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

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

Cases

How many people fired at JFK?

Cases

Death of Napoleon

What is an Element?

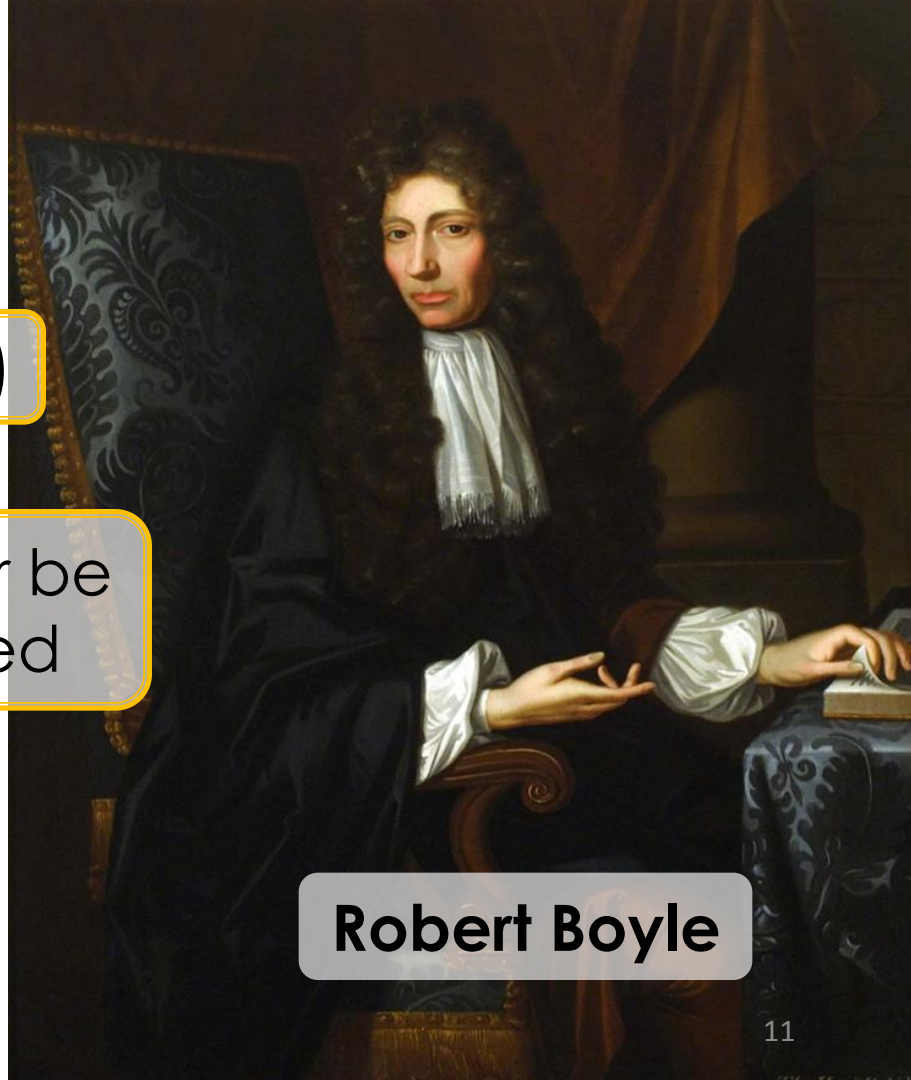
Ancient Greeks

- 4 elements
- Concept discarded

What is an Element?

