USEFUL ballpark (not exact!) conversion estimates to keep in mind

1 inch ~ 2.5 cm

60 miles ~ 100 km

1 gallon ~ 4 liters

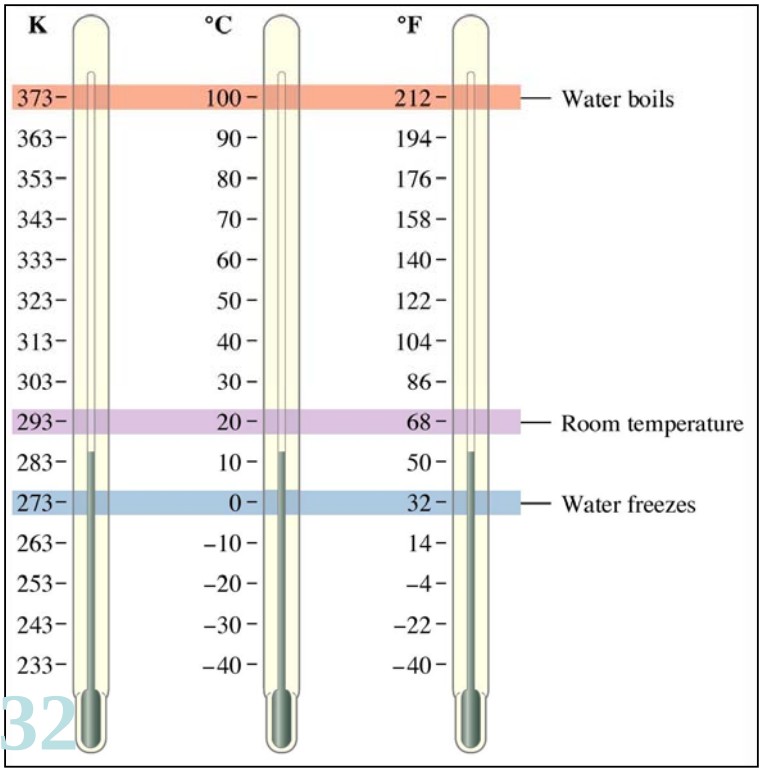
Comparison of temperature scales.

Conversions:

$$K = {}^{o}C + 273.15$$

$${}^{o}C = \frac{{}^{o}F - 32}{1.8}$$

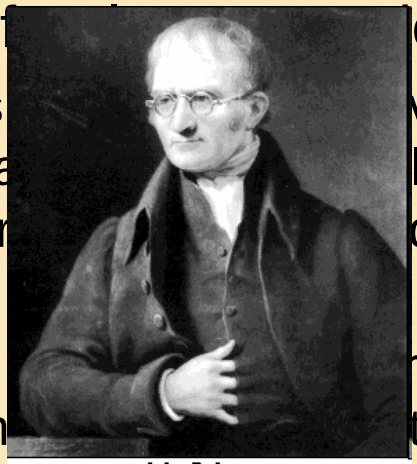
$${}^{o}F = 1.8({}^{o}C) + 32$$



Example: converting 113 F to Celsius: C = (113-32)/1.8 = 45 C

Chapter 2 : Atomic Theory of Matter

- Postulates of [illegible]c Theory
  - All matter is [illegible]visible atoms. An atom is a [illegible]l particle of matter that r[illegible] during chemical reactions.
  - An element [illegible]r composed of only one kin[illegible]tom of a given element having the same properties. Mass is one such prope[illegible] the atoms of a given element have a characteristic mass.



John Dalton

1766-1844

Atomic Theory of Matter

- Postulates of Dalton's Atomic Theory
  - All matter is composed of indivisible atoms. An atom is an extremely small particle of matter that retains its identity during chemical reactions.
  - An element is a type of matter composed of only one kind of atom, each atom of a given element having the same properties. Mass is one such property. Thus the atoms of a given element have a characteristic mass.

Atomic Theory of Matter

- Postulates of Dalton's Atomic Theory
  - A **compound** is a type of matter composed of atoms of two or more elements chemically combined in fixed proportions.
- The relative numbers of any two kinds of atoms in a compound occur in simple ratios.
- Water, for example, consists of hydrogen and oxygen in a 2 to 1 ratio.
- Special case – Law of multiple proportions – if the same two elements can combine in *different* ratios – then they form *two different compounds*: like CO and CO_2. (the combinations of carbon to oxygen here is 1:1 and 1:2)

Atomic Theory of Matter

- Postulates of Dalton's Atomic Theory
  - A **chemical reaction** consists of the rearrangements of the atoms present in the reacting substances to give new chemical combinations present in the substances formed by the reaction.
  - Atoms are not created, destroyed, or broken into smaller particles by any chemical reaction.

