



## CHEMISTRY

### BOOKS - CHHAYA CHEMISTRY (BENGALI ENGLISH)

## HYDROGEN

#### Numerical Examples

1. Calculate the degree of hardness of a sample of hard water which is found to contain 72 mg of  $\text{MgSO}_4$  per kg of water.

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2. Estimate the hardness of a sample of water 1L of which contains 0.001 mol of dissolved  $\text{MgCl}_2$



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3. 1 L of river water contains 6 mg  $\text{Mg}^{2+}$  and 20 mg  $\text{Ca}^{2+}$  ions as chloride salts. Determine the degree of hardness of that sample of river water.



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4. The degree of hardness of a sample of water is 40 ppm. If the hardness is only due to the presence of  $\text{MgSO}_4$ ,

then determine the amount of  $\text{MgSO}_4$  in 1 kg of that water.



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5. 10 mL of 0.01 (N) HCl is required for titrating 100 mL of a sample of cold water using methyl orange as indicator. Determine the temporary hardness of that sample of water.



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6. Determine the weight of CaO required to remove the hardness of a sample of  $10^5$  L water, 1 L of which contains 1.62g of  $\text{Ca}(\text{HCO}_3)_2$ .



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7. Determine the strength of '10 volume  $H_2O_2$ ' solution in  
(1) gram per litre,



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8. Determine the strength of '10 volume  $H_2O_2$ ' solution  
in  
(2) normality and



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9. Determine the strength of '10 volume  $H_2O_2$ ' solution in (3)percentage strength.



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10. Determine the volume strength of 1.5 (N)  $H_2O_2$ .



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11. Determine the volume strength of a 6.07%  $H_2O_2$  solution.



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**12.** The strengths of three  $H_2O_2$  solutions are 10,15 and 20 volume respectively. 0.5L of each of these solutions are mixed and equal amount of water is added to it. Determine the volume strength of the mixed solution.



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**13.** 20 mL of a  $H_2O_2$  solution after acidification required 20 mL of N/10  $KMnO_4$  solution for complete oxidation. Calculate the percentage and volume strength of  $H_2O_2$  solution.



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## Warm Up Exercise

1. Name the isotopes of hydrogen and state their mass ratio.



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2. What is the source of solar energy?



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3. Which isotope of hydrogen is most abundant and which one is radioactive?



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4. The chemical properties of the isotopes are identical but they chemical different rates of chemical reactions-why?



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5. How can tritium be synthesised artificially? How can it be stored ? State one important use of tritium.



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6. State one important use of deuterium.



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7. How can dihydrogen be prepared in the laboratory?

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8. Although Fe is placed above hydrogen in the electrochemical series, dihydrogen is not obtained by its reaction with nitric acid. Explain with reasons.

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9. Why commercial variety of zinc is used instead of pure zinc in the laboratory preparation of dihydrogen?



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**10.** Concentrated sulphuric acid cannot be used in the laboratory preparation of dihydrogen-why?



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**11.** Name a metal and a non-metal which on reaction with alkali liberates dihydrogen and write the corresponding chemical reactions.



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12. Give an example and formula of a compound which on electrolysis liberates dihydrogen at anode.



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13. Name two metals which can replace hydrogen from acid.



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14. How can one prepare  $H_2$  gas from water by using a reducing agent?



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15. Write the industrial preparation of dihydrogen from water.



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16. Explain why dihydrogen is relatively inert at room temperature.



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17. Give example of two reaction one in which  $H_2$  acts as an oxidising agent & other in which it acts as a reducing agent.



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**18.** What do you mean by hardening of oils?



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**19.** Show that the reactivity of halogens towards dihydrogen decreases on going from fluorine to iodine.



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**20.** Name two compounds, in one of which hydrogen is in + 1 and in the other in - 1 oxidation state.



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**21.** Explain why the chemical properties of ortho and para-hydrogen are the same but their physical properties are different.



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**22.** What is nascent hydrogen?



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**23.** Show that nascent hydrogen is more active than ordinary molecular hydrogen and explain the cause of its hyperactivity.

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24. What do you mean by atomic hydrogen?

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25. Both dihydrogen and carbon monoxide burn in air with blue flame. How will you distinguish between them?

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26. Mention two advantages of using dihydrogen as a fuel with respect to gasoline.

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27. Mention four important uses of dihydrogen.



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28. What do you mean by hydrides? Give examples along with their general formula.



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29. Why ionic or salt-like hydrides on electrolysis liberates dihydrogen at anode?



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**30.** What characteristics do you expect from an electronegative and an electron-rich hydride with respect to their structures?



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**31.** Why the boiling point of HF is higher than that of other hydrogen halides?



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**32.** Which type of hydrides can be used as hydrogen storage media?



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33. How can you separate  $H_2$  or  $D_2$  from He?



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34. Why ionic or salt-like hydrides are used to dry organic solvents?



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35. Although the oxygen atom in water is  $sp^3$  hybridised, the value of H-O-H bond angle is  $104.5^\circ$  -why?



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**36.** Explain why a molecule of water is polar in nature.



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**37.** Explain why the freezing point, boiling point, heat of fusion and heat of vaporisation of water are higher as compared to the hydrides of the other members of same group (16).



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**38.** Explain why ice floats on water.



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**39.** At which temperature the density of water is maximum and why?



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**40.** Many electrovalent or ionic compounds and some non-electrolytes such as organic compounds get readily dissolved in water-why?



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**41.** Water is very stable compound - why ?



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**42.** Explain why water is called 'universal solvent'?



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**43.** Explain why water is called an 'amphiprotic solvent'.

Establish this giving chemical equations.



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**44.** What do you understand by 'self-ionisation' or 'autoprotolysis' of water?



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**45.** Give examples of two reactions one in which water acts as an oxidising agent and the other in which it acts as a reducing agent.

