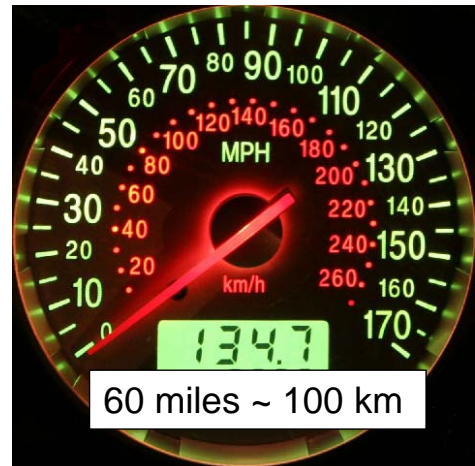


USEFUL ballpark (not exact!) conversion estimates to keep in mind



1 inch ~ 2.5 cm



60 miles ~ 100 km



1 gallon ~ 4 liters



1

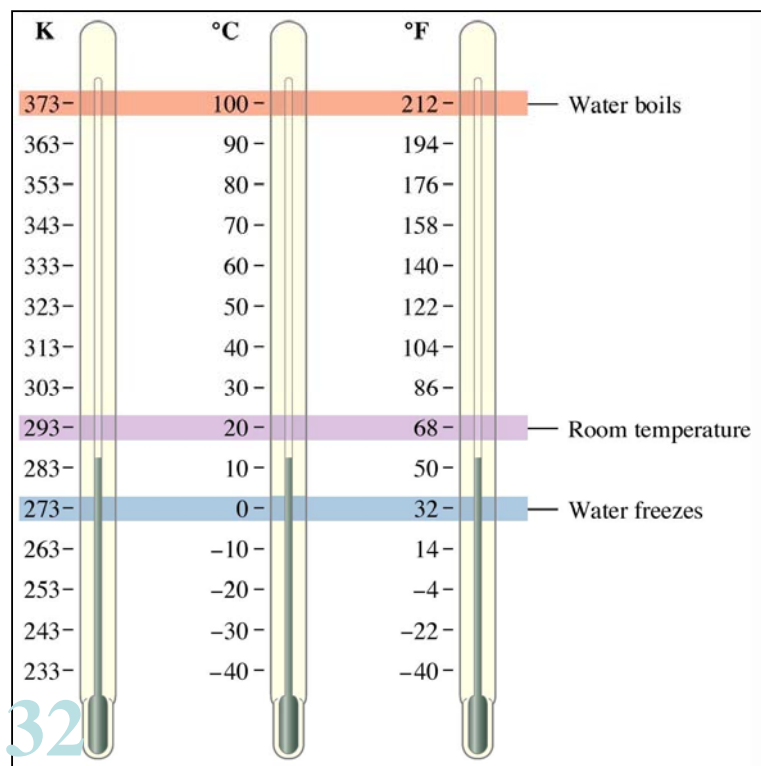
## Comparison of temperature scales.

Conversions:

$$K = ^\circ C + 273.15$$

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

$$^\circ F = 1.8 (^\circ C) + 32$$

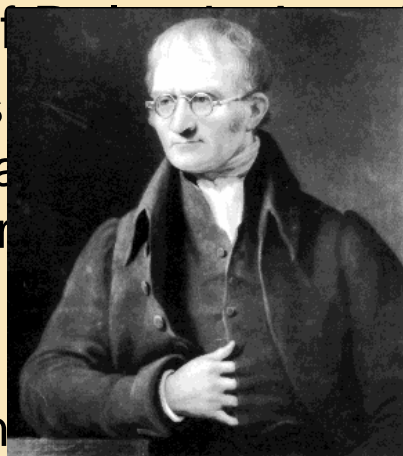


Example: converting 113 F to Celsius:  $C = (113-32)/1.8 = 45\text{ C}$

2

# Chapter 2 : 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.



John Dalton

1766-1844

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## 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.
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4

# 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<sub>2</sub>. (the combinations of carbon to oxygen here is 1:1 and 1:2)

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# 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.

6

# 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.

7

# 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.”

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# 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.

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# 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,  $e$ .

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# 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  **$9.109 \times 10^{-31}$  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.

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# 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.

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# 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**.

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# 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** ( $Z$ ).

