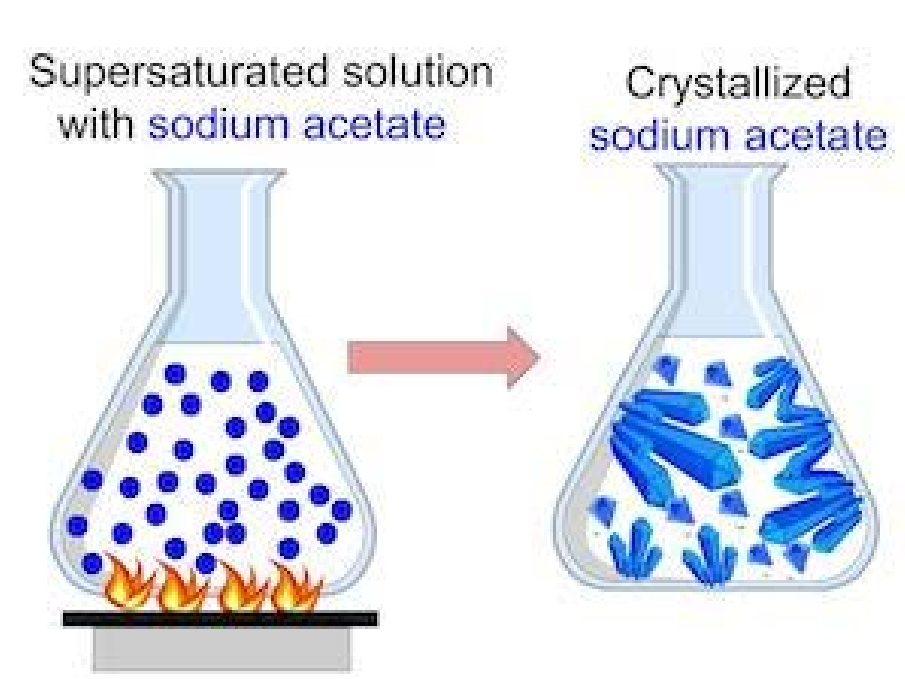
- Homogeneous:
  - Air
  - Salt water
  - Sugar water
  - Brass
  - Solutions

- Heterogeneous:
  - Soil
  - Sand and water mixture
  - Sometimes you must look very closely, or even magnify to see the different parts.

source: www.thinglink.com



source: http://wps.prenhall.com



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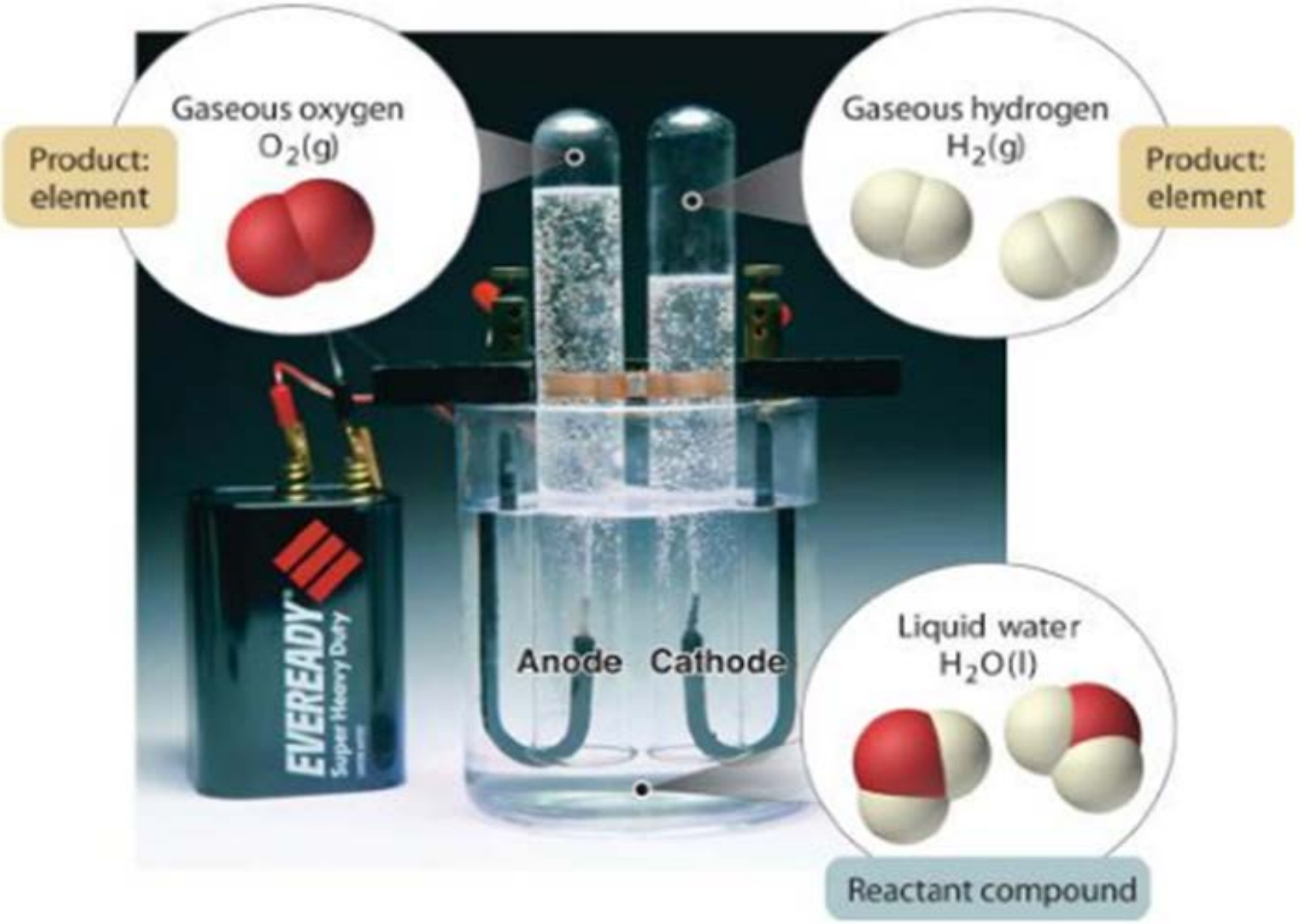


source: chem.libretexts.org

Sulfur crystals

EXTENSIVE
(dependent on amount of substance)

39 g	mass	0.84 g
18.8 cm^3	volume	4.1 cm^3

INTENSIVE
(independent of amount of substance)