Atomic Theory of Matter

- An atomic symbol is a one– or two–letter notation used to represent an atom corresponding to a particular element.
  - Typically, the atomic symbol consists of the first letter, capitalized, from the name of that element, sometimes with an additional letter from the name in lowercase.
  - Other symbols are derived from the name in another language (usually Latin).
  - Symbols of selected elements are listed in Table 2.1.

Atomic Theory of Matter

- The Structure of the Atom
  - Although Dalton postulated that atoms were indivisible, experiments at the beginning of the present century showed that atoms themselves consist of particles.
  - Experiments by Ernest Rutherford in 1910 showed that the atom was mostly “empty space.”

Atomic Theory of Matter

- The structure of the atom
  - These experiments showed that the atom consists of two kinds of particles: a **nucleus**, the atom's central core, which is positively charged and contains most of the atom's mass, ***and*** one or more **electrons**.
  - **Electrons** are very light, negatively charged particles that exist in the region around the atom's positively charged nucleus.

Atomic Theory of Matter

- The structure of the atom
  - In 1897, the British physicist J. J. Thompson conducted a series of experiments that showed that atoms were not indivisible particles.
  - From his experiments, Thompson calculated the ratio of the electron's mass, m_e, to its electric charge, e.

Atomic Theory of Matter

- The structure of the atom
  - In 1909, U.S. physicist, Robert Millikan had obtained the charge on the electron.
  - These two discoveries combined provided us with the electron's mass of **9.109×10^{-31} kg**, which is more than 1800 times smaller than the mass of the lightest atom (hydrogen).
  - These experiments showed that the electron was indeed a subatomic particle.

Atomic Theory of Matter

- The nuclear model of the atom.
  - Ernest Rutherford, a British physicist, put forth the idea of the **nuclear model** of the atom in 1911, based on experiments done in his laboratory by Hans Geiger and Ernest Morrison.
  - Rutherford's famous **gold leaf experiment** gave credibility to the theory that the majority of the mass of the atom was concentrated in a very small nucleus.

Atomic Theory of Matter

- Nuclear structure; Isotopes
  - The nucleus of an atom is composed of two different kinds of particles: protons and neutrons.
  - An important property of the nucleus is its ***positive electric charge***.

Atomic Theory of Matter

- Nuclear structure; Isotopes
  - A **proton** is the nuclear particle having a positive charge equal to that of the electron's (a "unit" charge) and a mass more than 1800 times that of the electron's.
  - The number of protons in the nucleus of an atom is referred to as its **atomic number** (*Z*).

Atomic Theory of Matter

- Nuclear structure; Isotopes
  - An **element** is a substance whose atoms all have the **same atomic number**.
  - The **neutron** is a nuclear particle having a mass almost identical to that of a proton, but **no electric charge**.

Atomic Theory of Matter

- Nuclear structure; Isotopes
  - The **mass number** is the total number of protons and neutrons in a nucleus.
  - A **nuclide** is an atom characterized by a definite atomic number and mass number.
  - The shorthand notation for a nuclide consists of its symbol with the atomic number as a subscript on the left and its mass number as a superscript on the left.

$sodium - 23 \qquad {}^{23}_{11}Na$

Atomic Theory of Matter

- Nuclear structure; Isotopes
  - **Isotopes** are atoms whose nuclei have the same atomic number but different mass numbers; that is, the nuclei have the same number of protons but different numbers of neutrons.
  - Specific nucleus with given number of protons and neutrons is called **nuclide**

Example: using periodic table find a symbol of nuclide with 18 electrons, 18 protons and 22 neutrons.

Solution: 18 protons leads us to element number 18 – that is argon, Ar. The mass of this specific nuclide is a sum of all neutron and protons, that is 18 + 22 = 40. Thus we are dealing with "argon-40" nuclide.

