

Chapter 2

Atoms, Molecules, and Ions

Section 2.5

The Modern View of Atomic Structure: An Introduction



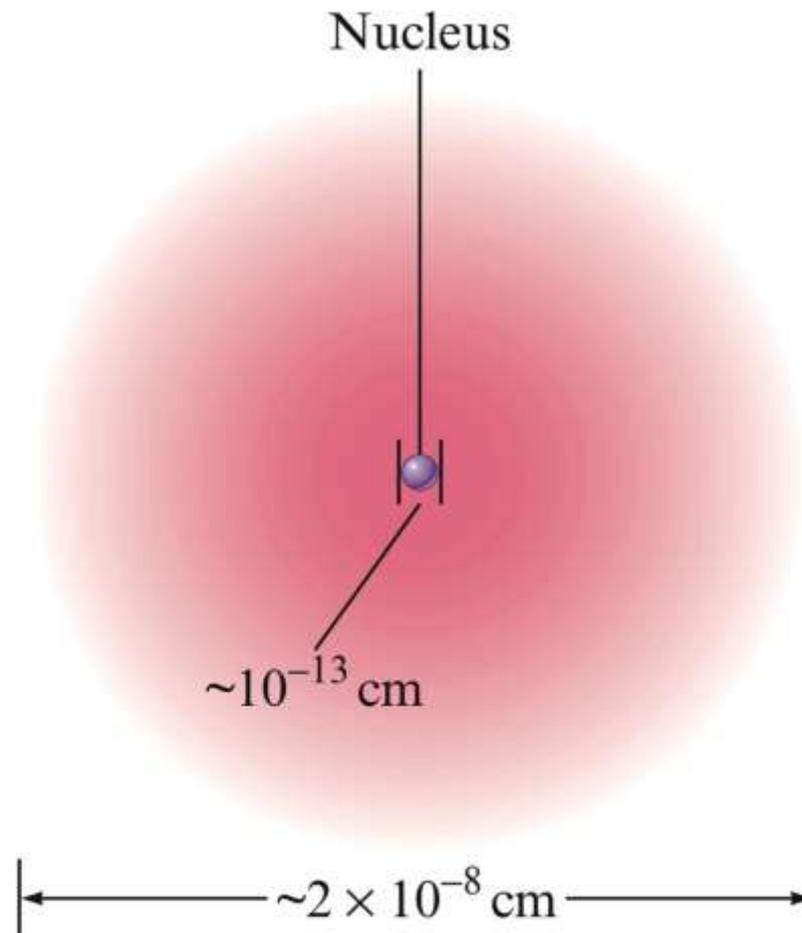
- The atom contains:
 - Electrons: Found outside the nucleus; negatively charged.
 - Protons: Found in the nucleus; positive charge equal in magnitude to the electron's negative charge.
 - Neutrons: Found in the nucleus; no charge; virtually same mass as a proton.
- The nucleus is:
 - Small compared to the overall size of the atom.
 - Extremely dense; accounts for almost all of the atom's mass.