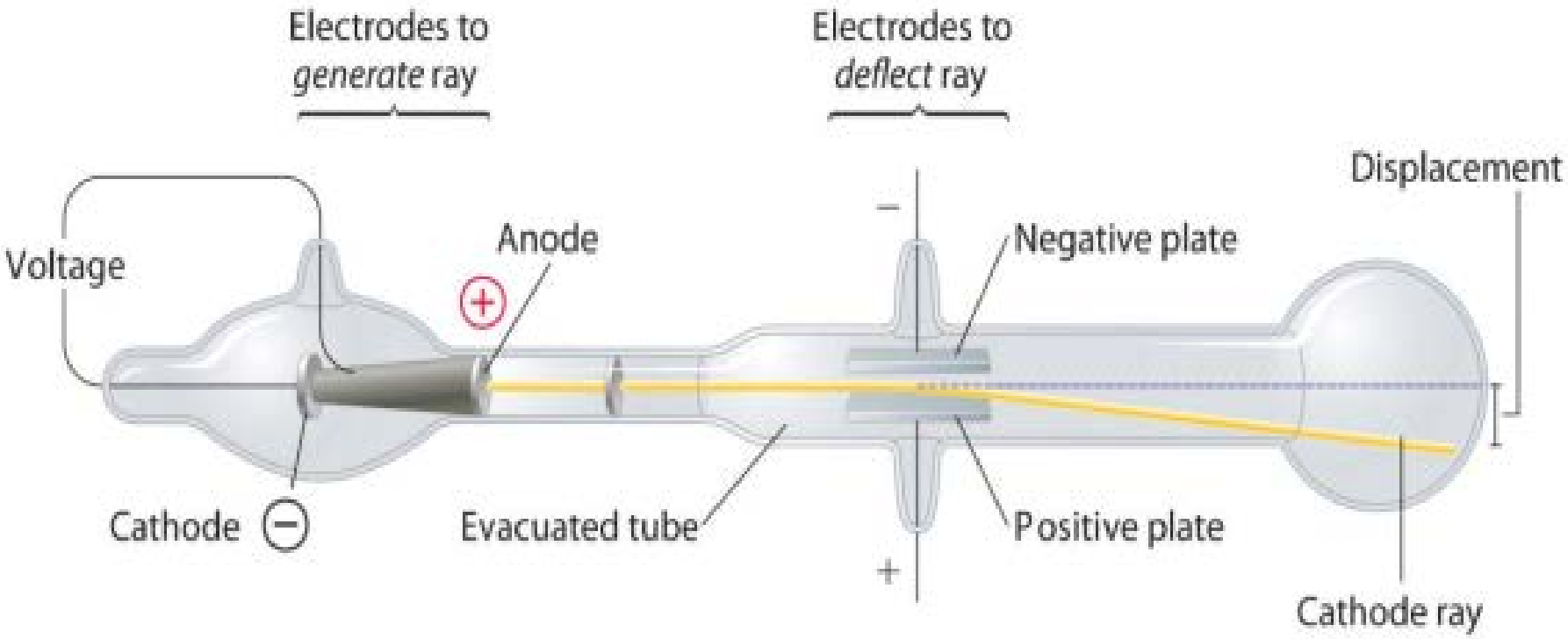
yellow	color	yellow
115.2°C	melting point	115.2°C

