

Reactions—continued

And chemical review!!

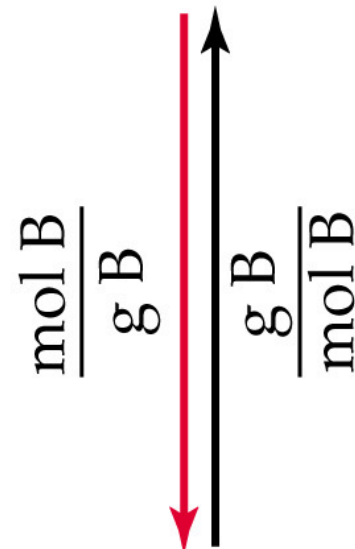
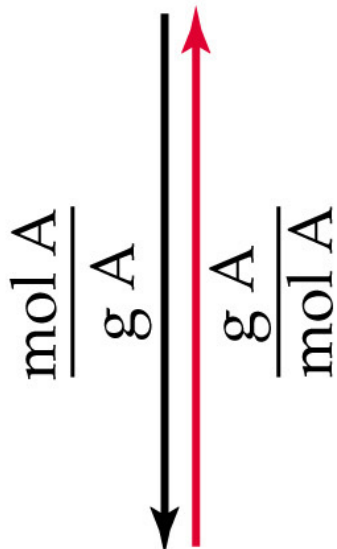
Steps to find grams in chemical reaction

- Balance the equation to get molar ratios
- Find molar mass of the substances in question
- Find moles of the one given in grams
- Set up a proportion to compare molar ratio to the moles of known and unknown
- If the unknown is on top, it is easier to solve, so set it up that way!!

Mass of A,
grams

Mass of B,
grams

Molar mass
as conversion
factors



Amount of A,
moles

Amount of B,
moles



Proportions

- Mathematical device to compare ratios
- Cross-multiply to solve
- Correctly organized
- Be sure you keep same:same in columns and rows

Proportions to find moles

- Correctly organized

Example

$$\frac{\text{moles of a}}{\text{moles of b}} = \frac{\text{coefficient of a}}{\text{coefficient of b}}$$

or

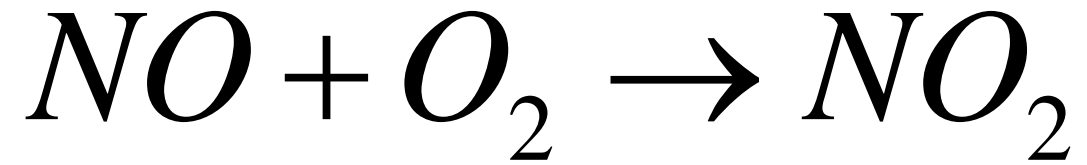
$$\frac{\text{moles of a}}{\text{coefficient of a}} = \frac{\text{moles of b}}{\text{coefficient of b}}$$

- cross-multiply to solve
- The convert moles back to grams

Proportions

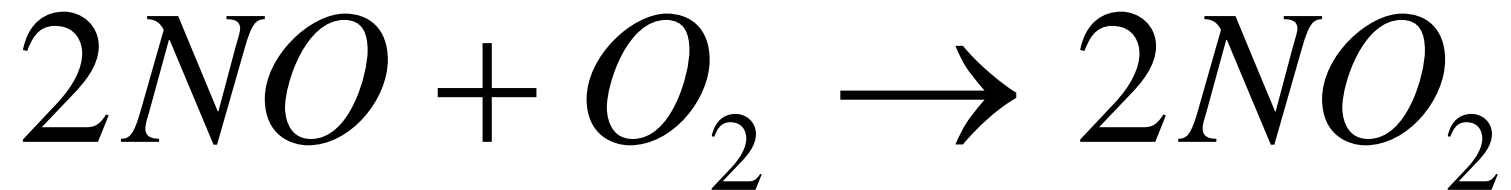
- Correctly organized
- It doesn't matter how you write the first ratio, as long as you label the numbers
- Try to put unknown on the top—easier to solve
- The second ratio needs to match the first

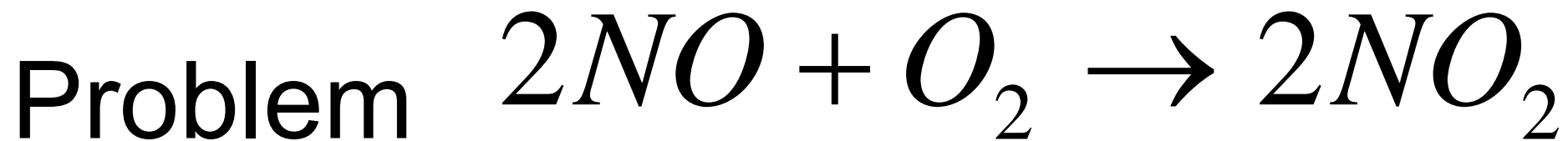
Problem



- 64 grams O_2
- How many grams NO_2 produced?

First: Balance Equation





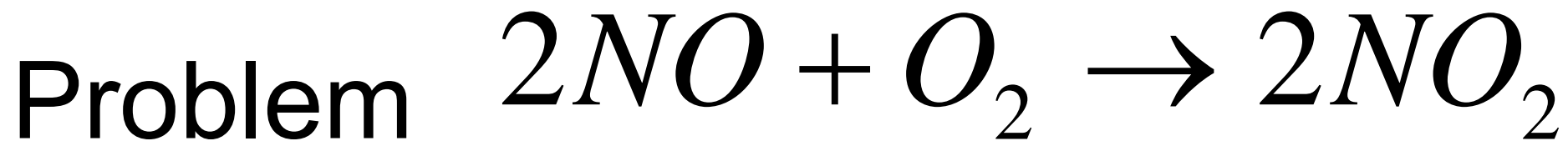
- 64 grams O_2
- How many grams NO_2 produced?

Balance Equation

Determine molar ratios of them 1:2

Find molar mass of each component

$$NO_2 = 46 \text{ g}, O_2 = 32 \text{ g}, (NO = 30 \text{ g})$$

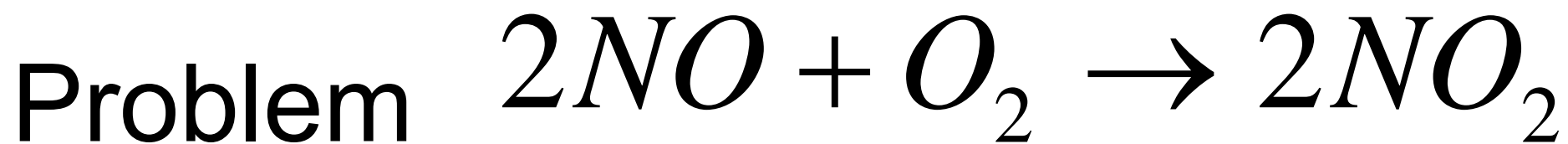


- 64 grams O_2
- How many grams NO_2 produced?

