



Slide 1

•CHAPTER 2




Slide 2

**Life depends on
chemical and
molecular
reactions**



atoms and molecules

laws of physics and chemistry



Slide 3

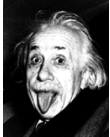
Matter - takes up space has mass

Energy - capacity to do work
(move matter)

Related

$E = mc^2$ (Einstein's equation – rest energy)

E = energy
m – mass (in this case matter at rest)
c = speed of light (299,792,458 m/s =
186,000 miles/s)
 $c^2 = ??$

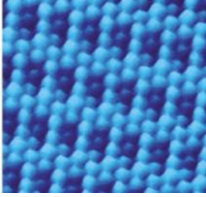


Slide 4

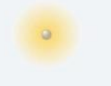



Matter consists of Atoms
Atomic structure determines behavior

- **atom** - smallest unit of matter that retains element's properties

– composed of subatomic particles



Slide 5

Hydrogen	Oxygen
1 Proton 1 Electron	8 Protons 8 Neutrons 8 Electrons
	
	

neutrons and protons form atomic nucleus

proton (positive charge) electron (negative charge) neutron (no charge)

Slide 6

Atoms -mostly empty space!

- **Electrons** form a cloud around the nucleus.

nucleus = golf ball ●

- electrons >1 kilometer (.62 miles)

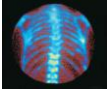
schematics
useful
deceptive

Slide 13

Radioactive isotopes -many applications

- ^{14}C is **radioactive isotope**
- In decay, a neutron is converted to a proton and electron.
- converts ^{14}C to ^{14}N , changing identity
- Radioactive decay rates are used to date fossils

Slide 14


• decay can trace cancer 

(cancerous bone concentrates more isotope)

- energy emitted in decay can be **hazardous**
- destroys cellular molecules

- depends on type and amount absorbed

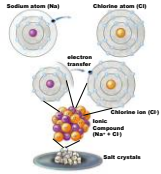
Slide 15

 **ELECTRONS**

- When two elements interact in chemical reaction

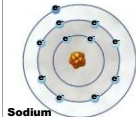
electrons are involved

nuclei - not even close



Slide 16

- Electrons have **potential energy position** relative to the nucleus




- electrons attracted \dagger nucleus
- farther from nucleus, more potential energy

Slide 17

- **Energy** - ability to do work
- **Potential energy** - energy that matter stores because of its position or location.
 - Water /levee has potential energy
 - Rushing water has kinetic energy

Slide 18

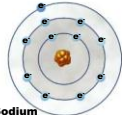
- 1st electron shell - 2 electrons
 - The two electrons fill the first shell.
- other shells - up to 8 electrons.



Slide 22

–to complete valence shells:

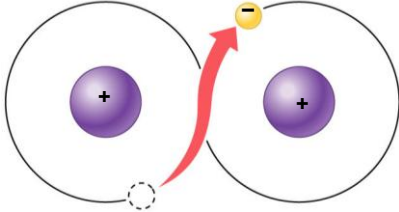
- share electrons
- transfer electrons
- receive electrons



–interactions form chemical bonds

Slide 23

•losing electrons – oxidation
•gaining electrons - reduction



Oxidation **Reduction**

Slide 24

WHY??

- THINK NEGATIVE!!**
- gaining negative electron - reduced
- losing negative electron – oxidized

OIL RIG

Slide 31

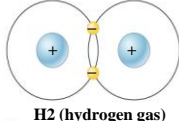
electron interactions form

- **chemical bonds**
 - Strongest chemical bonds
 - **Covalent** (water)
 - **Ionic**
 - Weaker (water)
 - Hydrogen bond

Slide 32

- 1) **covalent bond** - sharing of a pair of valence electrons by two atoms
 - hydrogen atom- 1s orbitals overlap, share their electrons

Covalent bond



H2 (hydrogen gas)

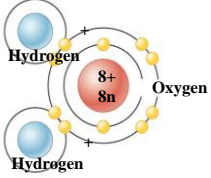
(a)

covalent = sharing

Slide 33

*Covalent bonds -also different elements

- What is water?
- Is bond covalent? single or double?
- Are valences satisfied?



Hydrogen

Hydrogen

Oxygen

8+

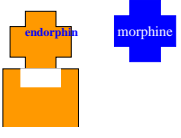
8n

*Oxygen add 2 electrons to 6
*complete valence shell.

- **double covalent bond**

Slide 40

- Molecules -similar shapes interact similar ways
 - morphine, heroin, similar shape to natural endorphins
- produces euphoria
- relieves pain



WEAK Good -
signal molecules bind briefly to receptor molecules

Slide 41

WEAK BAD

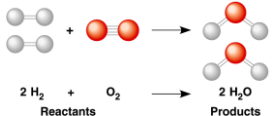
Free radicals – unpaired electrons

- blood - irritate artery walls, fat deposits build up
- mutate DNA
- damage mitochondria

- producers - cigarettes, x rays, sunlight, alcohol, etc.
- scavengers – beta carotene, vitamin C, vitamin E

Slide 42

- **In chemical reactions** -bonds broken and reformed
- new arrangements of atoms