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# 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.

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# 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*       ${}_{11}^{23}\text{Na}$

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# Atomic Theory of Matter

- Nuclear structure; Isotopes

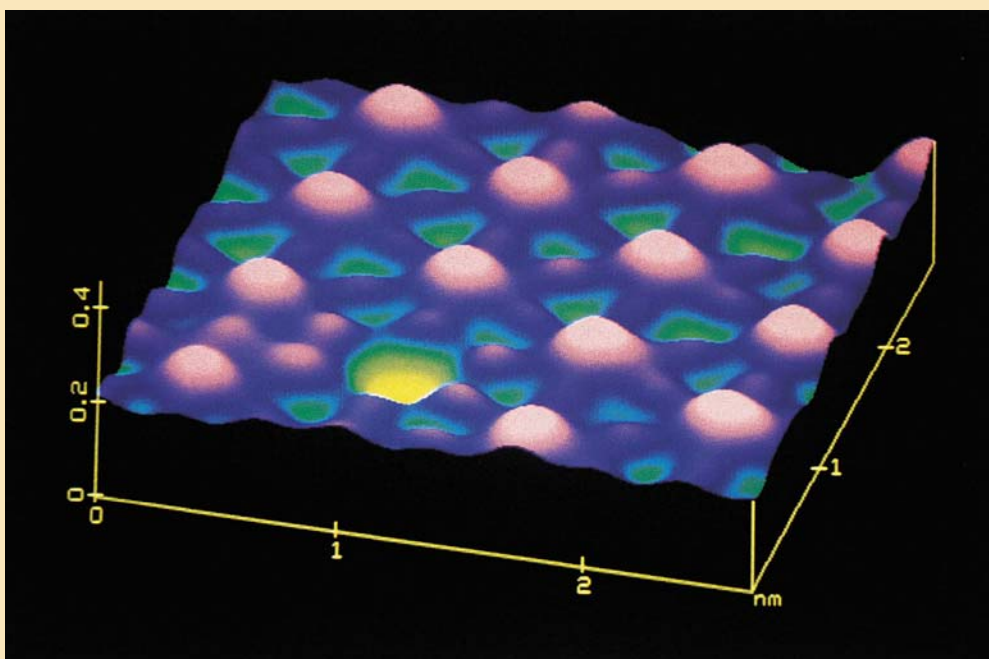
- **Isotopes** are atoms whose nuclei have the same atomic number but different mass numbers; that is, the nuclei have the same number of protons but different numbers of neutrons.
- Specific nucleus with given number of protons and neutrons is called **nuclide**