Molar mass of each: $O_2 = 32 \text{ g}$, $NO_2 = 46 \text{ g}$

How many moles is 64 grams O_2 ?

2 moles



- 64 grams O_2
- How many grams NO_2 produced?
- Molar mass of each $O_2 = 32 \text{ g}$, $NO_2 = 46 \text{ g}$

Molar ratios $O_2:NO_2$ is 1:2

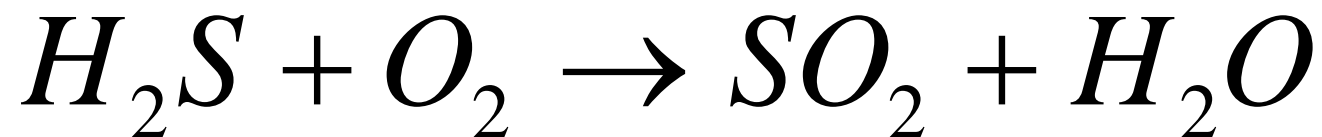
Two moles of O_2 —do you need proportion to find moles of NO_2 ?

So four moles of NO_2 is produced

How many grams is that?

$4 \text{ mol} \times 46 \text{ g/mol} = 184 \text{ grams}$

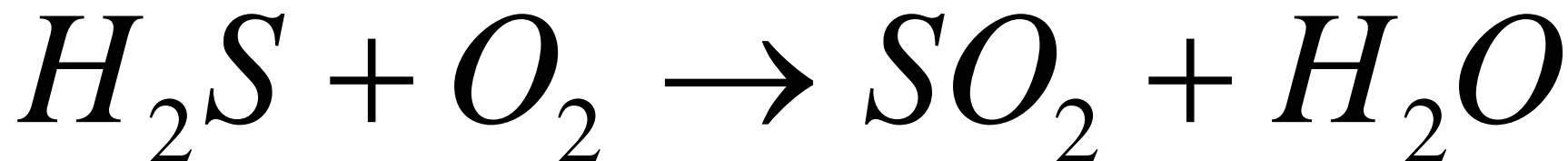
Problem



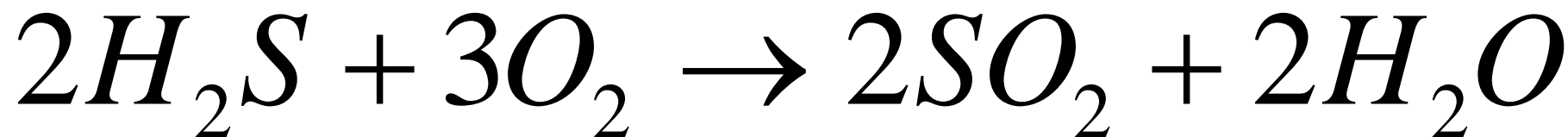
- 32 grams SO_2
- How many grams O_2 used?

Problem

- 32 grams SO_2
- How many grams O_2 used?



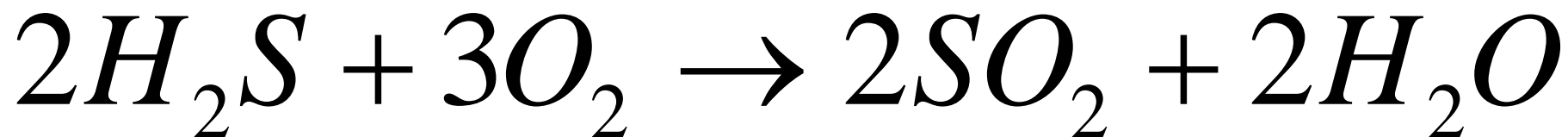
- Balance first



- Then determine molar ratios
- 2 SO_2 to 3 O_2

Problem

- 32 grams SO_2
- How many grams O_2 used?



- Find molar masses

- $\text{SO}_2 = 32 + 32 = 64 \text{ g/mol SO}_2$

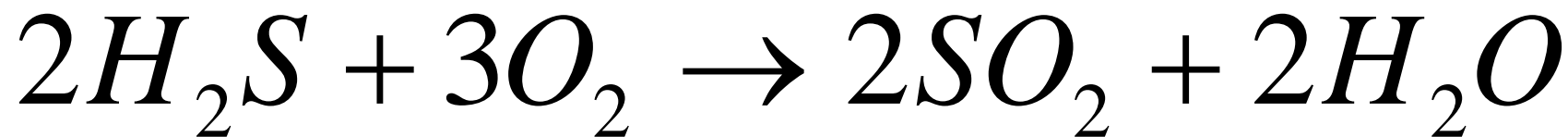
- $\text{O}_2 = (2 \times 1) + 16 = 32 \text{ g/mol O}_2$

- $\text{H}_2\text{O} = (2 \times 1) + 16 = 18 \text{ g/mol H}_2\text{O}$

- $\text{H}_2\text{S} = (2 \times 1) + 32 = 34 \text{ g/mol H}_2\text{S}$

Problem

- 32 grams SO_2
- How many grams O_2 used?



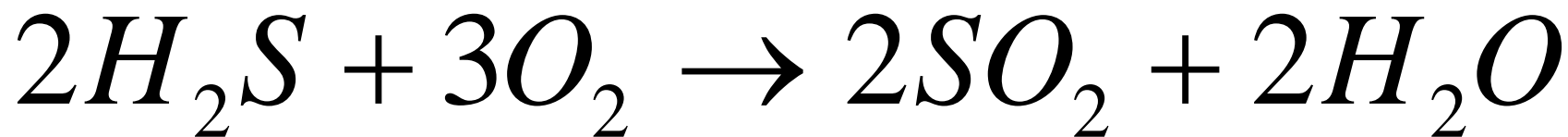
- 32 g SO_2 needs how many grams O_2 ?
- How many moles is 32 g SO_2 ?

$$32 \text{ g } \text{SO}_2 \cdot \frac{1 \text{ mole}}{64 \text{ g}} = 0.5 \text{ moles } \text{SO}_2$$

- 32 grams SO_2

Problem

- How many grams O_2 used?