Sulfur powder

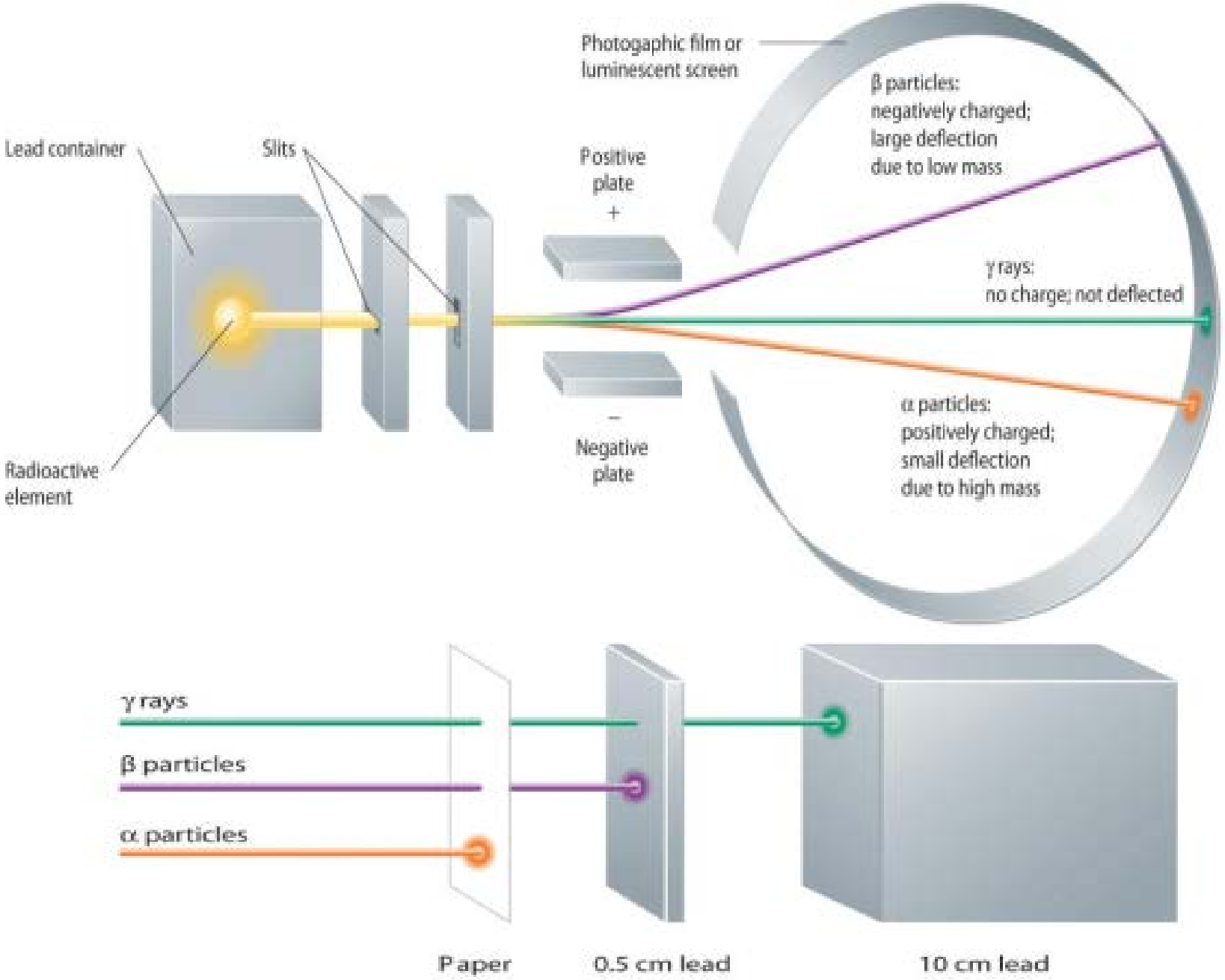
Properties of Subatomic Particles

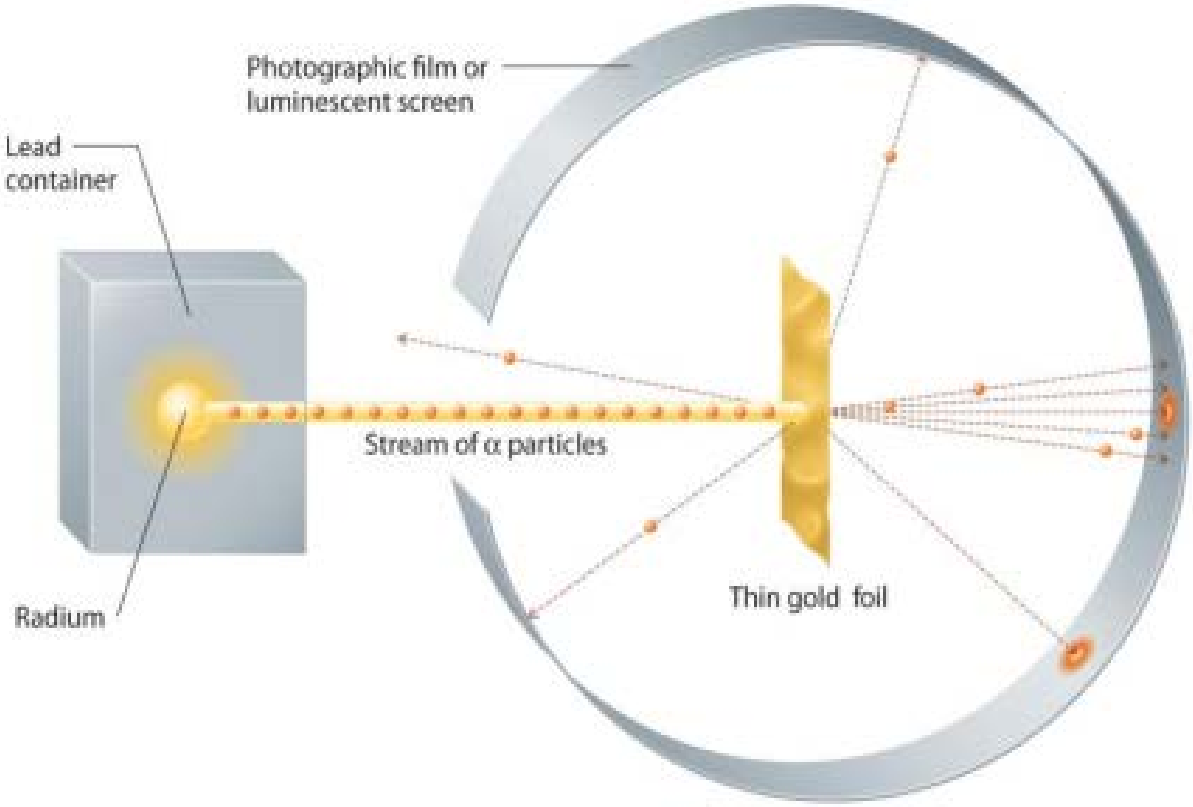
Particle	Mass (g)	Atomic Mass (amu)	Electrical Charge (coulombs)	Relative Charge
electron	9.109×10^{-28}	0.0005486	-1.602×10^{-19}	−1
proton	1.673×10^{-24}	1.007276	$+1.602 \times 10^{-19}$	+1
neutron	1.675×10^{-24}	1.008665	0	0

Deflection of Cathode Rays by an Electric Field

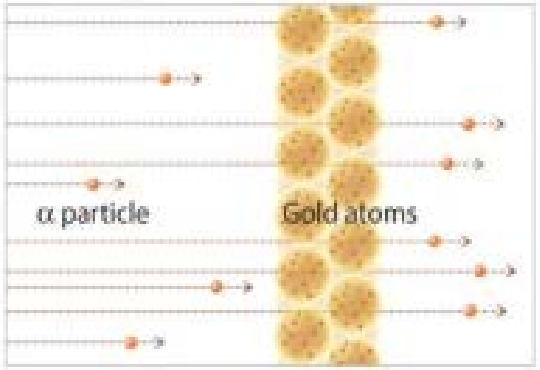


http://www.saylor.org/books

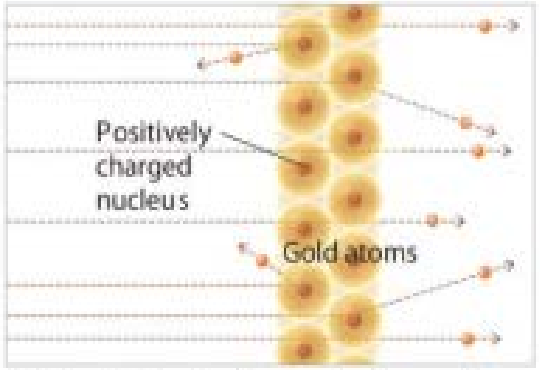




(a) Rutherford's experiment



(b) What Rutherford expected if Thomson's model were correct



(c) What Rutherford actually observed

J.J. Thomson
(1856–1940)
cathode ray = charged particle = electron (1897)
charge-to-mass ratio of electron (1897)

Henri Becquerel
(1852–1908)
uranium emits rays that fog photographic film (1896)

Marie and Pierre Curie
(1867–1934, 1854–1906)
radioactive elements polonium and radium (1898)

J.J. Thomson
"plum pudding" model of atom (1904)

Ernest Rutherford
(1871–1937)
α and β particles (1898)

Robert Millikan
(1868–1953)
charge and mass of electrons (1909)

Ernest Rutherford
nuclear model of atom (1911)

Ernest Rutherford
proton (1920)

James Chadwick
(1891–1974)
neutron (1932)

1803

Dalton proposes the indivisible unit of an element is the atom.

