

Learning Objectives

- 1 Explain the structure of the atom and Bohr's model
- 2 Differentiate between emission and absorption spectroscopy
- 3 Explain the chemistry behind EDX and SEM-EDX
- 4 Explain the chemistry behind NAA

What Is It Made Of?

What are the chemical elements present?

Spectroscopy & the structure of atoms



How can we do elemental analysis?



When and why do we want to carry out elemental analysis?

What Is It Made Of?

When and why do we want to carry out elemental analysis ?



When it gives the required information

Examples

1 Poisoning



Suspected arsenic, lead or chromium poisoning



Analyze body fluids



Poison

Examples

1 Poisoning

2 Determining the time of death



Analyze bone chemistry

Examples

1 Poisoning

2 Determining the time of death

3 Elemental analysis of bullets



Forensic information about firearms use

Cases



River Thames, London, September 2001

Fingerprints

Fibre Analysis

Poison

Blood

Cases

How many people
fired at JFK?



John F Kennedy

Cases

Death of Napoleon



Napoleon

What is an Element?

Ancient Greeks



4 elements



Concept discarded

DNA

Fingerprints

Fibre Analysis

Poison

Blood

What is an Element?

Robert Boyle (1627 – 1691)



Elements can neither be created nor destroyed

A portrait of Robert Boyle, a 17th-century natural philosopher, chemist, physicist, and inventor. He is depicted as a man with long, dark, curly hair, wearing a dark robe with a white cravat. He is seated in a chair with a blue patterned backrest, and his hands are resting on a table covered with a blue patterned cloth. The background is dark and indistinct.

Robert Boyle

What is an Element?

Elements are the basic building blocks



93 naturally occurring



Others created artificially

What is an Element?

Common naturally occurring elements



H



Fe



Zn



O



Ag



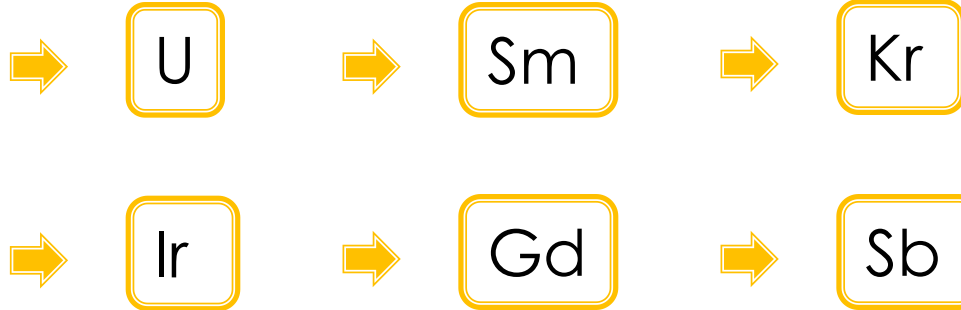
Sn



C

What is an Element?

