## 14. CHEMICAL REACTIONS - COMBINATION AND DECOMPOSITION

## SOLUTIONS

## TEACHING TASK

### JEE MAINS LEVEL QUESTIONS

1. Which of the following statements is TRUE about combination reactions?
   A) They always involve the breaking of bonds in a single reactant.
   B) They always produce multiple products.
   C) They involve the formation of a single compound from two or more reactants.
   D) They are also known as decomposition reactions.

**Answer:C**

Solution:A) False — combination reactions involve two or more reactants forming one product, not breaking bonds in a single reactant.

B) False — they produce a single product, not multiple products.

C) True — they involve formation of a single compound from two or more reactants.

D) False — decomposition is the opposite of combination.

2. Which of these reactions is NOT an example of a combination reaction?
   A) $2Mg + O_2 \rightarrow 2MgO$
   B) $C + O_2 \rightarrow CO_2$
   C) $2H_2O \rightarrow 2H_2 + O_2$
   D) $SO_3 + H_2O \rightarrow H_2SO_4$

**Answer:C**

Solution:A) $2Mg + O_2 \rightarrow 2MgO$ ---two reactants, one product $\rightarrow$combination.

B) $C + O_2 \rightarrow CO_2$---two reactants, one product $\rightarrow$combination.

C) $2H_2O \rightarrow 2H_2 + O_2$--- one reactant, two products $\rightarrow$ decomposition (not combination).

D) $SO_3 + H_2O \rightarrow H_2SO_4$---two reactants, one product $\rightarrow$combination.

3. What would likely happen if sodium metal was exposed to chlorine gas?
   A) It would produce a colorless gas.
   B) It would explode and form sodium chloride.
   C) It would remain unchanged.
   D) It would break down into simpler elements.

**Answer:B**

Solution: Sodium reacts vigorously with chlorine gas to form sodium chloride (NaCl) — a combination reaction that releases a large amount of energy

$$2Na + Cl_2 \rightarrow 2NaCl$$

4. Why is acid rain considered an example of a combination reaction?
   A) Because multiple acids combine to form acid rain.
   B) Because sulfur trioxide reacts with water to form sulfuric acid.
   C) Because acid rain decomposes into sulfur dioxide and oxygen.
   D) Because acid rain is a mixture of various pollutants.

**Answer:B**

Solution:One of the main chemical processes forming acid rain is

$$SO_3 + H_2O \rightarrow H_2SO_4$$

This is a combination reaction — two reactants combine to form one product (sulfuric acid)

5. Which of the following is INCORRECT about combination reactions?
   A) They are also known as synthesis reactions.
   B) They always require a metal and a non-metal to react.
   C) They can involve the reaction of an element with oxygen to form an oxide.
   D) They always result in the formation of a single compound.

**Answer:B**

Solution:Combination (synthesis) reactions can involve many types of reactants (elements, compounds, nonmetals, metals), so saying they always need a metal + nonmetal is incorrect

6. $2A\ell(OH)_{3(s)} \xrightarrow{D} A\ell_2O_{3(s)} + 3H_2O_{(g)}$

   Which of the following statements is true for the above reaction?
   A) A compound decomposes to form two elements.
   B) A compound decomposes to form two new compounds.
   C) A compound decomposes to form two compounds and elements.
   D) A compound decomposes to form another compound and an element.

**Answer:B**

Solution:One compound $\rightarrow$ two compounds (no elements).

7. When electric current is passed through molten sodium chloride, it decomposes to give sodium metal and chlorine gas:
   Which of the following is true for the above reaction?
   A) It is a electrolytic combination.
   B) It is a chemical decomposition of a compound to form two compounds.
   C) It is also called electrolysis of molten sodium chloride.
   D) The above reaction is used to obtain molten sodium chloride.

**Answer:C**

Solution:Passing current through molten NaCl is electrolysis (a form of electrolytic decomposition) that yields Na and $Cl_2$

8. Which chemical equation correctly represents the decomposition reaction that takes place when ammonia breaks down to form hydrogen gas and nitrogen gas?