Section 2.5

The Modern View of Atomic Structure: An Introduction



Cross-Section of the Nuclear Atom



Section 2.5

The Modern View of Atomic Structure: An Introduction



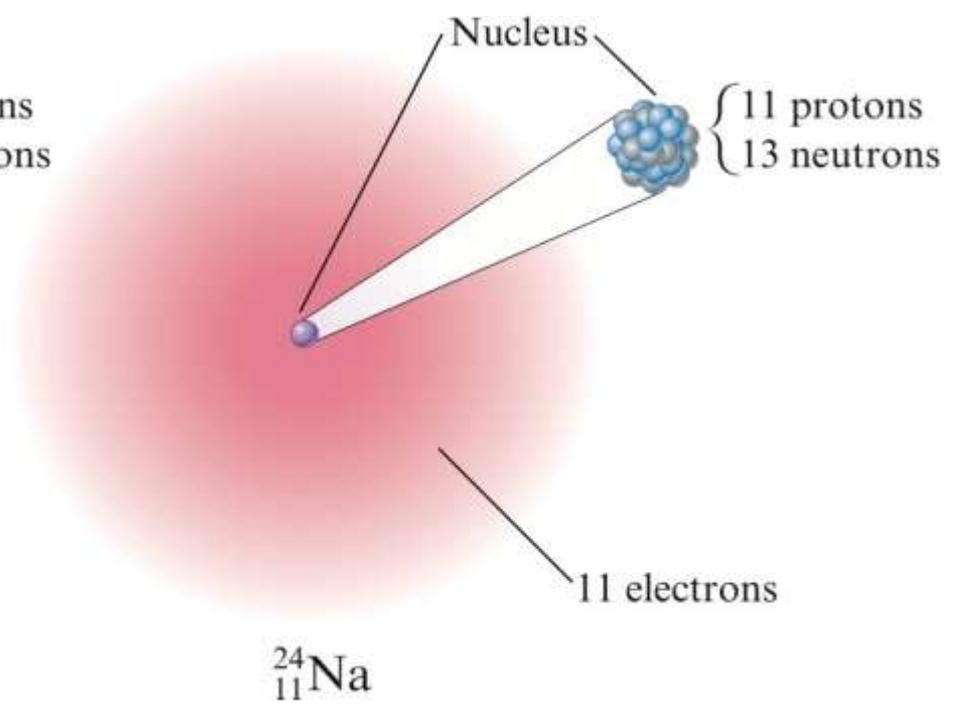
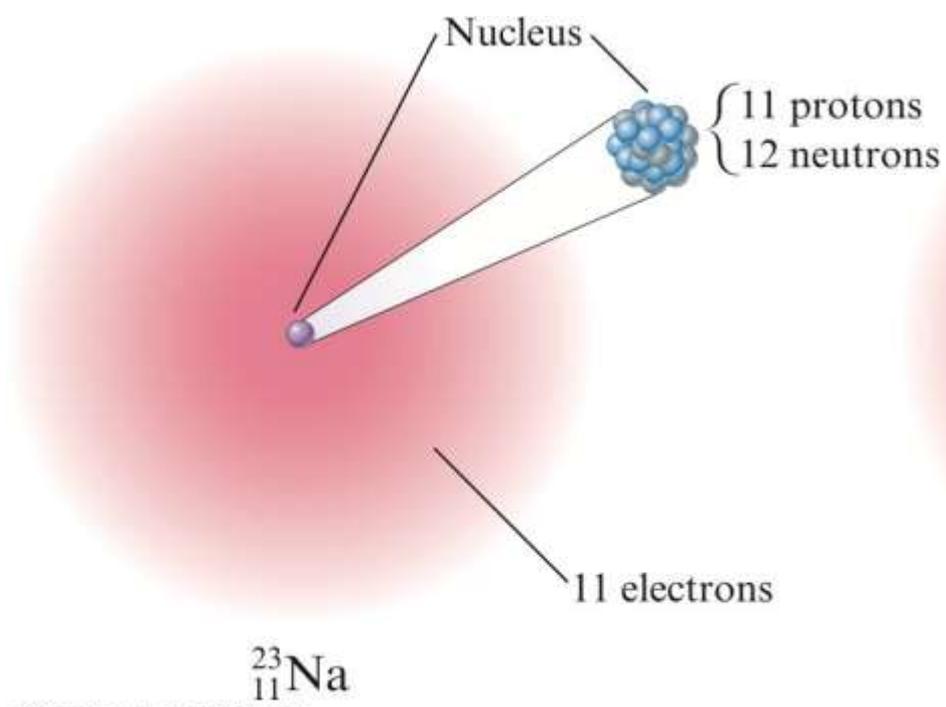
Isotopes:

- Atoms with the same number of protons but different numbers of neutrons.
- Show almost identical chemical properties; the chemistry of an atom is due to its valence electrons.
- In nature most elements contain mixtures of isotopes.