- How many moles O_2 is needed?
- 0.5 moles SO_2 in 2:3 ratio with O_2
- 0.75 moles O_2

$$32 \text{ g } \text{SO}_2 \cdot \frac{1 \text{ mole}}{64 \text{ g}} = 0.5 \text{ moles } \text{SO}_2$$

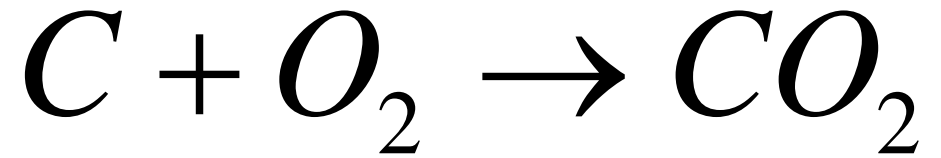
Set up
proportion

- 32 grams SO_2
- How many grams O_2 used?

with the unknown on top (the O_2)

$$\frac{? \text{ moles } \text{O}_2}{[\quad]} = \frac{[\quad]}{[\quad]}$$

Problem 6



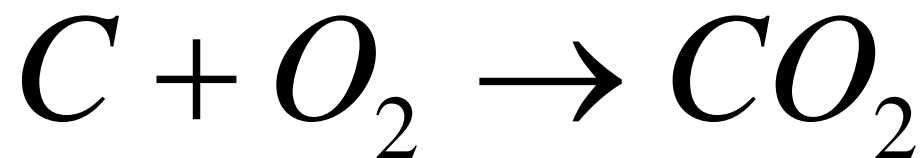
Is it balanced?

Molar ratio 1:1:1

4 grams oxygen

- Grams carbon consumed?
- Grams carbon dioxide produced?

Problem 6



Molar ratio 1:1:1

4 grams oxygen

- 1 mole $O_2 = 32 \text{ g}$

$$4 \text{ g } O_2 \cdot \frac{1 \text{ mole}}{32 \text{ g}} = 0.125 \text{ moles } O_2$$



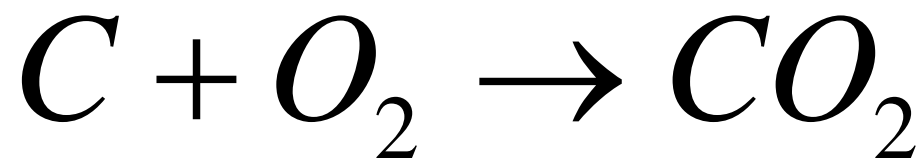
Molar ratio 1:1:1

0.125 moles O_2 in 1:1 ratio

0.125 moles C

0.125 moles CO_2

Problem 6



0.125 moles C

Grams carbon consumed?

$$0.125 \text{ moles } C \cdot \frac{12 \text{ g}}{1 \text{ mole}} = 1.5 \text{ g } C$$

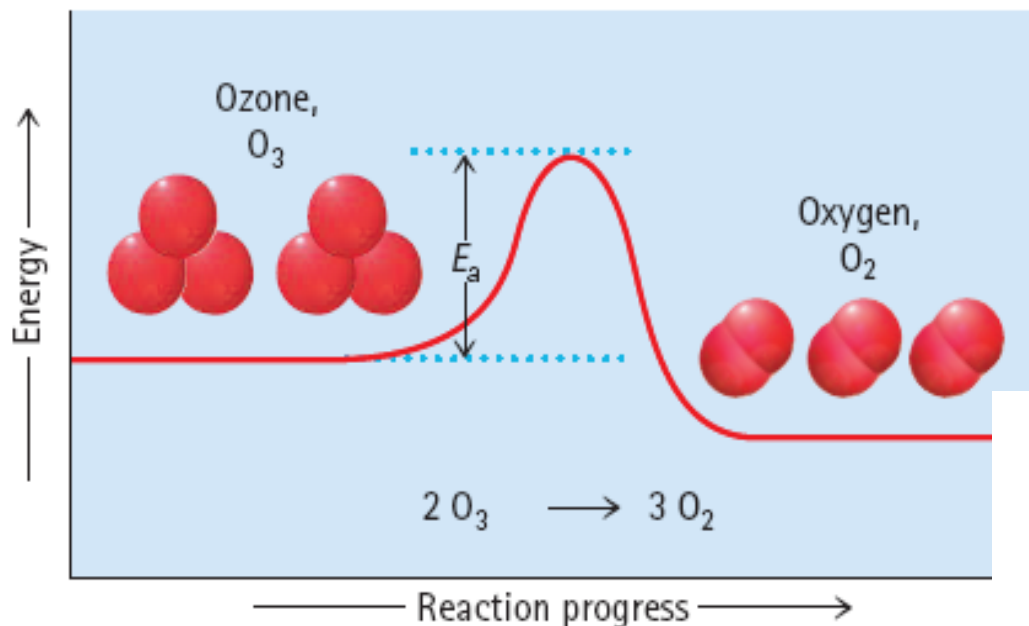
$$0.125 \text{ mole } CO_2 \cdot \frac{44 \text{ g}}{1 \text{ mole}} = 5.5 \text{ g } CO_2$$

Reaction Speed

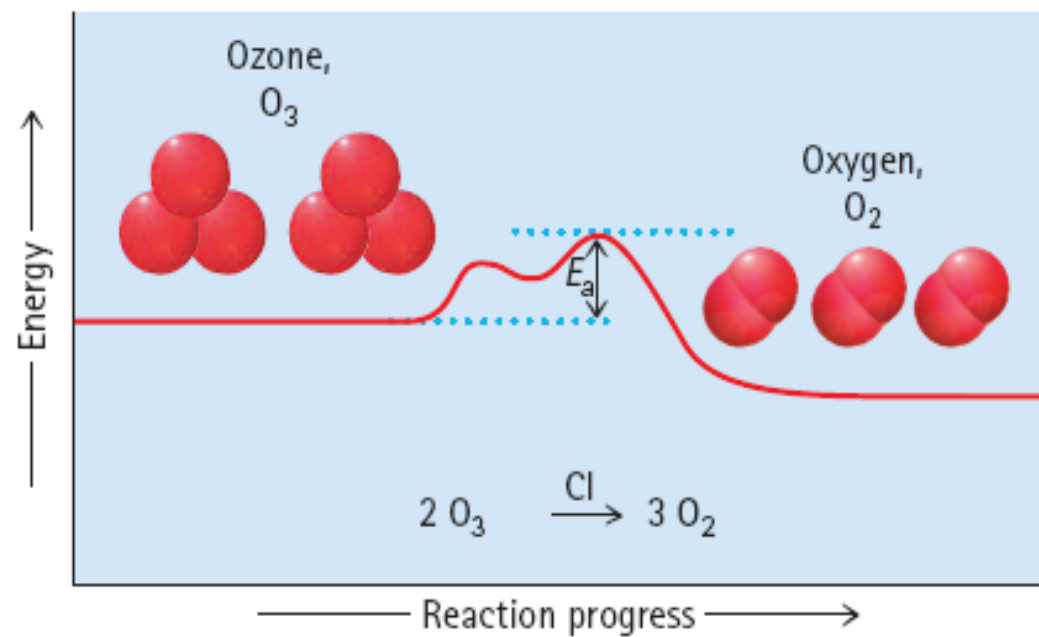
Collision of molecules required for it to occur

- Increase concentration
- Increase temperature
- Catalyst can facilitate reaction

