

Analytical Chemistry

1st year

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Introduction to the Analytical Chemistry



- **Analytical Chemistry** is a measurement science consisting of a set of methods that are vital in all fields of science and medicine. Qualitative information, Structural information, and Quantitative information



The analytical chemistry and The Red planet Mars

- Alpha proton X-ray spectrometer (*APXS*) used to determine the **identity** and **concentration** of the elements of the periodic table.





Types of analysis in analytical chemistry

The pathfinder example demonstrates that both qualitative information and quantitative information are required in an analysis.

- ❖ **Qualitative Analysis** reveals the identity of the elements and compounds in a sample
- ❖ **Structural analysis** is the determination of the special arrangement of atoms in molecule
- ❖ **Quantitative Analysis** indicates the amount of each substance in a sample.



Methods used in Analytical Chemistry



- The methods used to determine the identity and the quantity of the **analytes** in the field of analytical chemistry can be broadly divided into
 - Classical Methods, for example **Titration**
 - Instrumental Methods, for example **Mass spectrometry**
 - Analytical Methods involve separation, **identification**, and the **quantification** of matter.



Organic Mass Spectrometry

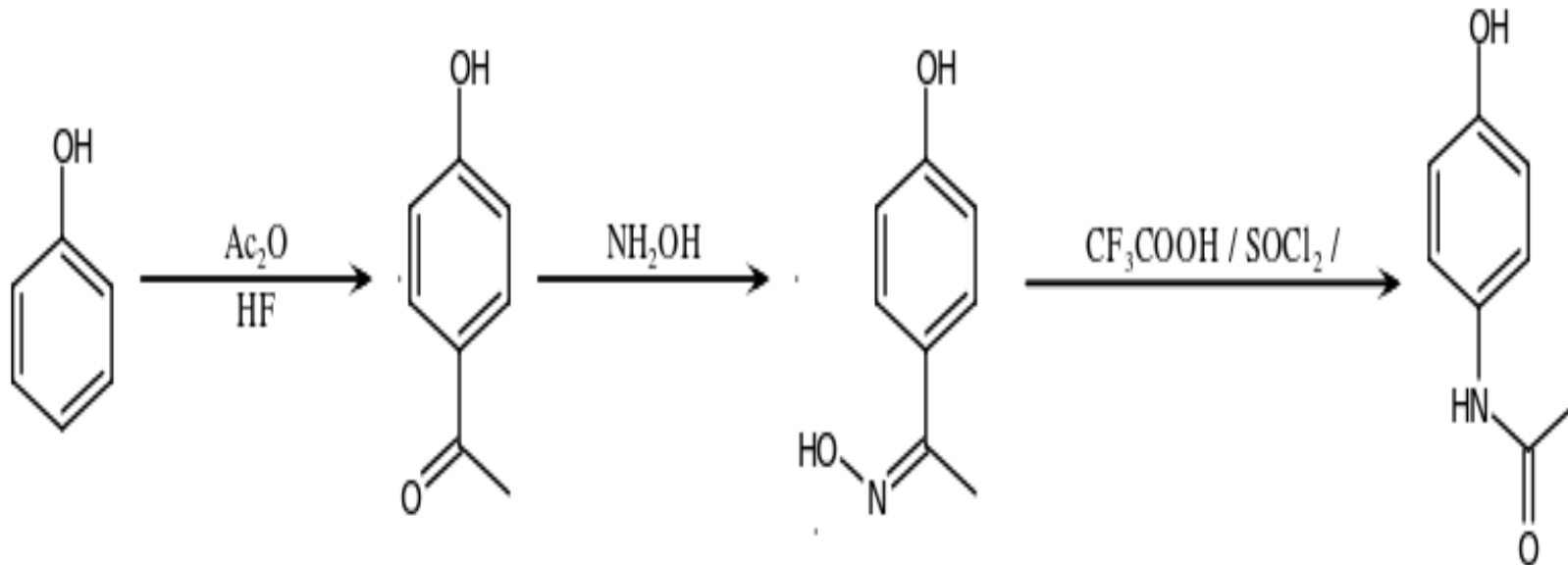
is a powerful analytical technique used to identify unknown compounds within a sample, to **quantify** known materials, and to **elucidate** the structure and chemical properties of different molecules.

