KIMIA UMUM (TKK 134)

(*General Chemistry*)

Semester 1, Year 2011-2012

By: Assoc. Prof. Dr. Istadi

Dept. of Chemical Engineering,
Diponegoro University

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Evaluation/Exams

- **Credit** : 2 credits/SKS
- **Evaluations**:
  - Tugas untuk Section Dr. Istadi: 10%
  - Ujian (UTS) untuk Section Dr. Istadi: 40%

  - Ujian (UAS) untuk Section Aprilina P., ST, MT.: 40%
  - Tugas untuk Section Aprilina P., ST, MT.: 10%

- **References/Textbook Utama**:
  - Martin S. Silberberg, (2006), "***Chemistry: The Molecular Nature of Matter and Change***", 4th Edition, The McGraw-Hill Companies, Inc., ISBN 0-07-111658-3

- Online/Web Course: **http://tekim.undip.ac.id/staf/istadi**

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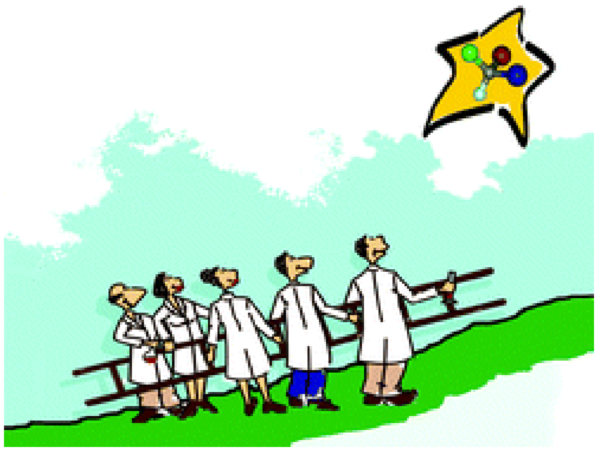

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SILABI – KIMIA UMUM

- ☐ Komponen-komponen Penyusun Materi;
- ☐ Perkembangan Teori Atom;
- ☐ Ikatan Kovalen dan Ikatan Ionik;
- ☐ Ikatan Hydrogen; Ikatan Van der Walls;
- ☐ Teori Kuantum dan Struktur Atom;
- ☐ Konfigurasi Elektron dan Sistem Periodik Unsur;
- ☐ Gaya Intramolekuler dan Gaya Intermolekular

Dr. Istadi
(aspek-aspek molekular)

- ☐ kesetimbangan kimia dan prinsip Le-Chatelier,
- ☐ teori asam-basa,
- ☐ kesetimbangan asam-basa,
- ☐ reaksi oksidasi-reduksi,

Aprilina Purbasari, ST, MT

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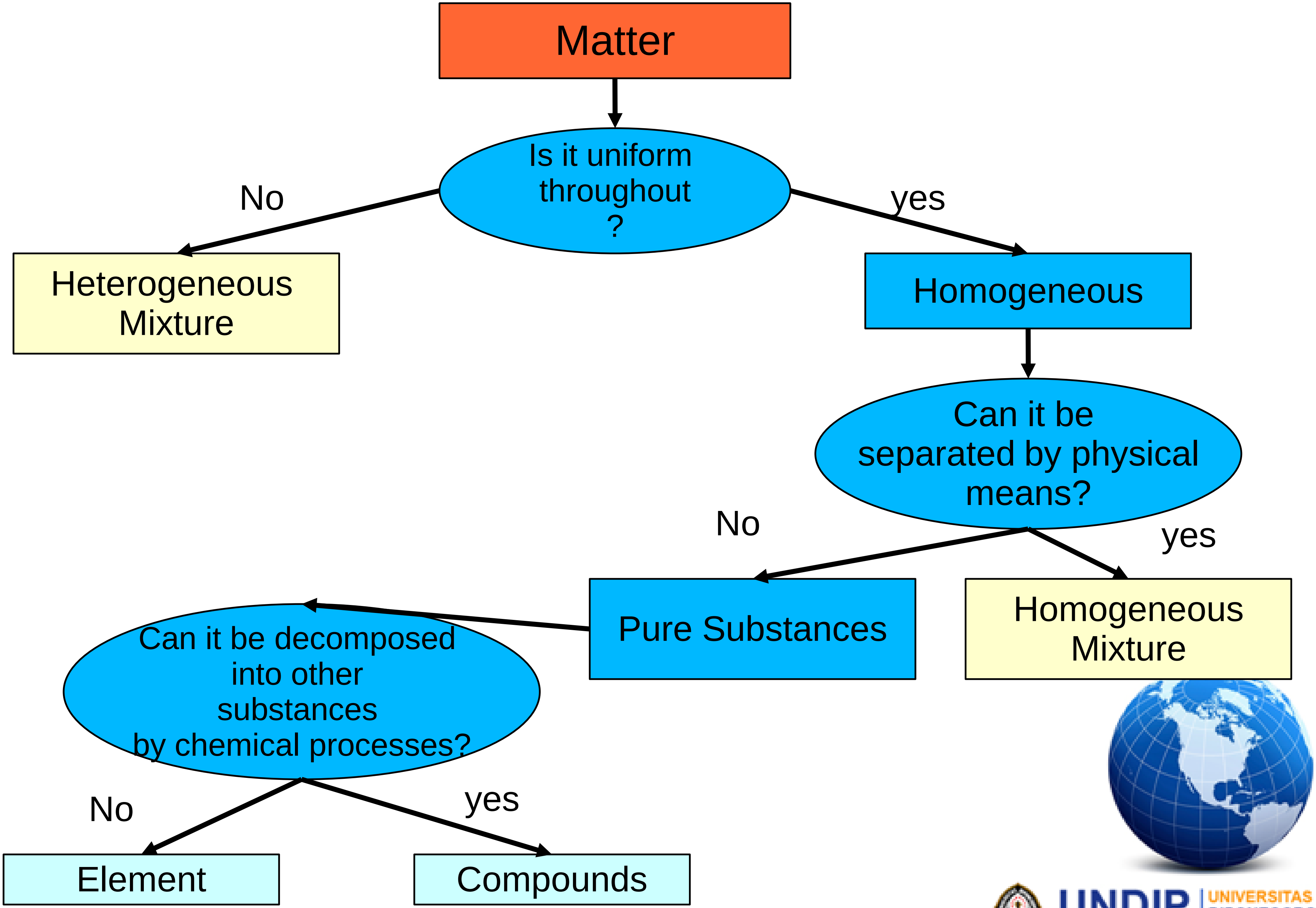
Elements, Compounds and Mixtures: *An Atomic Overview*