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**46.** Which type of compounds undergo hydrolysis? Give examples.

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47. What happens when steam is passed over red hot coke? Give suitable equation.



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48. Water plays a significant role in controlling the atmospheric and body temperature-explain.



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49. How does water stabilise an ion?



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**50.** Why water is liquid at ordinary temperature?



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**51.** How will you prove that a colourless liquid is water?



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**52.** Indicate whether water undergoes oxidation or reduction during photosynthesis. Give the reaction involved.



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**53.** Cobalt chloride is blue in anhydrous state . In contact with water vapours it turns



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**54.** What is heavy water? Why it is called so? State the major source of heavy water.



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**55.** All physical constants of heavy water are higher than the corresponding values of ordinary water-why?



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56. What amount of water should be electrolysed to get 1L of 99% pure  $D_2O$ ?



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57. Why concentration of  $D_2O$  increases when electrolysis of water is carried out for a long period of time?



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58. Explain why the reactions of  $D_2O$  occur at a rate slower than the corresponding reactions of  $H_2O$ .



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59. How would you prepare deuterium peroxide ( $D_2O_2$ ) ?



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60. How will you prepare deuterioammonia ( $ND_3$ ) from  $N_2$  ?



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61. Write down two important uses of heavy water.



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**62.** How will you prove that hypophosphorus acid ( $H_3PO_2$ ) is a monobasic acid?



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**63.** Sodium chloride is less soluble in heavy water than ordinary water-why?



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**64.** Why is heavy water ( $D_2O$ ) injurious to human beings, animals and plants?



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65. Some  $H_2SO_4$  has been added to distilled water. Explain whether this acidic water will behave as hard water or not?



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66. Explain why lather is not formed when soap is used in hard water.



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67. It is better to use detergent than soap in hard water - explain why.



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68. What do you understand by the term softening of hard water?



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69. What is calgon? Which ions are rendered ineffective by calgon thereby eliminating the hardness of water?



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70. Temporary hardness caused by  $\text{Mg}(\text{HCO}_3)_2$  cannot be removed completely by boiling - why?





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**71.** What are the inorganic cation exchangers which are known as permutits (synthetic) or zeolites (naturally occurring)? How do they remove cations from hard water?



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**72.** What do you understand by deionised or demineralised water?



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**73.** In the preparation of deionised water how do organic cation or anion exchange resins work?



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**74.** How can the exhausted inorganic and organic ionexchangers be regenerated?



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**75.** Explain why the water obtained after passing hard water through cation exchange resins is acidic.



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**76.** A sugar solution prepared in distilled water is passed successively through cation and anion exchange resins. What will be the taste of the collected water and why?



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**77.** Why is hard water not used for cooling purpose in industry?



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**78.** The hardness of water of a tube well is 300 ppm. What do you mean by this statement?



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**79.** Will the water obtained by passing hard water through anion exchange resin, form lather with soap? Why ?



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**80.** A sample of water contains  $\text{MgSO}_4$  and urea. How can they be eliminated easily?



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**81.** How can hydrogen peroxide be prepared in the laboratory? What is the limitation of this process?



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**82.** Explain why in the laboratory preparation of  $H_2O_2$  :  
the reaction is carried out at low temperature,



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**83.** Explain why in the laboratory preparation of  $H_2O_2$  :  
dilute  $H_2SO_4$  is used instead of concentrated  $H_2SO_4$  ,



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**84.** Explain why in the laboratory preparation of  $H_2O_2$  :

A thin paste of hydrated barium peroxide is used instead of anhydrous barium peroxide



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**85.** Explain why in the laboratory preparation of  $H_2O_2$  :

At the end of the reaction, the mixture should contain a small amount of surplus acid,



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**86.** Explain why in the laboratory preparation of  $H_2O_2$  :

HCL or  $HNO_3$  is not used,



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**87.** Explain why in the laboratory preparation of  $H_2O_2$  :

The paste of  $BaO_2$  is poured into dilute  $H_2SO_4$  instead of pouring dilute  $H_2SO_4$  into the paste,



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**88.** Explain why in the laboratory preparation of  $H_2O_2$  :

It is better to use syrupy phosphoric acid instead of dilute sulphuric acid.



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**89.** Explain why in the laboratory preparation of  $H_2O_2$  :  
 $MnO_2$  or  $PbO_2$  cannot be used instead of  $BaO_2$  for  
preparing  $H_2O_2$  - why ?



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**90.** What is Merck's perhydrol? How can it be prepared ?



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**91.** How can  $H_2O_2$  be manufactured by using 50%  $H_2SO_4$   
solution?



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92. What is Marshall's acid?



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93. How can  $H_2O_2$  solution be prepared by electrolysis of an equimolar mixture of sulphuric acid and ammonium sulphate?



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94. Explain why a solution of  $H_2O_2$  cannot be concentrated by distillation at atmospheric pressure. How will you get pure  $H_2O_2$  from its dilute solution?



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**95.** Which organic compound is used for manufacturing  $H_2O_2$  conveniently and economically by reducing atmospheric oxygen?



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**96.** Discuss the structure of  $H_2O_2$  molecule. Explain why the shape of  $H_2O_2$  molecule in the solid phase differs from that in the gas phase.



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97. Explain why the dissociation of  $H_2O_2$  is a disproportionation reaction.



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98. Mention some of the factors which accelerate the decomposition of  $H_2O_2$ .



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99. Name two compounds which can decelerate the decomposition of  $H_2O_2$ .



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100.  $H_2O_2$  reacts with NaOH to give two types of salts - why? Write down the reactions.



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101. Explain why  $H_2O_2$  cannot liberate  $CO_2$  by reducing carbonate or bicarbonate salts.



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102.  $H_2O_2$  exhibits both oxidising and reducing properties. Explain why.



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**103.** What do you mean by the 'antichlor' property of  $H_2O_2$ ?