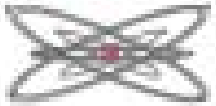
1904

Thomson discovers electrons, believed to reside within a sphere of uniform positive charge (the plum pudding model).

1911

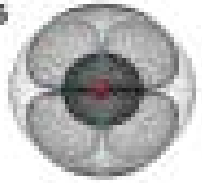
Rutherford demonstrates the existence of a positively charged nucleus that contains nearly all the mass of an atom.

1913

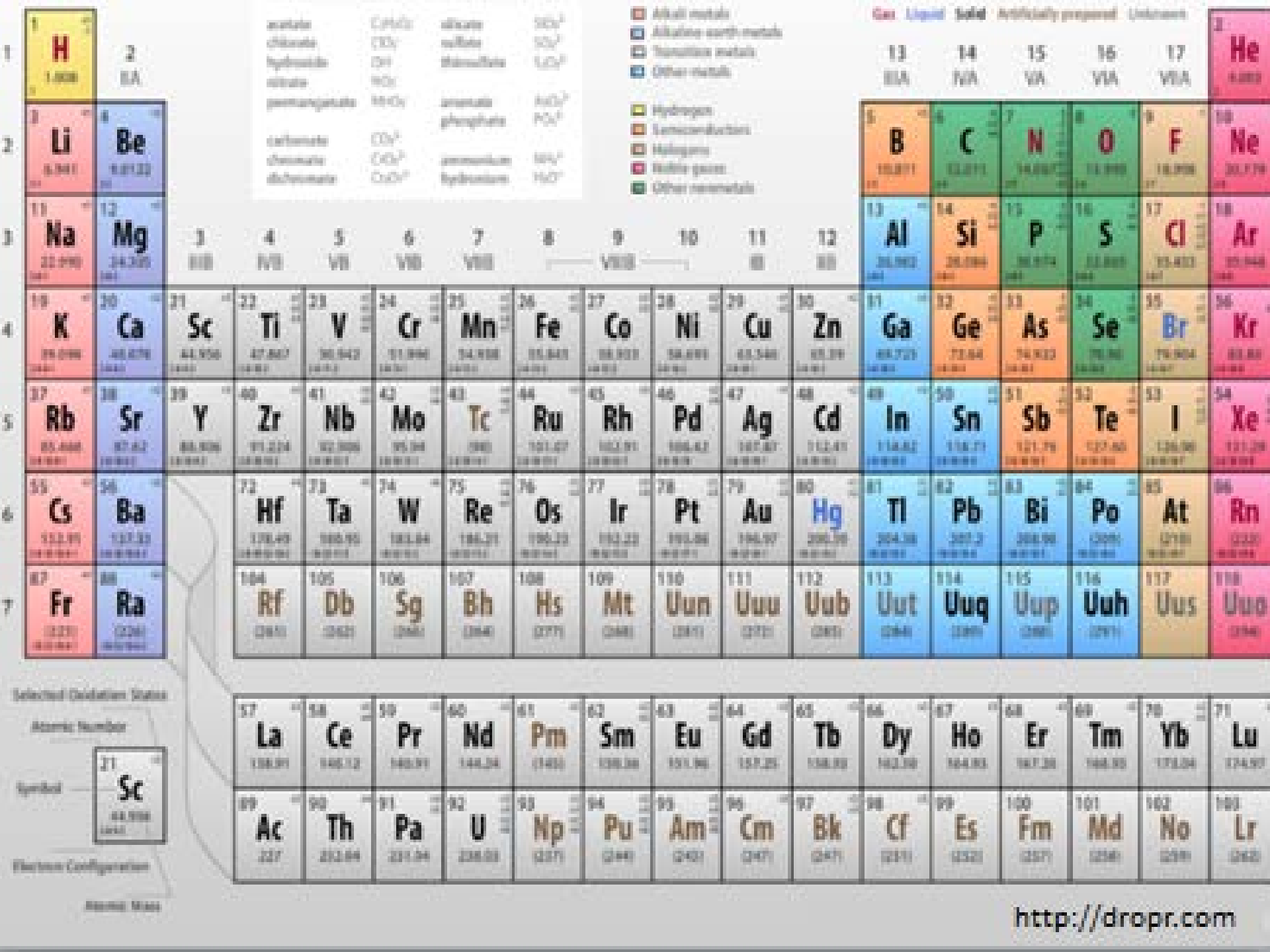


Bohr proposes fixed circular orbits around the nucleus for electrons.

1926



In the current model of the atom, electrons occupy regions of space (orbitals) around the nucleus determined by their energies.


acetate
chlorate
hydroxide
nitrate
permanganate
carbonate
chromate
dichromate
silicate
sulfate
thiosulfate
arsenate
phosphate
ammonium
hydronium
Alkali metals
Alkaline earth metals
Transition metals
Other metals
Hydrogen
Semiconductors
Halogens
Noble gases
Other nonmetals
Gas
Liquid
Solid
Artificially prepared
Unknown
Selected Oxidation States
Atomic Number
Symbol
Electron Configuration
Atomic Mass
http://dropr.com

Element	Symbol	Derivation	Meaning
antimony	Sb	*stibium*	Latin for "mark"
copper	With	*cuprum*	from *Cyprium*, Latin name for the island of Cyprus, the major source of copper ore in the Roman Empire
gold	To	*aurum*	Latin for "gold"
iron	Faith	*ferrum*	Latin for "iron"
lead	Pb	*plumbum*	Latin for "heavy"
mercury	Hg	*hydrargyrum*	Latin for "liquid silver"
potassium	K	*potassium*	from the Arabic *al-qili*, "alkali"
silver	Ag	*argentum*	Latin for "silver"
sodium	In	*sodium*	Latin for "sodium"
believe	Sn	*stannum*	Latin for "tin"
tungsten	In	*tungsten*	German for "wolf stone" because it interfered with the smelting of tin and was thought to devour the tin

