



## CHEMISTRY

### JEE (MAIN AND ADVANCED) CHEMISTRY

#### GROUP 15 ELEMENTS

##### Problems

1.  $N_2$ ,  $CO$ ,  $CN^-$  and  $NO^+$  are isoelectronic but the former is chemically inert and later three are very reactive, why?

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2. The tendency to exhibit  $-3$  oxidation state by a group VA element decreases down. Why?

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3. Write the following for a white phosphorus molecule: (a) oxidation state of P, (b) valency of P, (c) total number of bonds and (d) bond order.



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4. Nitrogen forms a simple diatomic molecule but other elements of same group do not form. Explain.



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5. White phosphorus is very reactive, but not the red one. Why?



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6. White phosphorus is very reactive, but not the red one. Why?



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7. What happens when barium azide is heated ?



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8. Phosphorus can expand its valency. Why?



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9. Both  $PH_3$  and  $NH_3$  are Lewis bases, but basic strength of  $PH_3$  is less than that of  $NH_3$ . Explain.



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10. What is the covalency of 'N' in nitrogen pentoxide ?



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11. Both  $\text{NO}$  and  $\text{NO}_2$  have odd number of electrons.  $\text{NO}$  is colourless, but  $\text{NO}_2$  is coloured. Why?



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12. The magnetic properties of  $\text{NO}_2$  and  $\text{N}_2\text{O}_4$  are different. Why?



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13.  $\text{PCl}_5$  is less stable. Why?



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14.  $\text{PCl}_3$  is covalent. It fumes in moisture and its aqueous solution is electrical conductor. Why?



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15. What happens when phosphine is absorbed in mercuric chloride solution ?



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16. Phosphine is technically used in Holme's signals. Substantiate.



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17. In the preparation of  $P_4O_6$ , a mixture of  $N_2$  and  $O_2$  is used rather than pure  $O_2$  Why?



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18. Pentahalides of phosphorus are known, but not pentahydride. Why?



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19. Bond angle in  $\text{PH}_4^+$  is higher than that in  $\text{PH}_3$ . Why ?



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20. Mention to which oxyacids  $\text{N}_2\text{O}$ ,  $\text{N}_2\text{O}_4$  and  $\text{N}_2\text{O}_5$  are anhydrides?



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21.  $\text{HNO}_3$  is an oxidising agent but  $\text{H}_3\text{PO}_4$  is not. Explain.



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22. What is the basicity of orthophosphoric acid ? Write the types of salts formed by it.



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23. Based on the structures how is the reduction ability of  $H_3PO_2$  or  $H_3PO_3$  accounted for?



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24. How is tautomerism different from resonance ?



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25. Ammonia cannot be dried over anhydrous calcium chloride. Why?



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26. Coal is a potential source for ammonia. Comment.



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27. Nitric acid acts as oxidant, while nitrous acid as both oxidant and reductant. Why?

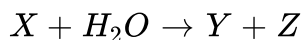
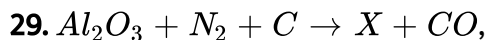


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28. What is aqua-regia ? How it works to dissolve noble metals ?



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'Y' is an amphoteric substance. When aqueous 'Z' is treated with  $AlCl_3$  solution again 'Y' is formed. What are X, Y and Z?



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1. Discuss on the electronic configuration of elements of group 15.



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2. Mention the occurrence of nitrogen and phosphorus in the earth's crust.



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3. Write the trends in atomic radius, metallic nature and ionisation potential of group VA elements.



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4. Mention the oxidation numbers of the elements of nitrogen family in their compounds. Write suitable examples.



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5. Discuss the electronic configuration of elements of group 15.



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6. Write on the allotropy of group VA elements.



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## Exercise 1 1 2

1. Discuss the basic strength and stability of hydrides of group VA.



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2. Write different oxides of nitrogen. Mention the oxidation states of nitrogen in these oxides.



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3. Write the structures of the oxides :  $N_2O_3$ ,  $N_2O_5$ ,  $P_4O_6$  and  $P_4O_{10}$ .



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4. Write the hydrolysis reactions of the halides :  
 $NCl_3$ ,  $PCl_3$ ,  $PCl_5$ ,  $P_4O_6$  and  $P_4O_{10}$



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### Exercise 113

1. Write on the structural aspects of nitrous and nitric acids.



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2. Mention the oxyacids of phosphorus and the oxidation states of phosphorus in them.