- **Elements:** Substances which cannot be decomposed into simpler substances by chemical means. Each elements is unique because the properties of its atoms are unique
  - Composed of one type of atom
  - Classified as metal, nonmetal, or metalloid
  - Simplest type of matter that retains characteristic properties
  - May occur as individual atoms or as molecules
  - Atomic mass is average of isotopic masses weighted by abundance
  - Examples: hydrogen, oxygen, silicon, etc.
- **Molecules:** an independent structural unit consisting of two or more atoms chemically bound together ==> O_2, H_2, etc.

- **Compounds:** a type of matter can be decomposed into two or more different elements that are chemically bound together ==> ammonia, water
  - Two or more elements combined in fixed parts by mass
  - Properties differ from those of component elements
  - Molecular mass is sum of atomic masses
- **Mixtures:**
  - a group of two or more substances (elements and/or compounds) that are physically mixed together, not chemically bound.
  - The components retain their individual properties and can be present in any proportions


Matter
Is it uniform throughout ?
No
yes
Heterogeneous Mixture
Homogeneous
Can it be separated by physical means?
No
yes
Pure Substances
Homogeneous Mixture
Can it be decomposed into other substances by chemical processes?
No
yes
Element
Compounds

The Atomic Theory of Matter

- The word "**atom**" is derived from the Greek word "*<u>atomos</u>*", meaning **indivisible**.
- The philosopher **Democritus** (460-370 B.C.) believed that matter was composed of fundamentally indivisible particles, called "atomos".
- **Dalton's (1766-1844) postulates on atomic theory** of 1808:
  - All matter or each element is composed of extremely small particles called atoms, tiny indivisible particles that cannot be created or destroyed.
  - Atoms of an element can not be converted atoms of another elements. Atoms are neither created nor destroyed in chemical reactions, the atoms of the original substances recombine to form different substances.
  - All atoms of an element are identical in mass and other properties and are different from atoms of any other element.
  - Compounds are formed when atoms of more than one element combine chemically with a specific ratio.

Atoms are the smallest particle of an element which retains the chemical properties of that element

Dalton's Postulates Explain Mass Laws

- **Mass Conservation:**
  - Atoms cannot be created or destroyed (Postulate 1) or converted into other type of atoms (Postulate 2).
  - Since each type of atoms has a fixed mass (Postulate 3), a chemical reaction, in which atoms are just combined differently with each other, cannot possibly result in a mass change.
- **Mass is constant during a reaction** because atoms form new combinations;
  - each compound has a fixed mass fraction of each of its elements because it is composed of a fixed number of each type of atom
  - Different compounds of the same elements exhibit multiple proportions because they each consist of whole atoms.

Atomic Models Discoveries: *J.J. Thomson, R. Millikan* and *Ernest Rutherford*

- **J.J. Thompson (1897)**: measured the charge to mass ratio for a stream of electrons (using a cathode ray tube apparatus) at 1.76E8 coulombs/gram.
  - Thompson determined the **charge to mass ratio for the electron**, but **was not able to determine the mass of the electron**.
  - Thompson estimated that the cathode ray particle weighed less than 1/1000 as much as hydrogen (the lightest atom)
  - However, if the charge of a single electron could be determined, then the mass of a single electron could be determined.
  - ***Thompson's Atom Model:*** The atom consists of a sphere of positive charge within which was buried negatively charged electrons
- **R. Millikan (1909):** was able to successfully **measure the charge on a single electron** (the "Millikan oil drop experiment")
  - This value was determined to be -1.602E-19 coulombs.
  - Thus, the mass of a single electron was determined to be:

$$Mass\ of\ \ Electron = \frac{mass}{charge} * charge$$

$$= (-5.686\text{E-}12\ kg/C) * (-1.602\text{E-}19\ C)$$

$$= 9.109\text{E-}31\ kg = 9.109\text{E-}28\ g$$

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Experiment of Thomson (1897)

