

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

1. What are the main categories of sources of NO_x?

Ans. The main categories of NO_x sources are:

- **Natural Sources of NO_x**

Natural sources include lightning, volcanoes, biological decay, forest fires, soil microorganisms, oceans, etc. NO is produced when N₂ and O₂ in the air react during lightning. It is produced by microorganism using air N₂.

- **Man-made Sources of NO_x**

The main anthropogenic sources of NO_x are the combustion of fossil fuels in vehicles and power plants. Other sources include chemical plants, biomass burning, welding, etc.

2. Differentiate between nitrification and denitrification.

Ans.

Nitrification	Denitrification
Ammonia NH ₃ / NH ₄ ¹⁺ is converted into nitrite (NO ₂ ¹⁻) and nitrate (NO ₃ ¹⁻).	Nitrite (NO ₂ ¹⁻) and nitrate (NO ₃ ¹⁻) are converted back to N ₂ that is released into the atmosphere.
Nitrifying bacteria aerobic conditions, pH 6.5 – 8.0, optimum temperature 20 °C – 30 °C.	Denitrifying bacteria anaerobic conditions, pH 7.0 – 9.0, optimum temperature 26 °C – 38 °C.

3. What is catalytic converter?

Ans. Catalytic Converter

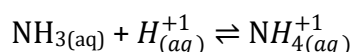
A catalytic converter is a ceramic or metallic monolith with a honeycomb-like structure. Its inner channels have a layer of alumina to provide a high surface area.

4. Write down the natural sources of oxides of nitrogen.

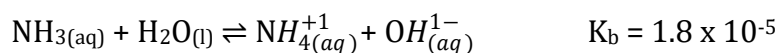
Ans. Natural sources include lightning, volcanoes, biological decay, forest fires, soil microorganisms, oceans, etc. NO is produced when N₂ and O₂ in the air react during lightning. It is produced by microorganism using air N₂.

5. Ammonia is basic in nature. How?

Ans. Ammonia behaves as a Lowry-Brønsted base by accepting a proton (H⁺) from an acid to form ammonium:



It dissolves in water to form ammonium hydroxide (NH₄OH) and equilibrium is established between ammonia molecules and ammonium ions in the solution.



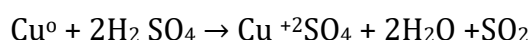
Ammonia solution is a weak base due to the low basicity constant (K_b) and the equilibrium position being towards the far left side.

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6. Write down the equation for the reaction between conc. H_2SO_4 and copper and explain what type of reaction it is.

Ans. Reaction between Conc. H_2SO_4 and Copper:

Hot conc. Sulphuric acid reacts with Cu to form copper sulphate and SO_2 .



In this reaction, the oxidation state of Cu is changed from "zero" to "2" in $CuSO_4$ and thus Cu is oxidized. The oxidation state of S in H_2SO_4 is +6 whereas in SO_4 it is +4. This shows that sulphur is reduced.

Therefore the reaction is an oxidation reduction.

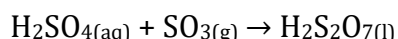
7. Give the advantages of contact process for the manufacturing of sulphuric acid (H_2SO_4).

Ans. The advantages of contact process for the manufacturing of sulphuric acid (H_2SO_4) are given below.

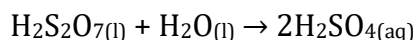
- By using this process, we can get H_2SO_4 of any required concentration.
- As no by product is obtained during this process. So, it is an environment friendly process.
- It is used in commercial preparations.
- The catalyst used i.e. V_2O_5 is solid. So, it can be handled easily.

8. Why is SO_3 dissolved in H_2SO_4 and not in water?

Ans. When SO_3 is dissolved in 98% H_2SO_4 , pyrosulphuric acid (oleum) is obtained.



Oleum can be converted to sulphuric acid of any required concentration. By mixing adequate amount of water.



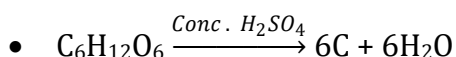
SO_3 is not dissolved in water directly because

- The reaction is highly exothermic.
- SO_3 is less soluble in H_2O at high temperature.
- A dense fog is produced which does not easily condense.
- Sulphuric acid of required concentration cannot be prepared.

9. H_2SO_4 is a dehydrating agent. Write down some chemical equations to prove it.

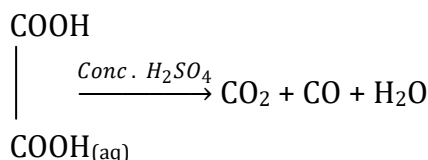
Ans. Reactions as a Dehydrating Agent:

H_2SO_4 has a great affinity for water, so it acts as a dehydrating agent and eliminates water from different compounds.