Reaction of ozone to oxygen



(a) Without catalyst



(b) With chlorine catalyst

- Chlorine catalyst

Energy of reactions

- Release heat energy from chemical bonds
- EXOTHERMIC
- Methane combustion

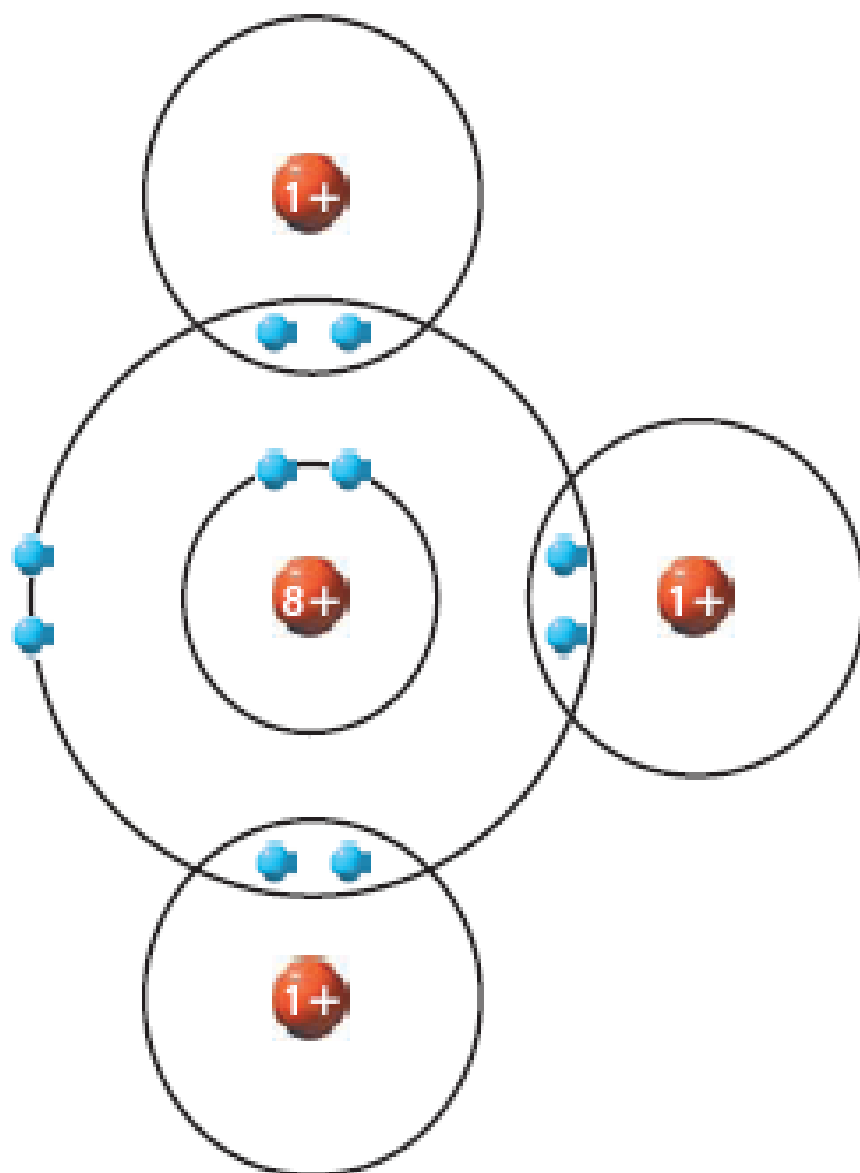
- Take heat energy into chemical bonds
- ENDOTHERMIC
- Formation of water

Two Types of Reactions

- Acid-Base reactions
- Oxidation-Reduction reactions

Acid-Base Reactions

- Transfer of hydrogen ions—protons
- Makes water into H_3O^+ and OH^-
- Hydronium and Hydroxide



Electron dot structure
of hydronium ion



Space-filling model
of hydronium ion

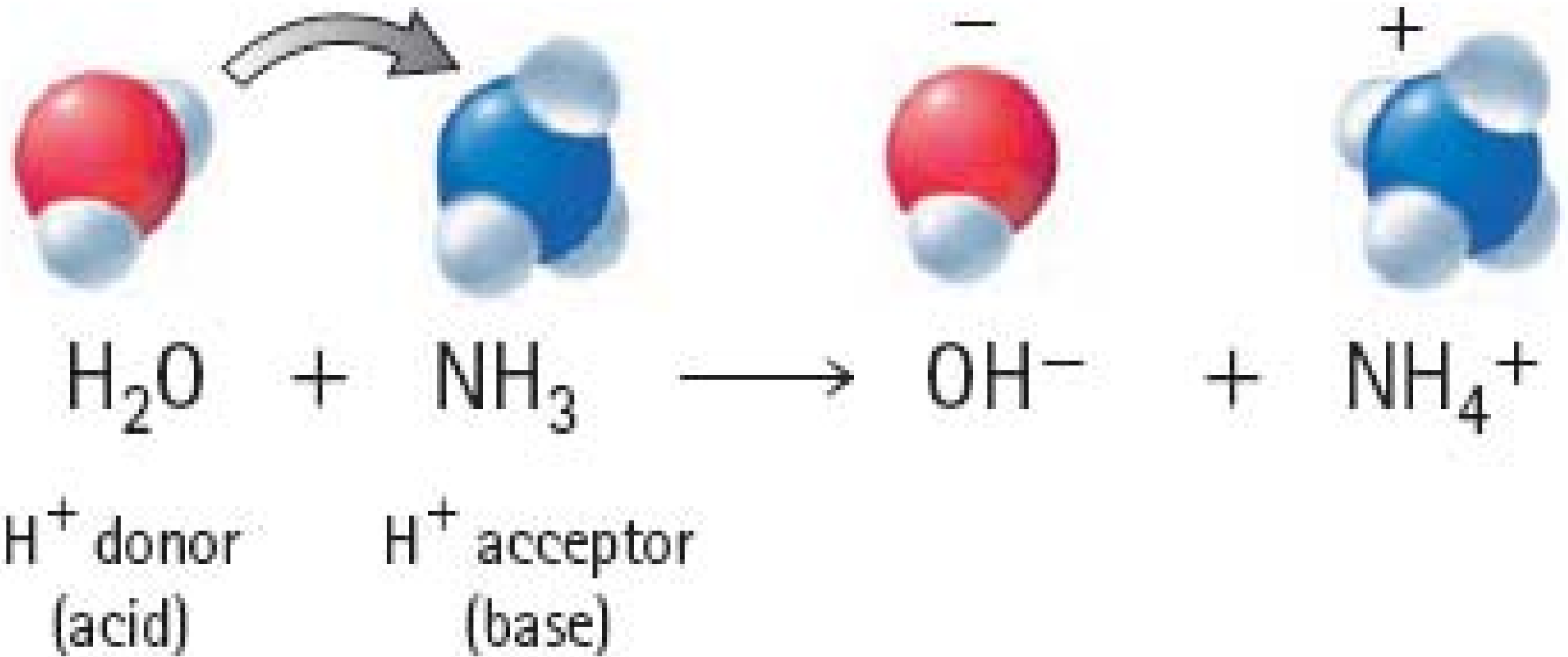
Dissolving HCl makes acid



H^+ donor
(acid)

