

Chapter	12 Nitrogen and Sulphur	Class	1 st Year	Subject	Chemistry
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Give Short Answers of the Following Questions

1. List two reasons for the inertness of N₂.

Ans. (i) High Bond Energy: The nitrogen molecule (N₂) is inert primarily due to its strong triple covalent bond (N≡N), which has a very high bond dissociation energy of 946 kJ/mol. This makes the bond extremely difficult to break under normal conditions.

(ii) Non-Polar Nature: N₂ is nonpolar because both nitrogen atoms have equal electronegativity, reducing its tendency to react with polar or ionic substances. The absence of lone pair availability for donation further contributes to its chemical inertness.

2. How is nitrogen isolated from air?

Ans. Nitrogen is isolated from air through a process called fractional distillation of liquefied air. First, air is filtered to remove dust and then compressed and cooled to very low temperatures (-200°C), turning it into a liquid. Since nitrogen has a lower boiling point (-196°C) than oxygen (-183°C), it evaporates first when the liquid air is gradually warmed. The nitrogen gas is then collected, while the remaining liquid contains oxygen, argon, and other trace gases. Further purification steps may be applied to obtain high-purity nitrogen.

3. Why ammonia (NH₃) is a weak base?

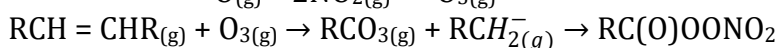
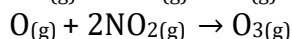
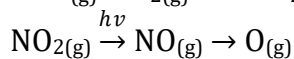
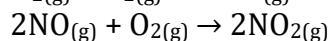
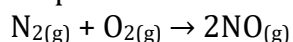
Ans. Reason:

- **Partial Dissociation in Water:** NH₃ reacts with water to form NH₄⁺ and OH⁻, but only a small fraction dissociates, making it a weak base.
- **Lone Pair Availability:** The nitrogen lone pair can accept a proton (H⁺), but it does so weakly compared to strong bases like NaOH.
- **Equilibrium Lies to the Left:** The reaction NH₃ + H₂O ⇌ NH₄⁺OH⁻ favors the reactants, resulting in a low concentration of OH⁻ ions.

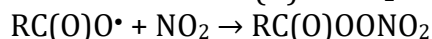
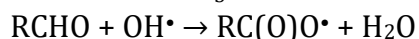
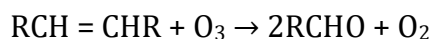
4. Write down the reactions of photochemical smog formation?

Ans. Chemical Reaction:

The formation of photochemical smog involves the following chemical reactions.



Alternate for the last reaction:



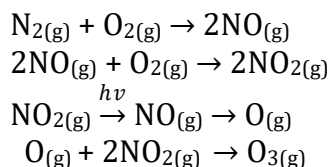
5. Write down the reactions of photochemical smog formation.

Ans. Photochemical smog (Los Angeles smog) forms in the atmosphere from NO_x and volatile organic compounds (VOCs) in the sunlight. It is oxidizing in nature. Photochemical oxidants, such as NO₂, ozone, and peroxyacyl nitrates (PANs) can react and oxidize specific compounds in the atmosphere.

Photochemical smog is becoming more common than classical smog (London smog) due to

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increasing NO_x emissions. The formation of photochemical smog involves the following chemical reactions.



6. What is the construction and function of a catalytic converter?

Ans. Construction:

A catalytic converter is a ceramic or metallic monolith with a honeycomb-like structure, Its inner channels have a layer of alumina to provide a high surface area. Noble expensive metals as Pt (Platinum), Pd (Palladium), and Rh (Rhodium) are dispersed on the alumina.

Functions:

It functions in two stages:

(i) Reduction Catalyst (Rh): Converts harmful nitrogen oxides (NO_x) into nitrogen (N₂) and oxygen (O₂).

(ii) Oxidation Catalyst (Pt/Pd): Oxidizes carbon monoxide (CO) and unburned hydrocarbons into carbon dioxide (CO₂) and water (H₂O).

This process significantly reduces the toxicity of exhaust gases.

7. Why sulphur is quite unreactive at room temperature?

Ans. Sulfur is unreactive at room temperature because it exists as cyclic S₈ molecules (crown-shaped rings) held together by strong covalent S-S bonds. Breaking these bonds requires significant energy, making sulfur inert under mild conditions. Additionally, the nonpolar nature of S₈ reduces its interaction with polar solvents or reactants.