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**104.** Give the mechanism of the bleaching action of  $H_2O_2$ .



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**105.** What are perhydrates? Give examples.



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106. How is  $H_2O_2$  preserved in the laboratory?



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107. It is better to preserve  $H_2O_2$  in a polythene bottle than in a glass bottle - why?



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108. Explain why  $H_2O_2$  is used to restore the original colour of oil-paintings.



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**109.** How will you identify a colourless liquid as  $H_2O_2$  or  $H_2O$ ?



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**110.** What happens when  $H_2O_2$  is added to acidified KI solution followed by addition of starch?



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**111.** What is perhydrol?



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**112.** What is Fenton's reagent? Mention its use.



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**113.** Give the name and structure of the compound used as brightener in washing powder.



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**114.** Mention the role of  $H_2O_2$  in pollution control.



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115. What do you understand by the expression '30 volume  $H_2O_2$  solution'?



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116. What do you mean by 20%  $H_2O_2$  solution?



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117. Calculate the volume strength of 1%  $H_2O_2$  solution.



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118. Determine the volume strength of 1(N)  $H_2O_2$ .



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119. Calculate the percentage strength of '6.588 volume  $H_2O_2$ '.



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### Question Answer Zone For Board Examination Very Short Answer Type

1. Explain why concentrated HCL is not used in the laboratory preparation of  $H_2$  gas.





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2. Write down the name and formula of a compound which on electrolysis produces dihydrogen at anode.



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3. What is syngas?



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4. Which isotope of hydrogen is used as a tracer in organic reactions?



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5. Explain why dihydrogen is not suitable for balloons.

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6. Which bond between two atoms has the highest bond dissociation enthalpy?

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7. Explain why  $H_2$  is more reactive than  $D_2$ .

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8. What change is expected to take place when vegetable oils are hydrogenated?



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9. Which isotope of hydrogen is used in nuclear reactors?



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10. Why are ionic hydrides used as solid fuels?



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**11.** The densities of ionic hydrides are greater than that of the metal from which they are formed- why ?



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**12.** Give examples of two interstitial hydrides.



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**13.** Which gaseous compound on treatment with dihydrogen produces methanol?



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**14.** Give the chemical reaction that occurs when hydrogen is used as a rocket fuel.



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**15.** A sample of water containing KCL does not behave as hard water, but a sample of water containing  $\text{CaCl}_2$  behaves as hard water-why?



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**16.** What is EDTA, a compound used to determine the hardness of water?



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17. Can distilled water be called deionised water?



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18. What is the difference between the water softened by the permutit process and the water softened by the organic ion exchangers?



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19. What will be the hardness of a sample of water,  $10^6$  g of which contains  $\frac{1}{6}$  mol  $Al_2(SO_4)_3$ ?



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20. What is calgon?



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21. Give the chemical formula of permutit.



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22. What is the main source of heavy water?



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23. Can sea animals survive in distilled water?



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24. Although  $D_2O$  resembles  $H_2O$  chemically, yet it is a toxic substance - why?



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25. Which compound is used to colour hair golden?



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26. What is the trade name of hydrogen peroxide used as an antiseptic?



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27. What is the strength in normality of a '11.2 volume'  $H_2O_2$  solution?



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28. Name a compound which suppresses the decomposition of  $H_2O_2$



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29.  $H_2O_2$  molecule has an open-book like structure. What is the angle between the two pages of the book in the gas phase?



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30. Name an organic compound without peroxo bond which is used to manufacture  $H_2O_2$ .



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Short Answer Type

1. Why do most of the reactions of  $H_2$  occur at much higher temperature?



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2. What characteristics do you expect from electroneficient hydrides with respect to their structure and chemical reactivity?



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3. Explain why it is harmful to bathe in heavy water and use it for drinking purposes.



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4. Explain why the thermal stability of  $H_2O_2$  is very low.



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5. How the presence of  $H^-$  ions confirmed in ionic hydrides?



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6. How do you separate 2 allotropic forms of hydrogen?



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7. Mention the difference in chemical characteristics of the two hydrides obtained when hydrogen combines with two elements having atomic number 17 and 20.



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8. Two samples of hard water contain same cations,  $Ca^{2+}$  &  $Mg^{2+}$ . One is marked as temporary and the other as permanent. In which respect do they differ?



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9. Tube-well water, if left for sometime, assumes a brownish turbidity-explain.

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10. Write the reactions for:

preparation of  $H_2O_2$  from two sodium salts and

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11. Write the reactions for:

preparation of  $D_2O_2$  from potassium persulphate.

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12. Between deionised water and distilled water which one is more pure and why?



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**13.** Rain water is soft, but after passing over hills and mountains it gets converted into hard water-why?



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**14.** Why is  $Na_2O_2$  used for purifying air in submarines and in crowded places?



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**15.** Comment on the reactions of dihydrogen with Chlorine



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**16.** Comment on the reactions of dihydrogen with sodium



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**17.** Comment on the reactions of dihydrogen with copper (II) oxide.



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**18.** An ionic alkali metal hydride has covalent character to some extent and it does not react with oxygen and



chlorine. This hydride is used in the synthesis of another hydride. Write the formula of the hydride and what happens when it reacts with  $Al_2Cl_6$ .



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**19.** Sodium reacts with dihydrogen to form a crystalline ionic solid. It is non-volatile and a non-conductor of electricity. It also reacts vigorously with water to liberate  $H_2$  gas. Write the formula of the ionic solid and give reaction between this solid & water. What happens when the ionic solid in its molten state is electrolysed?



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20. Why is sea water not used in boilers?



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21. The values of melting point, enthalpy of vaporisation and viscosity of  $H_2O$  and  $D_2O$  are given below:

	$H_2O$	$D_2O$
(i) Melting point(K)	373.0	374.4
(ii) Enthalpy of vaporisation $(kJ \cdot mol^{-1}, 373K)$	40.66	41.61
(iii) Viscosity (centipoise)	0.8903	1.107

From the given data, determine which liquid has greater magnitude of intermolecular forces of attraction.