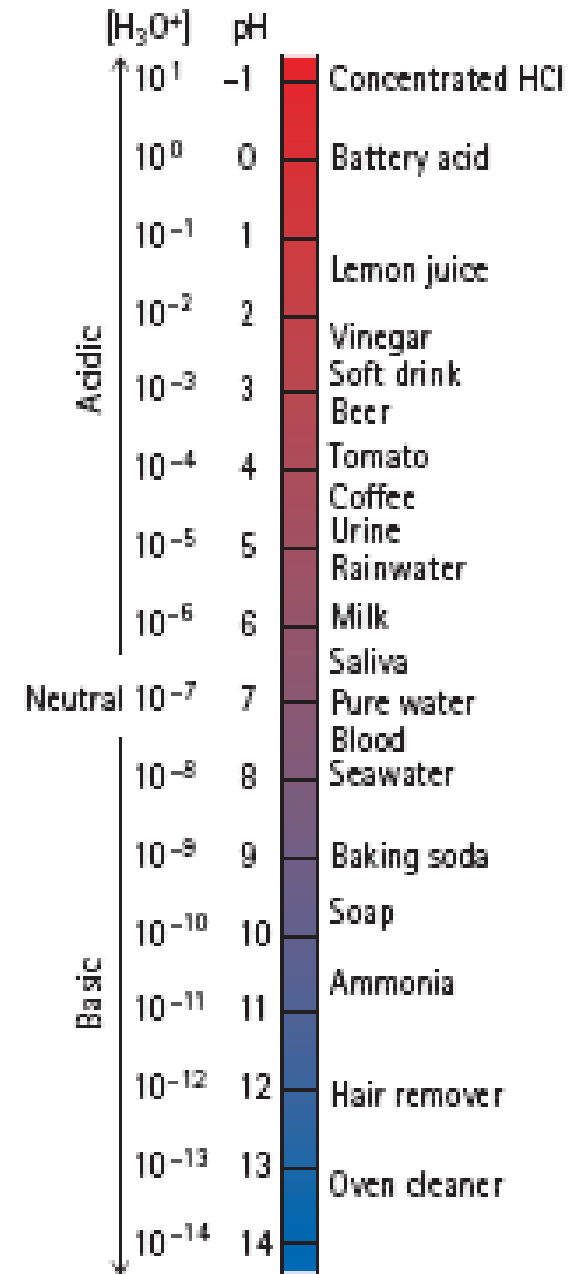
H^+ acceptor
(base)

Dissolving NH_3 makes base



Measuring Acid Strength

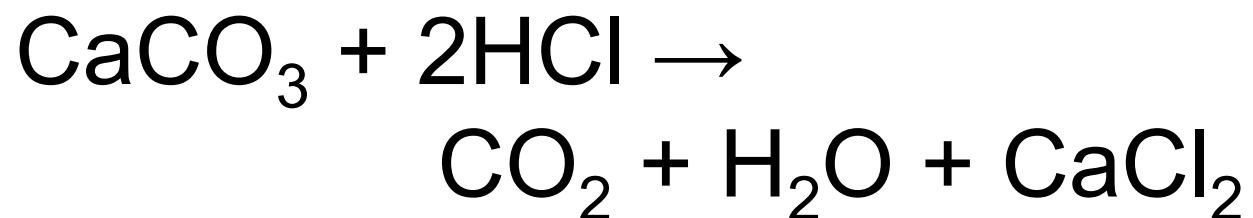
- Measure of acidity is pH
 - Concentration of H_3O^+ in powers of 10
 - Negative of that power is the pH
 - pH of pure water is 7
 - Acids 0 to 7, bases 7 to 14
- Use electric current to determine pH



Acid Base Reactions



- Neutralize one another
- Acid + Base \rightarrow Water + Salt
- Generic term ***salt*** is the ionic product of an acid-base reaction

