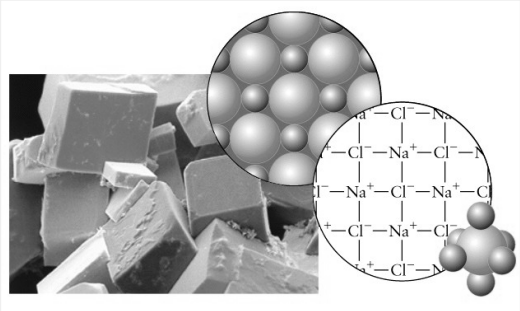
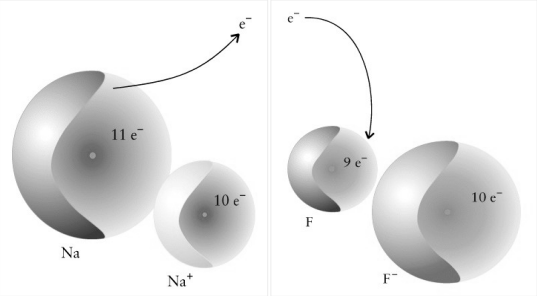


1.10 Ionic Compounds

- Positive and negative ions held together by electrostatic attraction. (NaCl, CaO, ...)
  - cations - positive ions (Na^+, Ca^{2+}, ...)
  - anions - negative ions (Cl^-, O^{2-}, ...)
- Monoatomic ions - formed through gain or loss of e^- by atoms.



Figs. 1.25 and 1.28

- Charges of monoatomic ions can be predicted from the periodic table.
  - typically metals form cations while nonmetals form anions
  - groups **1, 2** - cations with charges equal to the **group#**
  - groups **12, 13** - cations with charges equal to the **group# - 10** (only the lighter members)
  - groups **15, 16, 17** - anions with charges equal to the **group# - 18** (only the lighter members of 15 and 16)

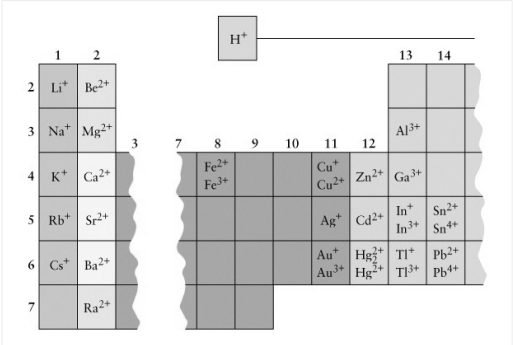


Fig. 1.26

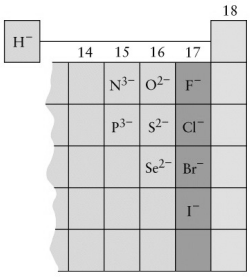


Fig. 1.29

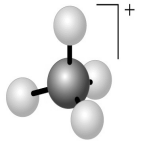
Example:

- What ions are Al and Br expected to form?

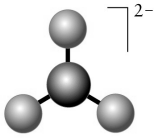
1.11 Chemical Formulas of Ionic Compounds

- Ionic compounds do not consist of molecules
- Formulas show the relative # of ions of each type in terms of the smallest hole numbers ($CaBr_2$ $\rightarrow$ two Br^- ions for each Ca^{2+} ion)
- Formula unit - a group of ions with a composition given by the formula (must be neutral)

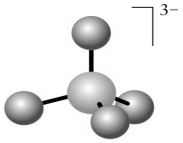
- Polyatomic ions - consist of more than one atom
  - oxoanions - contain O



5 Ammonium ion, NH_4^+



6 Carbonate ion, CO_3^{2-}



7 Phosphate ion, PO_4^{3-}

Table 1.3 Common polyatomic ions

Cations		Anions that end in -ide	
NH_4^+	ammonium	CN^-	cyanide
Hg_2^{2+}	mercury(I)	O_2^{2-}	peroxide
		OH^-	hydroxide

Oxoanions					
−1 charge		−2 charge		−3 charge	
$CH_3CO_2^-$	acetate	CO_3^{2-}	carbonate	PO_4^{3-}	phosphate
NO_2^-	nitrite	$C_2O_4^{2-}$	oxalate		
NO_3^-	nitrate	CrO_4^{2-}	chromate		
ClO^-	hypochlorite	$Cr_2O_7^{2-}$	dichromate		
ClO_2^-	chlorite	SO_3^{2-}	sulfite		
ClO_3^-	chlorate	SO_4^{2-}	sulfate		
ClO_4^-	perchlorate				
MnO_4^-	permanganate				

- How to distinguish between ionic and molecular compounds
  - molecular - typically consist of nonmetals (H_2O, NH_3, CO_2, C_2H_6O, ...)
  - ionic - combination of metals and nonmetals ($NaCl$, $MgSO_4$, $AlPO_4$, KOH, ... exception NH_4^+ containing)

Example:

Classify the compounds CH_5N, NH_4NO_3 and HCl as ionic or molecular and identify the ions if present.

1.12 Chemical and Physical Properties of Matter

- Physical properties - can be measured without changing the identity of a substance
- Chemical properties - refer to changes in the identity of a substance (reactions)
- Physical states:
  - gas - no definite volume or shape (vapor)
  - liquid - definite volume, but not shape
  - solid - definite volume and shape

*Table 1.4 Common physical and chemical properties**

Physical property	Chemical property
melting point	reaction with acids
boiling point	reaction with bases (alkalis)
vapor pressure	reaction with oxygen (combustion)
color	ability to act as oxidizing agent
state of matter	ability to act as reducing agent
density	reaction with other elements
electrical conductivity	decomposition into simpler substances
solubility	corrosion
adsorption to a surface	
hardness	

*Many of the terms in this table are explained later in the text.

1.13 Mixtures

- Contain more than one pure substances

Table 1.5 Differences between mixtures and compounds

Mixture	Compound
Components can be separated by using physical techniques.	Components cannot be separated by using physical techniques.
Composition is variable.	Compositon is fixed.
Properties are related to those of its components.	Properties are unlike those of its components.

- Heterogeneous mixtures - composition changes from one part to another (soil, blood, milk, dust, fog, ...)
- Homogeneous mixtures - composition is uniform throughout (sea water, air, gasoline, vinegar, brass, ...)
- Solutions - homogeneous mixtures
  - solvent - present in the larger amount
  - solute - the dissolved substance
- Aqueous solutions - the solvent is water

1.14 Separation of Mixtures

- Relies on differences in the physical properties of the components
  - extraction - differences in the solubility
  - filtration - differences in the the physical state

– distillation - differences in the boiling points

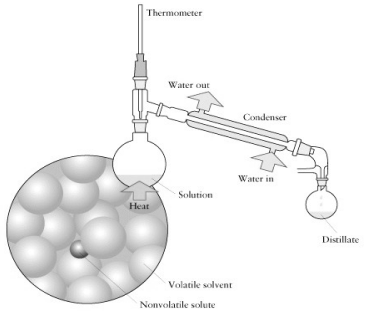


Fig. 1.37

– chromatography - differences in the ability to adsorb on surfaces or absorb into liquids
  - stationary and mobile phases
  - GC
  - LC

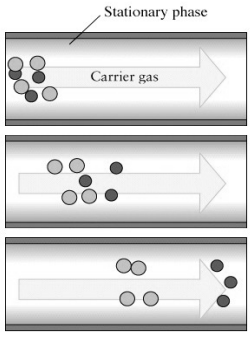


Fig. 1.39