Chapter 1
Basic Concepts of Chemistry

Applying Chemical Principles

CO_2 in the Oceans

1.1.1. Name of CO_2: carbon dioxide

1.1.2. Symbols for metals mentioned in the article:

calcium, Ca; copper, Cu; manganese, Mn; iron, Fe

1.1.3. Most dense metal: Cu (8920 kg/m^3) Least dense metal: Ca (1550 kg/m^3)

Data taken from www.ptable.com

1.1.4. $CaCO_3$ (calcium carbonate) contains Ca, C, and O.

PRACTICING SKILLS

Nature of Science

1.1. (a) Proposal that pressure increases with decreased volume—hypothesis

(b) Over time experiments indicate that pressure and volume are inversely proportional—law

(c) Proposal that more molecules colliding per given area results in increased pressure--theory

1.2. Categorize as hypothesis, theory, or law: Hypothesis--a tentative explanation or prediction in accord with current knowledge.

Green Chemistry

1.3. Sustainable development means meeting today's needs while ensuring that future generations will be able to meet theirs.

1.4. Green chemistry refers to practices that reduce waste products during chemical processes, use materials wisely, use renewable materials, generate substances with the lowest possible toxicity, and conserve energy as well as materials.

1.5. Practices of Green Chemistry described:

- ∞ Preventing waste
- ∞ Energy saved
- ∞ Synthetic methods to generate substances with little or no toxicity
- ∞ Raw materials (solid catalyst) should be renewable
- ∞ To a lesser extent—ALL the practices are used in the new process

1.6. Practices of Green Chemistry described:

- ∞ Raw materials (yeast) renewable
- ∞ Energy saved—processes run near room temperature and pressure
- ∞ Synthesis uses products with low or no toxicity (palm kernel or coconut oil) and not nitric acid or produce a greenhouse gas
- ∞ Substances used to minimize hazards (no nitric acid)
- ∞ To a lesser extent—ALL the practices are used in the new process

Matter: Elements and Atoms, Compounds and Molecules

1.7. The name of each of the elements:

(a)	C	carbon	(c)	Cl	chlorine	(e)	Mg	magnesium—typically confused with manganese (Mn)
(b)	K	potassium—from *Latin*, Kalium	(d)	P	phosphorus—frequently confused with Potassium	(f)	Ni	nickel

1.8. The names of each of the elements:

(a)	Mn	manganese--typically confused with magnesium (Mg)	(c)	Na	sodium	(e)	Xe	xenon
(b)	Cu	copper	(d)	Br	bromine	(f)	Fe	iron

1.9. The symbol for each of the elements:

(a)	barium	Ba	(c)	chromium	Cr	(e)	arsenic	As
(b)	titanium	Ti	(d)	lead	Pb	(f)	zinc	Zn

1.10. The symbol for each of the elements:

(a)	silver	Ag	(c)	plutonium	Pu	(e)	technetium	Tc
(b)	aluminum	Al	(d)	tin	Sn	(f)	krypton	Kr

1.11. In each of the pairs, decide which is an element and which is a compound:

[HINT: If the isolated symbol is on the periodic table, it's an element!]

(a) Na and NaCl—Sodium(Na) is an element and Sodium chloride(NaCl) is a compound.

(b) Sugar and carbon—Sugar($C_xH_yO_x$) is a compound, and carbon(C) is an element.

(c) Gold and gold chloride—Gold(Au) is an element, and gold chloride ($AuCl_x$) is a compound.

1.12. In each of the pairs, decide which is an element and which is a compound:

[HINT: If the isolated symbol is on the periodic table, it's an element!]

(a) $Pt(NH_3)_2Cl_2$ is a compound; Pt is an element

(b) Copper is an element; copper(II) oxide is a compound

(c) Silicon is an element; sand is a compound

1.13. Masses of hydrogen and oxygen gases prepared from 27 g of water?

An 18 g sample of water contains 2 g of hydrogen gas and 16 g of oxygen gas. A 27 g sample will contain the same proportion of hydrogen and oxygen.

$$\frac{2 \text{ g hydrogen}}{18 \text{ g water}} = \frac{x}{27 \text{ g water}} \quad x = \frac{(2 \cdot 27)}{18} = 3 \text{ g hydrogen}$$ The amount of oxygen would be 27-3 or 24 g oxygen. Obviously one could have used the ratio of oxygen to water to solve for the amount of oxygen in 27 g water.

The Law of Constant Composition (or the Law of Definite Proportions) is used.

1.14. 60. g of magnesium produces 100. g of magnesium oxide. A simple ratio will tell us the amount of oxide formed when 30. g of magnesium are used (An example of The Law of Constant Composition or the Law of Definite Proportions).

$$\frac{60. \text{ g magnesium}}{40. \text{ g oxygen}} = \frac{30. \text{ g magnesium}}{x} \quad x = \frac{(30. \cdot 40.)}{60.} = 20. \text{ g oxygen}$$

Physical and Chemical Properties

1.15. Determine if the property is a physical or chemical property for the following:

(a) color a physical property

(b) transformed into rust a chemical property

(c) explode a chemical property

(d) density a physical property
(e) melts a physical property
(f) green a physical property (as in (a))

Physical properties are those that can be observed or measured without changing the composition of the substance. Exploding or transforming into rust results in substances that are **different** from the original substances—and represent chemical properties.

1.16. Determine if the following represent physical or chemical changes:

[HINT: Physical changes are usually **easily reversible**, while chemical changes are not.]

(a) chemical change—not easy to change the color of the sheet back to purple
(b) physical change—the vapor (gaseous) and liquid states of matter are easily interconverted
(c) chemical change—the carbon dioxide is chemically changed when making sugar
(d) physical change—as in (b), the various states of butter can be easily interconverted

1.17. Descriptors of physical versus chemical properties:
(a) Color and physical state are physical properties (colorless, liquid) while **burning** reflects a chemical property.
(b) Shiny, metal, orange, and liquid are physical properties while **reacts readily** describes a chemical property.

1.18. Descriptors of physical versus chemical properties:
(a) Physical properties: color (white), physical state (solid), density (2.71 g/cm^3)
Chemical properties: reactivity towards acid (reacts to produce gaseous carbon dioxide)
(b) Physical property: color (gray zinc, purple iodine, white compound)
Chemical property: reactivity (zinc and iodine react to give a white compound)

Energy

1.19. To move the lever, one uses mechanical energy. The energy resulting is manifest in electrical energy (which produces light); thermal (radiant) energy would be released as the bulb in the flashlight glows.

1.20. Mechanical energy propels the car, electrical energy recharges the batteries, (thermal) radiant energy is released as the sun shines on the solar panels.