Mass Spectrometry

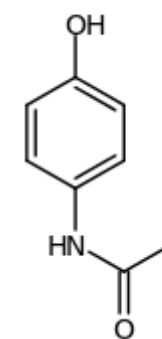
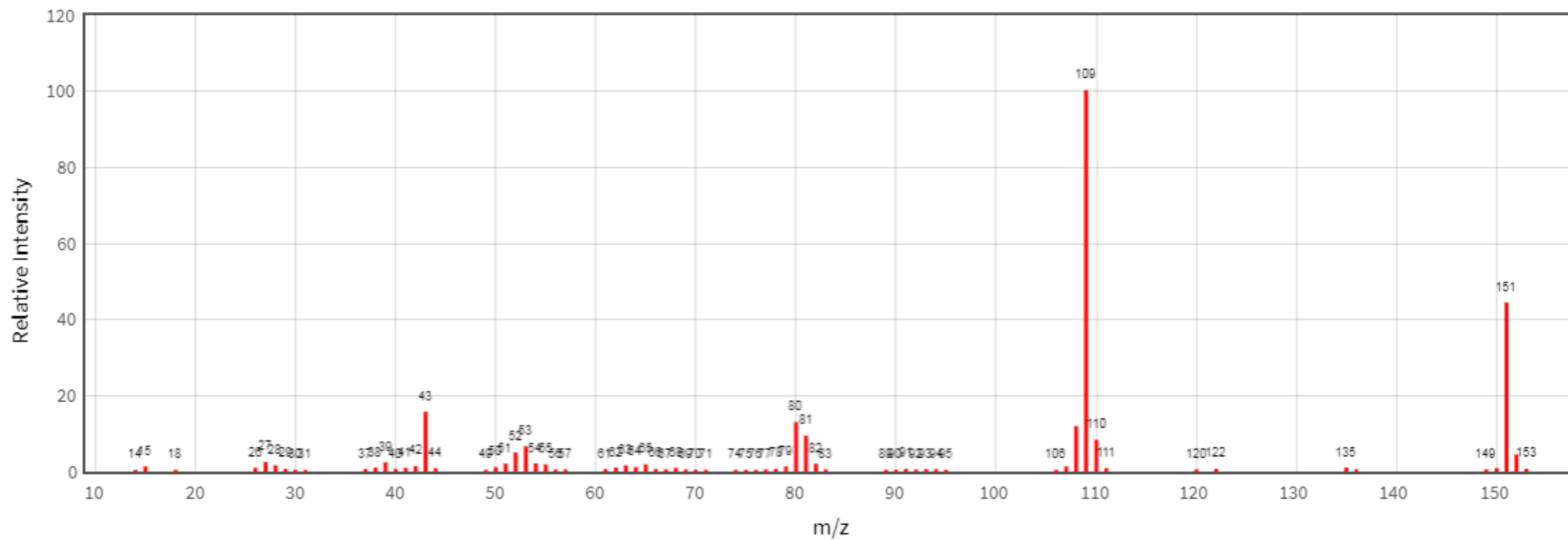


Paracetamol

- Paracetamol Molar mass is 151.165



Mass Spectrum



151.165



Openlynx Report - James B

Sample: 1

File: JB175 filtsol-1

Description:

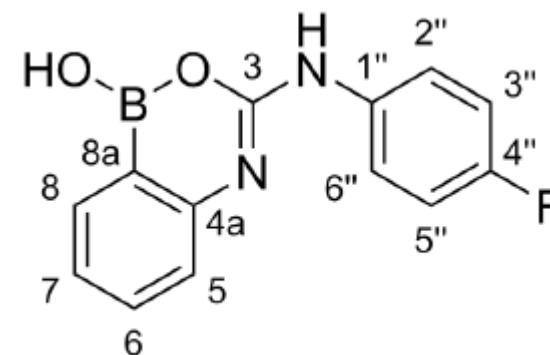
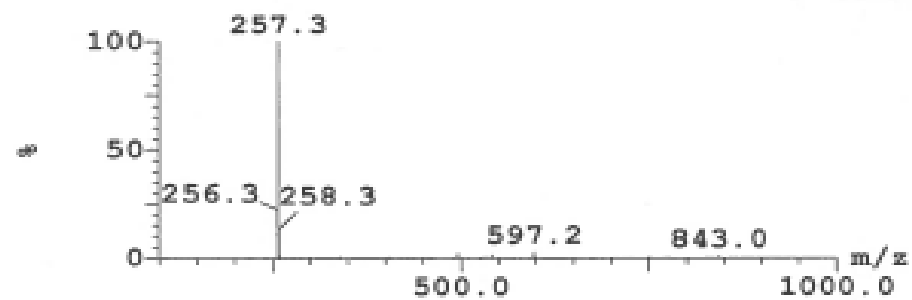
Vial: 1:19