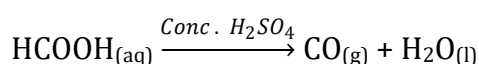


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- $\text{C}_2\text{H}_5\text{OH} \xrightarrow[100^\circ]{\text{Conc. H}_2\text{SO}_4} \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
- With oxalic acid it forms CO_2 and CO .



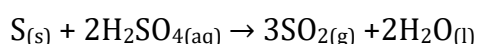
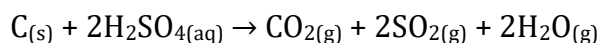
- With formic acid, CO is formed.



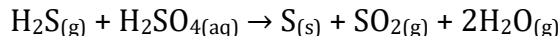
10. Prove that H_2SO_4 acts as an oxidizing agent.

Ans. H_2SO_4 acts as an oxidizing agent.

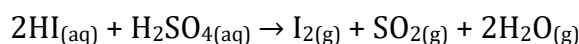
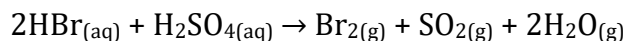
- It oxidizes C and S giving CO_2 and SO_2 respectively.



- H_2S is oxidized to S .

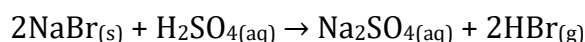


- Reactions of H_2SO_4 with HBr and HI produced bromine and iodine respectively.



11. Write reactions of H_2SO_4 with $\text{NaCl}_{(\text{s})}$ and $\text{NaBr}_{(\text{s})}$.

Ans. $2\text{NaCl}_{(\text{s})} + \text{H}_2\text{SO}_{4(\text{aq})} \rightarrow \text{Na}_2\text{SO}_{4(\text{aq})}$



12. Write four physical properties of sulphuric acid.

Ans. Physical Properties:

- Pure sulphuric acid is a colourless oily liquid without an odour.
- Its specific gravity is 1.834 at 18°C .
- It freezes at 10.5°C .
- Its boiling point is 338°C .
- It dissolves in water liberating a lot of heat which raises the temperature of the mixture up to 120°C .
- Pure acid is a nonconductor of electricity but the addition of a little water makes it a good conductor.
- It is extremely corrosive to skin and causes very serious burns to all the tissues.

13. How does H_2SO_4 react with: (i) Zn (ii) Cu

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Ans. (i) $\text{H}_2\text{SO}_{4(\text{aq})} + \text{Zn}_{(\text{s})} \rightarrow \text{ZnSO}_{4(\text{aq})} + \text{H}_2$

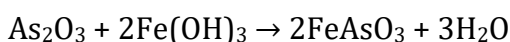
(ii) $\text{Cu}_{(\text{s})} + 2\text{H}_2\text{SO}_{4(\text{aq})} \rightarrow \text{CuSO}_{4(\text{aq})} + 2\text{H}_2\text{O}_{(\text{l})} + \text{SO}_{2(\text{l})}$

(It is an oxidation-reduction reaction).

14. How Arsenic is removed in contact process?

Ans. Arsenic Purifier:

Arsenic oxide is then removed in the form of ferric arsenite by passing the dry gases through a chamber provided with shelves packed with freshly prepared ferric hydroxide.



(Ferric arsenite)

15. Write four uses of sulphuric acid.

Ans. Uses of Sulphuric Acid (King of Chemicals):

It is used

- (i) In the manufacture of fertilizers like ammonium sulphate and calcium superphosphate.
- (ii) In refining of petroleum to remove nitrogen and sulphur compounds.
- (iii) In electrical batteries and storage cells.
- (iv) As a dehydrating agent for drying gases.

16. List two reasons for the inertness of N_2 .

Ans. (i) High Bond Energy: The nitrogen molecule (N_2) is inert primarily due to its strong triple covalent bond ($\text{N} \equiv \text{N}$), 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: N_2 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.

17. 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.

18. Why ammonia (NH_3) is a weak base?

Ans. Reason:

- **Partial Dissociation in Water:** NH_3 reacts with water to form NH_4^+ 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 .

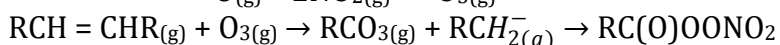
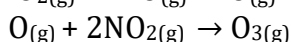
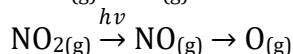
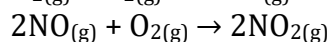
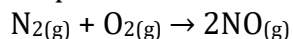
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- **Equilibrium Lies to the Left:** The reaction $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ \text{OH}^-$ favors the reactants, resulting in a low concentration of OH^- ions

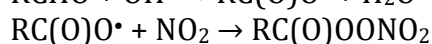
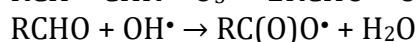
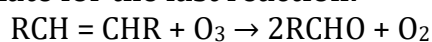
19. Write down the reactions of photochemical smog formation?