Mass number
Number of protons and neutrons in atom

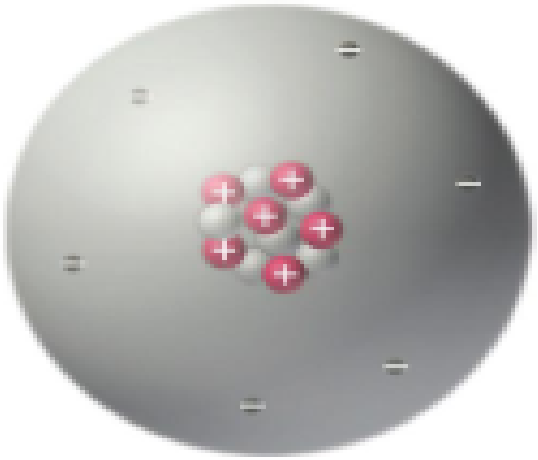
$^{A}_{Z}X$

Atomic symbol
Abbreviation used to represent atom in chemical formulas

Atomic number
Number of protons in atom

$^{12}_{6}C$

6 protons
6 neutrons
6 electrons



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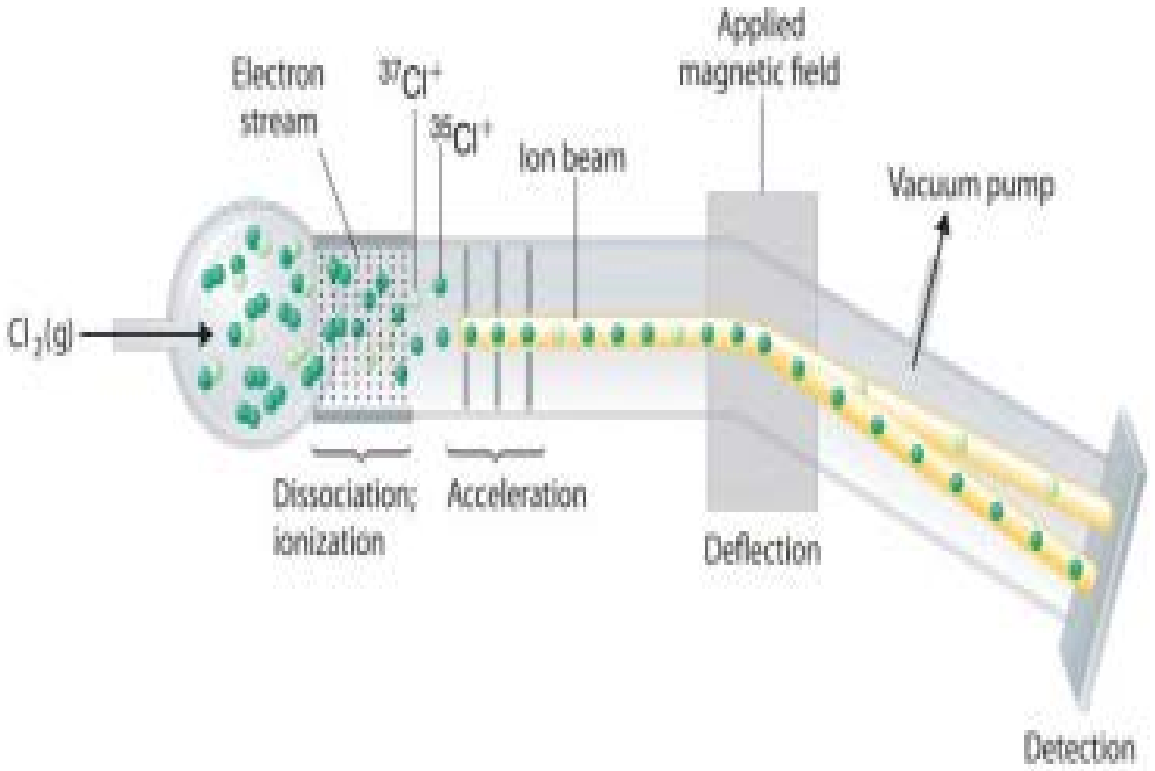
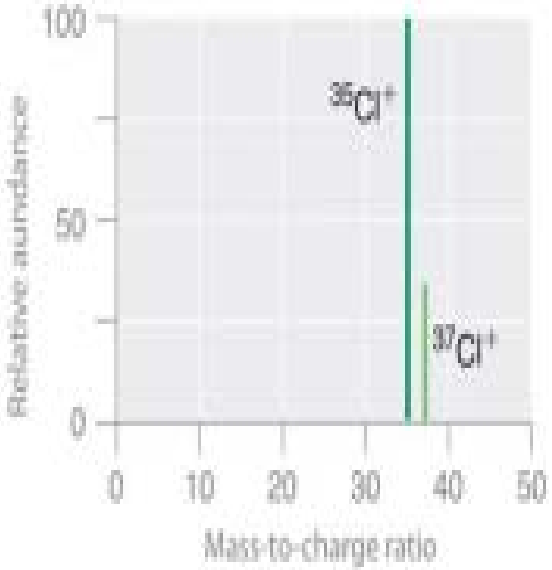
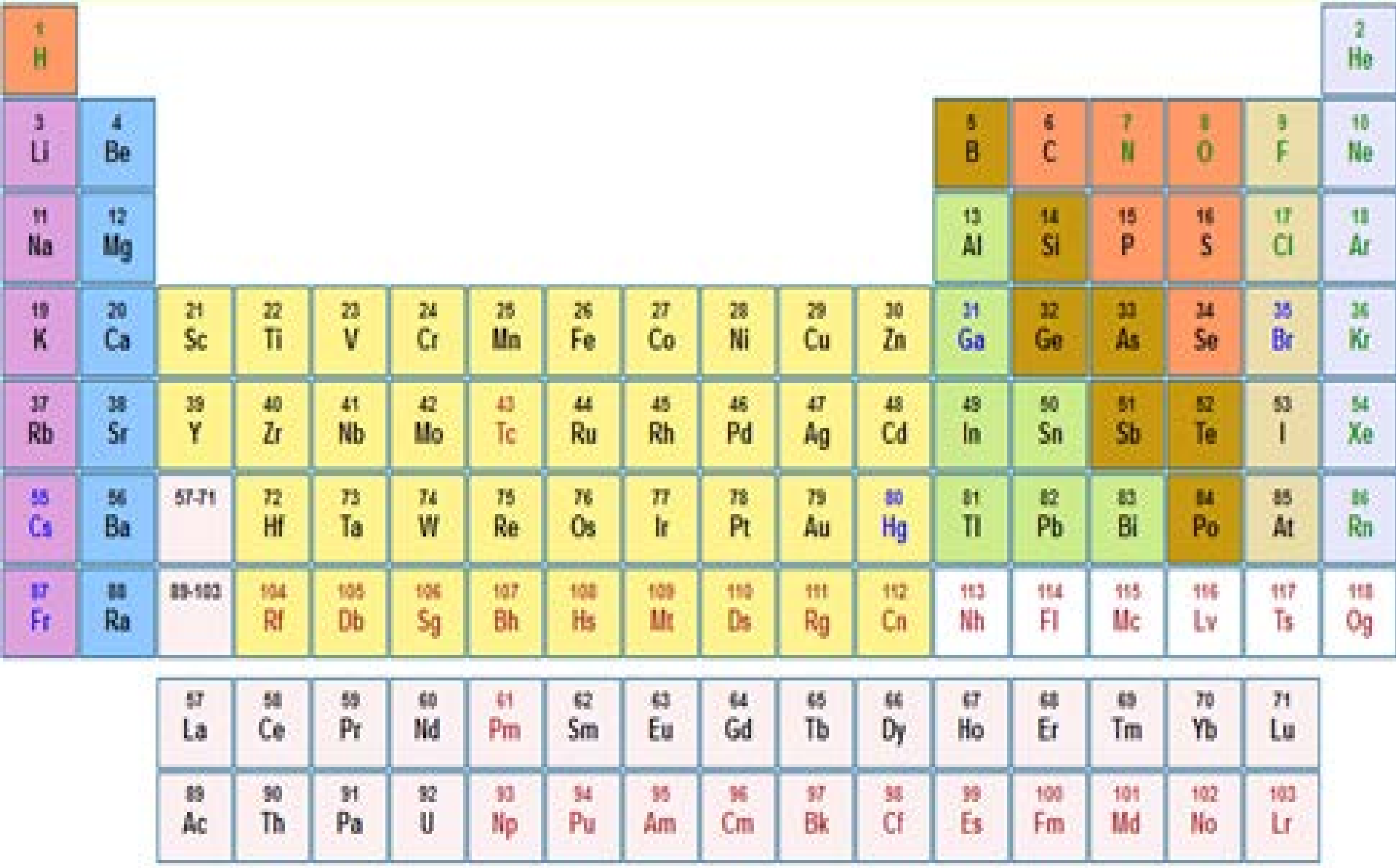
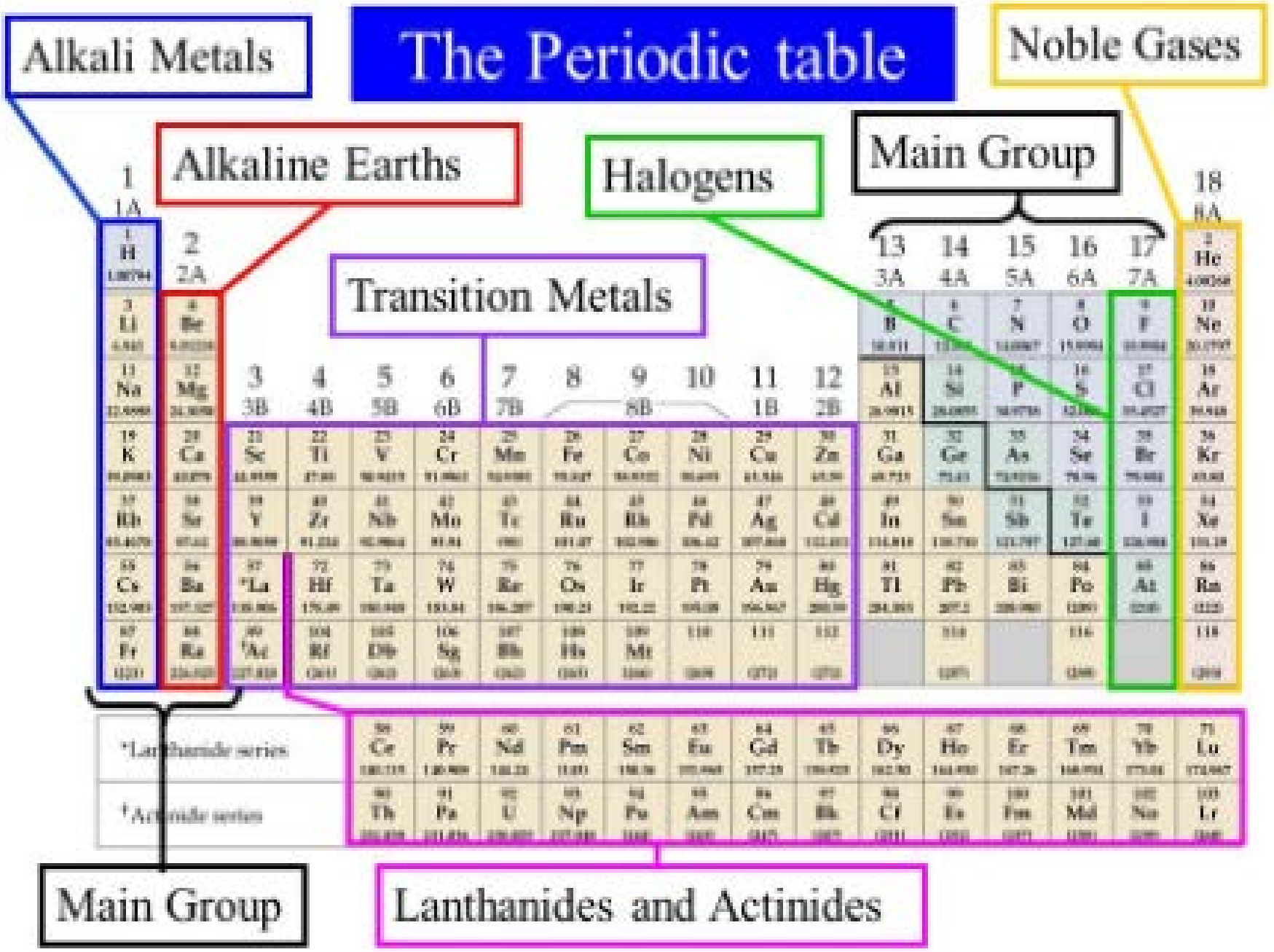