Date: 19-Jun-2019

Printed: Thu Jun 20 14:20:48 2019

Peak ID	Compound	Time	Mass Found
1	Found	2.01	257

1:MS ES+
9.1e+006



Sample: 1

Vial:1:19

ID:JB175 filtsol-1

File:JB175 filtsol-1

Date:19-Jun-2019

Time:18:29:26

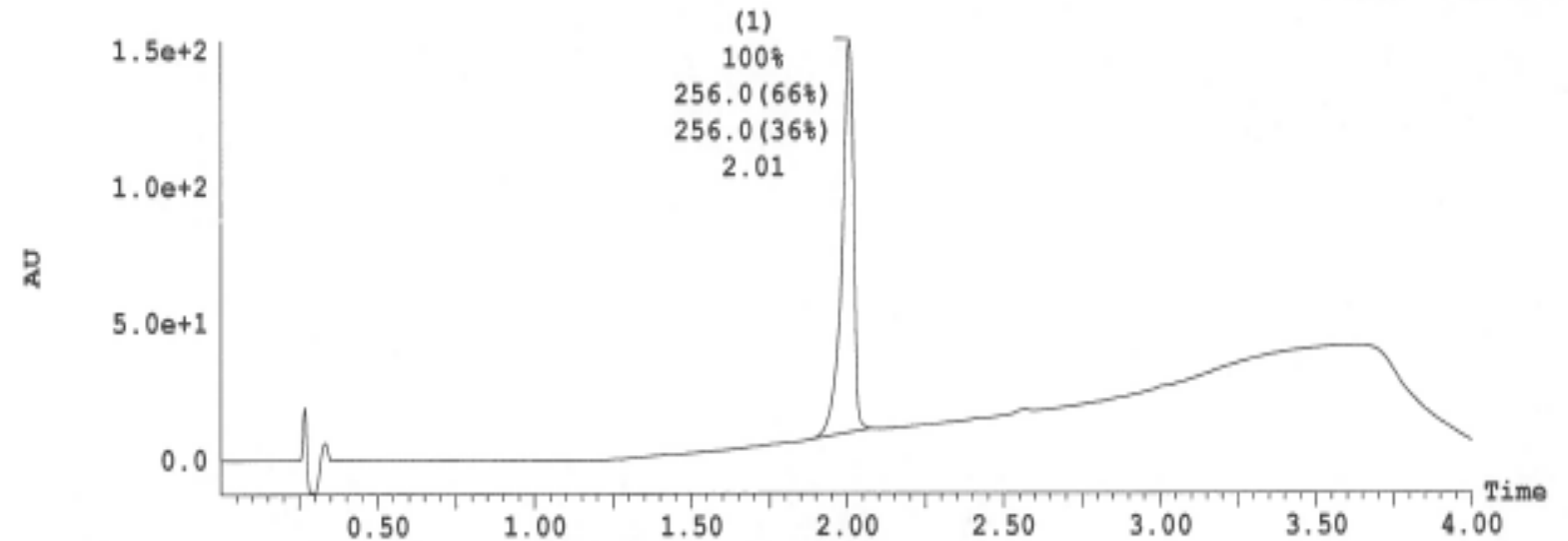
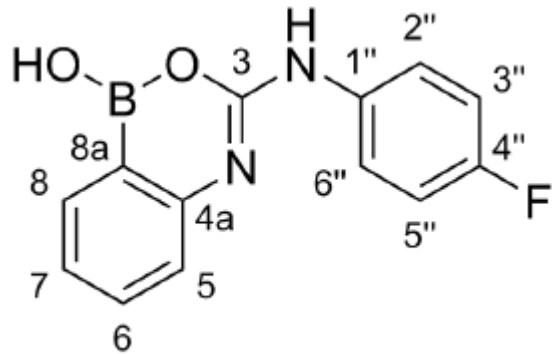
Description:

Printed: Thu Jun 20 14:20:48 2019

3: UV Detector: TAC: Wavelength Range: (210 - 400)

1.537e+2

Range: 1.659e+2



Peak Number	Compound	Time	Area %Total	Mass Found
1	Found	2.01	100.00	256.0, 256.0