A) $N_2 + H_2 \rightarrow NH_3$ B) $NH_3 \rightarrow N_2 + H_2$

C) $NH_3 + H_2 \rightarrow N_2$ D) $NH_3 \rightarrow N + H$

**Answer:B**

Solution: Decomposition of ammonia (balanced form : $2\ NH_3 \rightarrow N_2 + 3\ H_2$)

9. In a decomposition reaction:

A) the reactants are usually a metal and a nonmetal

B) the reactants are generally two ionic compounds in aqueous solution

C) one of the reactants is often water

D) energy in the form of heat or light is often produced

**Answer:D**

Solution:Decomposition reactions are frequently associated with energy changes (many release energy — e.g., explosive decompositions — while some require energy input)

10. A student writes a chemical equation of the reaction between carbon monoxide and hydrogen. $CO_2 + 2H_2 \rightarrow CH_3OH$. How can the reaction be classified?

A) The reaction is an example of a combination reaction as a compound sepa rates into two compounds.

B) The reaction is an example of a decomposition reaction as a compound dissociates into two compounds.

C) The reaction is an example of a combination reaction as two compounds react to form a single compound.

D) The reaction is an example of a decomposition reaction as two compounds react to form a single compound.

**Answer:C**

Solution:$H_2$ is element, $CO_2$ compound. So two substances react to form one compound = combination.

11. Sodium and chlorine are reacted and as a result, sodium chloride is formed which is also called table salt. What option gives the reactants and products of the reaction?

A) reactants – sodium; products – chlorine

B) reactants – sodium and table salt; products – chlorine

C) reactants – tables salt; products – sodium and chlorine

D) reactants – sodium and chlorine; products – sodium chloride

**Answer:D**

Solution:Sodium + chlorine $\rightarrow$ sodium chloride.

Reactants: sodium and chlorine.

Products: sodium chloride.

## JEE ADVANCED LEVEL QUESTIONS

**Multi correct answer type:**

12. Which of the following are chemical changes?
    A)Melting of ice B)Burning of sulphur power
    C)Burning of paper D) Burning of crackers.

**Answer:B,C,D**

Solution:

B) Sulfur reacts with oxygen to form sulfur dioxide ($S+O_2 \rightarrow SO_2$), a new substance.
C)Paper combusts to produce ash, $CO_2$, and water vapor, irreversibly changing its composition.
D)Crackers undergo explosive chemical reactions (e.g., oxidation of gunpowder), releasing gases and energy.
A) Melting of ice $\rightarrow$ Physical change (phase transition from solid to liquid; $H_2O$ molecules remain unchanged).

13. Which of the following is an example for decomposition reaction?
    A)$C+O_2 \rightarrow CO_2$ B)$Fe+S \rightarrow FeS$
    C) $2HgO \rightarrow 2Hg+O_2$ D)$2C+O_2 \rightarrow 2CO$

**Answer:C**

Solution:

A single compound (HgO) breaks down into two simpler substances (Hg and $O_2$).

**Statement Type:**

A) Statement-I, is True, Statement - II is True; Statement - II is a correct explanation for Statement-I
B) Statement - I is True, Statement is True; Statement -II is NOT a correct explanation for Statement - I
C) Statement - I is True, Statement - II , is False
D) Statement - I is False, Statement - II is True

14. **Statement - I** : Electrolysis is a process in which water decomposes into hydrogen gas and oxygen gas when an electric current is passed through it.
    **Statement - II** : Electrolytic decomposition reactions are generally endothermic and require energy in the form of heat, light, or electricity.

**Answer:C**

Solution:Electrolysis is a process in which water decomposes into hydrogen gas and oxygen gas when an electric current is passed through it $\rightarrow$ true
Electrolytic decomposition specifically requires electricity, not heat or light.

15. **Statement - I** : The decomposition of ozone into dioxygen and oxygen radicals is an example of a photochemical decomposition reaction.
    **Statement - II** : Photochemical decomposition reactions require heat or

electricity to decompose compounds.

**Answer:C**

Solution:Statement I:True.

Ozone decomposition: $O_3 \xrightarrow{h\upsilon} O_2 + O^{\bullet}$ — this is caused by light (UV), so it's photochemical decomposition.