Robert Boyle (1627 – 1691)

➡ Elements can neither be created nor destroyed



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

- U
- Sm
- Kr
- Ir
- Gd
- Sb

Paper

Made of cellulose → C, H, O

Burning a piece of paper

- C → CO_2
- H → H_2O

Human Body

C, H, O, N, P, S, Ca, Na, K, Fe…

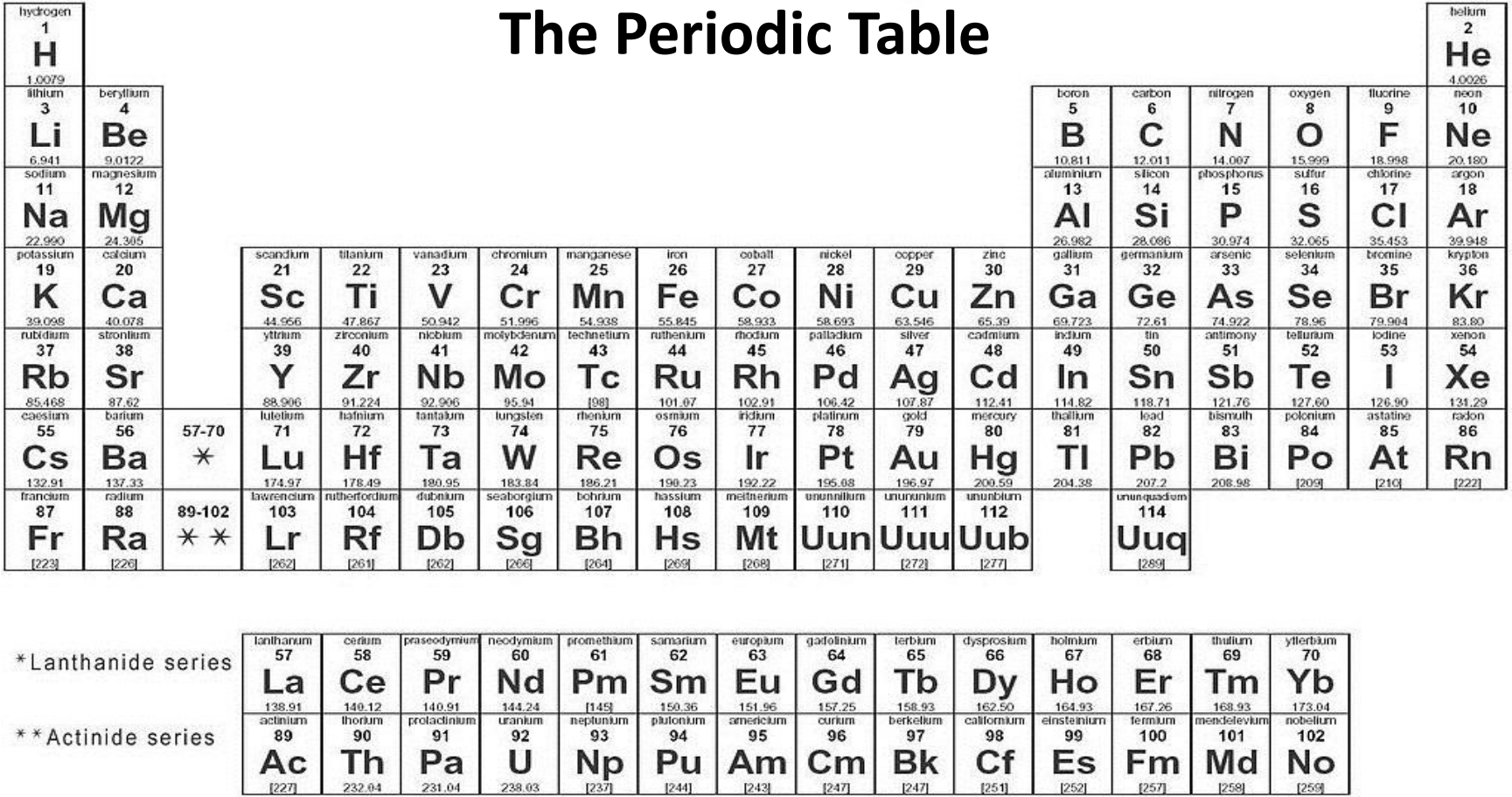
- C → CO_2
- H → H_2O
- N → N oxides
- P → P oxides