1: MS ES+ :TIC Smooth (Mn, 2x2)

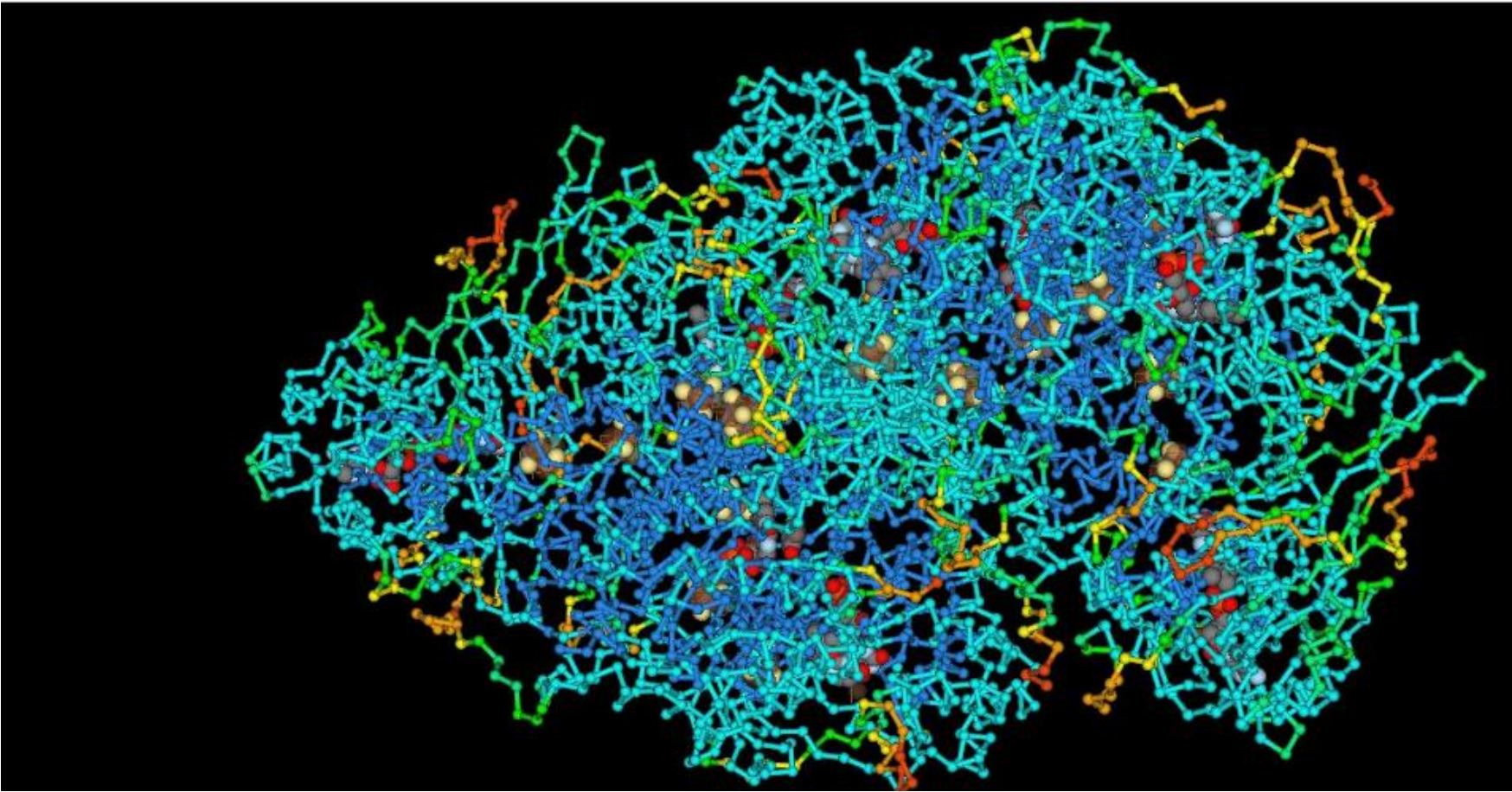
3.1e+007

100

(1)