Statement II:False

Photochemical decomposition requires light, not heat or electricity.

**Comprehension Type:**

**Comprehension - I**

Acid rain is formed when pollutants like sulfur trioxide ($SO_3$) are released into the atmosphere. This gas reacts with water vapor in the atmosphere to form sulfuric acid ($H_2SO_4$), which then falls to the Earth's surface as acid rain. Acid rain can have harmful effects on buildings, monuments, and natural environments. For example, the Taj Mahal, one of the most famous monuments in India, has been losing its shining due to the corrosive effect of acid rain on its marble surface.

16. Which of the following is the correct chemical reaction responsible for the formation of acid rain?

A) $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$ B) $SO_2(g) + H_2O(l) \rightarrow H_2SO_4(l)$

C) $CO_2(g) + H_2O(l) \rightarrow H_2CO_3(l)$ D) $NO_2(g) + H_2O(l) \rightarrow HNO_3(l)$

**Answer:A**

Solution:Acid rain is mainly caused by sulfuric acid and nitric acid.

Sulfuric acid forms when $SO_2$ is oxidized to $SO_3$ in the atmosphere, then $SO_3$ reacts with water: $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$

But $SO_2$ can also dissolve in water to form sulfurous acid, which can be oxidized to sulfuric acid.

The primary direct reaction in the atmosphere for $H_2SO_4$ formation is $SO_3 + H_2O$.

17. What is the main reason the Taj Mahal is losing its shining?

A) Due to the corrosive effect of acid rain

B) Due to natural weathering and erosion

C) Due to air pollution from vehicles

D) Due to damage from strong winds and earthquakes

**Answer:A**

Solution:Acid rain containing $H_2SO4$ and $HNO_3$ reacts with the calcium carbonate ($CaCO_3$) in the marble of the Taj Mahal.

This reaction forms calcium sulfate and calcium nitrate, which are more soluble and wash away, leading to yellowing and loss of shine — a process called marble cancer.

**Comprehension - II:**

Photochemical reactions are chemical processes that occur in the presence of

light, typically UV light or sunlight. The energy from light plays a crucial role in breaking chemical bonds, leading to the formation of new substances or the decomposition of reactants. A classic example of a photochemical reaction is the decomposition of silver bromide (AgBr) in the presence of light. When silver bromide is exposed to light, it breaks down into silver metal and bromine, causing the material to change color from light yellow to gray. This reaction is widely used in black-and-white photography, where silver bromide is a key component of photographic film.

18. What is a common use of the photochemical reaction involving the decomposition of silver bromide?
    A) In black-and-white photography
    B) In the formation of ozone
    C) In food preservation
    D) In producing electricity

**Answer:A**

Solution:Silver bromide (AgBr) decomposes under light to form metallic silver and bromine gas

$$2AgBr \xrightarrow{light} 2Ag + Br_2$$

The metallic silver formed creates the dark image on photographic film — this is the principle behind black-and-white photography



19. What is the result of the photochemical decomposition of silver bromide?
    A) Formation of silver metal
    B) Formation of oxygen gas
    C) Formation of carbon dioxide
    D) Formation of sulfur dioxide

**Answer:A**

Solution:During the reaction, silver bromide $\rightarrow$ silver metal + bromine, and the deposited silver metal causes the film to darken where light hits

**Integer type:**

20. During an endothermic reaction, the temperature drops by 6°C. If the reaction absorbs 300 joules of heat per degree Celsius, what is the total amount of heat absorbed during the reaction?

**Answer:1800**

Solution: Given data: Temperature drop = 6 °C

Heat absorbed per °C = 300 J/°C

Total heat absorbed = Heat per °C x Temperature drop

= 300 x 6 = 1800J

**Matrix Matching Type:**

Match the Characteristics of Photochemical Reactions with their Description.