8. Which are the most stable oxidation states of sulphur in water at pH = 0 and pH=14?

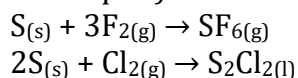
Ans. • At pH = 0 (strongly acidic conditions), sulfur's most stable oxidation states are:

- +6 (sulfate, SO₄²⁻)-Dominant due to high thermodynamic stability.
- +4 (sulfur dioxide, SO₂ or sulfite, SO₃²⁻) - Stable but can be oxidized further.
- At pH = 14 (strongly alkaline conditions), the stable forms shift to:

- +6 (sulfate, SO₄²⁻)- Remains stable.
- -2 (sulfide, S²⁻) - Favored in reducing environments

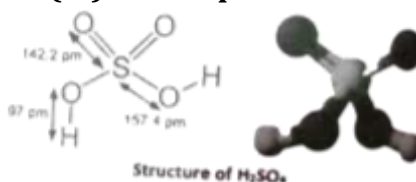
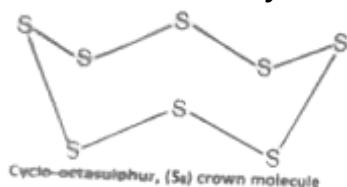
9. How does sulphur react with halogens?

Ans. Sulfur reacts directly with F₂ to form SF₄ and SF₆. Sulfur hexafluoride (SF₆) is a gas and is very unreactive. It is used as an insulator gas in electric devices. Sulfur readily reacts with Cl₂ to form S₂Cl₂ (yellow liquid) which further reacts with Cl₂ to form SCl₂ (red liquid).



10. Draw the structures of cyclo-octasulphur (S₈) and sulphuric acid.

Ans.



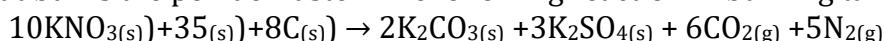
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11. What is the role of sulphur in the vulcanization of rubber?

Ans. Sulphur is used as a cross linker for the rubber molecular chains. This is called vulcanization and it the strength of rubber.

12. What is the composition and the chemical reaction of gunpowder combustion?

Ans. Gun powder is a coarse blend of 75% potassium nitrate (KNO_3), 15% wood charcoal, and 10% sulfur Charcoal carbon is the main fuel, nitrate is the oxidizer and sulfur is the additional fuel that burns the powder faster. The following reaction in burning takes place:

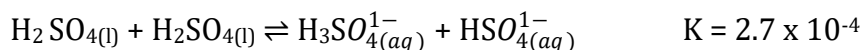


13. What is the importance of disulfide bridges?

Ans. Disulfide sulfide bridges (-S-S-) are covalent bonds between sulfur atoms in cysteine residues of proteins. They stabilize protein structures (e.g., keratin in hair, insulin) by linking distant parts of the polypeptide chain, ensuring proper folding and mechanical strength. Disruption of these bonds (e.g., by reducing agents) can denature proteins.

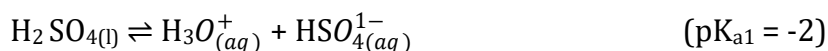
14. Write down self-ionization equation of sulphuric acid and its ionization in water.

Ans. It self-ionizes or undergoes autoprotolysis as follows.

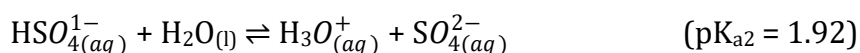


The equilibrium constant value is greater than that of water which makes it to be used as a non-aqueous protic solvent.

Sulphuric acid is a strong acid as shown by its pK_{a1} value:

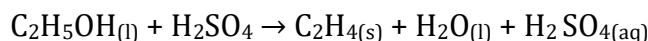


But hydrogen sulphate ($\text{HSO}_{4(aq)}^{1-}$) is a far weaker acid due to a positive pK_{a2} value:



15. Give two examples where sulphuric acid acts as a dehydrating agent.

Ans. H_2SO_4 dehydrates ethyl alcohol to ethane or ethoxyethane (Diethyl ether) depending upon the reaction conditions.



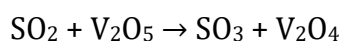
Dehydration of sugar (sucrose):



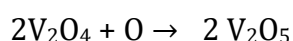
16. How does V_2O_5 catalyze the formation SO_3 ?

Ans. Vanadium pentoxide (V_2O_5) catalyzes the oxidation of SO_2 to SO_3 in the contact process:

(i) SO_2 reduces V_2O_5 to V_2O_4 :



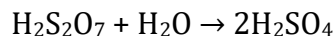
(ii) O_2 reoxidizes V_2O_4 back to V_2O_5 .



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17. What is purpose of formation of oleum?

Ans. Oleum ($\text{H}_2\text{S}_2\text{O}_7$) is produced to safely transport and store sulfuric acid. Since concentration H_2SO_4 tends to crystallize, oleum (a solution of SO_3 in H_2SO_4) prevents this problem. When diluted with water, oleum releases SO_3 , which reacts to form addition H_2SO_4 :



This ensures high-purity sulfuric acid delivery.