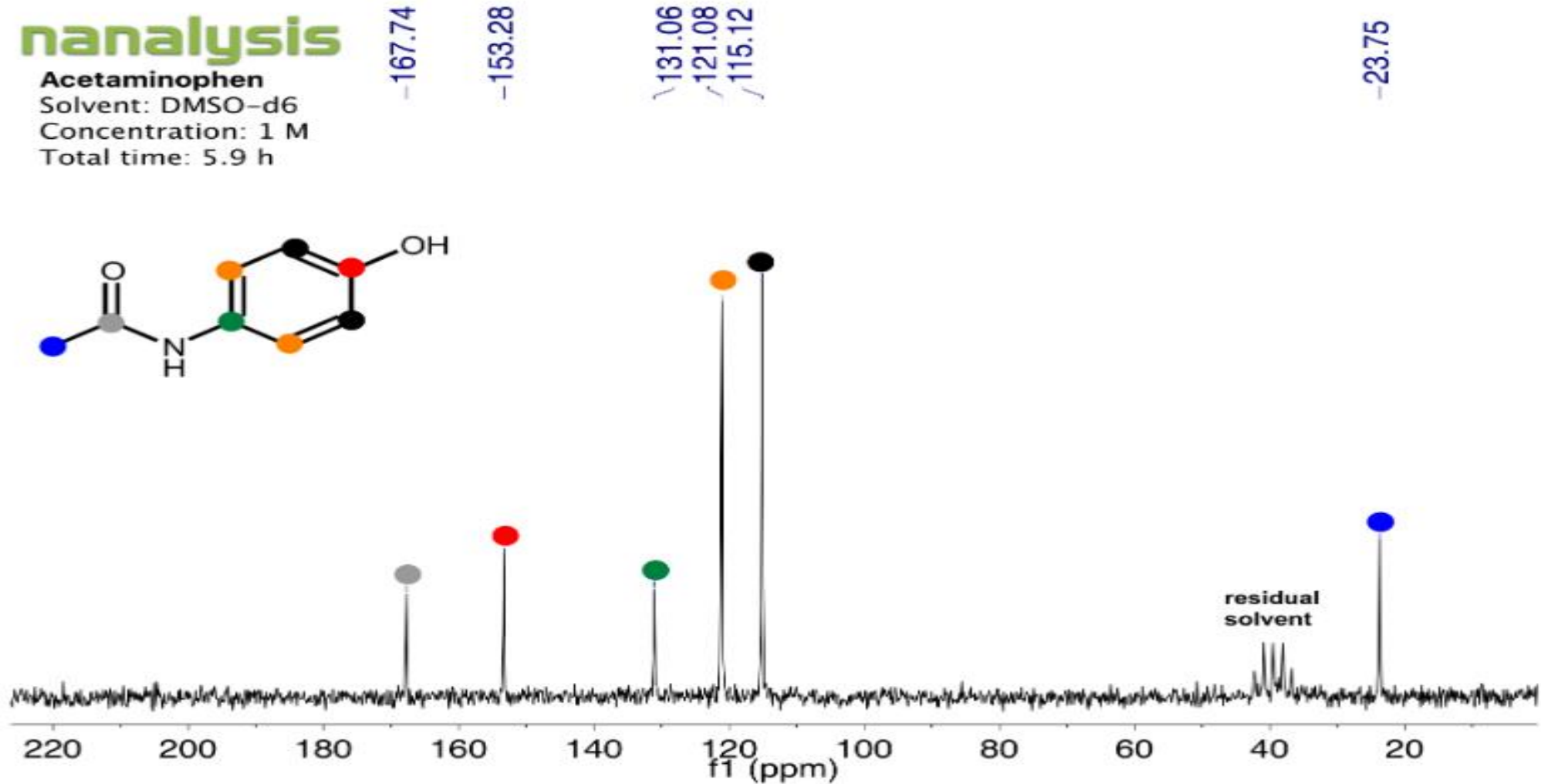
Chemical structure of a polypeptide macromolecule



Nuclear magnetic resonance spectroscopy

nanalysis

Acetaminophen
Solvent: DMSO-d6
Concentration: 1 M
Total time: 5.9 h



Quantitative Analysis

- Volumetric Methods of Analysis
- Gravimetric Methods of analysis
- Spectrophotometric Methods analysis
- The most quantitative analytical measurements are performed in **solutions**



The Solutions

- ❑ A solution is a special type of homogeneous mixture composed of two or more substances. In that mixture, a solute is a substance dissolved in another substance, known as a solvent.
- ❑ Aqueous solution is prepared by dissolving a solute (NaCl/NaOH/HCl) in solvent water.
- ❑ We must understand the Concentration of solution
- ❑ The concentration of a solution is the quantity of solute present in a given quantity of solution.