Figure 2.2: Iodine atoms on a metal surface. *Courtesy of Digital Instruments.*

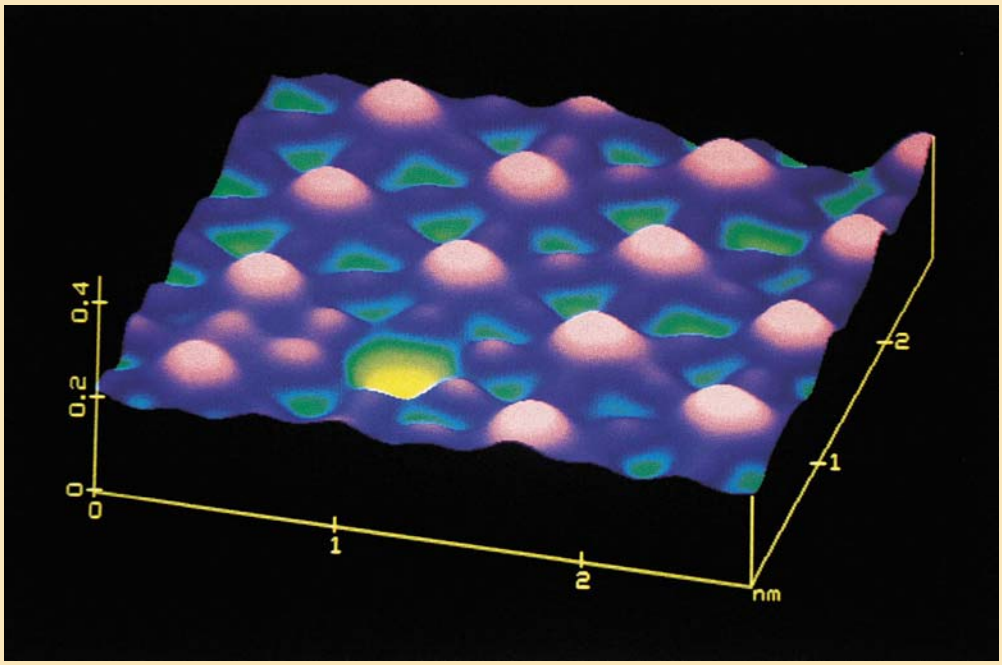


Figure 2.4: Formation of cathode rays.

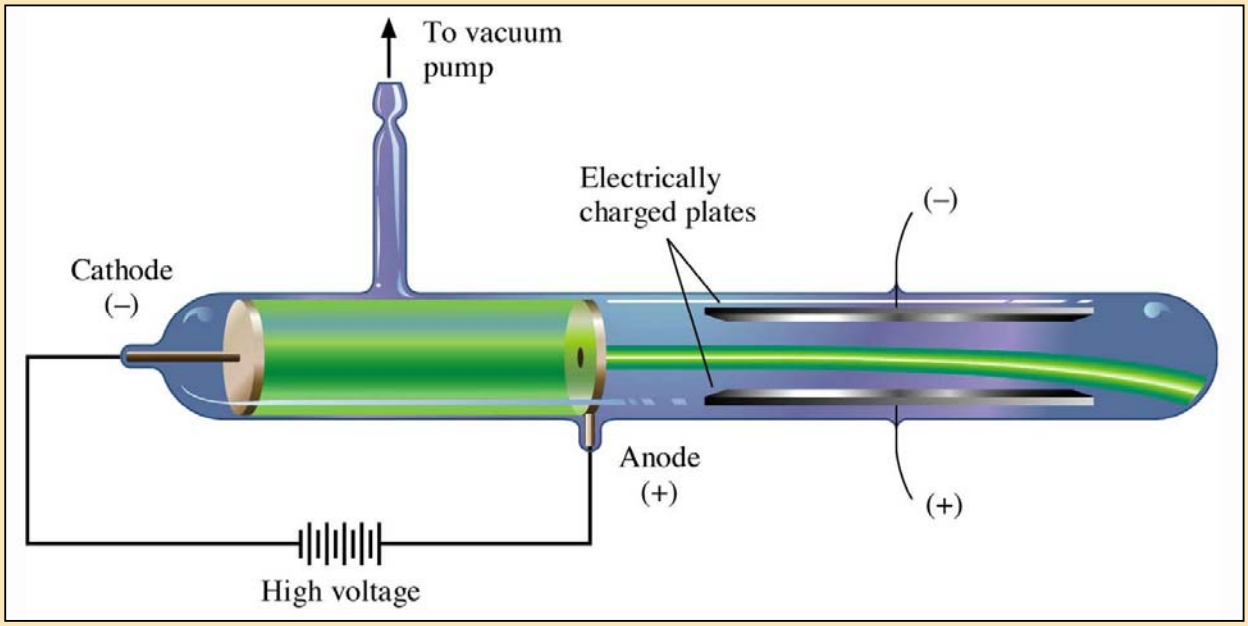


Figure 2.6: Millikan's oil drop experiment.