Human Body

Au or Hg in teeth

- Au → Au
- Hg → Hg oxides

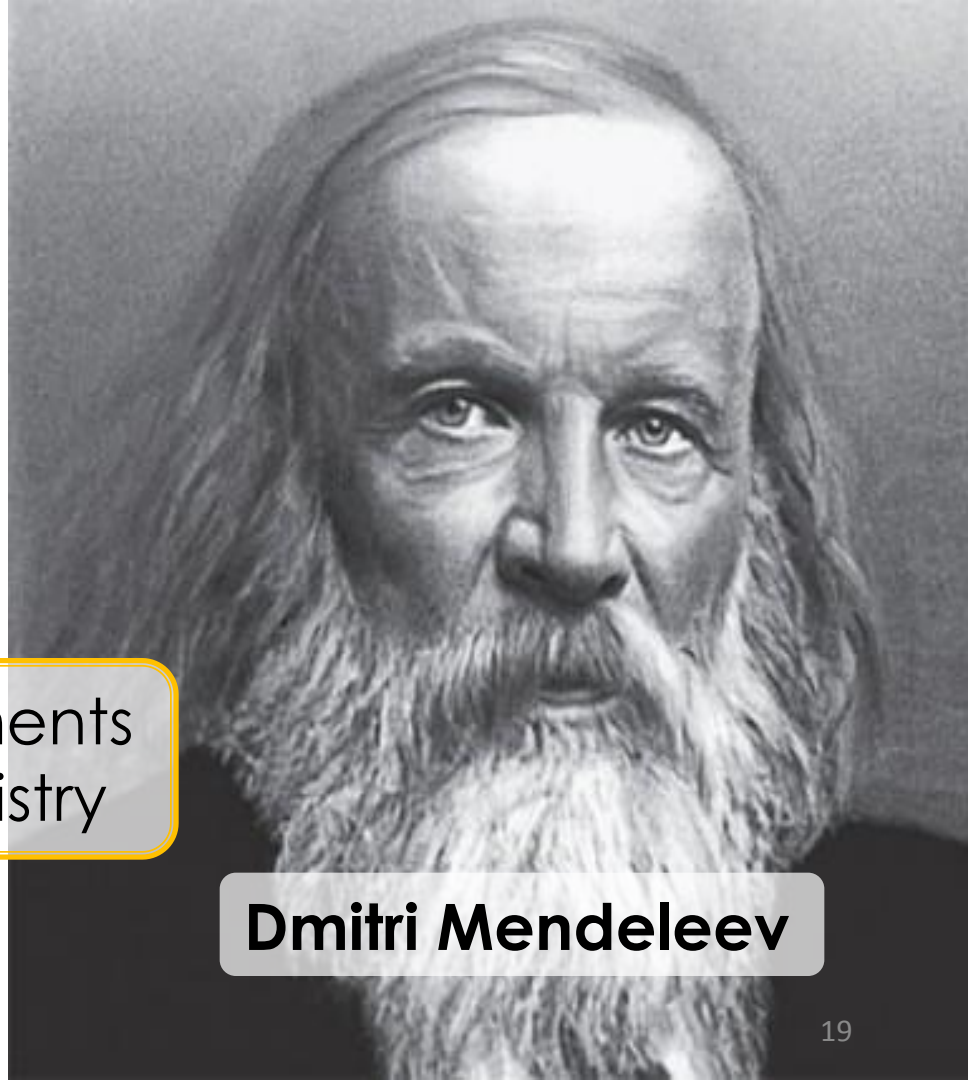
The Periodic Table



The Periodic Table

Dmitri Mendeleev

- Chemist
- Organized the elements according to chemistry



The Periodic Table

Tom Lehrer

- Mathematician and musician
- Organized elements musically
- 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

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 / 1000th
1 microgram	1 µg	0.000 001 g	1 / 1000 000th
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