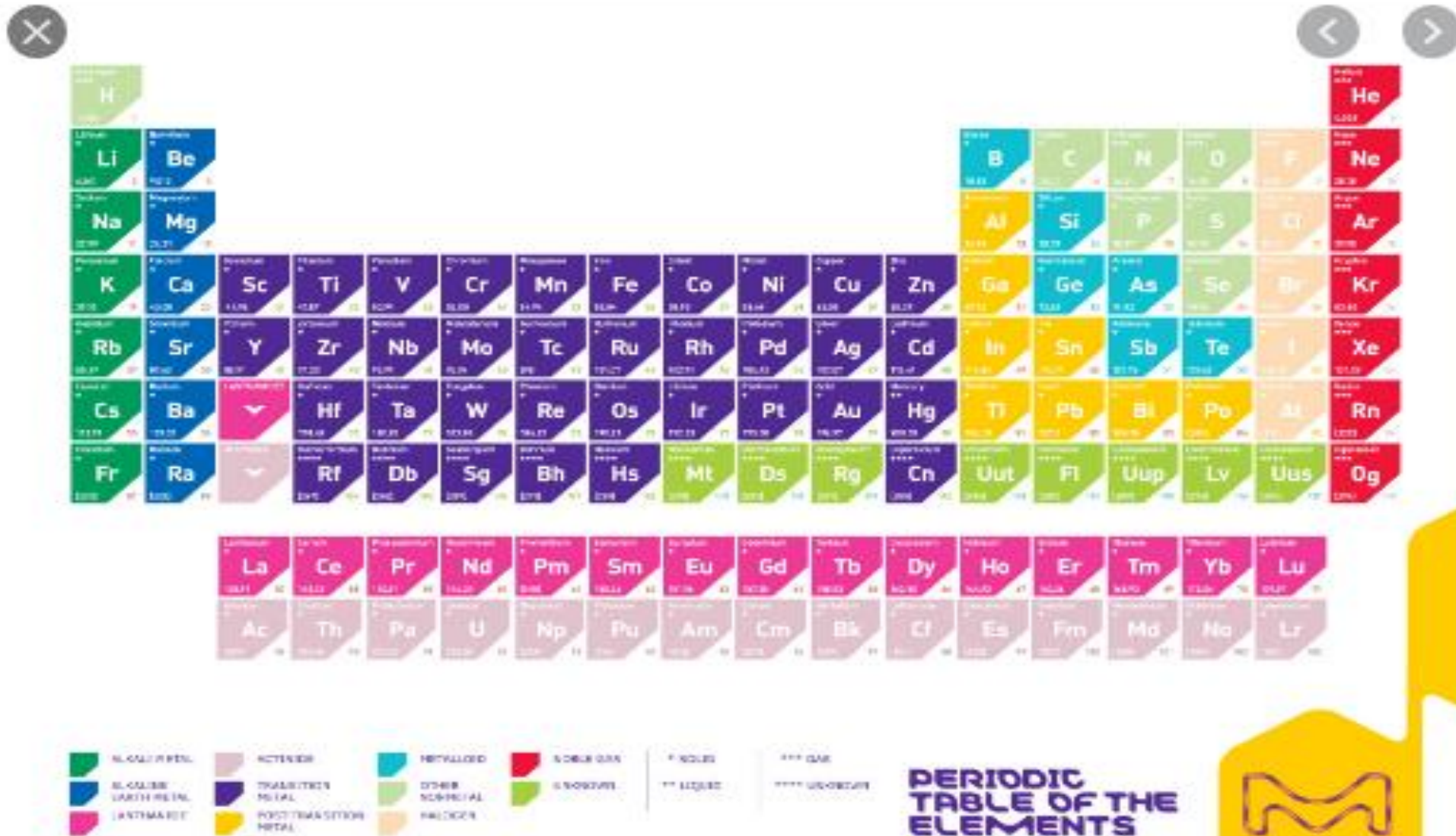


Molecular weight

- To calculate the M.wt of NaCl
- The sum of atomic weights that consist the molecule
- M.wt of NaCl is $23+35.5 = 58.5$
- M.wt of H₂SO₄ is $2(1)+32.0+4(16)=98$