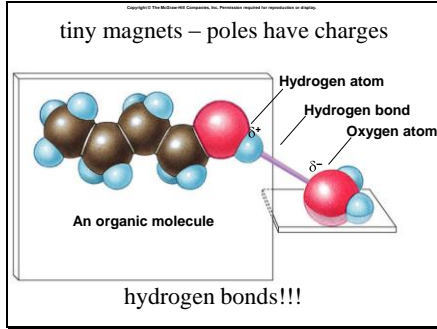
2 H₂ + O₂ → 2 H₂O

Reactants Products

- starting molecules -**reactants**
- end molecules - **products**

Copyright © 2002 Pearson Education, Inc., publishing as Benjamin Cummings

Slide 49



Slide 50

solution salt water
solute salt
solvent water

Like dissolves like

polar - salt and water

non polar- soap and grease

Slide 51

Cohesion

- water molecules stick to each other
- results of H-bonds

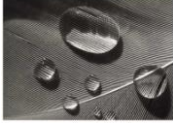
SURFACE TENSION

Slide 52

Adhesion

water molecules stick to other substances

- Result of H-bonds
- meniscus




Slide 53

- More Water appreciation facts

– HIGH Specific heat

– boil a pan of water



- lots of energy needed to change temperature of water
- WHY???

collective effect of H-bonds

Slide 54

- Heat absorbed to break hydrogen bonds
- Heat released when hydrogen bonds form

– Energy used to disrupt hydrogen bonds


- not move molecules faster

- Sweats cools - heat energy used to break H-bonds

Slide 55

Temperature Moderation

- absorb/release large quantities of heat with little change in temperature
- **heat** – total kinetic energy
- **temperature** – average kinetic energy
- specific heat – amount absorbed or lost for 1 g of substance to change temp by 1 degree



Slide 56

- difference between a **calorie** (cal.) and “Calories” on food packages?


calorie - amount of heat energy necessary to raise temperature of one g of water by 1°C.
One mL water?

Calorie on food packages - kilocalorie
the amount of heat energy necessary to raise the temperature of 1000g of water by 1°C.

Slide 57


- vaporization or evaporation –
- transformation from liquid to a gas
- molecule move so fast - overcome the attraction of molecules in liquid

- Even in low temperature liquid
- (low average kinetic energy)
- some molecules move fast
- even in ice! (sublimation)



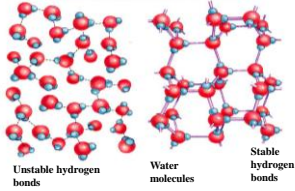
Slide 58

- **evaporative cooling**
 - the most energetic molecules evaporate
 - lower kinetic energy molecules stay
- Evaporative cooling - moderates temperature in lakes, etc.
 - helps stop us from overheating



Slide 59

- at 0°C lattice
- (ice crystals and snow)



Unstable hydrogen bonds Water molecules Stable hydrogen bonds
(a) Liquid water (b) Ice

Slide 60


Why live by the lake?

“Heat sink”

Equilibrium
two objects of different temperatures meet,
heat (energy) passes from warmer to cooler

Molecules in cooler object speed up at expense of kinetic energy of warmer object

Ice cools by absorbing heat



Slide 67

• Acids donate protons
– (HCl, vinegar).

• Bases accept protons
– (NaOH, lye).

• what **IS** a proton?
(what happens when hydrogen loses an electron?)

SO - Acids donate hydrogen ions

Slide 68

• An **acid** is a substance that increases the hydrogen ion concentration in a solution.

– When hydrochloric acid is added to water, hydrogen ions dissociate from chloride ions:

• $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$

• Addition of an acid makes a solution more acidic.

Slide 69

Any substance that reduces the hydrogen ion concentration in a solution is a **base**.

1) Some bases reduce H^+ directly by accepting hydrogen ions.

2) Other bases reduce H^+ indirectly forming water.

– $\text{NaOH} \rightarrow \text{Na}^+ + \text{OH}^-$ $\text{OH}^- + \text{H}^+ \rightarrow \text{H}_2\text{O}$

Solutions with more OH^- than H^+ are basic solutions.

Slide 70

Some acids and bases (HCl and NaOH) are strong
WE USE THESE IN A WET LAB
These molecules dissociate completely in water

At equilibrium there will be a fixed
ratio of products to reactants

NOTE: not an EQUAL ratio

Slide 71

The H^+ and OH^- concentrations of solutions can vary by a factor of 100 trillion or more.

So H^+ and OH^- concentrations are expressed using **pH** scale.

The pH scale, ranging from 1 to 14, compresses the range of concentrations by employing logarithms.

Slide 72

- In a neutral solution
- $pH = 7$ (7.4 is physiologically balanced)
- Values for pH *decline* as $[H^+]$ *increase*.
- pH scale is based on $[H^+]$, but values for $[OH^-]$ can be easily calculated from the product relationship.
-

Slide 76

To maintain cellular pH values , biological fluids have buffers.

Buffers resist changes to the pH of a solution when H^+ or OH^- is added to the solution.

Buffers accept hydrogen ions from the solution when they are in excess and donate hydrogen ions when they have been depleted.

Slide 77

Buffers - weak acid and corresponding base

–One important buffer in human blood **carbonic acid**

Slide 78

molecular weight -sum of the weights of all the atoms in a substance

a 1 molar solution (1M) is the molecular weight of a material in grams

dissolved in 1 liter (1000mL) of (usually) deionized water

Slide 79

- Lab
- a mole of table sugar - sucrose ($C_{12}H_{22}O_{11}$)?
 - A carbon atom weighs 12 daltons, hydrogen 1 dalton, and oxygen 16 daltons
 - One molecule of sucrose = 342 daltons
 - the sum of weights of all the atoms
 - **molecular weight** of sucrose
 - one mole of sucrose we would weigh out 342 grams

Slide 80

solution sugar water
solute sugar
solvent water

aqueous?