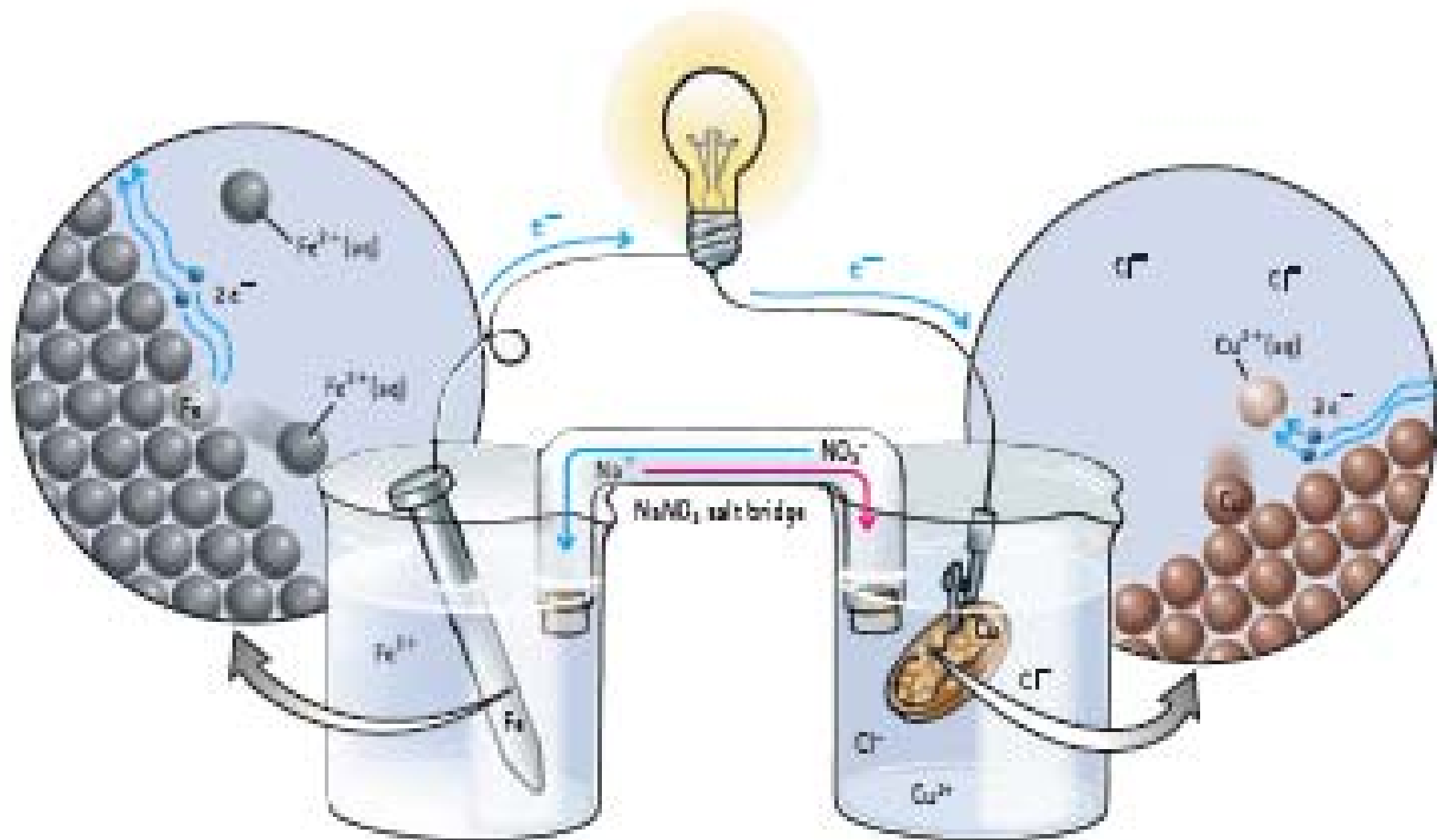


Oxidation-Reduction Reactions

- Transfer of electrons
- Often bonding with oxygen
- Identifying the components of reaction—
look for the transfer of electrons
 - Loss of Electrons—Oxidation (LEO)
 - Gain of Electrons—Reduction (GER)
 - (LEO the lion goes GER) =)

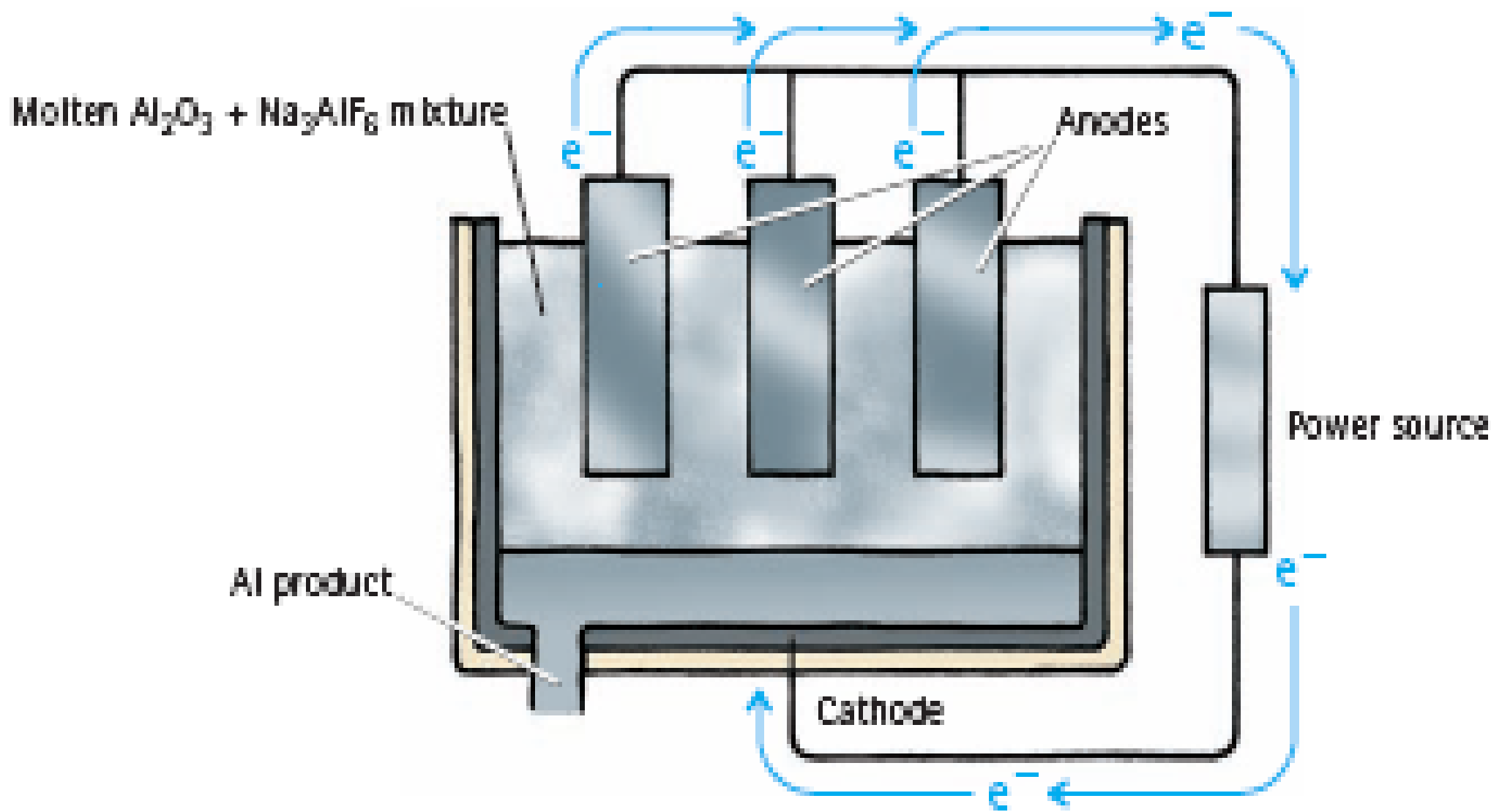
Batteries

- Batteries function because of an oxidation-reduction reaction
 - Anode—source of electrons
 - Cathode—destination of electrons
- Need to have a way for electrons to get back to their source
 - Complete the circuit
 - Salt bridge or other device



Electrolysis

- Electroplating is a useful Oxidation-Reduction Reaction
 - Ancient weak-acid electric circuits probably were utilized for this
- Electrolysis breaks covalent bonds
 - Aluminum oxide ore
 - Water can be source of hydrogen and oxygen,
 - For use in a fuel cell
 - Combining the two becomes source of electricity



Corrosion

- An oxidation-reduction reaction
- Metals combine with oxygen
 - the oxide product has different properties
 - Weaker
 - Greater volume



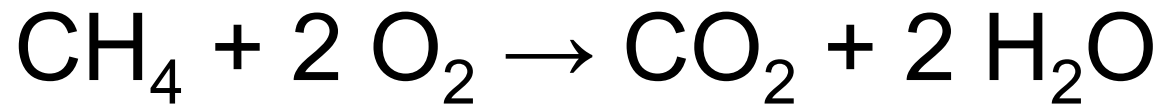
Corrosion

- An oxidation-reduction reaction
- Metals combine with oxygen
 - Some metals coated or connected by electric circuit with others as a 'sacrifice' metal to protect strength of another
 - Zinc oxidizes more readily than iron
 - Attached to steel ship keels and rudders
 - Zinc galvanized nails