The Periodic Table of the Elements



The Periodic Table of the Elements

group 1																	18	
period 1	1 H Hydrogen																	2 He Helium
2	3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
3	11 Na Sodium	12 Mg Magnesium											13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
4	19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
5	37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
6	55 Cs Cesium	56 Ba Barium	57 Lu Lutetium	71 Hf Hafnium	72 Ta Tantalum	73 W Tungsten	74 Re Rhenium	75 Os Osmium	76 Ir Iridium	77 Pt Platinum	78 Au Gold	79 Hg Mercury	80 Tl Thallium	81 Pb Lead	82 Bi Bismuth	83 Po Polonium	84 At Astatine	85 Rn Radon
7	87 Fr Francium	88 Ra Radium	89 Lr Lawrencium	103 Rf Rutherfordium	104 Db Dubnium	105 Sg Seaborgium	106 Bh Bohrium	107 Hs Hassium	108 Mt Meitnerium	109 Ds Darmstadtium	110 Rg Roentgenium	111 Cn Copernicium	112 Uut Ununtrium	113 Uuq Ununquadium	114 Uup Ununpentium	115 Uuh Ununhexium	116 Uus Ununseptium	117 Uuo Ununoctium

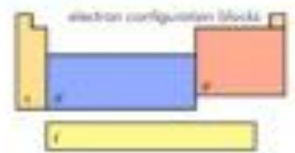
atomic mass
or metal stable mass number
 1st ionization energy
 chemical symbol
 name
 electron configuration

55.845
 762.5 1.83
Fe
 Iron
 $[Ar] 3d^6 4s^2$

atomic number
 electronegativity
 oxidation states
 most common are bold

26
 +2
 +3
 +6

- alkali metals
- alkaline metals
- other metals
- transition metals
- lanthanoids
- actinoids
- metalloids
- nonmetals
- halogens
- noble gases
- unknown elements
- radioactive elements have masses in parentheses



- notes
- as of yet, elements 112-118 have no official name designated by the IUPAC
 - 1 eV/mol = 96.485 eV
 - all elements are implied to have an oxidation state of zero

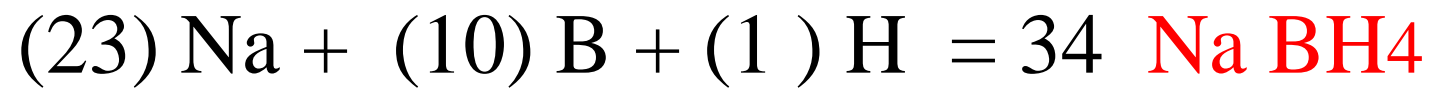
57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium
89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium



- Find the M.wt of Na_2SO_4
- HNO_3
- $\text{C}_2\text{H}_2\text{O}_4$

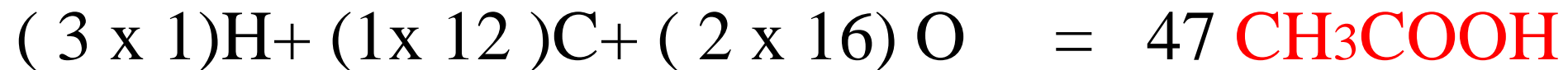
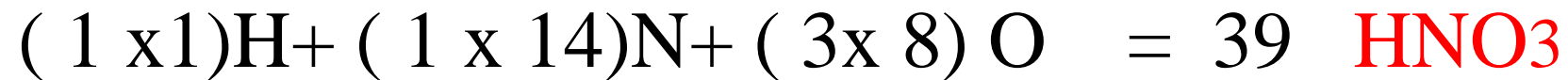
Helium *** He 4.003 2					
Boron * B 10.81 5	Carbon * C 12.01 6	Nitrogen *** N 14.01 7	Oxygen *** O 16.00 8	Fluorine *** F 19.00 9	Neon *** Ne 20.18 10
Aluminium * Al 26.98 13	Silicon * Si 28.09 14	Phosphorus * P 30.97 15	Sulfur * S 32.07 16	Chlorine *** Cl 35.45 17	Argon *** Ar 39.95 18





$$(3 \times 12) \text{ C} + (3 \times 19) \text{ F} + 2 \times 8 + (1) \text{ H} = 109 \quad \text{CF}_3\text{COOH}$$

$$(3 \times 1) \text{ H} + (15) \text{ P} + (4 \times 16) \text{ O} = 82 \quad \text{H}_3\text{PO}_4$$





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Thank you