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22. How will you prepare heavy water from ordinary water? Explain its principle.



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23. Can phosphorus form  $PH_5$  with its outer electronic configuration of  $3s^2 3p^3$ ?



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24. How will you prepare dihydrogen from  $\text{HNO}_3$  ?



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25. Do you think the hydrides of N, O and F will have lower boiling points than hydrides of their corresponding group members? State reasons.



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26. KF reacts with HF to form the compound,  $\text{KF} \cdot 2\text{HF}$ . Discuss the probable structure of the compound.



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27. Calculate the amount of energy liberated due to combustion of 4g dihydrogen.



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28. Under what conditions, water reacts with calcium cyanamide and what are the products formed due to this reaction?



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29. Discuss the industrial preparation of  $H_2O_2$  from 2ethylanthraquinol. State advantages of this process.



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30. Why  $H_2O_2$  is a better oxidant than water?



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Solved Wbchse Scanner

1. Why during preparation of  $H_2O_2$  a paste of hydrated barium peroxide is added to ice-cold  $H_2SO_4$  but the reverse process is not done?



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2. How is heavy water produced?



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3. Hydrogen can be placed in Group 17 instead of Group 1 of periodic table. Give reason.



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4. What is heavy water? Why is it so called?



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5. What happens when  $H_2O_2$  is mixed with cold acidic potassium dichromate solution.



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6. A water sample contains 1 millimole of  $Mg^{2+}$  ion per litre. Calculate the hardness of the water sample in ppm unit.



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7.  $BaO_2$  is a peroxide but  $MnO_2$  is not a peroxide explain.



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8. What is calgon?



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9. What is heavy water?



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10. With balanced chemical equation, give an example of reducing property of  $H_2O_2$ .



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1. Justify the position of hydrogen in the periodic table on the basis of its electronic configuration.



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2. Write the names of isotopes of hydrogen. What is the mass ratio of these isotopes ?



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3. Why does hydrogen occur in a diatomic form rather than in a monoatomic form under normal conditions?



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4. How can the production of dihydrogen, obtained from 'coal gasification, the increased?



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5. Describe the bulk preparation of  $H_2$  by electrolytic method. What is the role of electrolyte in this process?



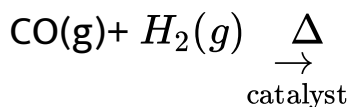
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6. Complete the following reactions:



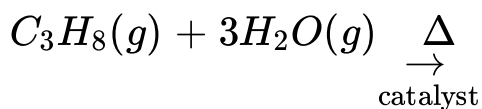
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7. Complete the following reactions:



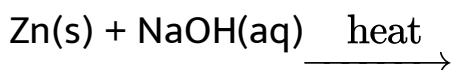
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8. Complete the following reactions:



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9. Complete the following reactions:





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**10.** Discuss the consequences of high enthalpy of H-H bond in terms of chemical reactivity of dihydrogen.



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**11.** What do you understand by (1) electron-deficient, (2) electron-precise and (3) electron-rich compounds of hydrogen? Provide justification with suitable examples.



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12. What characteristics do you expect from an electrondeficient hydride with respect to its structure and chemical reactions?



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13. Do you expect the carbon hydrides of the type  $(C_nH_{2n+2})$  to act as 'Lewis' acid or base? Justify your answer.



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14. What do you understand by the term "non-stoichiometric hydrides"? Do you expect this type of the

hydrides to be formed by alkali metals? Justify your answer.



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**15.** How do you expect the metallic hydrides to be useful for hydrogen storage? Explain.



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**16.** How does the atomic hydrogen or oxy-hydrogen torch function for cutting welding purposes?



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17. Among  $NH_3$ ,  $H_2O$  and HF, which would you expect to have highest magnitude of hydrogen bonding & why?



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18. Saline hydrides are known to react with water violently producing fire, Can  $CO_2$ , a well known fire extinguisher, be used in this case? Explain.



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19. Arrange the following:

$CaH_2$ ,  $BeH_2$  and  $TiH_2$  in order of increasing electrical conductance.





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**20.** Arrange the following:

LiH, NaH and CsH in order of increasing ionic character.



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**21.** Arrange the following:

H-H, D-D and F-F in order of increasing bond dissociation enthalpy.



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22. Arrange the following:

$\text{NaH}$ ,  $\text{MgH}_2$  and  $\text{H}_2\text{O}$  in order of increasing reducing property.



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23. Compare the structures of  $\text{H}_2\text{O}$  and  $\text{H}_2\text{O}_2$ .



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24. What do you understand by the term 'auto-protolysis' of water? What is its significance?



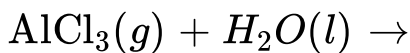
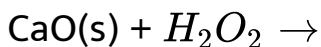
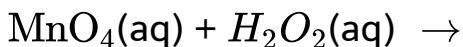
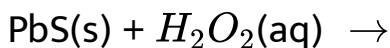
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**25.** Consider the reaction of water with  $F_2$  and suggest, in terms of oxidation and reduction, which species are oxidised/reduced?



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**26.** Complete the chemical reactions.



Classify the above into [a] hydrolysis,[b] redox and [c] hydration reactions.



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**27.** Describe the structure of the common form of ice.



**Watch Video Solution**

**28.** What causes the temporary and permanent hardness of water?



**Watch Video Solution**

**29.** Discuss the principle and method of softening of hard water by synthetic ion-exchange resins.



**Watch Video Solution**

**30.** Write chemical reactions to show the amphoteric nature of water.



**Watch Video Solution**

**31.** Write chemical reactions to justify that hydrogen peroxide can function as an oxidising as well as reducing agent.