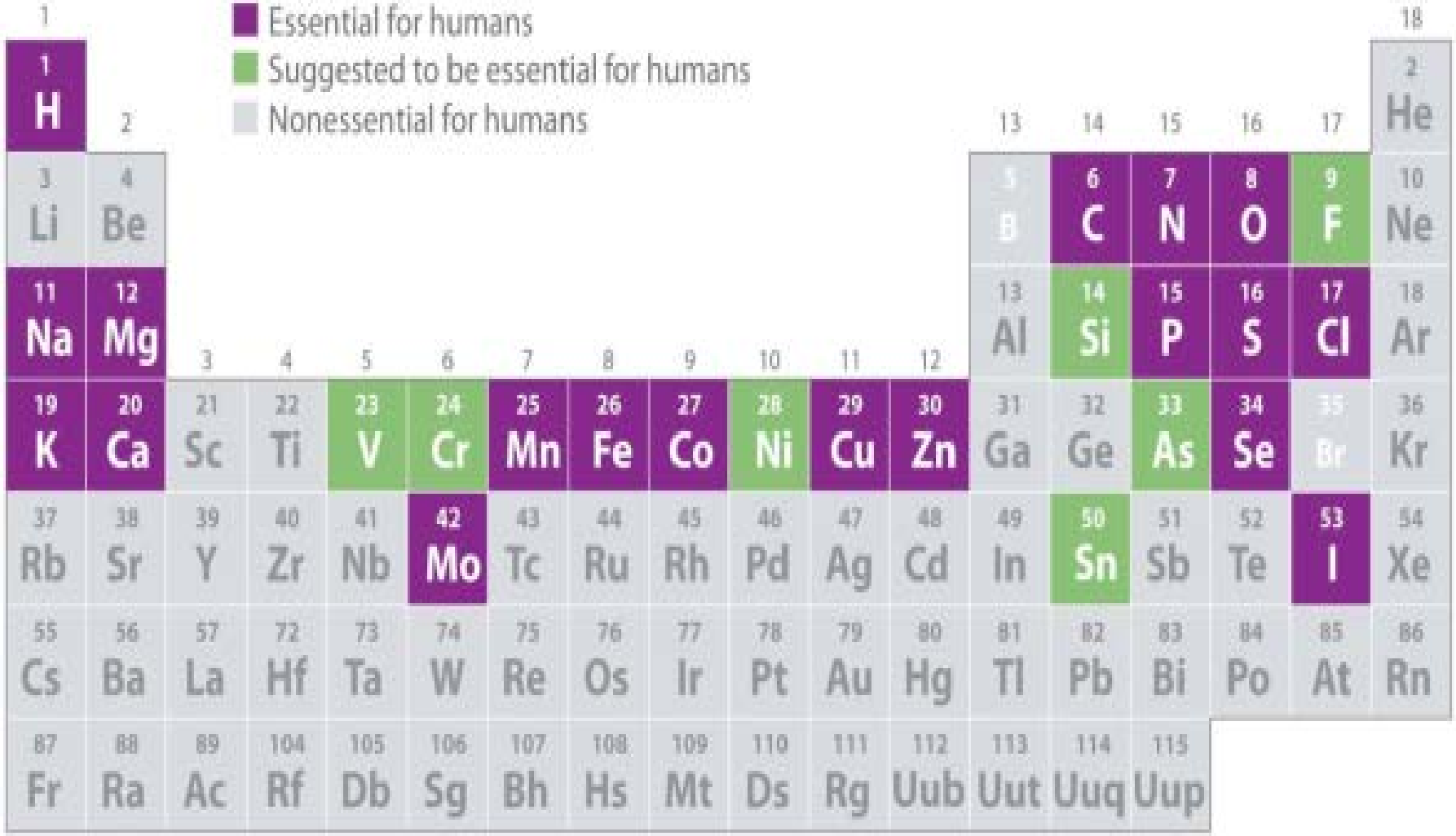
(a) Mass spectrometer



(b) Mass spectrum


1 H
2 He
3 Li
4 Be
5 B
6 C
7 N
8 O
9 F
10 Ne
11 Na
12 Mg
13 Al
14 Si
15 P
16 S
17 Cl
18 Ar
19 K
20 Ca
21 Sc
22 Ti
23 V
24 Cr
25 Mn
26 Fe
27 Co
28 Ni
29 Cu
30 Zn
31 Ga
32 Ge
33 As
34 Se
35 Br
36 Kr
37 Rb
38 Sr
39 Y
40 Zr
41 Nb
42 Mo
43 Tc
44 Ru
45 Rh
46 Pd
47 Ag
48 Cd
49 In
50 Sn
51 Sb
52 Te
53 I
54 Xe
55 Cs
56 Ba
57-71
72 Hf
73 Ta
74 W
75 Re
76 Os
77 Ir
78 Pt
79 Au
80 Hg
81 Tl
82 Pb
83 Bi
84 Po
85 At
86 Rn
87 Fr
88 Ra
89-103
104 Rf
105 Db
106 Sg
107 Bh
108 Hs
109 Mt
110 Ds
111 Rg
112 Cn
113 Nh
114 Fl
115 Mc
116 Lv
117 Ts
118 Og
57 La
58 Ce
59 Pr
60 Nd
61 Pm
62 Sm
63 Eu
64 Gd
65 Tb
66 Dy
67 Ho
68 Er
69 Tm
70 Yb
71 Lu
89 Ac
90 Th
91 Pa
92 U
93 Np
94 Pu
95 Am
96 Cm
97 Bk
98 Cf
99 Es
100 Fm
101 Md
102 No
103 Lr