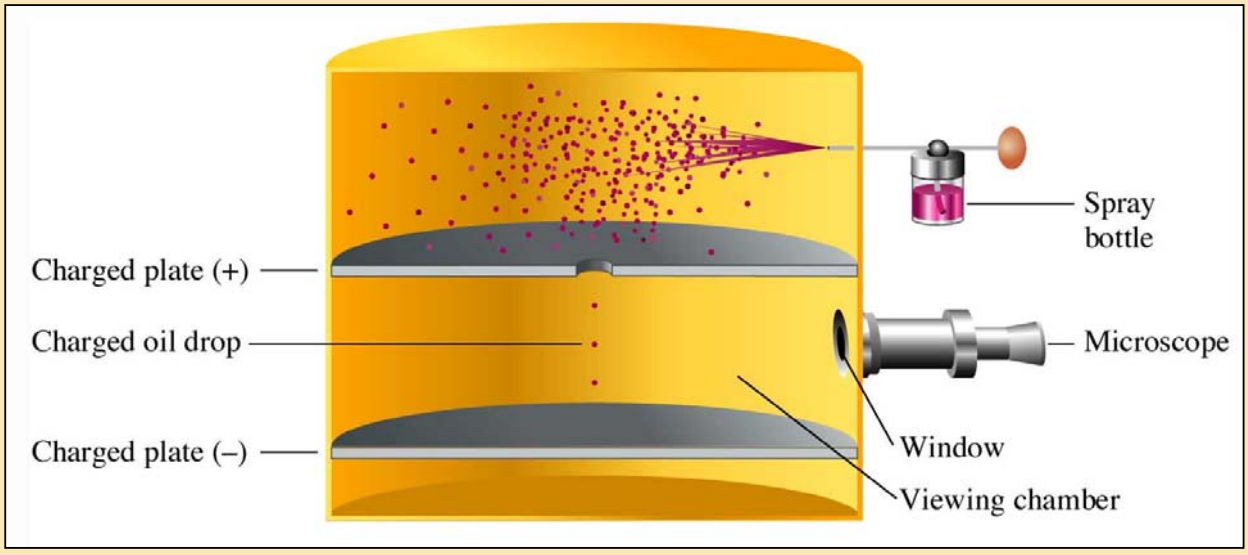
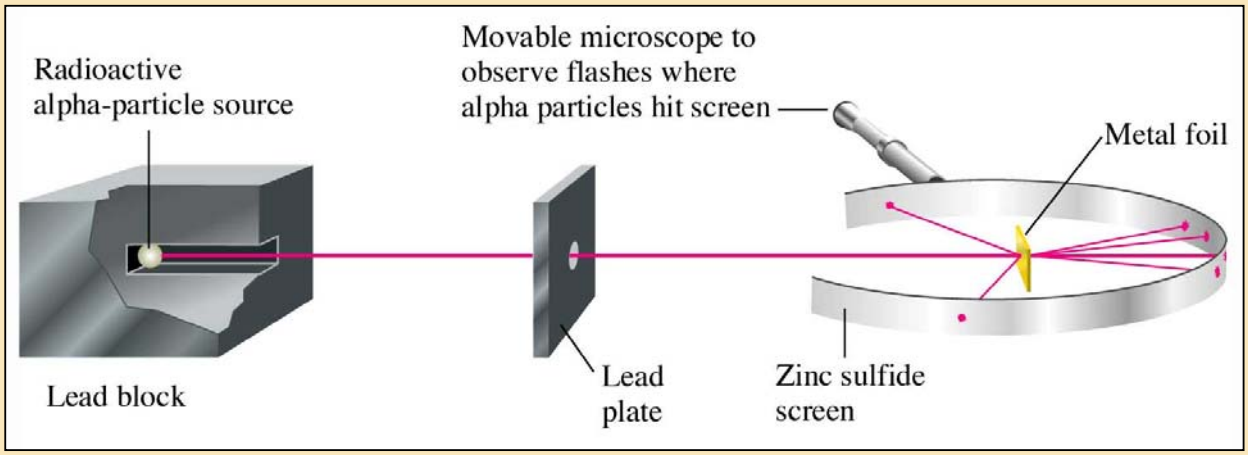


Figure 2.7: Alpha-particle scattering from metal foils.



Rutherford gold leaf experiment

Figure 2.9: A representation of two isotopes of carbon.