Less common naturally occurring elements



Paper

Made of cellulose



C, H, O

Burning a piece of paper



C



CO₂



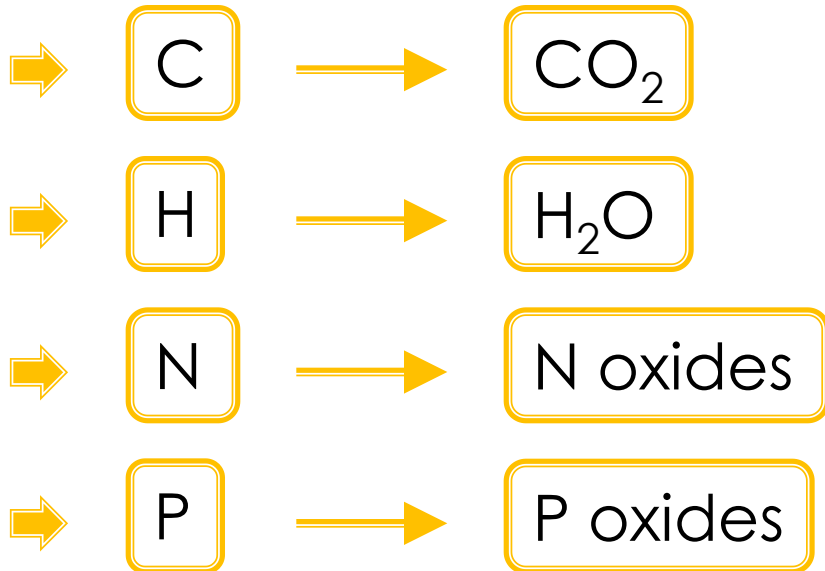
H



H₂O

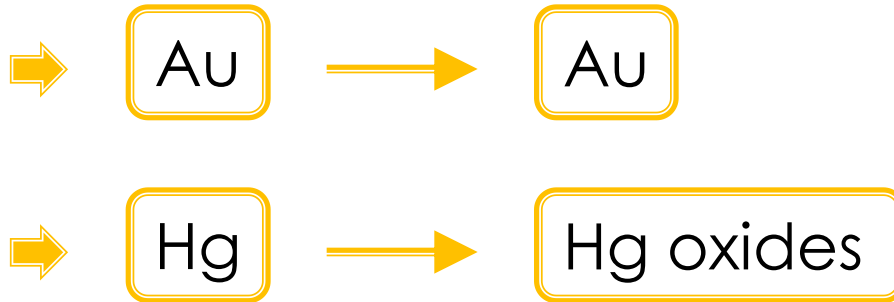
Human Body

C, H, O, N, P, S, Ca, Na, K, Fe...



Human Body

Au or Hg in teeth



<h1>The Periodic Table</h1>																			
hydrogen 1 H 1.0079											helium 2 He 4.0026								
beryllium 4 Be 9.0122											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180			
sodium 11 Na 22.990	magnesium 12 Mg 24.305											aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948		
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80		
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29		
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 ✱		lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	wolfram 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 ✱ ✱		lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	ununium 111 Uuu [272]	unbibium 112 Uub [277]	ununquadium 114 Uuq [289]					