Ans. Chemical Reaction:

The formation of photochemical smog involves the following chemical reactions.



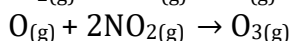
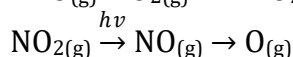
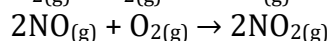
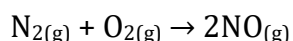
Alternate for the last reaction:



20. 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 NO_2 , ozone, and peroxyacyl nitrates (PANs) can react and oxidise specific compounds in the atmosphere.

Photochemical smog is becoming more common than classical smog (London smog) due to increasing NO_x emissions. The formation of photochemical smog involves the following chemical reactions.



21. 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 (N_2) and oxygen (O_2).

(ii) Oxidation Catalyst (Pt/Pd): Oxidizes carbon monoxide (CO) and unburned hydrocarbons into carbon dioxide (CO_2) and water (H_2O).

This process significantly reduces the toxicity of exhaust gases.

22. Why sulphur is quite unreactive at room temperature?

Ans. Sulfur is unreactive at room temperature because it exists as cyclic S_8 molecules (crown-shaped rings) held together by strong covalent S-S bonds. Breaking these bonds requires

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significant energy, making sulfur inert under mild conditions. Additionally, the nonpolar nature of S₈ reduces its interaction with polar solvents or reactants.

23. 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:

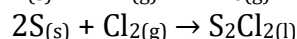
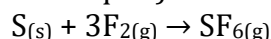
- +6 (sulfate, SO₄²⁻) - Dominant due to high thermodynamic stability.
- +4 (sulfur dioxide, SO₂ or sulfite, SO₃²⁻) - Stable but can be oxidized further.

• At pH = 14 (strongly alkaline conditions), the stable forms shift to:

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

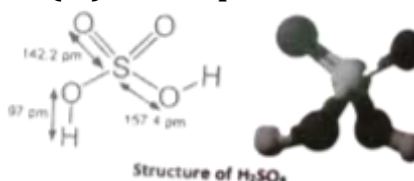
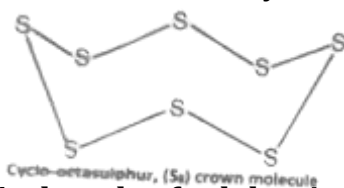
24. How does sulphur react with halogens?

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).



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

Ans.

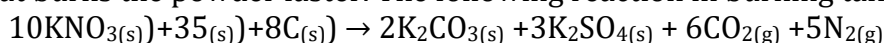


26. What is the role of sulphur in the vulcanization of rubber?

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

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

Ans. Gun powder is a coarse blend of 75% potassium nitrate (KNO₃), 15% wood charcoal, and 10% sulfur. Charcoal carbon is the main fuel, nitrate is the oxidiser and sulfur is the additional fuel that burns the powder faster. The following reaction in burning takes place:

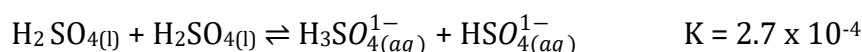


28. What is the importance of disulfide bridges?

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.

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

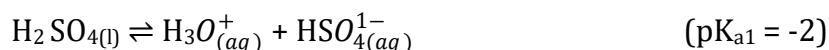
Ans. It self-ionizes or undergoes autoprotolysis as follows.



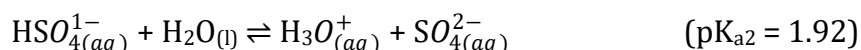
The equilibrium constant value is greater than that of water which makes it to be used as a non-aqueous protic solvent.

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

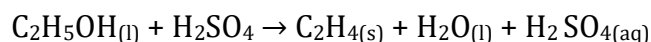


But hydrogen sulphate ($HSO_{4(aq)}^{1-}$) is a far weaker acid due to a positive pK_{a2} value:



30. 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.



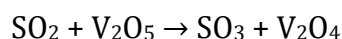
Dehydration of sugar (sucrose):



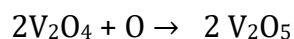
31. How does V_2O_5 catalyze the formation SO_3 ?

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 :

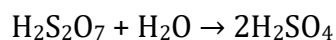


(ii) O_2 reoxidizes V_2O_4 back to V_2O_5 .



32. What is purpose of formation of oleum?

Ans. Oleum ($H_2S_2O_7$) 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.