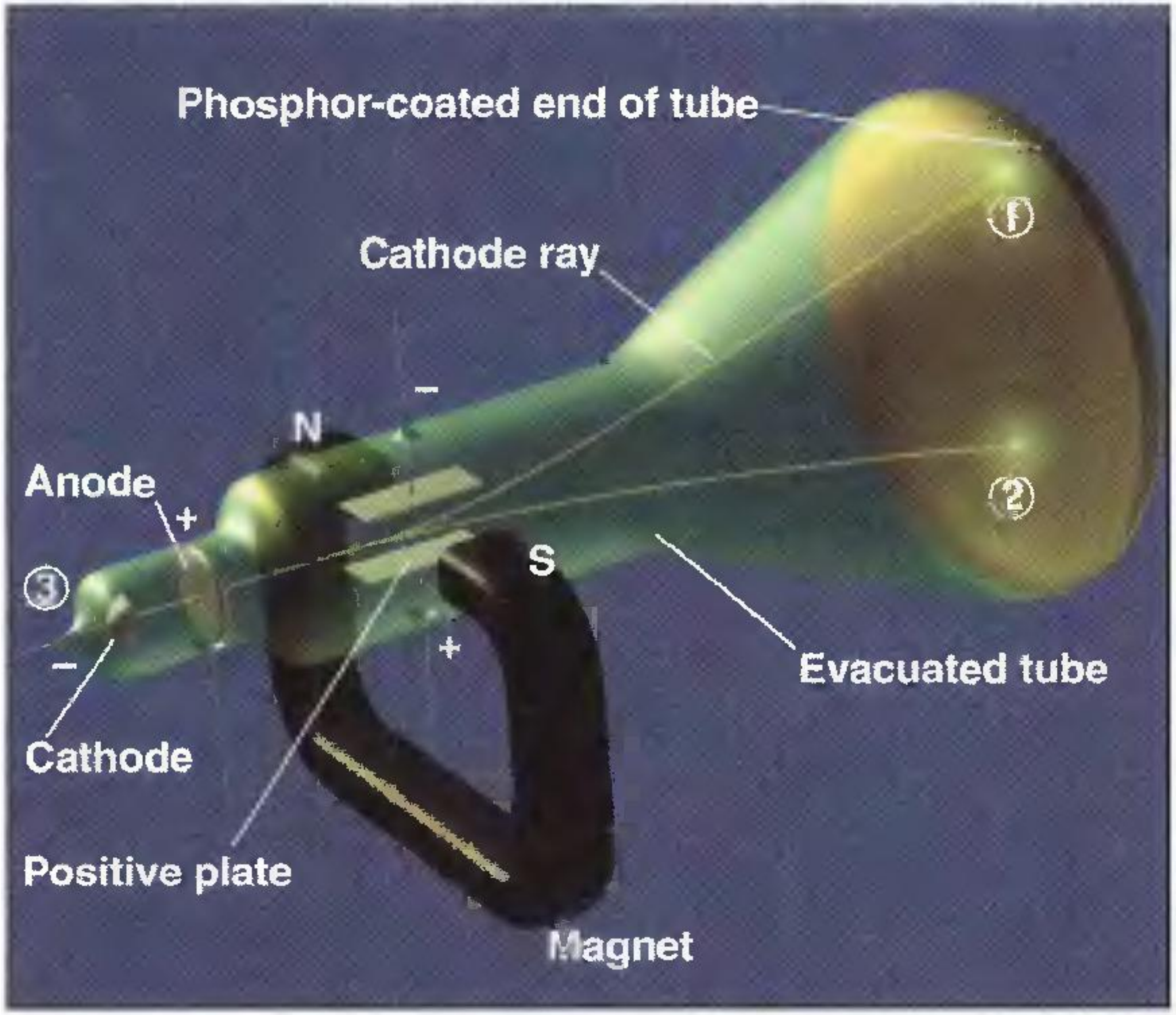

Figure 2.5 Experiments to determine the properties of cathode rays. A cathode ray forms when high voltage is applied to a partially evacuated tube. The ray passes through a hole in the anode and hits the coated end of the tube to produce a glow.

OBSERVATION	CONCLUSION
1. Ray bends in magnetic field	Consists of charged particles
2. Ray bends toward positive plate in electric field	Consists of negative particles
3. Ray is identical for any cathode	Particles found in all matter