21.

| **COLUMN -I** | **COLUMN-II** |
|---|---|
| 1. Requires light energy | A. Absorbs energy from light to initiate the reaction |
| 2. Breaks chemical bonds | B. Chemical bonds in the reactants are broken by light energy |
| 3. Forms new substances | C. Results in the creation of new products or decomposition of reactants |
| 4. Endothermic nature | D. Energy is absorbed during the reaction |

**Answer: 1-A,2-B,3-C,4-D**

Solution:

1. Requires light energyA. $\rightarrow$A. Absorbs energy from light to initiate the reaction $\rightarrow$ Photochemical reactions need light energy to start.

2. Breaks chemical bonds $\rightarrow$B. Chemical bonds in the reactants are broken by light energy $\rightarrow$Light energy helps break existing chemical bonds.

3. Forms new substances $\rightarrow$C. Results in the creation of new products or decomposition of reactants $\rightarrow$Breaking bonds and rearranging atoms forms new substances.

4. Endothermic nature $\rightarrow$D. Energy is absorbed during the reaction $\rightarrow$ Since light energy is absorbed, the process is endothermic.

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## LEARNERS TASK

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### CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1. The reaction in which two or more substances combined to form a single product is called …

   A)Combination reaction B)Decomposition reaction

   C) Displacement reaction D) Double displacement reaction.

**Answer:A**

Solution:Two or more substances $\rightarrow$ single product = Combination reaction

2. $2NaNO_3 \rightarrow 2NaNO_2 + O_2$ is an example for…

   A)Combination reaction B)Decomposition reaction

   C) Displacement reaction D) Double displacement reaction.

**Answer:B**

Solution:One reactant $\rightarrow$ two products = Decomposition reaction

3. A combination reaction in which a compound is formed from combination of its constituent element is called……..

   A)Combination reaction B)Decomposition reaction

C) Synthesis reaction D) Double displacement reaction.

**Answer:C**

Solution:A combination reaction in which a compound is formed from combination of its constituent elements is called a Synthesis reaction

4. The reaction in which single reactant gives two or more products is called...
A)Combination reaction B)Decomposition reaction
C) Displacement reaction D) Double displacement reaction.

**Answer:B**

Solution: Single reactant $\rightarrow$ two or more products = Decomposition reaction

5. $H_2 + Cl_2 \rightarrow$ A . What is A ?
A)HCl B)2HCl C)HO D)Cl

**Answer:B**

Solution:Hydrogen + Chlorine $\rightarrow$ Hydrogen chloride (balanced: $H_2 + Cl_2 \rightarrow 2HCl$)

6. $2Mg + O_2 \rightarrow 2MgO$ is ..... reaction
A)Decomposition B)Combination C)Synthesis D)Both B & C

**Answer:D**

Solution:Two reactants $\rightarrow$ one product = Combination reaction, also called Synthesis reaction



## JEE MAINS LEVEL QUESTIONS

7. Which of the following are decomposition reactions?
1)$CH_4$ (g) + $O_2$ (g) $\rightarrow$ $CO_2$ (g) + $H_2O$ (l) 2)CaO (s) + $CO_2$ (g) $\rightarrow$ $CaCO_3$ (s)
3)Mg (s) + $O_2$ (g) $\rightarrow$ MgO (s) 4) $PbCO_3$ (s) $\rightarrow$ PbO (s) + $CO_2$ (g)
A) 4 only B)2, 3, and 4
C)All are decomposition reactions. D)2 and 3

**Answer:A**

Solution:

$1.CH_4 + O_2 \rightarrow CO_2 + H_2O \rightarrow$ Combustion

$2.CaO + CO_2 \rightarrow CaCO_3 \rightarrow$ Combination

$3.Mg + O_2 \rightarrow MgO \rightarrow$ Combination

$4.PbCO_3 \rightarrow PbO + CO_2 \rightarrow$ Decomposition

8. One of the following processes does not involve a chemical reaction. That is:
A) Melting of candle wax when heated
B) Burning of candle wax when heated
C) Digestion of food in our stomach
D) Ripening of banana

**Answer:A**

Solution:A) Melting of candle wax — physical change (no new substance)
B) Burning of wax — chemical change

C) Digestion of food — chemical change
D) Ripening of banana — chemical change

9. The chemical equation, $KClO_3 \rightarrow KCl + O_2$, is an example of which type of reaction?
A)double-replacement B)combustion
C)decomposition D)single-replacement

**Answer:C**

Solution:One reactant $\rightarrow$ multiple products = decomposition

10. Rusting of iron is an example for
A)Combination B)Decomposition
C)Displacement D)Double displacement.

**Answer:A**

Solution: $4Fe + 3O_2 + xH_2O \rightarrow 2Fe_2O_3 \cdot xH_2O$ — combination of Fe with $O_2$ and $H_2O$

11. $2AgBr \rightarrow 2Ag + Br_2$ is an example for
A)Combination B)Decomposition
C)Displacement D)Double displacement.