**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.

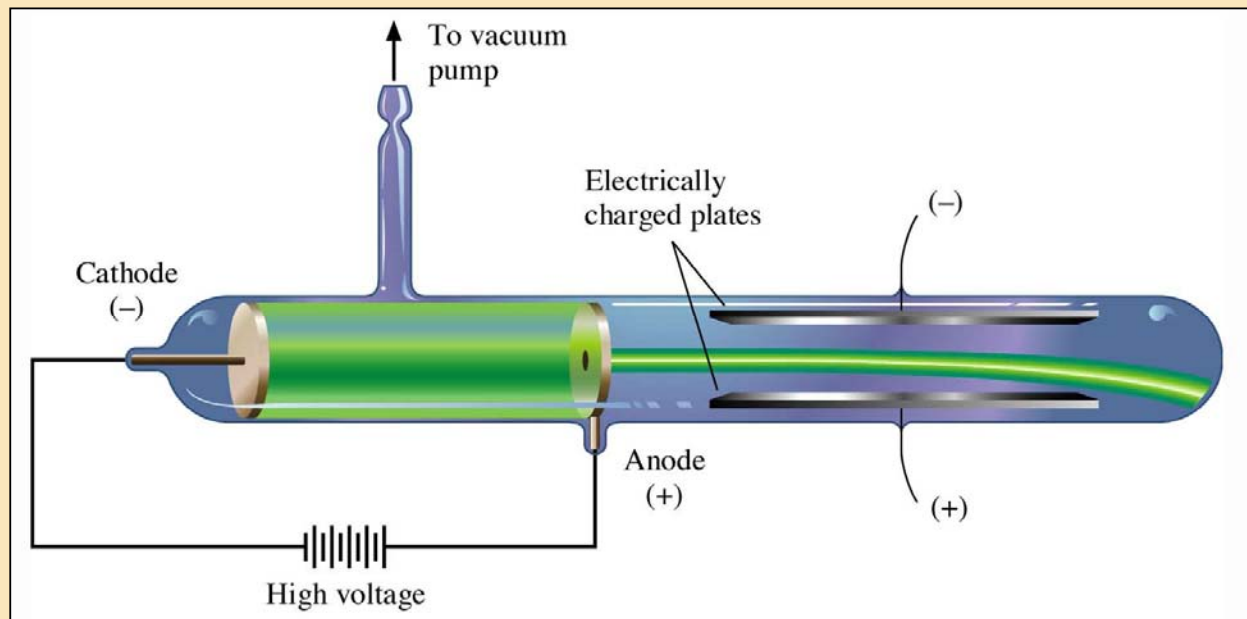
17

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



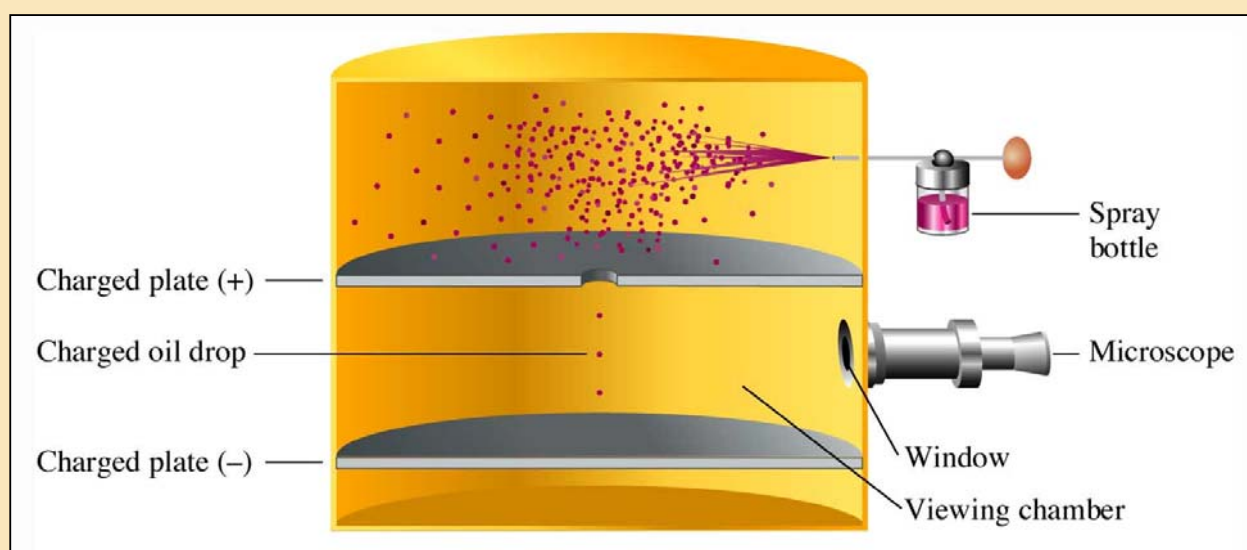
18

## Figure 2.4: Formation of cathode rays.



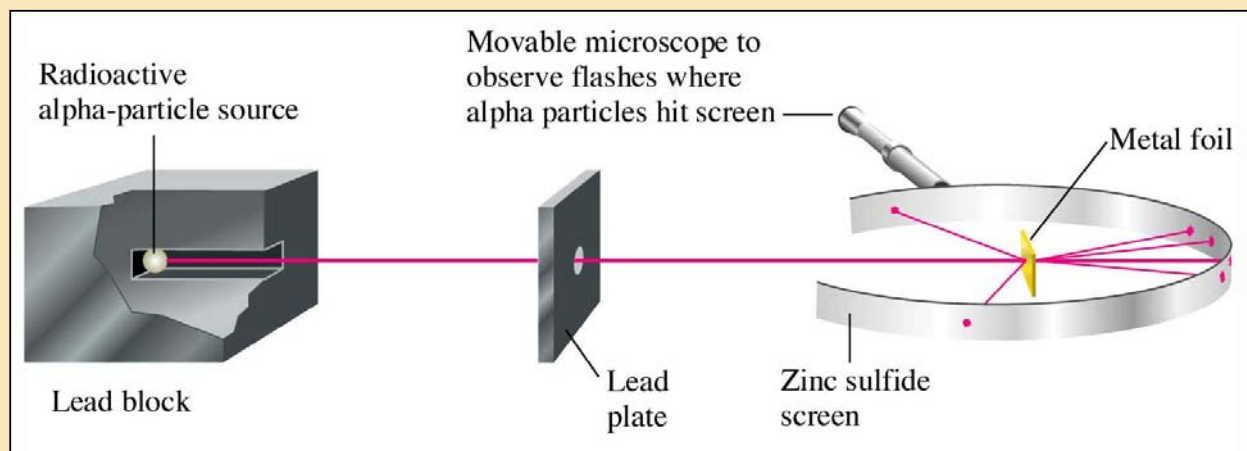
19

## Figure 2.6: Millikan's oil drop experiment.



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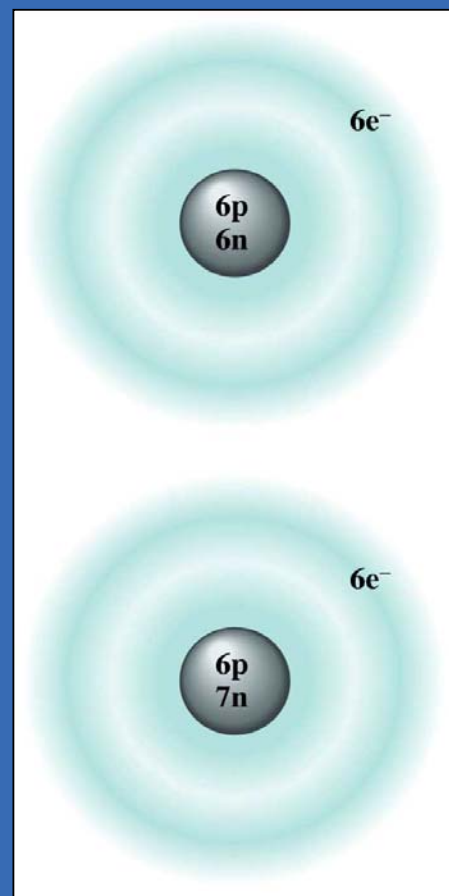
## Figure 2.7: Alpha-particle scattering from metal foils.



Rutherford gold leaf experiment

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Figure 2.9:  
A  
representation  
of two  
isotopes of  
carbon.



22

Figure 2.15: A modern form of the periodic table.

Main-Group Elements												Main-Group Elements													
1 IA		2 IIA		Transition Metals									13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA							
1	1 H 1.00794																2 He 4.002602								
2	3 Li 6.941	4 Be 9.012182										5 B 10.811	6 C 12.011	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797								
3	11 Na 22.989768	12 Mg 24.3050	3 Al 26.981539	4 Si 28.0855	5 P 30.973762	6 S 32.066	7 Cl 35.4527	8 Ar 39.948																	
4	19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.93805	26 Fe 55.845	27 Co 58.93320	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92159	34 Se 78.96	35 Br 79.904	36 Kr 83.80							
5	37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29							
6	55 Cs 132.90543	56 Ba 137.327	57 La* 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.85	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.08	79 Au 196.96654	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98037	84 Po (209)	85 At (210)	86 Rn (222)							
7	87 Fr (223)	88 Ra (226)	89 Ac** (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Uun (269)	111 Uuu (272)	112 Uub (277)	114 Uuq (289)	116 Uuh (289)			118 Uuo (293)								
												Inner-Transition Metals													
												58 Ce 140.115	59 Pr 140.90765	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.965	64 Gd 157.25	65 Tb 158.92534	66 Dy 162.50	67 Ho 164.93032	68 Er 167.26	69 Tm 168.93421	70 Yb 173.04	71 Lu 174.967
												90 Th 232.0381	91 Pa 231.03888	92 U 238.0289	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Legend:

- Metal
- Metalloid
- Nonmetal

\*Lanthanides

\*\*Actinides

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## 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 !!

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