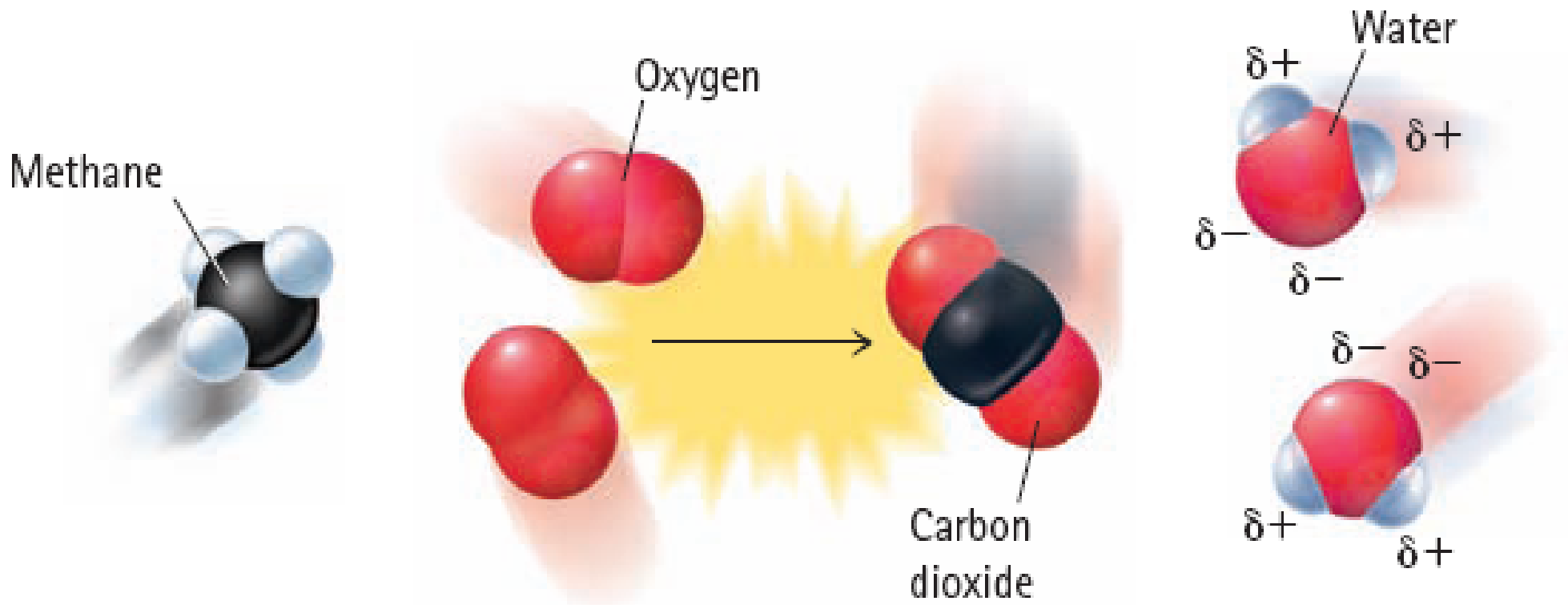
Combustion Reactions

- Combustion is an oxidation-reduction reaction



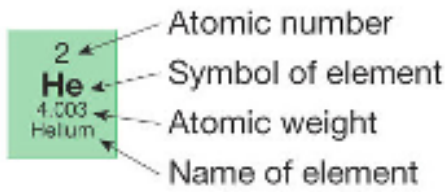
- Methane: C and H are oxidized
- Oxygen is reduced

Methane Combustion



Periodic Table

1																	VIII A	
	IA	IIA											III A	IVA	VA	VIA	VIIA	VIIIA
1	1 H 1.0080 Hydrogen																	2 He 4.003 Helium
2	3 Li 6.939 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.011 Carbon	7 N 14.007 Nitrogen	8 O 15.9994 Oxygen	9 F 18.998 Fluorine	10 Ne 20.183 Neon
3	11 Na 22.990 Sodium	12 Mg 24.31 Magnesium	III B	IV B	V B	VI B	VII B	VIII B			B	II B	13 Al 26.98 Aluminum	14 Si 28.09 Silicon	15 P 30.974 Phosphorus	16 S 32.064 Sulfur	17 Cl 35.453 Chlorine	18 Ar 39.948 Argon
4	19 K 39.102 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.88 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.71 Nickel	29 Cu 63.54 Copper	30 Zn 65.37 Zinc	31 Ga 69.72 Gallium	32 Ge 72.59 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.909 Bromine	36 Kr 83.80 Krypton
5	37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc (98) Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.90 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.87 Silver	48 Cd 112.40 Cadmium	49 In 114.82 Indium	50 Sn 118.69 Tin	51 Sb 121.75 Antimony	52 Te 127.60 Tellurium	53 I 126.90 Iodine	54 Xe 131.30 Xenon
6	55 Cs 132.91 Cesium	56 Ba 137.34 Barium	57 TO 71	72 Hf 178.49 Hafnium	73 Ta 180.95 Tantalum	74 W 183.85 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.09 Platinum	79 Au 197.0 Gold	80 Hg 200.59 Mercury	81 Tl 204.37 Thallium	82 Pb 207.19 Lead	83 Bi 208.98 Bismuth	84 Po (210) Polonium	85 At (210) Astatine	86 Rn (222) Radon
7	87 Fr (223) Francium	88 Ra 226.05 Radium	89 TO 103	57 La 138.91 Lanthanum	58 Ce 140.12 Cerium	59 Pr 140.91 Praseodymium	60 Nd 144.24 Neodymium	61 Pm (147) Promethium	62 Sm 150.35 Samarium	63 Eu 151.86 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.92 Terbium	66 Dy 162.50 Dysprosium	67 Ho 164.93 Holmium	68 Er 167.26 Erbium	69 Tm 168.93 Thulium	70 Yb 173.04 Ytterbium	71 Lu 174.97 Lutetium
				89 Ac (227) Actinium	90 Th 232.04 Thorium	91 Pa (231) Protactinium	92 U 238.03 Uranium	93 Np (237) Neptunium	94 Pu (242) Plutonium	95 Am (243) Americium	96 Cm (247) Curium	97 Bk (249) Berkelium	98 Cf (251) Californium	99 Es (254) Einsteinium	100 Fm (253) Fermium	101 Md (256) Mendelevium	102 No (254) Nobelium	103 Lw (257) Lawrencium



- Metals
- Transition metals
- Nonmetals
- Noble gases
- Lanthanide series
- Actinide series

Groups or Families

- Alkali Metals
- Alkaline Earth Metals
- Transition Metals
- Oxygen Group (chalcogens)
- Halogens
- Noble Gases