THOMSON EXPERIMENT ANIMATION

CATHODE RAYS ANIMATION

Experiments of Millikan

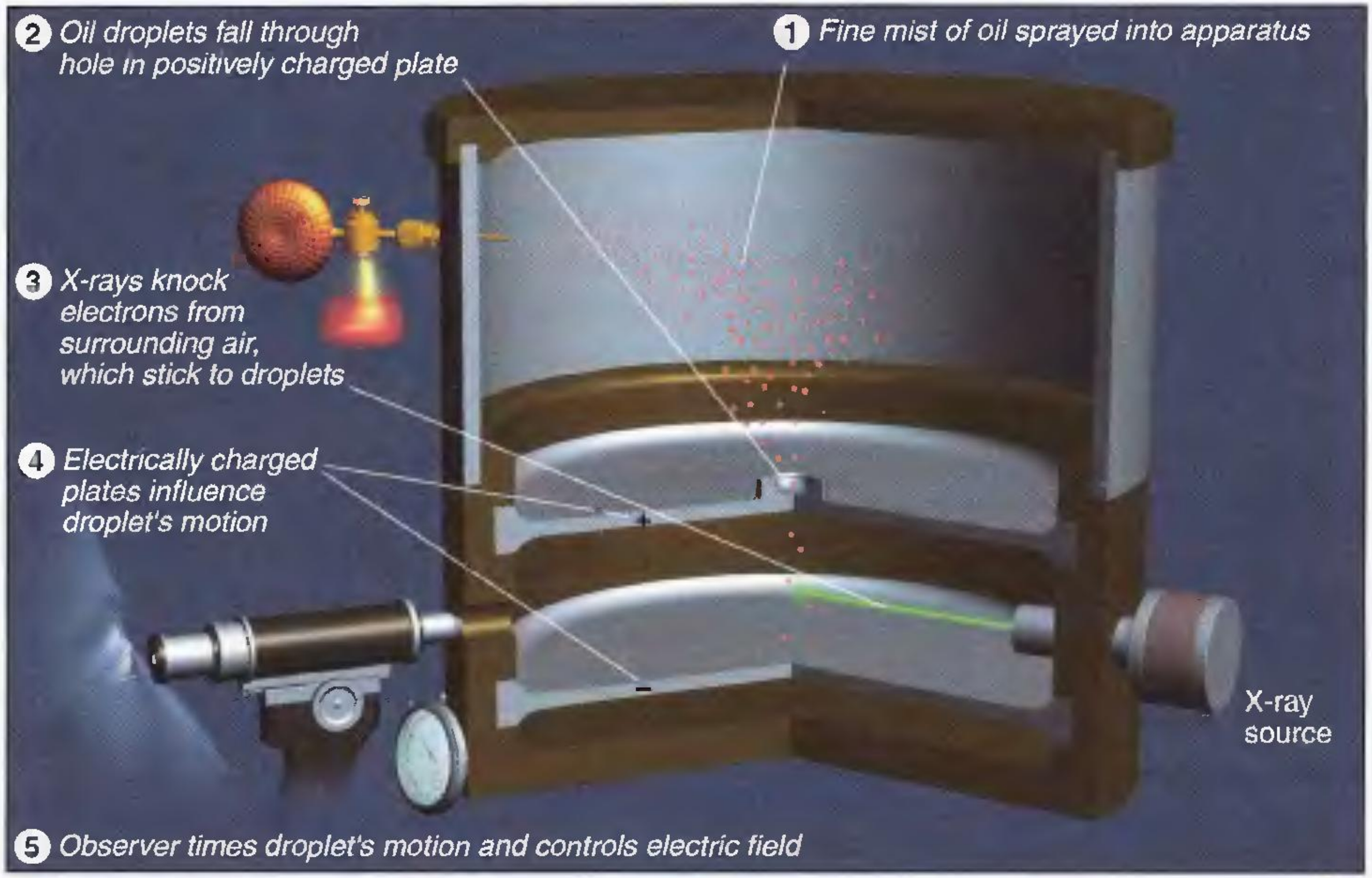

Figure 2.6 Millikan's oil-drop experiment for measuring an electron's charge. The motion of a given oil droplet depends on the variation in electric field and the total charge on the droplet, which depends in turn on the number of attached electrons. Millikan reasoned that the total charge must be some whole-number multiple of the charge of the electron.

MILLIKAN EXPERIMENT ANIMATION

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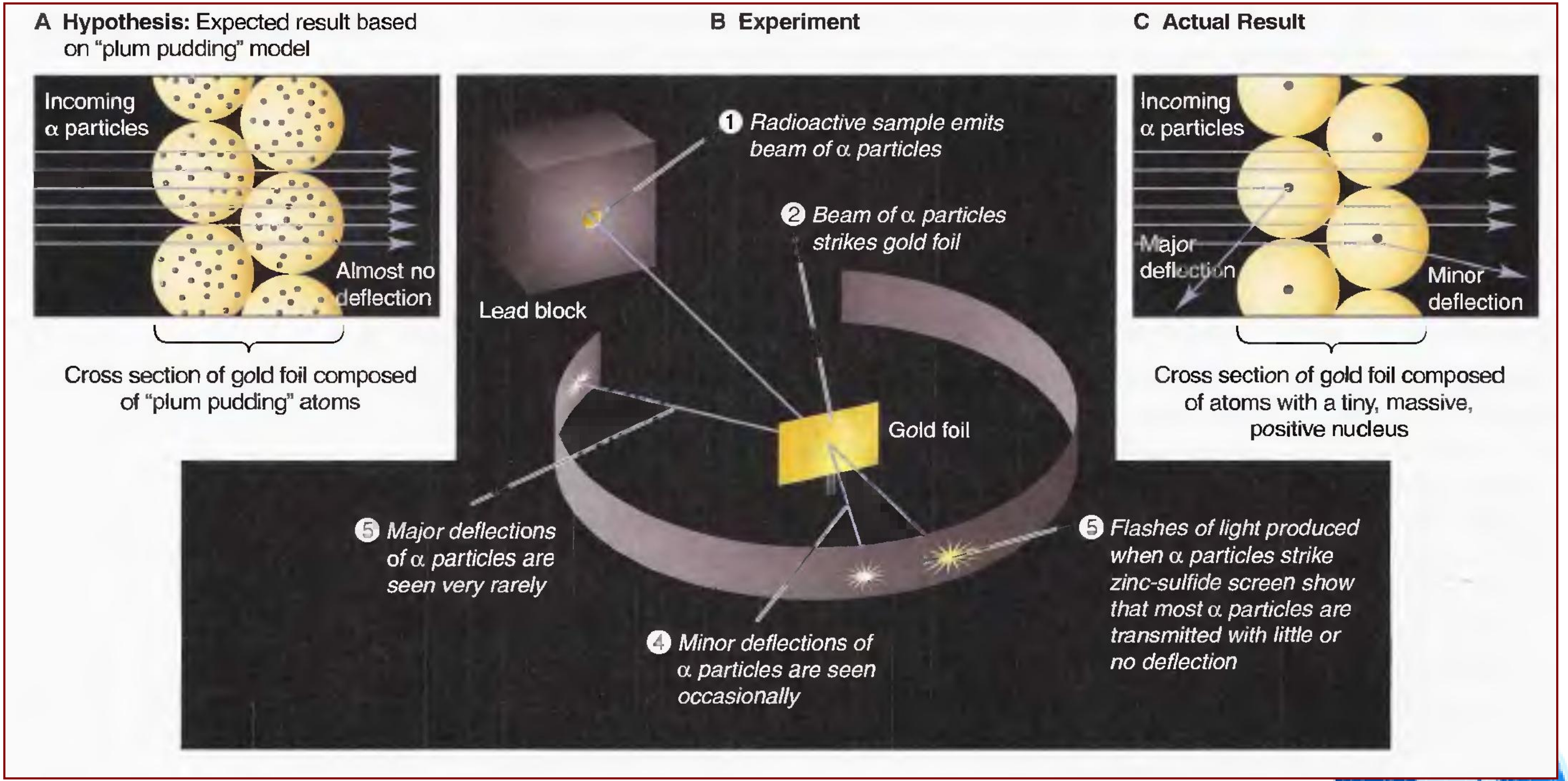
E. Rutherford's & Chadwick's Atom Model ==> Atomic Nucleus

- **Ernest Rutherford (1910):** studied alpha rays, beta rays and gamma rays, emitted by certain radioactive substances.
  - an atom is mostly space occupied by electrons, but in the center of that space is a tiny region, which he called the "Nucleus"
  - The nucleus contains all the positive charge and essentially all the mass of the atom
  - Most of the total volume of the atom is empty space within which the negatively charged electrons move around the nucleus
  - Hypothesis: Atoms consist of electrons embedded in diffuse, positively charged matter, so the speeding α particles should pass through the gold foil with, at most, minor deflections
  - Experiment: α particles emit a flash of light when they pass through the gold atoms and hit a phosphor-coated screen
  - Results: Occasional minor deflections and very infrequent major deflections are seen. This means very high mass and positive charge are concentrated in a small region within the atom, the nucleus.
  - Rutherford (1919) discovers **protons** - positively charged particles in the nucleus

