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| **Student Objectives:** | | |
| * Recognize when a chemical reaction is taking place. * Know the four basic types of inorganic reactions. * Know the characteristics of a neutralization reaction. * Know the characteristics of an oxidation-reduction reaction. * Know the characteristics of a combustion reaction.  * Given the reactants, predict the products of a reaction. |  |  |

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| **Chemical Reaction:**  **a process in which substances change into other substances.** |  |

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| |  | | --- | | **You know a chemical reaction takes place if one or more of these occur:**   1. **Color changes** - Different combinations of molecules reflect light differently. A color change indicates a change in molecules. 2. **Heat content changes** - In all chemical reactions, the heat content of the reactants and the content of the products is never the same. Sometimes the difference is great and can be easily detected; at other times the difference is slight and is more difficult to detect. 3. **A gas is produced** - Whenever a gaseous product forms in a liquid solution, bubbles can be seen. A colorless gas produced in a reaction of solids is much harder to detect. 4. **A precipitate forms** - Precipitates are insoluble products formed by a reaction taking place in a liquid solution. This insoluble product will eventually settle to the bottom, but might immediately appear by turning the clear solution cloudy. | |

**Most inorganic reactions can be placed into one of four types:**



**1. Decomposition Reactions**

* A compound breaks into parts.
* 2H2O 2H2 + O2



* **compound element + element**



**Some decomposition complications with heat:**

\* Some acids, when heated, decompose into an acidic oxide and H2O.

H2SO3 SO2 + H2O



\*Metallic hydroxides, when heated, decompose into a metallic oxide and H2O.

Ca(OH)2 CaO + H2O



\*Metallic carbonates, when heated, decompose into a metallic oxide and CO2.

Li2CO3 Li2O + CO2



\*Metallic chlorates, when heated, decompose into metallic chlorides and O2.

2KClO3 2KCl + 3O2



\* Some Oxides, when heated, decompose.

2HgO 🡪 2Hg + O2

\* Some Decomposition reactions are produced by Electricity.

2H2O 🡪 2H2 + O2

2NaCl 🡪 2Na + Cl2

**2. Synthesis Reactions**

* Elements are joined together.
* 2H2 + O2 2H2O



* **element + element compound**



* Compounds are joined together
* 6CO2 + 6H2O C6H12O6 + 6O2



**3. Single Displacement Reactions**

* A single element replaces an element in a compound.
* Zn + 2HCl H2 + ZnCl2



* **element + compound element + compound**



**4. Double Displacement Reactions**

* An element from each of two compounds switch places.
* H2SO4 + 2NaOH Na2SO4 + 2H2O



* **compound + compound compound + compound**



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| |  | | --- | | **The major reaction types can be sub-classified in several ways:** | |

**Neutralization Reactions**



* Special types of double displacement reactions that involve the reaction between an acid and base to form a salt and water.
* Heat is usually given off in neutralization reactions.
* A suspension of solid magnesium hydroxide in water is widely used as an antacid to neutralize excess stomach acid:   
  Mg(OH)2 (s) + 2HCl (aq) MgCl2 (aq) + 2H2O (s)



* **acid + base salt + water**



**Oxidation-Reduction Reactions**



* Any reaction in which elements experience a change in oxidation number.
* S + O2 SO2



* In this reaction, sulfur and oxygen both have an oxidation number of zero before the reaction. After the reaction, sulfur is +4 and oxygen is -2.

**Precipitation Reactions**



* Aqueous reactions that involve the formation of a precipitate (solid).
* 2KI (aq) + Pb(NO3)2 (aq) 2KNO3 (aq) + PbI2 (s)



* **soluble compound + soluble compound insoluble compound**



**Combustion Reactions**



1. A **hydrocarbon** (a compound containing only carbon and hydrogen) combines with oxygen. The products of combustion are always carbon dioxide and water.
   * CH4 + 2O2 CO2 + 2H2O



* + **hydrocarbon + oxygen carbon dioxide + water**



1. When metallic substances are burned in oxygen, the combustion reaction is also an oxidation-reduction reaction, an example of which is the rusting of iron.
   * 4Fe + 3O2 2Fe2O3



**Practice :**

Determine the reaction type for each of the following equations:

* + 1. 2Fe + O2 2FeO  4Fe + 3O2 2Fe2O3



* + 1. 2C4H10 + 13O2 8CO2 + 10H2O



* + 1. Ca(OH)2 + H3PO4 Ca3(PO4)2 + H2O



* + 1. 2NaCl 2Na + Cl2



* + 1. 2Na + H2O 2NaOH + H2



* + 1. N2 + 3H2 2NH3



* + 1. HCl + FeS FeCl2 + H2S



* + 1. Fe + CuSO4 FeSO4 + Cu



* + 1. 2P + 3Cl2 2PCl3



* + 1. HCl + AgNO3 HNO3 + AgCl



* + 1. C7H16 + 11O2 7CO2 + 8H2O



* + 1. P4O10 + 6H2O 4H3PO4



* + 1. 3Fe + 4H2O Fe3O4 + 4H2



* + 1. 2H3PO4 H4P2O7 + H2O



* + 1. Al2(SO4)3 + 3Ca(OH)2 2Al(OH)3 + 3CaSO4



* + 1. CaC2 + 2H2O C2H2 + Ca(OH)2



* + 1. Fe2O3 + 3C 3CO + 2Fe



* + 1. 2MgNH4PO4 Mg2P2O7 + 2NH3 + H2O



* + 1. 2As + 6NaOH 2Na3AsO3 + 3H2



* + 1. C10H16 + 8Cl2 10C + 16HCl



* + 1. AgNO3 + Cu CuNO3 + Ag



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| |  |  | | --- | --- | |  | **Your knowledge of reaction types can be used to predict the products of a reaction if the reactants are known.** | |

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| |  | | --- | | **Concept Understanding:**  Complete the following reactions using **words**, not formulas:   1. Magnesium plus oxygen yields 2. Chlorine plus lithium iodide yields 3. Aluminum plus lead (II) nitrate yields 4. Calcium oxide plus hydrogen chloride yields 5. Ammonium nitrite yields  (hint: there are two products, one of which is water) 6. Ammonium phosphate plus barium hydroxide yields 7. Butane plus oxygen yields  (hint: butane is a hydrocarbon) 8. Hydrogen sulfate plus potassium hydroxide yields 9. Copper plus silver nitrate yields 10. Silver Nirtate plus potassium chloride yields | |

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| |  | | --- | | **Practice Problems:**  Use these steps to write the correct formulas for the products in these reactions.   * Determine which type of reaction is represented. * Write the products based on the reaction type. * Check oxidation numbers to see that chemical formulas are correct.   1. K + Br  * 1. KClO3  * 1. C3H8 + O  * 1. Al + FeO  * 1. Al + O  * 1. FeCl3 + NH4OH  * 1. SiC + Cl  * 1. SrBr2 + (NH4)2CO3  * 1. Au2O3  * 1. Ba(OH)2 + heat | |



Practice problem answers:

1. KBr
2. KCl + O
3. CO2 + H2O
4. Al2O3 + Fe
5. Al2O3
6. Fe(OH)3 + NH4Cl
7. SiCl4 + C
8. SrCO3 + NH4Br
9. Au + O
10. BaO + H2O

Type of reaction answers:

1. synthesis
2. synthesis
3. combustion
4. double displacement
5. decomposition
6. single displacement
7. synthesis
8. double displacement
9. single displacement
10. synthesis
11. double displacement
12. combustion
13. synthesis
14. single displacement
15. decomposition
16. double displacement
17. double displacement
18. single displacement
19. decomposition
20. single displacement
21. single displacement
22. single displacement

**Predicting Reaction Products - Answers**

* 1. **Magnesium plus oxygen yields magnesium oxide.**
  2. **Chlorine plus lithium iodide yields lithium chloride plus iodine.**
  3. **Aluminum plus lead (II) nitrate yields aluminum nitrate plus lead.**
  4. **Calcium oxide plus hydrogen chloride yields calcium chloride plus water.**
  5. **Ammonium nitrite yields ammonia plus water.**
  6. **Ammonium phosphate plus barium hydroxide yields barium phosphate plus ammonium hydroxide.**
  7. **Butane plus oxygen yields carbon dioxide plus water.**
  8. **Hydrogen sulfate plus potassium hydroxide yields potassium sulfate plus water.**
  9. **Copper plus silver nitrate yields copper nitrate plus silver.**
  10. **Silver nitrate plus potassium chloride yields potassium nitrate plus silver chloride**