**Watch Video Solution**

**32.** What is meant by 'demineralised' water and how can it be obtained?



**Watch Video Solution**

**33.** Is demineralised or distilled water useful for drinking purposes? If not, how can it be made useful?



**Watch Video Solution**

**34.** Describe the usefulness of water in biosphere and biological systems.



**Watch Video Solution**

35. What properties of water make it useful as a solvent?

What types of compound can it (1) dissolve, and (2) hydrolyse?



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36. Knowing the properties of  $H_2O$  and  $D_2O$  do you think that  $D_2O$  can be used for drinking purposes?



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37. What is the difference between the terms 'hydrolysis' and 'hydration'?



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**38.** How can saline hydrides remove traces of water from organic compounds?



[Watch Video Solution](#)

**39.** What do you expect the nature of hydrides is, if formed by elements of atomic numbers 15,19,23 and 44 with dihydrogen? Compare their behaviour towards water.



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**40.** Do you expect different products in solution when aluminium (III) chloride and potassium chloride treated separately with normal water



**Watch Video Solution**

**41.** Do you expect different products in solution when aluminium (III) chloride and potassium chloride treated separately with acidified water and



**Watch Video Solution**

**42.** Do you expect different products in solution when aluminium (III) chloride and potassium chloride treated separately with alkaline water? Write equations wherever necessary.



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**43.** How does  $H_2O_2$  behave as a bleaching agent?



**Watch Video Solution**

**44.** What do you understand by the terms:

hydrogen economy



**Watch Video Solution**

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**45.** What do you understand by the terms:

hydrogenation



[Watch Video Solution](#)

**46.** What do you understand by the terms:

'syngas'



[Watch Video Solution](#)

**47.** What do you understand by the terms:

water-gas shift reaction





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48. What do you understand by the terms:  
fuel-cell?



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### Higher Order Thinking Skill Hots Questions

1. What is 'hydrogenite'? Mention its use.



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2. What is denoted by  $[H_9O_4]^+$  ion ? Explain.



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3. Pure para-hydrogen is available but not pure orthohydrogen. Explain.



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4. How many hydrogen bonded water molecule(s) are associated in  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ?



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5. Write down the reaction between  $\text{H}_2\text{O}_2$  and hydrazine ( $\text{NH}_2\text{NH}_2$ ) in the presence of  $\text{Cu(II)}$  catalyst. Mention

the use of this reaction.



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## Entrance Question Bank

1. The normality of '30 volume' of  $H_2O_2$  is-

A. 2.678(N)

B. 5.336(N)

C. 8.034(N)

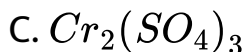
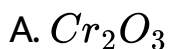
D. 6.685(N)

**Answer:**



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2. When  $H_2O_2$  is shaken with an acidified solution of  $K_2Cr_2O_7$  in presence of ether, layer turns blue due to the formation of-



**Answer:**



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3. Commercial sample of  $H_2O_2$  is labeled as 10V. Its % strength is nearly-

A. 3

B. 6

C. 9

D. 12

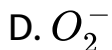
**Answer:**



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4. In aqueous alkaline solution, two electron reduction of  $HO_2^-$  gives-





**Answer:**



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5. Which statement is not correct for ortho- and para-hydrogen-

A. they have different boiling points

B. ortho-form is more stable than para-form

C. they differ in their nuclear spin

D. they ratio of ortho to para-hydrogen changes with  
change in temperature

**Answer:**



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**6.** At room temperature, the reaction between water and fluorine produces-

A. HF and  $H_2O_2$

B. HF,  $O_2$  and  $F_2O_2$

C.  $F^\ominus$ ,  $O_2$  and  $H^\oplus$

D. HOF and HF

**Answer:**



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7. Very pure hydrogen (99.9%) can be made by which of the following processes-

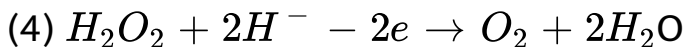
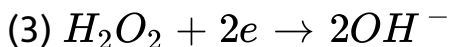
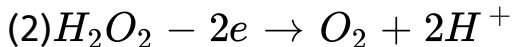
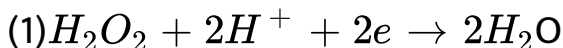
- A. mixing natural hydrocarbons of high molecular weight
- B. electrolysis of water
- C. reaction of salt-like hydrides with water
- D. reaction of methane with steam

**Answer:**



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8. In which of the following reactions,  $H_2O_2$  acts as a reducing agent-



A. 2,4

B. 1,2

C. 3,4

D. 1,3

**Answer:**



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9. From the following statement regarding  $H_2O_2$ , choose the incorrect statement-

- A. it has to be stored in plastic or wax lined glass bottles in dark
- B. it has to be kept away from dust.
- C. it can act only as an oxidizing agent.
- D. it decomposes on exposure to light

**Answer:**



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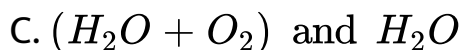
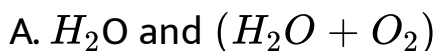
**10.** Which one of following statement about water is false-

- A. water can act both as an acid and as a base
- B. there is extensive intramolecular hydrogen bonding in the condensed phase
- C. ice formed by heavy water sinks in normal water
- D. water is oxidised to oxygen during photosynthesis

**Answer:**

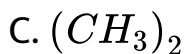
11. Hydrogen peroxide oxidises

$[\text{Fe}(\text{CN})_6]^{4-} \rightarrow [\text{Fe}(\text{CN})_6]^{3-}$  in acidic medium but reduces  $[\text{Fe}(\text{CN})_6]^{3-}$  to  $[\text{Fe}(\text{CN})_6]^{4-}$  in alkaline medium. The other products formed are, respectively-



**Answer:**

12. Which of the following is electron-deficient-



**Answer:**



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13. The reaction of aqueous  $KMnO_4$  with  $H_2O_2$  in acidic conditions gives-