* * Actinide series

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The Periodic Table

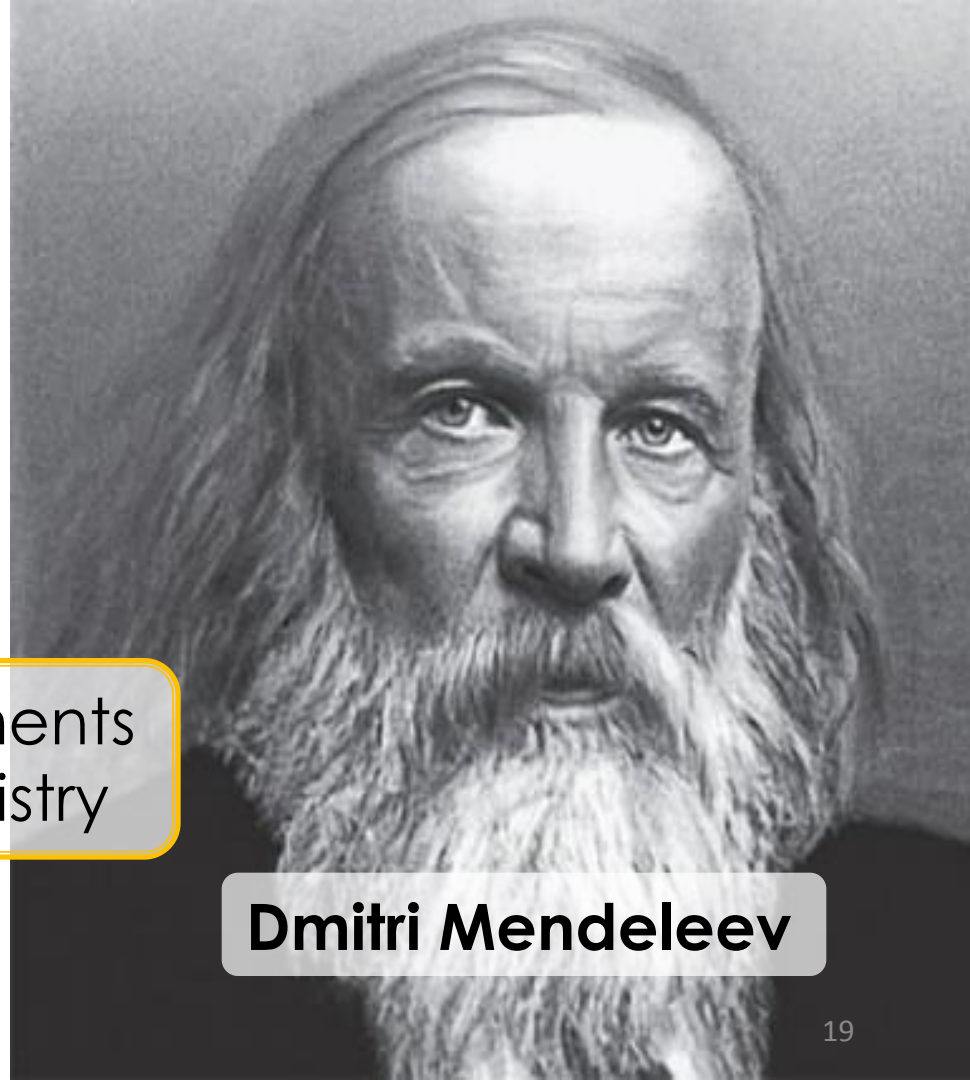
Dmitri Mendeleev



Chemist



Organized the elements
according to chemistry



Dmitri Mendeleev

The Periodic Table

Tom Lehrer



Mathematician and musician



Organized elements musically



[http://www.youtube.com/
watch?v=AcS3NOQnsQM](http://www.youtube.com/watch?v=AcS3NOQnsQM)



Tom Lehrer

What Is It Made Of?

Bulk composition



What is most of it made of?



Lead in bullets



Bullet

What Is It Made Of?

Trace impurities



What is a very small part of it made of?



Silver and antimony in bullets



Bullet

What Is It Made Of?

Analysis of elements

1 Bulk composition

2 Trace impurities



More informative for forensic scientists

Chemical Tests

Disadvantages



Large amounts of samples required



Destructive



Subject to interference

Chemical Tests

Advantages



Fast



Easy to do



Simple equipment

Trace Impurities

How small is small?



S. I. prefixes for units

Blood

Poison

Fibre Analysis

Fingerprints

DNA

S. I. Prefixes

1 Megagram	1 Mg	1 000 000 g	1 tonne
1 Kilogram	1 kg	1 000 g	
1 milligram	1 mg	0.001 g	1 / 1000 th
1 microgram	1 µg	0.000 001 g	1 / 1000 000 th
1 nanogram	1 ng	0.000 000 001 g	1 / billionth
1 picogram	1 pg	0.000 000 000 001 g	1 / trillionth

1 picogram



100 000 000 000 atoms

Trace Impurities

Trace elements often measured in ppm



Part per million



1 per 1 000 000



1 g of 1 tonne



1 ppm

Trace Impurities

5M people in Singapore



1 ppm = 5 people



Singapore map

Singapore

Trace Impurities

Trace elements often measured in ppm

Sometimes measured in ppb



Part per billion



1 per 1 000 000 000

Trace Impurities

7B people in the world



7 000 000 000



1 ppb = 7 people

World map

Scale 1:134,000,000
Robinson Projection
standard parallels 38°N and 38°S

January 2002

Boundary representation is
not necessarily authoritative.

802804AI (R00352) 12-01