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The Modern View of Atomic Structure: An Introduction

Two Isotopes of Sodium:

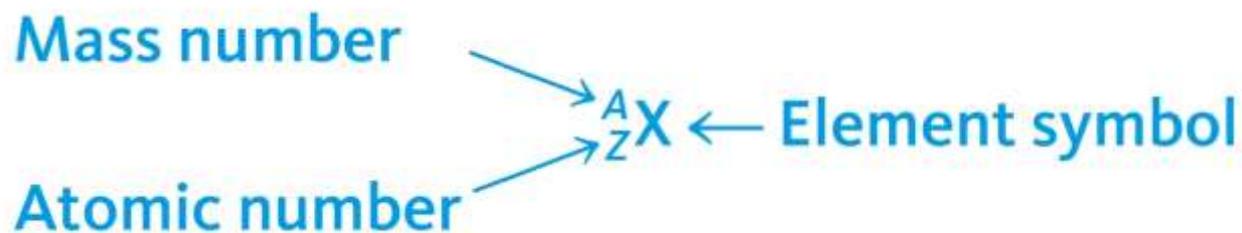


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- Isotopes are identified by:
 - Atomic Number (Z): Number of protons., $P = Z$
 - Mass Number (A): Number of protons plus number of neutrons (n). $A = n + P$



Section 2.5

The Modern View of Atomic Structure: An Introduction

EXERCISE!

A certain isotope X contains 23 protons and 28 neutrons.

- What is the **mass number** of this isotope?
- Identify the **element**.

Mass Number = 51 ($A = n + Z$)

Vanadium, V (From the periodic table, it the element with atomic number (Z) of 23).

Section 2.6

Molecules and Ions

Types of Chemical Bonds

- Covalent Bonds: Bonds form between atoms by sharing electrons to form molecules. H_2O
- Ionic Bonds: Bonds form due to force of attraction between oppositely charged ions. Ex: NaCl

Definitions:

- **Ion**: atom or group of atoms that has a net positive or negative charge. (poly atomic ions), Mg^{2+} , S^{2-} , CO_3^{2-} .
- **Cation**: positive ion; lost electron(s).
- **Anion**: negative ion; gained electron(s).

Section 2.6

Molecules and Ions

EXERCISE!

A certain isotope M^+ contains 54 electrons and 78 neutrons.

- What is the element and **mass number** of this isotope?

$$Z = 54 + 1 = 55 \quad (\text{from the periodic table, it is Cesium, Cs})$$

$$A = Z + n = 55 + 78 = 133$$

S(2-)

Section 2.7

An Introduction to the Periodic Table



The Periodic Table

- Metals, Nonmetals, metalloides: (see the next two slides)
- Groups or Families: Elements in the same vertical columns; have similar chemical properties

Groups like: Alkaline metals, alkaline earth metals, Halogens, noble gases.

- Periods: horizontal rows of elements.
- Representative Elements.
- Transition Elements.
- Lanthanides and actinides.
- Metals, nonmetal, metalloids

Section 2.7

An Introduction to the Periodic Table



Ionic Charges, Group Number, and Ionic Compounds:

- G IA : +1 charge, Na^+ , K^+ , Cs^+ , ...
- GIIA: +2 charge, Mg^{2+} , Ca^{2+} , Ba^{2+} , ...
- G IIIA: +3 charge like Al^{3+} ,
- G VIIA: -1 charge, F^- , Cl^- , Br^- , I^- , ..
- GVIA: -2 charge, O^{2-} , S^{2-} , ...
- GVA: -3 charge, N^{3-} , P^{3-} , ...

Ionic Compounds: NaCl , MgO , Al_2O_3 , MgCl_2 , AlCl_3 , K_2O , Na_2

...