A.  $Mn^{4+}$  and  $O_2$

B.  $Mn^{2+}$  and  $O_2$

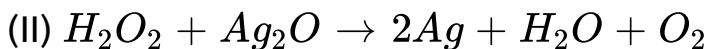
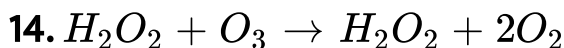
C.  $Mn^{2+}$  and  $O_3$

D.  $Mn^{4+}$  and  $MnO_2$

**Answer:**



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Role of hydrogen peroxide in the above reactions is respectively-

A. oxidising in (I) and reducing in (II)

B. reducing in (I) and oxidising in (II)

C. reducing in (I) and (II)

D. oxidising in (I) and (II)

**Answer:**



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**15.** Which of the following statement is false

A. hydrogen has three isotopes of which tritium is the most common

B. hydrogen never acts as cation in ionic salts

C. hydronium ion,  $H_3O^{\oplus}$  exists freely in solution

D. dihydrogen does not act as a reducing agent

**Answer:**



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**16.** In ice, oxygen atom is surrounded-

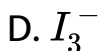
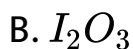
- A. tetrahedrally by 4 hydrogen atoms
- B. octahedrally by 2 oxygen and 4 hydrogen atoms
- C. tetrahedrally by 2 hydrogen 2 oxygen atoms
- D. octahedrally by 6 hydrogen atoms.

**Answer:**



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17. Predict the product of reaction of  $I_2$  with  $H_2O_2$  in basic medium-



**Answer: A**



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18. Strength of  $H_2O_2$  is  $15.18 \text{ g} \cdot L^{-1}$ . They it equal to -

A. 1 volume

B. 10 volume

C. 5 volume

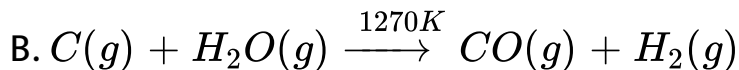
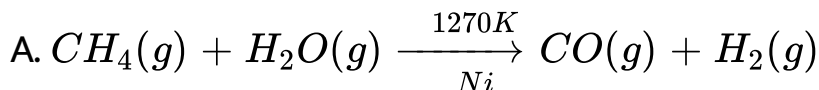
D. 7 volume

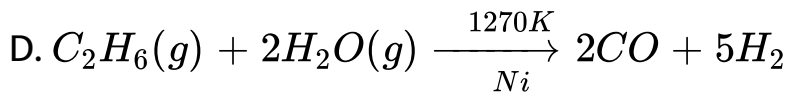
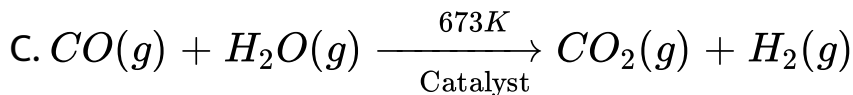
**Answer:**



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**19.** Which of the following reaction increases the production of dihydrogen from synthesis gas-



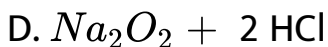
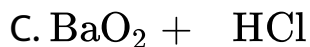
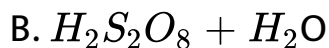
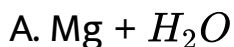


**Answer:**



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**20.** Which of the following reactions produces hydrogen-



**Answer:**



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21.  $H_2O_2$  can be obtained when following reacts with  $H_2SO_4$  except with-

A.  $BaO_2$

B.  $PbO_2$

C.  $Na_2O_2$

D.  $SrO_2$

**Answer:**



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1. At absolute zero-

- A. only para-hydrogen exists
- B. only ortho-hydrogen exists
- C. both ortho-and para-hydrogen exist.
- D. neither para-nor ortho-hydrogen exists

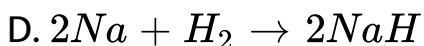
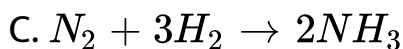
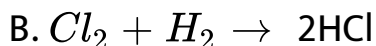
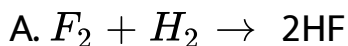
**Answer: A**



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2. In which of the following reaction dihydrogen acts as an oxidising agent-



**Answer: D**



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3. Which of the following halogens has least affinity towards hydrogen-

A.  $I_2$

B.  $Cl_2$

C.  $Br_2$

D.  $F_2$

**Answer: A**



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4. Which of the following compounds on electrolysis produces hydrogen-

A. dil.  $H_2SO_4$

B. dil. Solution of NaOH

C.  $\text{Ba}(\text{OH})_2$  solution

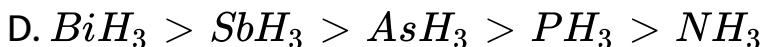
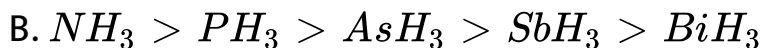
D. KOH solution

**Answer: C**



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5. Thermal stability of Gr-15 hydrides follows the order-

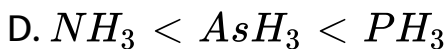
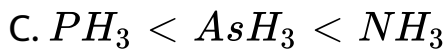
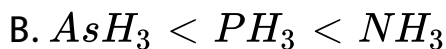


**Answer: B**



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6. The correct order of vaporisation enthalpy of the following hydride is-



Answer: C



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7. Interstitial hydrides are formed by-

- A. s-block elements
- B. p-block elements
- C. d-block elements
- D. inert gas elements

**Answer: C**



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8. The correct descending order of thermal stability of alkali metals hydrides is -