Experiment of E. Rutherford



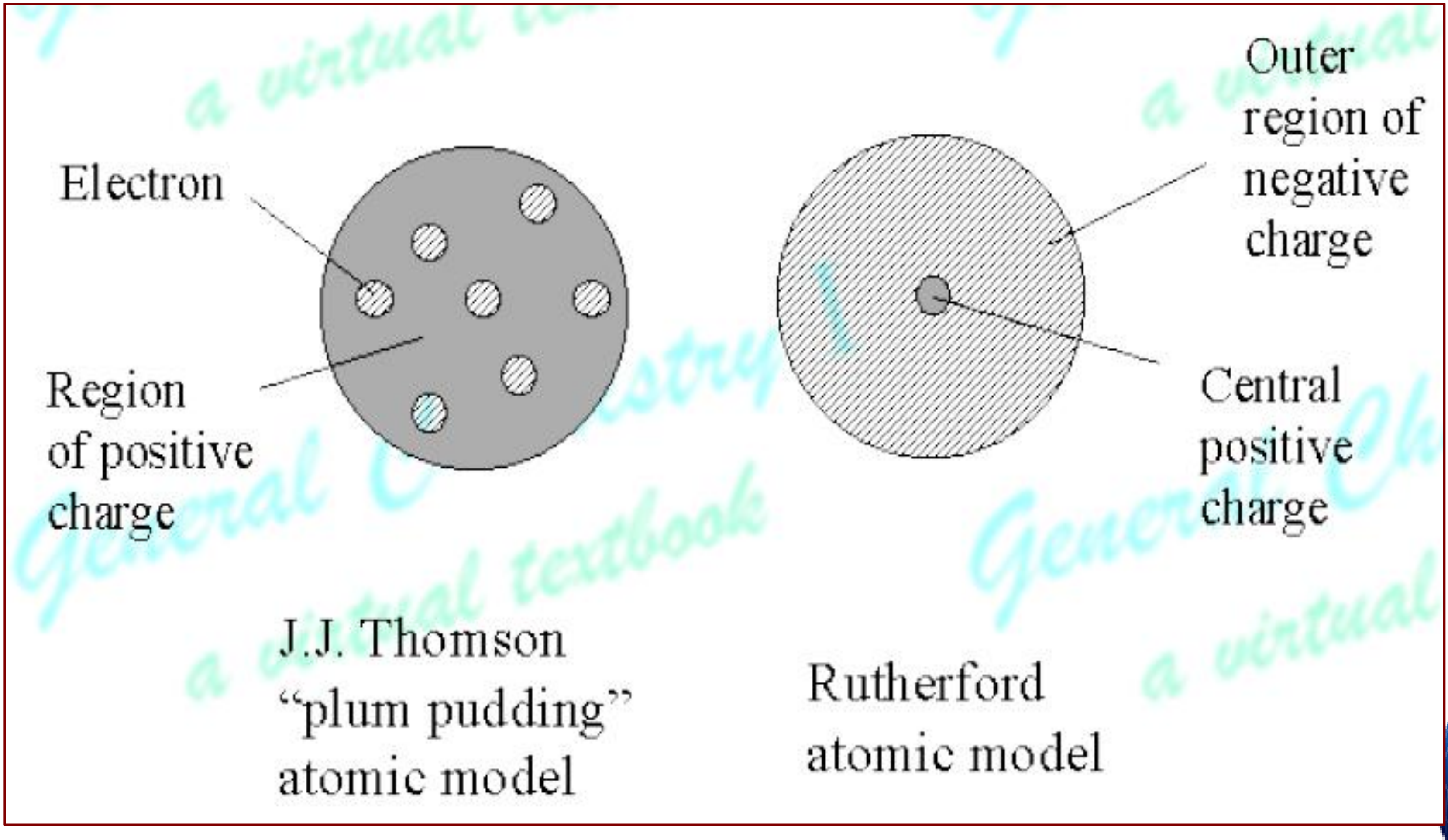
RUTHERFORD ATOMIC MODEL (nucleus)

RUTHERFORD EXPERIMENT ANIMATION

Rutherford's a-scattering experiment and discovery of the atomic nucleus

- **HYPOTHESIS**: Atoms consist of electrons embedded in diffuse, positively charged matter, so the speeding a particles should pass through the gold foil with, at most, minor deflections.
- **EXPERIMENT:** a Particles emit a flash of light when they pass through the gold atoms and hit a phosphor-coated screen.
- **RESULTS:** Occasional minor deflections and very infrequent major deflections are seen. This means very high mass and positive charge are concentrated in a small region within the atom, the nucleus.

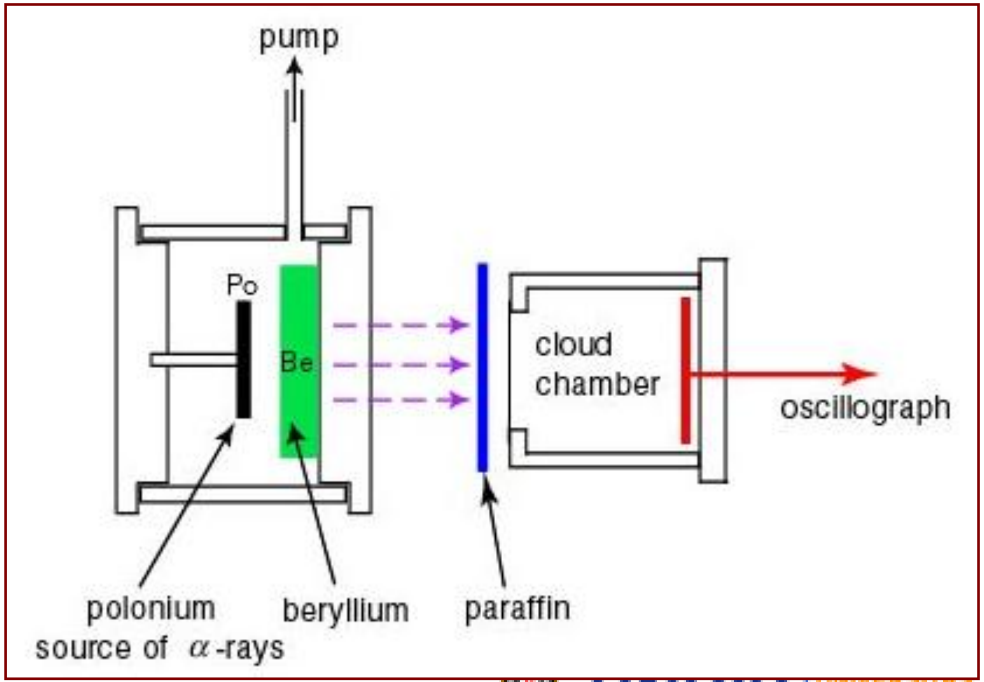
Comparison of Thomson and Rutherford Atomic Model