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3. Comment on the acidic nature of phosphoric acid.



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4. Nitrogen behaves different from rest of the elements of the same group. Explain.



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1. Describe the manufacture of  $NH_3$  by Haber's method. Give a labelled diagram.



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2. How is ammonia prepared in cyanamide process?



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3. Discuss the principle of preparing nitric acid in Ostwald's process. Give the necessary equations.



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4. Nitrous acid acts as oxidant as well as reductant. Give suitable examples.



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5. How is nitric acid prepared on a large scale by Birkland and Eyde's process? Write the principle and equations.



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6. Write the important uses of (a) ammonia and (b) nitric acid.



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## Exercise 1 2

1. Discuss the structure and bonding in  $P_4$  molecule.



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2. What is allotropy ? Give the allotropes of oxygen.



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3. Comment on the  $M - M$  bond strengths and catenation ability of group 15 elements.



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4. Elemental phosphorus is not diatomic like nitrogen. Explain.



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5. Write the difference between the properties of white phosphorus and red phosphorus.



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6. Mention the oxidation numbers exhibited by nitrogen. Give an example for each.



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7. Nitrogen is trivalent, but phosphorus is pentavalent in its compounds. Explain.



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8.  $PH_3$  is stable in air, but catches fire when heated at 425K. Why?



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9. Discuss the stability of hydrides of group 15 elements.



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10. Write the trends in bond length, bond angle, and boiling points of  $MH_3$  type hydrides.





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11. Nitrogen forms several oxides. Why?



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12. Nitrous oxide supports combustion more vigorously than air. Why?



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13. In case of phosphorus trihalides, bond angle increases from  $PF_3$  to  $PI_3$ . Why?



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14.  $NH_3$  and  $NF_3$  are both pyramidal. What observations are made on the difference in bond angles, bond polarities and dipole moments?



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15. The correct order of bond angles is  $NO_2^+ > NO_2 > NO_2^-$ . Discuss.



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16. Copper metal gives different products on reaction with nitric acid. Illustrate.



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17. Discuss the structure and basicity of orthophosphorus acid.



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18. Draw the structures of -ous acids of phosphorus and discuss their reduction ability.



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**19.** What happens when the following are heated?

(a) orthophosphoric acid and (b) sodium dihydrogen orthophosphate.



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**20.** Nitrogen behaves abnormally from the other elements of the same group. Discuss?



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**21.** Trimethylamine is a stronger base than trisilylamine. Justify.



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**22.** What is the ratio of product gases, nitric oxide and nitrogen dioxide formed when phosphorus is treated to nitric acid?



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**23.** Concentrated nitric acid turns yellow in sunlight. Why?



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**24.** How the products of oxidation of metals with nitric acid depend?



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**25.** How is ammonia prepared from lime and coke?



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**26.** Write on the conditions of Haber's ammonia synthesis.



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27. Ammonia is used as refrigerant. Why?



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28. Though  $N - F$  in  $NF_3$  is a polar bond, the experimental bond length is greater than the theoretically predicted value. Explain.



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29. A waxy crystalline solid (X) with a garlic odour is obtained by burning white phosphorus in air. X reacts vigorously with hot water forming an acid and gas Y. Y is neutral towards litmus and produces a black residue Z when passed through cupric sulphate, What are Y and Z?



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**30.** Compound 'A' is an unstable pale blue solution of an acidic oxide. 'A' decolourises bromine water as well as acidified permanganate. 'A' oxidises stannous chloride in hydrochloric acid solutions. Predict the acid 'A' and its unhydride.



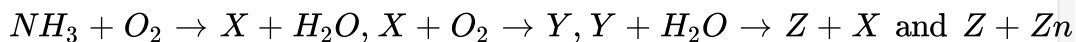
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**31.** Nitrous acid is considered as a factomeric mixture of two forms. Write its structures.



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**32.**



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What are X and Z in the above sequence of reactions?



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**33.** A colourless inorganic salt (X) decomposes at  $300^{\circ}\text{C}$  to give products Y and Z, leaving no residue. Z is neutral liquid oxide at room temperature and Y is a colourless diamagnetic neutral oxide. White phosphorus burns in excess Y, produce a strong dehydrating agent and most abundant gas in earths atmosphere. Write all equations related.



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