A.  $\text{LiH} > \text{NaH} > \text{KH} > \text{RbH} > \text{CsH}$

B.  $\text{CsH} > \text{RbH} > \text{KH} > \text{NaH} > \text{LiH}$

C.  $\text{NaH} > \text{KH} > \text{LiH} > \text{CsH} > \text{RbH}$

D.  $\text{CsH} > \text{LiH} > \text{KH} > \text{NaH} > \text{RbH}$

**Answer: A**



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**9.** Solubility of  $\text{NaCl}$  in the solvents  $\text{H}_2\text{O}$  and  $\text{D}_2\text{O}$  is -

A. equal in both

B. more in  $\text{D}_2\text{O}$

C. more in  $\text{H}_2\text{O}$

D. only in  $H_2O$

**Answer: C**



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**10.** Degree of hardness of 1L sample water containing 0.002 mol  $MgSO_4$  is -

A. 20 ppm

B. 200ppm

C. 2000ppm

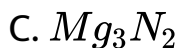
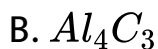
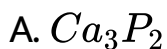
D. 120 ppm

**Answer: B**



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11. Which of the following reacts with water to produce electron-precise hydrides-



D. none of these

**Answer: B**



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12. Which of following couples reacts with water to produce same gaseous product-

A. K and  $KO_2$

B. Ca and  $CaH_2$

C. Na and  $Na_2O_2$

D. Ba and  $BaO_2$

**Answer: B**



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13. Which of the following compounds contain free hydrogen-

A. water

B. marsh gas

C. water gas

D. acid

**Answer: C**

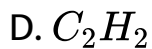
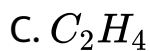


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**14.** Which of the followings reacts with metallic sodium to produce hydrogen-

A.  $CH_4$

B.  $C_2H_6$

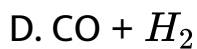
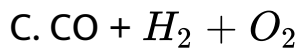
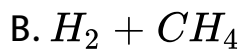


**Answer: D**



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**15. Semi-water gas is-**



**Answer: A**



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16. Which of the following metals does not react with cold water but liberates  $H_2$  gas with steam water-

A. Na

B. K

C. Ca

D. Fe

**Answer: D**



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17. Volume of '10 volume'  $H_2O_2$  required to convert 0.01 mol PbS into  $PbSO_4$  is -

- A. 11.2 mL
- B. 22.4 mL
- C. 33.6 mL
- D. 44.8 mL

**Answer: D**



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18. On dilution of  $H_2O_2$  the value of dielectric constant-

- A. increases
- B. remains same
- C. decreases
- D. none of these

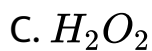
**Answer: A**



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**19.** By which of the following water gets oxidised to oxygen-



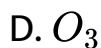
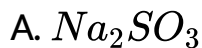
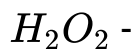


**Answer: D**



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**20.** Which of the following does not get oxidised by



**Answer: D**



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**21.** Temperature at which the density of  $D_2O$  is maximum is-

A.  $9^{\circ}\text{C}$

B.  $11.5^{\circ}\text{C}$

C.  $15.9^{\circ}\text{C}$

D.  $20^{\circ}\text{C}$

**Answer: B**



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22. Which of the followings undergoes disproportionation reaction with water-



**Answer: C**



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23. The non-inflammable hydride is -

A.  $NH_3$

B.  $PH_3$

C.  $AsH_3$

D.  $SbH_3$

**Answer: A**



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**24.** Triple point of water is -

A. 203K

B. 193K

C. 273K

D. 373K

**Answer: C**



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25. The process by which hydrogen is prepared by the reaction of silicon, iron alloy and NaOH is-

- A. Wood process
- B. Haber's process
- C. Silicol process
- D. Bosch process

**Answer: C**



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26. An element reacts with hydrogen to form a compound A, which on reaction with water liberates hydrogen again.

The element is -

A. Cl

B. Ca

C. Se

D.  $N_2$

**Answer: B**



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27. Only one element of which of the following groups forms metal hydride-

A. Gr-6

B. Gr-7

C. Gr-8

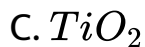
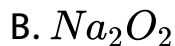
D. Gr-9

**Answer: A**



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28. Acidic solution of which of the following turns orange in presence of  $H_2O_2$ -

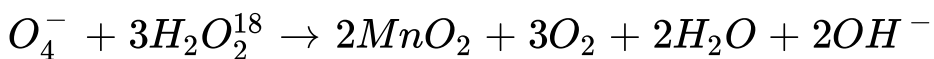


**Answer: C**



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**29.** In the following reaction the isotopic oxygens-



A. both get converted into  $O_2$

B. both get converted into  $OH^-$

C. both get converted into  $MnO_2$

D. one of them gets converted to  $O_2$ , another to  $MnO_2$

**Answer: A**



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**30.** X on electrolysis produces Y which on vacuum distillation produces  $H_2O_2$ . The numbers of peroxo linkage present in X and Y are-

A. 1,1

B. 1,2

C. 0,1

D. 0,0

**Answer: C**



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**31.** The compound which on electrolysis in its molten or liquid state liberates hydrogen at anode is -

A. NaOH

B.  $CaH_2$

C. HCl



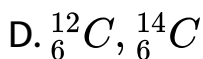
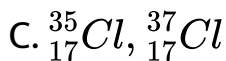
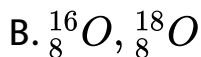
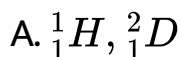
D.  $H_2O$

**Answer: B**



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**32.** Which of the following couples exhibit the maximum isotope effect-



**Answer: A**



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33. Which of the following emits by tritium-

A. Neutron

B.  $\gamma$ -ray

C.  $\beta$ -particle

D.  $\alpha$ -particle

**Answer: C**



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34. Oxidation of benzene by  $H_2O_2$  in presence of ferrous sulphate produces-

- A. phenol
- B. cyclohexane
- C. anisole
- D. benzaldehyde

**Answer: A**



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35. The oxidation state of Cr in the product obtained by the reduction of  $K_2Cr_2O_7$  by atomic hydrogen is-