The Discovery of the Neutron by Chadwick (1932)

- **Chadwick (1932):** discovers **neutron** - neutral charge particles in the nucleus
- The high-energy radiation emitted from the (Po-Be) source on the left-hand side is led to the cloud chamber, in front of which a paraffin layer is placed. The radiation is scattered by a proton in the parafin and a photograph of the recoil proton is taken in the cloud chamber on the right-hand side.

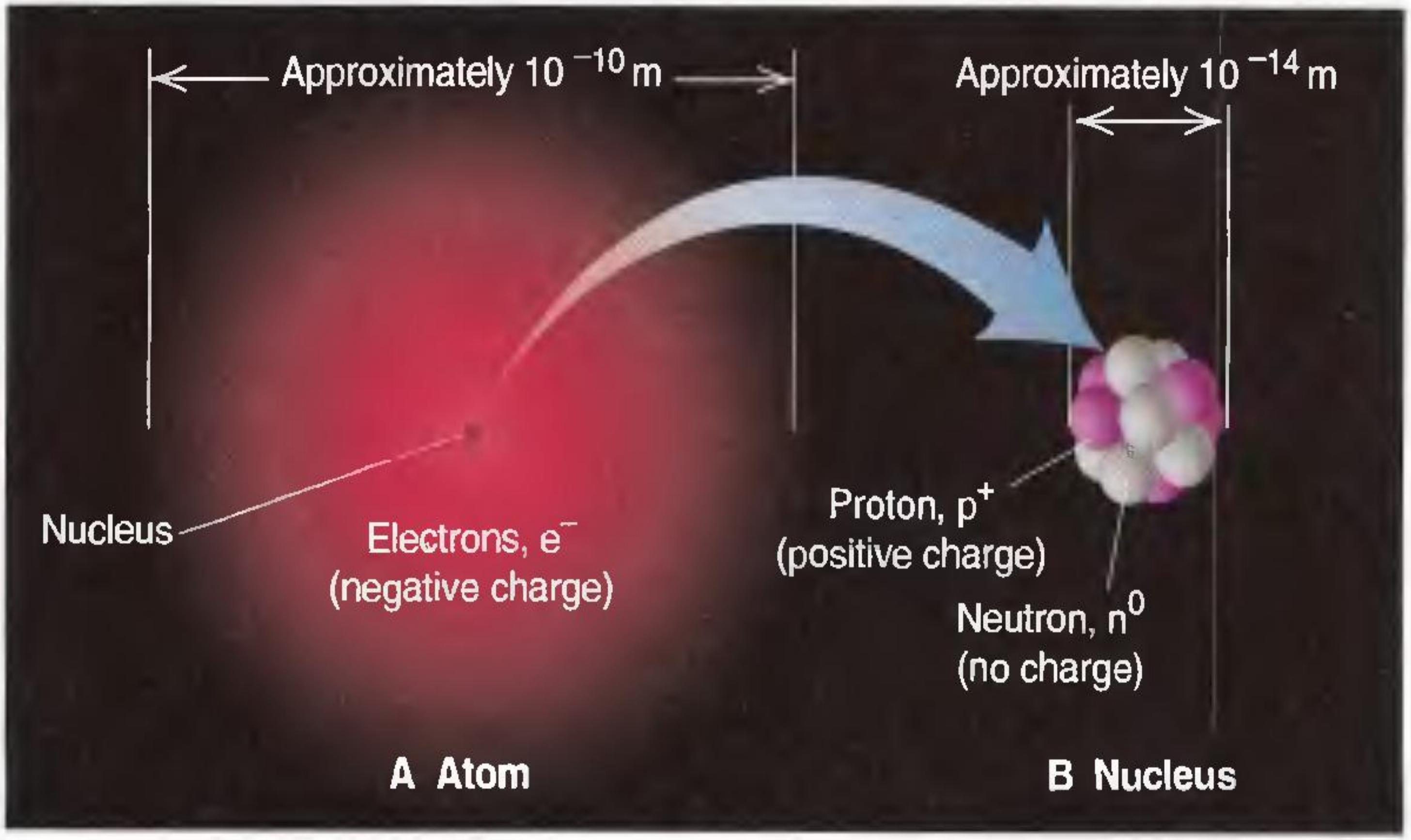
Chadwick concluded that this mysterious radiation from the (Po-Be) source cannot be interpreted by assuming it to be a gamma ray. He finally concluded that all were able to be understood without any contradiction by assuming that the mysterious radiation is electrically neutral particles with almost the same mass as a proton. This is the confirmation of the existence of the "**neutral proton**" predicted by Rutherford. Chadwick named this particle "**neutron**" (1932).



The Modern View of Atomic Structure: *electron, proton, neutron*

- An **atom** has: a central **nucleus**, which contains positively charged **protons (p^+)** and uncharged **neutrons (n^0)** and is surrounded by negatively charged **electrons (e^-)**.
- Magnitude of charge possessed by a proton is equal to that of an electron (e^-)
- Look at **Table 2.2** for properties of proton, neutron, and electron (charge, mass, and location in atom).
- An **atom is neutral** because the number of protons in the nucleus equals the number of electrons surrounding the nucleus.

Modern Atom Concept



MODERN ATOM MODEL

Figure 2.8 General features of the atom. A, A "cloud" of rapidly moving, negatively charged electrons occupies virtually all the atomic volume and surrounds the tiny, central nucleus. **B,** The nucleus contains virtually all the mass of the atom and consists of positively charged protons and uncharged neutrons. If the nucleus were actually the size in the figure (~1 cm across), the atom would be about 100 m across—slightly more than the length of a football field!

