

Chemical Reactions

- 1) Chemical reaction - process by which one or more substances are changed into one or more different substances.
- 2) Reactants - substances undergoing chemical change.
- 3) Products - resulting substances from the reaction.
- 4) Chemical Equation - represents with symbols and formulas, the identities and relative molecular or molar amounts of the reactants and products in a chemical reaction.
- 5) Example: $A + X \rightarrow AX$
 reactant ↑ product
- 6) Characteristics of Chemical equations:
 - 1) The equation must represent the facts.
 - 2) The equation must have the correct formulas in the reactants and products.
 - 3) The law of conservation of mass must be satisfied.
- 7) Coefficient - small whole number that appears in front of a formula in a chemical equation.

8) Word equation - an equation in which the reactants and products in a chemical reaction are represented by words.

9) Formula equation - represents the reactants and products of a chemical reaction by their symbols or formulas.

10) Example: Carbon + Oxygen \rightarrow Carbon Dioxide

reactants yield product

$C + O_2 \rightarrow CO_2$

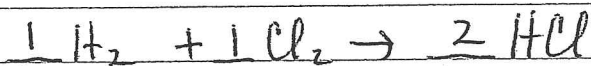
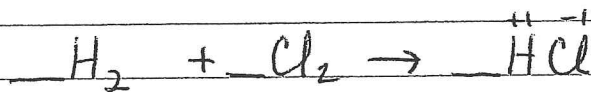
Word Form.

Formula Form.

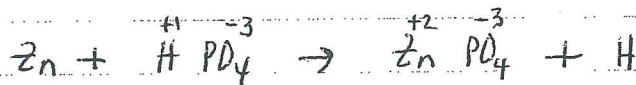
11) Steps for balancing chemical equations:

- 1) Make sure the chemical formulas are correct in the products and reactants.
- 2) Check to see what is out of balance.
- 3) Check for group ions that stay together on both sides.
- 4) Save one atom, diatomic, then H_2O molecules for last.
- 5) See what looks the worst and balance it first.

12) Example #1 Hydrogen + Chlorine \rightarrow Hydrogen Chloride

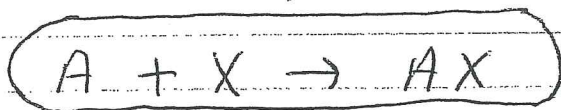


Example #2 Zinc + Phosphoric Acid \rightarrow Zinc Phosphate + Hydrogen

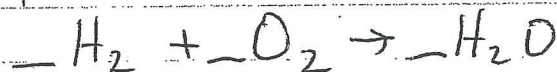


13) 5 Types of Chemical Reactions

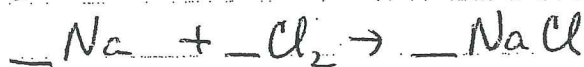
(1) Synthesis or Composition Rx. - 2 or more substances combined to form one.



Ex. #1



Ex. #2



(2) Decomposition Rx. - One substance breaks down to form two or more substances.



Ex. #1



Ex. #2

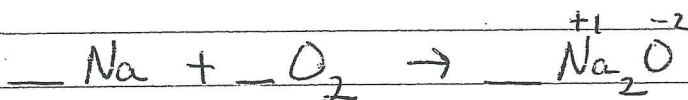


14) Combustion reactions - a substance combines with oxygen, releasing a large amount of energy in the form of heat and light.

15) Example of balancing chemical equations.

Sodium + Oxygen \rightarrow Sodium Oxide

Step 1: Correct formulas in reactant and product side.



Step 2: Check to see what is out of balance.

Note: 1 Na \rightarrow 2 Na
2 O \rightarrow 1 O
reactant side product side

Step 3: Check for group ions staying together in the reaction.

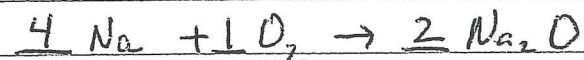
Note: No group ions

Step 4: Save one atom, diatomic, water for last.

Note: Save Na for last
Save O₂ for next to last

Step 5: Balance what looks the worst.

Note: Balance O first



(122)

(5)

Synthesis Rxn.

16) Mole - Amount of a substance that is contained in avogadro's number of particles.

17) Avogadro's Number. - 6.022×10^{23} particles of anything.

18) Molar Mass - Mass of 1 mole of a substance.

19) Calculations using mole:

Example #1: $55.61 \text{ g H}_2 = \underline{\hspace{2cm}} \text{ mole H}_2$

MW. $\text{H}_2 = 2.02 \text{ g/mole}$

$$\left(55.61 \text{ g} \right) \left(\frac{\text{mole}}{2.02 \text{ g}} \right) = 27.5 \text{ mole H}_2$$

Example #2: $6.25 \text{ mole H}_2 = \underline{\hspace{2cm}} \text{ g H}_2$

$$\left(6.25 \text{ mole H}_2 \right) \left(\frac{2.02 \text{ g}}{\text{mole}} \right) = 12.6 \text{ g H}_2$$

Example #3: $3.15 \text{ mole H}_2 = \underline{\hspace{2cm}} \text{ molecules H}_2$

$6.022 \times 10^{23} \text{ molecules H}_2 / 1 \text{ mole H}_2$

$$\left(3.15 \text{ mole H}_2 \right) \left(\frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mole H}_2} \right) = 1.90 \times 10^{23} \text{ molecules H}_2$$

20) Calculating molar mass of Compound - (Sum of atomic masses)

Example:



1 Na = 22.990

1 Cl = 35.453

57.443 G/mole

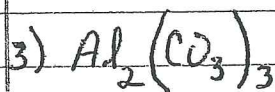


1 Ca = 40.078

2 Cl = 35.453 = 70.906

110.984 G/mole

110.98 G/mole sig. figs



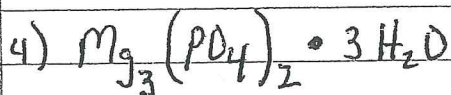
2 Al = 26.982 = 53.964

3 C = 12.011 = 36.033

9 O = 16.00 = 144.0

233.997 G/mole

234.0 G/mole sig. figs



3 Mg = 24.305 = 72.915

2 P = 30.974 = 61.948

8 O = 16.00 = 128.0

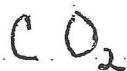
3 H₂O = 18.02 = 54.06

308.923 G/mole

308.9 G/mole

21) % Composition by mass:

Example:



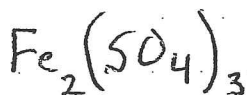
$$1 \text{ C} = 12.01$$

$$2 \text{ O} = 16.00 = 32.00$$

$$44.01 \text{ g/mole}$$

$$\% \text{ C} = \frac{12.01}{44.01} \times 100 = 27.29 \%$$

$$\% \text{ O} = \frac{32.00}{44.01} \times 100 = 72.71 \%$$



$$2 \text{ Fe} = 55.845 = 111.69$$

$$3 \text{ S} = 32.065 = 96.195$$

$$12 \text{ O} = 16.00 = 192.0$$

$$399.885 \text{ g/mole}$$

$$\boxed{399.9 \text{ g/mole}}$$

$$\% \text{ Fe} = \frac{111.69}{399.9} \times 100 = 27.93 \%$$

$$\% \text{ S} = \frac{96.195}{399.9} \times 100 = 24.05 \%$$

$$\% \text{ O} = \frac{192.00}{399.9} \times 100 = 48.01 \%$$

22) Thermodynamics - Study of the transfer of energy as heat that accompany chemical reactions and physical changes.

23) Calorimeter - device used measure the heat released in a combustion reaction of a substance.

24) Calorie - amount of heat energy needed to raise the temperature of 1 gram of water one degree Celsius.

25) Joule - SI unit of heat.

26) Calculation of Heat energy. Note: $1 \text{ cal} = 4.19 \text{ J}$

Example: #1

$$450.5 \text{ J} = \underline{\hspace{2cm}} \text{ cal}$$

$$(450.5) \left(\frac{1 \text{ cal}}{4.19 \text{ J}} \right) = 107 \text{ cal}$$

#2

$$6500. \text{ cal} = \underline{\hspace{2cm}} \text{ J}$$

$$(6500. \text{ cal}) \left(\frac{4.19 \text{ J}}{1 \text{ cal}} \right) = 27240 \text{ J}$$

27) Specific heat - amount of energy required to raise the temperature of 1 gram of a substance by 1°C .

28) Specific heat formula:

$$C_p = \frac{q}{(m)(\Delta t)}$$

C_p = specific heat at given pressure.

q = energy lost or gained

m = Mass of substance.

Δt = change in temp.

Units used

$$C_p = \frac{J}{g \cdot ^\circ C} \text{ or } \frac{J}{g \cdot ^\circ K} \text{ or } \frac{Cal}{g \cdot ^\circ C}$$

$$q = J \text{ or } Cal$$

$$m = g \text{ or } Kg$$

$$\Delta t = ^\circ C \text{ or } ^\circ K$$

29) Example #1 Determine the specific heat of a material if a 35 g sample absorbed 48 J as it was heated from 293 K to 313 K.

$$m = 35g \quad q = 48J \quad \Delta T = 293^\circ K - 313^\circ K \\ = 20.0^\circ K \quad C_p = \underline{\hspace{2cm}}$$

$$C_p = \frac{q}{(m)(\Delta t)} = \frac{48J}{(35g)(20.0^\circ K)} = \boxed{0.69 \frac{J}{g \cdot ^\circ K}}$$

Examp. #2 How much heat is absorbed by 25.5 g of water when its temperature is increased from 25.0°C to 65.0°C? Specific Heat (H_2O) = $4.184 \frac{J}{g \cdot ^\circ C}$

125 (B)

(10)

Continuous Example #2

$$m = 25.5 \text{ g} \quad \Delta T = 65.0^\circ\text{C} - 25.0^\circ\text{C} = 40.0^\circ\text{C} \quad c_p = 4.184 \frac{\text{J}}{\text{g}\cdot^\circ\text{C}} \quad q = \underline{\hspace{2cm}}$$

$$c_p = \frac{q}{m \Delta T}$$

$$q = (c_p)(m)(\Delta T) = \left(4.184 \frac{\text{J}}{\text{g}\cdot^\circ\text{C}}\right)(25.5 \text{ g})(40.0^\circ\text{C}) = 4268 \text{ J}$$

$\approx \boxed{4270 \text{ J}}$

30) Calorie Conversion - Note use of units has different meaning in different text.

lower case	Capital	
Calorie	Calorie	Kcal
1000 calorie = 1 Calorie = 1 Kcal		

31) Endothermic reaction - energy is going into the reaction to make it go.

32) Exothermic reaction - energy is given off as the reaction goes.

33) Factors that affect the rate of reactions:

- 1) Nature of reactants - types of bonds involved
- 2) Surface Area -
- 3) Temperature -
- 4) Concentration -
- 5) Catalyst - substance that speeds up the reaction without being changed itself