Ions of Element Groups

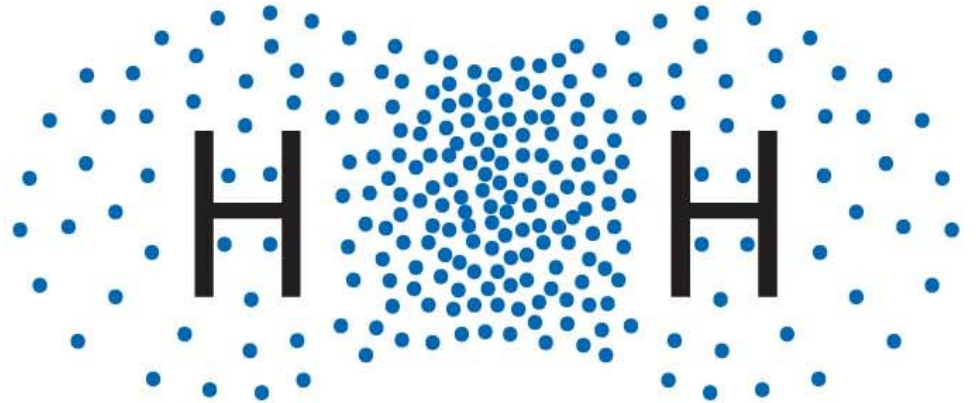
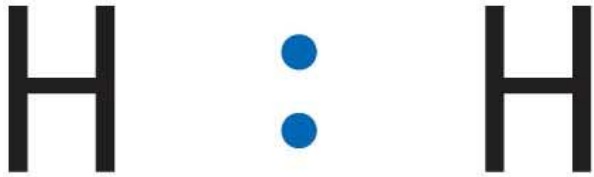
- Alkali Metals + 1
- Alkaline Earth Metals + 2
- Transition Metals +, number variable
- Oxygen Group - 2
- Halogens - 1
- Noble Gases no ions formed (usually)

Ionic bonds form ionic compounds

Need even ratio of charges in the compounds

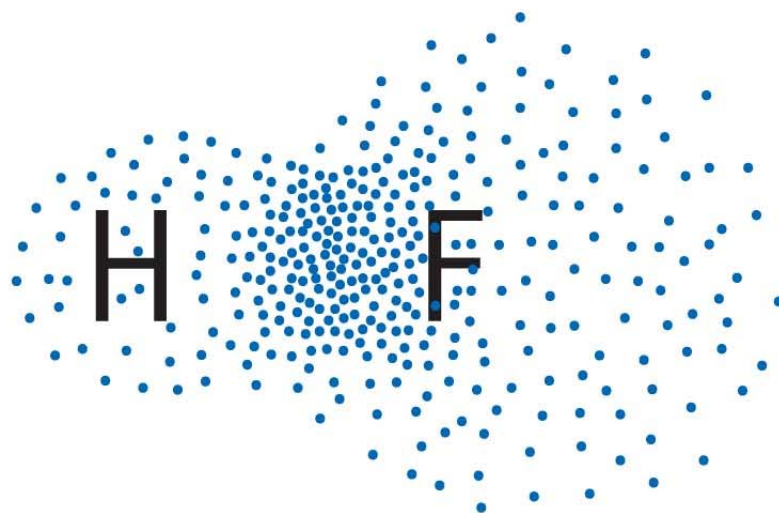
Covalent Bonds

- When the two atoms are the same, electrons within covalent bond shared evenly.
- Nonpolar



Polar Covalent Bonds

- They may be shared *unevenly*, however, when the bonded atoms are different.
- Forms a dipole—has uneven charge



Compounds

- More than one type of atom in the molecule
- Has a **Chemical Formula**
- Sodium Chloride NaCl
- Ammonia NH₃
- Subscript tells how many of each
- (Subscript 1 is omitted)

Chemical Equations

- $C + O_2 \rightarrow CO_2$
- $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$
- Reactants on left, products on right
- Each are balanced because same number of atoms of reactants as products
- Letter subscript refers to the phase of the substance

Formula Mass/Molar Mass

- Mole: A super-large number, 6.02×10^{23} , used to measure numbers of atoms or molecules, a.k.a. Avogadro's number.

The formula mass of a substance expressed in grams contains one mole.

Substance	Formula Mass
Carbon, C	12
Oxygen, O ₂	32
Carbon dioxide, CO ₂	44
Sucrose, C ₁₂ H ₂₂ O ₁₁	342

Molar mass of propane C_3H_8

- assume molar mass of C = 12 g/mole
 - 3 C x 12 g/mole = 36 g/mole
- assume molar mass of H = 1 g/mole
 - 8 H x 1 g/mole = 8 g/mole
- 8 g/mole + 36 g/mole = 44 g/mole **C_3H_8**

Grams calculated from Moles

- Can find the mass of substance from knowing molar mass and moles

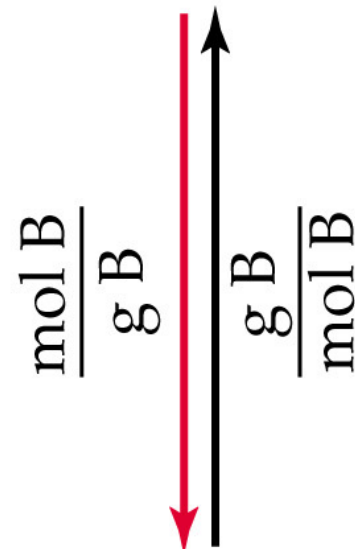
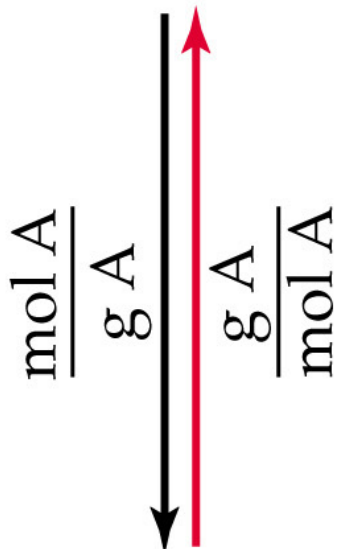
$$\text{Na} = 23 \text{ g/mole} \quad \frac{1}{4} \text{ mole}$$

- Multiply molar mass times moles
- $23 \text{ g/mole} \times 0.250 \text{ moles} = 5.75 \text{ g}$

Mass of A,
grams

Mass of B,
grams

Molar mass
as conversion
factors



Amount of A,
moles

Amount of B,
moles



Steps to find grams in chemical reaction

- Balance the equation to get molar ratios
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- Set up a proportion to compare molar ratio to the moles of known and unknown
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Proportions to find moles

- Correctly organized

Example

$$\frac{\text{moles of a}}{\text{moles of b}} = \frac{\text{coefficient of a}}{\text{coefficient of b}}$$

or

$$\frac{\text{moles of a}}{\text{coefficient of a}} = \frac{\text{moles of b}}{\text{coefficient of b}}$$

- cross-multiply to solve
- The convert moles back to grams