Section 2.7

An Introduction to the Periodic Table

The Periodic Table

	1 1A H	2 2A Be														13 3A B	14 4A C	15 5A N	16 6A O	17 7A F	18 8A He
	3 Li	4 Mg	3	4	5	6	7	8	9	10	11	12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar			
Alkali metals	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr			
	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe			
	55 Cs	56 Ba	57 La*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn			
	87 Fr	88 Ra	89 Ac†	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo			

*Lanthanides

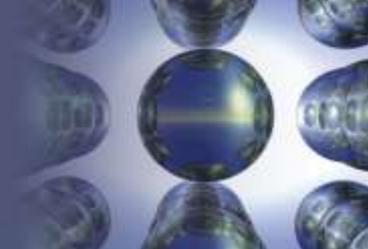
58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
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†Actinides

90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
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Section 2.8

Naming Simple Compounds



Naming Compounds:

- Binary Compounds:
 - Composed of two elements.
 - Ionic and covalent compounds included.
- Binary Ionic Compounds:
 - Metal with nonmetal (Type I and II).
 - Ionic compounds with polyatomic ions. NH_4^+
- Binary Covalent Compounds: (Type III)
Nonmetal with another nonmetal.

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Naming Simple Compounds



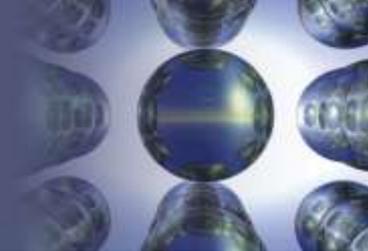
Binary Ionic Compounds (Type I)

Naming of the Compound:

- The **cation** is always named **first** and the **anion second**.
- The name of the **cation** simply is the name of the **positively** charge ion.
- The **anion** is named by taking the root of the element's name and adding **-ide**. **NaCl: Sodium Chloride**
- **Sodium** (name of the cation)
- **Chlorine** (root of the name of the anion)
- **Chloride** (-ide is added)

Section 2.8

Naming Simple Compounds



Binary Ionic Compounds (Type I)

- Examples:



Potassium chloride



Magnesium bromide



Calcium oxide

Section 2.8

Naming Simple Compounds



Binary Ionic Compounds (Type II)

- Metals in these compounds form more than one positive charge (Fe: +2 and +3; Cu: +1 and +2)
- Charge on the metal ion must be specified.
- Roman numeral indicates the charge of the metal cation.
- Transition metal cations usually require a Roman numeral (I, II, III, IV, V, VI, VII, VIII, IX, X,)
- Elements that form only one cation do not need to be identified by a roman numeral.

Section 2.8

Naming Simple Compounds



Binary Ionic Compounds (Type II)

- Examples:

CuBr Copper(I) bromide

CuBr₂ Copper(II) bromide

FeS Iron(II) sulfide

PbO₂ Lead(IV) oxide

Al₂O₃ Aluminum (III) Oxide X

Aluminum Oxide *(correct name)*

Section 2.8

Naming Simple Compounds



Ionic Compounds with Polyatomic Ions

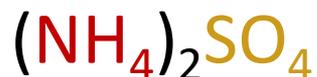
- Must be memorized (see Table 2.5 on pg. 65 in text).
- Examples of compounds containing polyatomic ions:



Sodium hydroxide



Magnesium nitrate



Ammonium sulfate



Potassium dichromate



Sodium Sulfite

(Show the list of the polyatomic ions to the students)

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Naming Simple Compounds

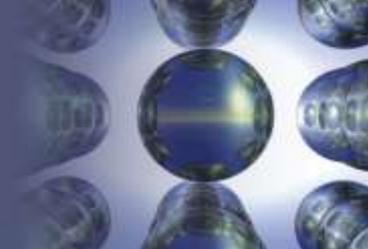


Binary Covalent Compounds (Type III)

- Formed between two nonmetals.
1. The first element in the formula is named first, using the full element's name.
 2. The second element is named as if it were an anion.
 3. Prefixes are used to denote the numbers of atoms present. (mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca ...)
 4. The prefix *mono-* is never used for naming the first element.

Section 2.8

Naming Simple Compounds



Binary Covalent Compounds (Type III)

- Examples:



Carbon dioxide



Sulfur hexafluoride



Di nitrogen tetr oxide



(Show a list of polyatomic ions)