Trace Impurities

Trace elements often measured in ppm

Sometimes measured in ppb

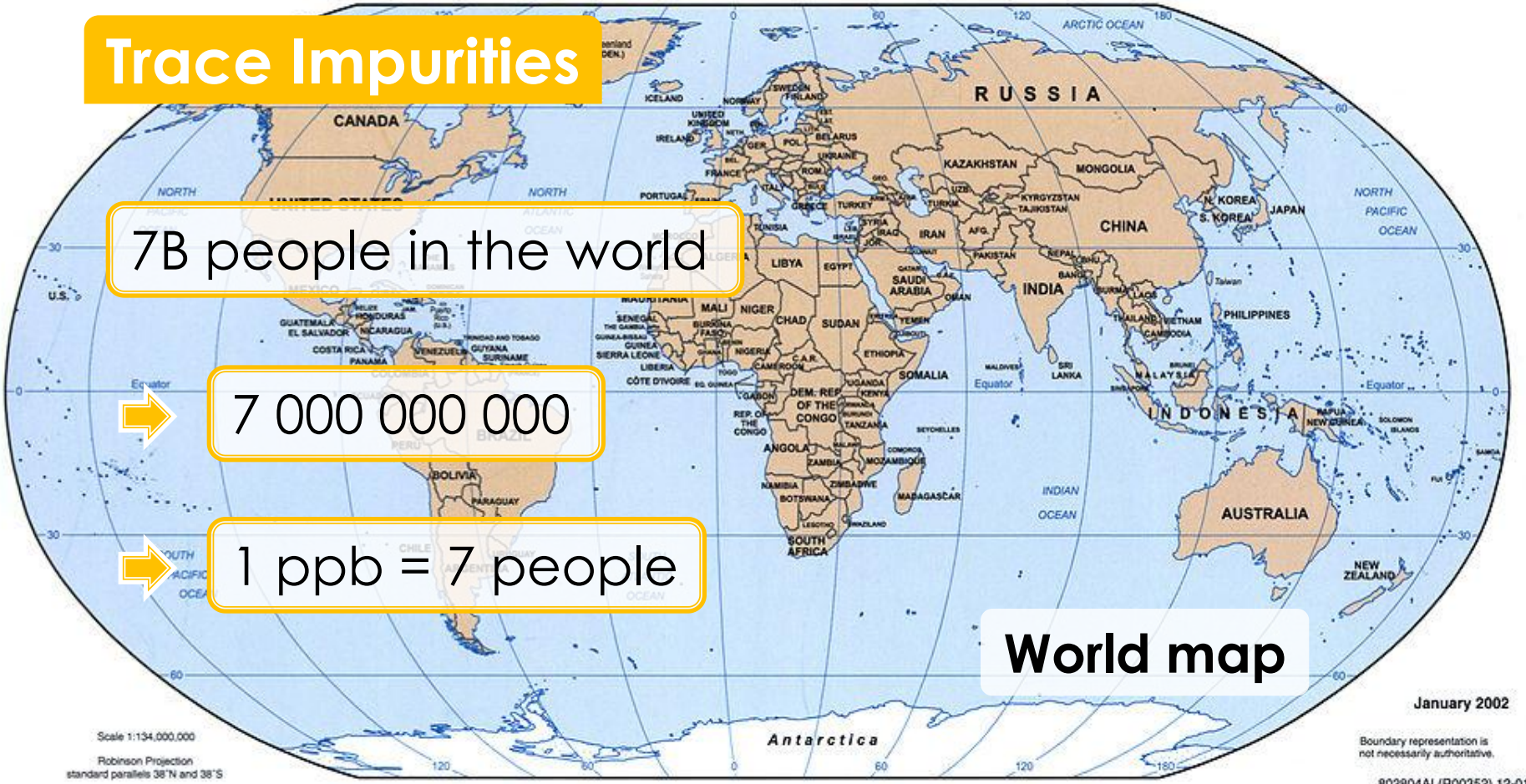
→ Part per billion → 1 per 1 000 000 000

Trace Impurities

7B people in the world

7 000 000 000

1 ppb = 7 people



World map