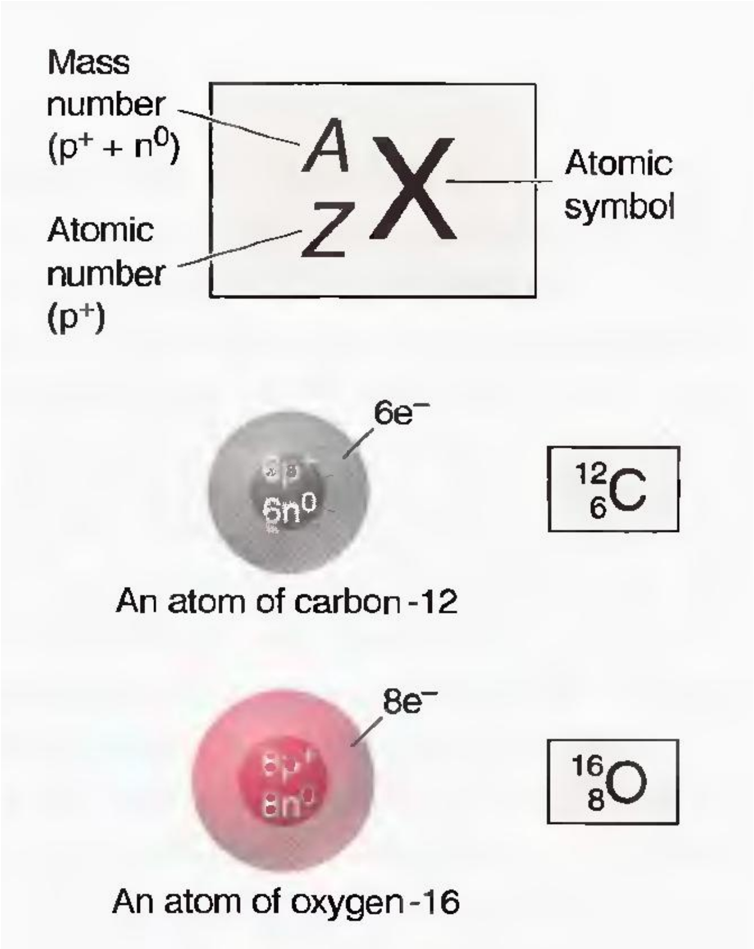
Properties of Subatomic Particles

Table 2.2 Properties of the Three Key Subatomic Particles

Name (Symbol)	Charge		Mass		Location in Atom
	Relative	Absolute (C)*	Relative (amu)†	Absolute (g)	
Proton (p^+)	1+	$+1.60218\times10^{-19}$	1.00727	1.67262×10^{-24}	Nucleus
Neutron (n^0)	0	0	1.00866	1.67493×10^{-24}	Nucleus
Electron (e^-)	1−	-1.60218×10^{-19}	0.00054858	9.10939×10^{-28}	Outside nucleus

*The coulomb (C) is the SI unit of charge.
†The atomic mass unit (amu) equals 1.66054×10^{-24} g; discussed later in this section.