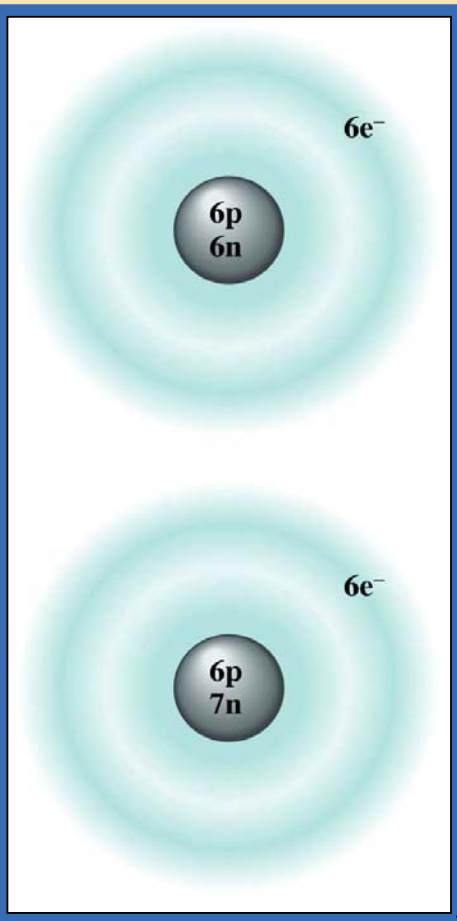
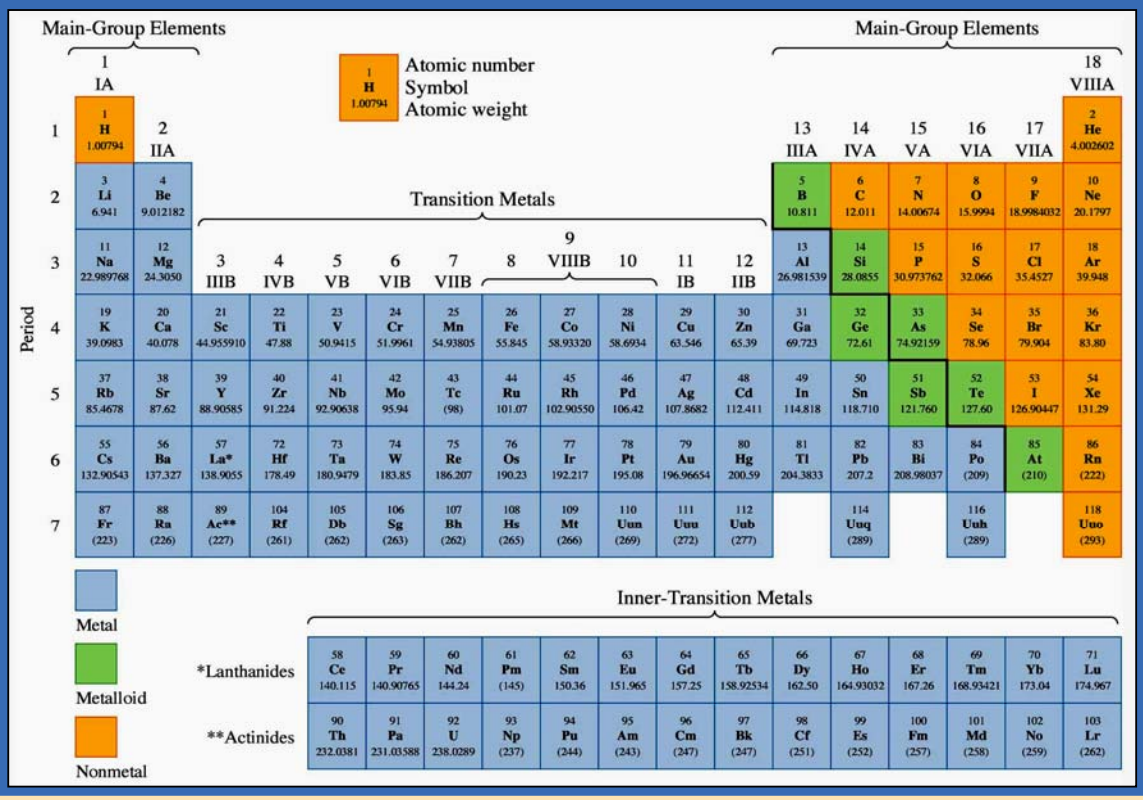


Figure 2.15: A modern form of the periodic table.



Reading assignment:

- This week read Chapter 2 up to and including section 2.7
- Do the assigned problems for Chapter 2 (posted on class web-site)
- NOTE posted SAMPLE PROBLEMS for MIDTERM 1 !!