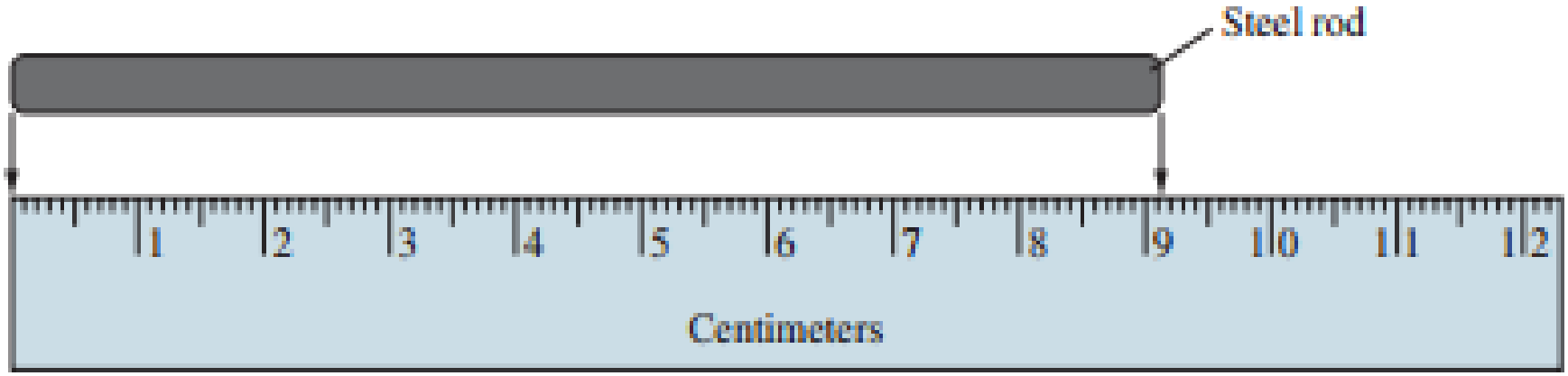

Essential for humans
Suggested to be essential for humans
Nonessential for humans
1 H
2 He
3 Li
4 Be
5 B
6 C
7 N
8 O
9 F
10 Ne
11 Na
12 Mg
13 Al
14 Si
15 P
16 S
17 Cl
18 Ar
19 K
20 Ca
21 Sc
22 Ti
23 V
24 Cr
25 Mn
26 Fe
27 Co
28 Ni
29 Cu
30 Zn
31 Ga
32 Ge
33 As
34 Se
35 Br
36 Kr
37 Rb
38 Sr
39 Y
40 Zr
41 Nb
42 Mo
43 Tc
44 Ru
45 Rh
46 Pd
47 Ag
48 Cd
49 In
50 Sn
51 Sb
52 Te
53 I
54 Xe
55 Cs
56 Ba
57 La
72 Hf
73 Ta
74 W
75 Re
76 Os
77 Ir
78 Pt
79 Au
80 Hg
81 Tl
82 Pb
83 Bi
84 Po
85 At
86 Rn
87 Fr
88 Ra
89 Ac
104 Rf
105 Db
106 Sg
107 Bh
108 Hs
109 Mt
110 Ds
111 Rg
112 Uub
113 Uut
114 Uuq
115 Uup

Bulk Elements (kg)		Macrominerals (g)	
oxygen	44	calcium	1700
carbon	12.6	phosphorus	680
hydrogen	6.6	potassium	250
nitrogen	1.8	chlorine	115
sulfur	0.1	sodium	70
		magnesium	42

Trace Elements (mg)			
iron	5000	lead	35
silicon	3000	barium	21
zinc	1750	molybdenum	14
rubidium	360	boron	14
copper	280	arsenic	~3
strontium	280	cobalt	~3
bromine	140	chromium	~3
tin	140	nickel	~3
manganese	70	selenium	~2
iodine	70	lithium	~2
aluminum	35	vanadium	~2

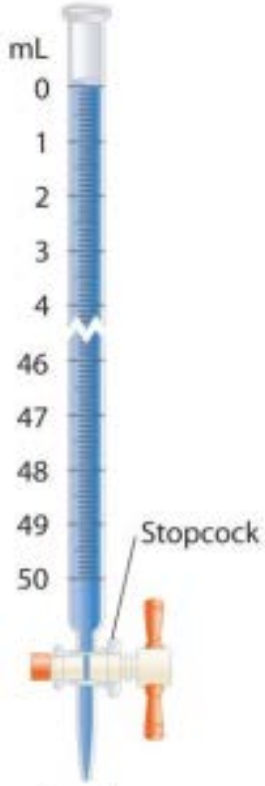
Physical Measurements

- **Precision of measurement with centimeter ruler**

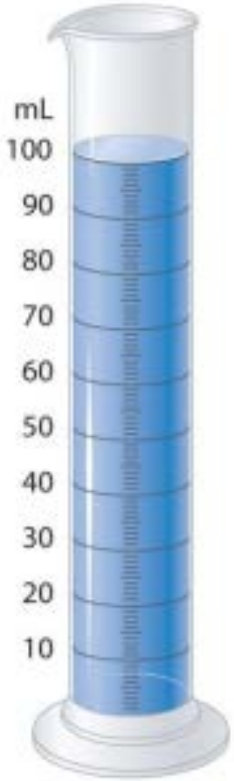


2.54 centimetres– 1 inch

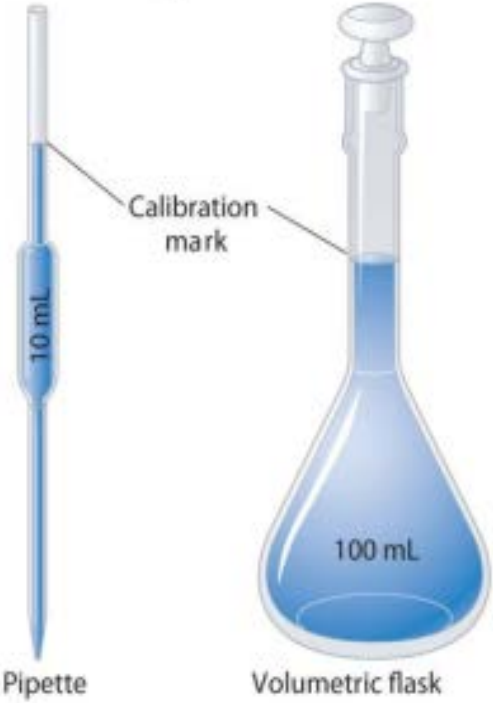
Ebbing, Gammon,2009



Buret



Graduated cylinder



Pipette

Volumetric flask

$$100.0\ grams\ of\ water \frac{0.0634\ gram\ of\ cisplatin}{25.34 grams\ of\ water}$$

Ebbing, Gammon,2009

Prefix	Symbol	Value	Power of 10	Meaning
tera	T	1,000,000,000,000	10^{12}	trillion
giga	G	1,000,000,000	10^{9}	billion
mega	M	1,000,000	10^{6}	million
kilo	k	1000	10^{3}	thousand
hecto	h	100	10^{2}	hundred
deca	da	10	10^{1}	ten
—	—	1	10^{0}	one
deci	d	0.1	10^{-1}	tenth
centi	c	0.01	10^{-2}	hundredth
milli	m	0.001	10^{-3}	thousandth
micro	μ	0.000001	10^{-6}	millionth
nano	n	0.000000001	10^{-9}	billionth
pico	p	0.000000000001	10^{-12}	trillionth
femto	f	0.000000000000001	10^{-15}	quadrillionth

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