Atomic Number, Mass Number, and Atomic Symbols

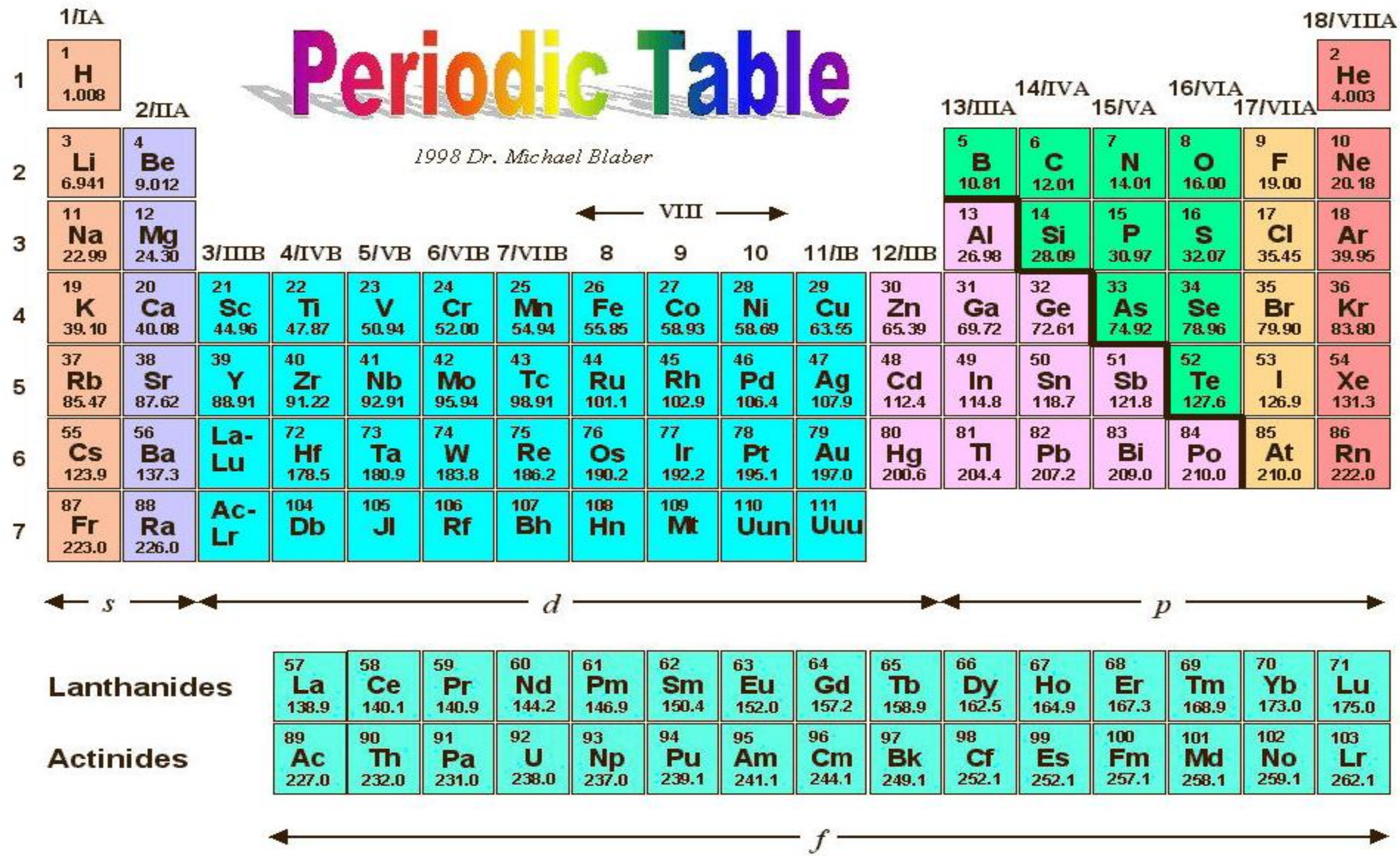


- All atoms of a particular element have the *same atomic number*, and each element has a different atomic number from that of any other element.
- **Mass number:** total number of protons and neutrons in the nucleus of an atom
- Number of neutrons = mass number – atomic number or **N = A – Z**
- All atoms of an element are identical in atomic number but not in mass number.
- **Isotopes** of an element are atoms that have different numbers of neutrons and therefore different mass numbers.
- All isotopes of an element have nearly identical chemical behavior, even though they have different masses.

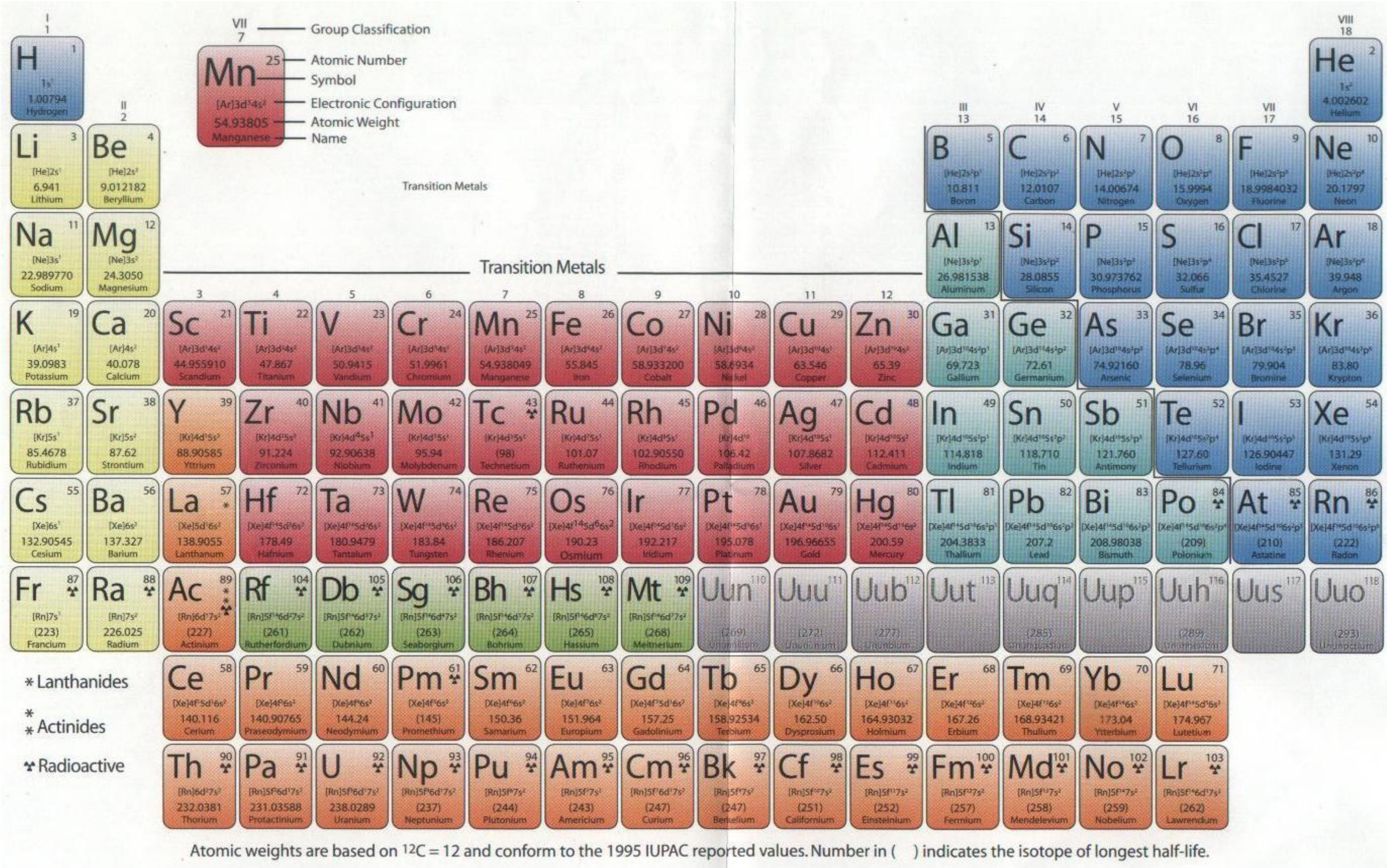
Modern Reassessment of Atomic Theory

- *All matter is composed of atoms*. Atoms are divisible and composed of smaller, subatomic particles (electron, protons, and neutrons), but the atom is still the smallest body that retains the unique identity of an element
- *Atoms of one element cannot be converted into atoms of another element in a chemical reaction*
- *All atoms of an element have the same number of protons and electrons,* which determines the chemical behavior of the elements.
- *Compounds are formed by the chemical combination of two or more elements* in specific ratios.

Elements: A First Look at The Periodic Table (Mendeleev)



Another Periodic Table



THANK YOU

SELAMAT BELAJAR