**Answer:B**

Solution:One reactant $\rightarrow$ two products = decomposition

12. Combination reactions always
A)form only one product
B)require oxygen gas
C)use only one reactant
D)involve an element and an ionic compound.

**Answer:A**

Solution: Combination reactions always form only one product.

13. If two or more substances are combined to form a new substance, the chemical reaction is termed as
A)thermal decomposition B)combination
C)addition D)combustion

**Answer:B**

Solution:If two or more substances are combined to form a new substance, the chemical reaction is termed as combination.

## JEE ADVANCED LEVEL QUESTIONS

**MULTI CORRECT ANSWER TYPE:**

14. Which of the following are characteristics of a decomposition reaction? (Select all that apply)
A) A single compound breaks down into two or more elements or compounds
B) Decomposition reactions always require energy, such as heat, light, or electricity

C) The reaction results in the formation of a new single compound
D) Decomposition reactions always release energy

**Answer:A,B**

Solution:A) True — single compound ? two or more elements/compounds.
B) True — they generally require energy input (heat, light, electricity).
C) False — that's combination, not decomposition.
D) False — they absorb energy (endothermic), not always release.

15. Which of the following are examples of binary compounds that can undergo decomposition? (Select all that apply)
A) Water ($H_2O$)
B) Sodium chloride (NaCl)
C) Calcium carbonate ($CaCO_3$)
D) Hydrogen peroxide ($H_2O_2$)

**Answer:A,B,D**

Solution:Binary compounds = composed of two elements.
A) $H_2O$— binary, decomposes to $H_2$ and $O_2$ with electrolysis.
B) NaCl — binary, decomposes to Na and $Cl_2$ with electrolysis.
C) $CaCO_3$— ternary (3 elements), not binary.
D) $H_2O_2$ — binary (H and O), decomposes to $H_2O$ and $O_2$ .

**STATEMENT TYPE:**

A) Statement-I, is True, Statement - II is True; Statement - II is a correct explanation for Statement-I
B) Statement - I is True, Statement is True; Statement -II is NOT a correct explanation for Statement - I
C) Statement - I is True, Statement - II , is False
D) Statement - I is False, Statement - II is True

16. **Statement I :** Lead nitrate on thermal decomposition gives lead oxide ,brown coloured gas called nitrogen dioxide and oxygen gas
**Statement II :** Lead nitrate reacts with potassium iodide to form yellow ppt of lead iodide and the reaction is double displacement as well as precipitation reaction.

**Answer:B**

Solution:Statement I:True

Lead nitrate on thermal decomposition: $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

Products: lead oxide (yellow when hot, reddish-brown when cool), brown gas $NO_2$ , and oxygen gas.

Statement II:

$Pb(NO_3)_2 + 2KI \rightarrow PbI_2(\text{yellow ppt}) + 2KNO_3$

Double displacement and precipitation reaction.

17. **Statement -I :** A single product is formed in combination reaction.
**Statement -II :** A single reactant is involved in decomposition reaction.

**Answer:B**

Solution:Statement I:True.

Combination reaction $\rightarrow$ single product formed.

Statement II:True
Decomposition reaction $\rightarrow$ single reactant involved.

**COMPREHENSION TYPE:**

**Comprehension - I**

A combination reaction, also known as a synthesis reaction, occurs when two or more reactants combine to form a single product. The product formed is always a compound. An example of a combination reaction is when hydrogen gas reacts with chlorine gas to form hydrochloric acid (HCl). This type of reaction can involve the combination of elements or compounds to produce a new substance. The general form of a combination reaction is represented as:

$A + B \rightarrow AB$

Where A and B are the reactants, and AB is the compound formed.

18. What is formed as a result of a combination reaction between hydrogen and chlorine?
    A) Hydrogen chloride (HCl)
    B) Hydrogen peroxide ($H_2O_2$)
    C) Chlorine gas ($Cl_2$)
    D) Water ($H_2O$)

**Answer:A**

Solution: $H_2 + Cl_2 \rightarrow 2HCl$

19 . What is another name for a combination reaction?
    A) Decomposition reaction
    B) Synthesis reaction
    C) Displacement reaction
    D) Redox reaction

**Answer:B**

Solution:Combination reaction = Synthesis reaction

**Comprehension-II:**

One of the most important natural photochemical reactions is photosynthesis. During photosynthesis, plants absorb sunlight and use it to convert carbon dioxide and water into glucose and oxygen. This process is not only vital for plants but also for life on Earth, as it provides oxygen, which is essential for respiration, and glucose, which serves as food for various organisms. The energy from the sunlight breaks the bonds in water and carbon dioxide molecules, enabling the formation of new substances. Photosynthesis is an example of a natural, large-scale photochemical reaction that sustains life by producing oxygen and food.

20. What does photosynthesis produce as a result of the photochemical reaction?
    A) Oxygen and glucose

B) Oxygen and nitrogen
C) Carbon dioxide and glucose
D) Carbon dioxide and oxygen

**Answer:A**

Solution:During photosynthesis, plants use sunlight to convert carbon dioxide and water into glucose ($C_6H_{12}O_6$) and oxygen ($O_2$)

21. Why is photosynthesis crucial for life on Earth?
A) It provides oxygen and food for other organisms
B) It produces carbon dioxide for plants
C) It converts sunlight into chemical energy
D) It reduces the level of UV radiation on Earth

**Answer:A**

Solution:Photosynthesis is vital because it:
Produces oxygen necessary for respiration.
Produces glucose, the primary source of food/energy for living organisms.

**INTEGER TYPE:**

22. In an endothermic reaction, the temperature drops by 5°C. If the reaction absorbs 500 joules of heat for each degree Celsius change, how much heat is absorbed by the reaction in total?

**Answer:2500**

Solution:Total heat absorbed=500×5=2500 J

**MATRIX MATCHING TYPE:**

23. **COLUMN -I** **COLUMN-II**

Question 1: Match the Photochemical Reaction with its Example and Use.

| | |
|---|---|
| 1. Decomposition of Silver Bromide | A. Converts carbon dioxide and water into glucose and oxygen, crucial for life on Earth |
| 2. Photosynthesis | B. Turns light yellow to gray in the presence of light, used in black-and-white photography |
| 3. Formation of Ozone | C. Breaks oxygen molecules into reactive oxygen atoms, forms ozone, protects Earth from UV **radiation** |

**Answer:1-B,2-A,3-C**

Solution:

| | |
|---|---|
| 1. Decomposition of Silver Bromide | B. Turns light yellow to gray in the presence of light, used in black-and-white photography |
| 2. Photosynthesis | A. Converts carbon dioxide and water into glucose and oxygen, |

3. Formation of Ozone

crucial for life on Earth

C. Breaks oxygen molecules into reactive oxygen atoms, forms ozone, protects Earth from UV **radiation**

# KEY

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|---|---|---|---|---|---|---|---|---|---|
| | | | | TEACHING TASK | | | | | |
| | | | JEE MAINS&ADVANCED LEVEL QUESTIONS | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| C | C | B | B | B | B | C | B | D | C |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| D | B,C,D | C | C | C | A | A | A | A | 1800 |
| 21 | | | | | | | | | |
| 1-A,2-B,3-C,4-D | | | | | | | | | |
| | | | | LEARNERS TASK | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| A | B | C | B | B | D | A | A | C | A |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| B | A | B | A,B | A,B,D | B | B | A | B | A |
| 21 | 22 | 23 | | | | | | | |
| A | 2500 | 1-B,2-A,3-C | | | | | | | |