A. +6

B. +2

C. 0

D. +3

**Answer: D**

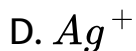


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**36.** Which of the following does not get reduced by  $H_2$  in its aqueous solution-

A.  $Cu^{2+}$

B.  $Fe^{3+}$



**Answer: C**



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**37.** Which of the following compounds has similar odour as that of  $H_2O_2$  -

A. caustic soda

B. chloroform

C. alcohol

D. nitric acid

**Answer: D**



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**38.** Which of the following compounds reacts with atomic hydrogen to form formaldehyde-

A.  $\text{CO}$

B.  $\text{CO}_2$

C.  $\text{CH}_4$

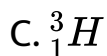
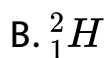
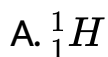
D.  $\text{C}_2\text{H}_2$

**Answer: A**



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39. Which of the following isotopes of hydrogen is the most reactive-



D. all the isotopes are equally reactive

**Answer: A**



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**40.** When equal amounts of Zn is allowed to react separately with excess  $H_2SO_4$  and excess NaOH, then ratio of the volumes of hydrogen produced for the first and the second case respectively is -

A. 1:2

B. 2:1

C. 4:9

D. 1:1

**Answer: D**



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41. Which of the following hydrides of s-block elements have polymeric structure-

A. LiH

B.  $BeH_2$

C. NaH

D.  $MgH_2$

**Answer: B::D**



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42. Which of the following statement are true-

A. if  $Z = 15$ , the element forms covalent hydride

B. if  $Z=23$ , the element forms ionic hydride

C. if  $Z=19$ ,the element forms ionic hydride

D. if  $Z=44$ , the element forms metallic hydride

**Answer: A::C**



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**43.** Which of the following hydrides are polynuclear hydrides-

A.  $\text{NaH}$

B.  $\text{C}_3\text{H}_8$

C.  $N_2H_4$

D. HF

**Answer: B::C**



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**44.** Which of the following statements are correct-

A. metallic hydrides are hydrogen deficient

B. metallic hydrides are conductors of heat and electricity

C. ionic hydrides in their solid state do not conduct electricity

D. ionic hydrides on electrolysis in their molten state produce  $H_2$  at cathode.

**Answer: A::B::C**



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**45.** Which of the following ions get exchanged with  $Na^+$  ion of zeolite when zeolite is added to the hard water-

A.  $H^+$  ion

B.  $Ca^{2+}$  ion

C.  $SO_4^{2-}$

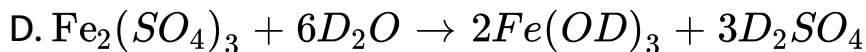
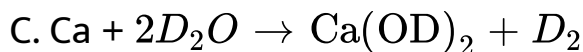
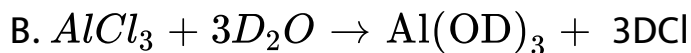
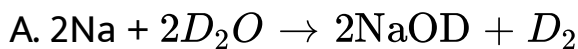
D.  $Mg^{2+}$  ion

**Answer: B::D**



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**46.** Which of the following reactions are deuterolysis-

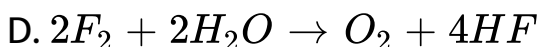
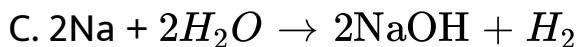
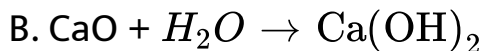


**Answer: B::D**



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47. Which of the following reactions are redox reactions -

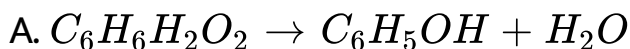


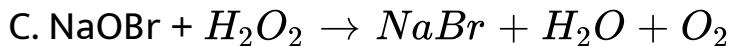
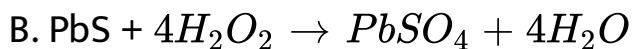
Answer: C::D



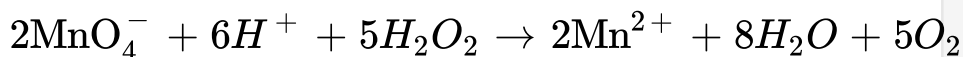
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48. In which of the following reactions  $H_2O_2$  acts as a reductant-





D.



**Answer: C::D**



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**49.** Which of the following properties are same for a metal and its hydride-

A. hardness

B. metallic lustre

C. electrical conductance

D. magnetic property

**Answer: A::B::C::D**



**View Text Solution**

**50.** The correct orders are-

A.  $H_2 < D_2 < T_2$  : boiling point

B.  $H_2 < D_2 < T_2$  : freezing point

C.  $H_2 < D_2 < T_2$  : latent heat of vaporisation

D.  $T_2O < H_2O < D_2O$  : dissociation constant

**Answer: A::B::C**





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51. Which of the following react with zinc to produce hydrogen gas-

A. dil.HCl

B. hot NaOH solution

C. cold water

D. conc.  $H_2SO_4$

**Answer: A::B::C**



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52. Which of the following properties have greater magnitude in  $D_2O$  than of in  $H_2O$ -

- A. Viscosity
- B. Surface tension
- C. dielectric constant
- D. latent heat of vaporisation

**Answer: A::D**



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53. Which of the following metal hydrides get reduced by hydrogen -

A.  $\text{CuO}$

B.  $\text{Pb}_3\text{O}_4$

C.  $\text{Na}_2\text{O}_2$

D.  $\text{MgO}$

**Answer: A::B**



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**54.** Multimolecular covalent hydrides of s-block are-

A.  $\text{LiH}$

B.  $\text{BeH}_2$

C.  $\text{NaH}$

D.  $\text{MgH}_2$

**Answer: B::D**



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55. The oxidation numbers of the most electronegative element in the product obtained due to the reaction between  $\text{BaO}_2$  and dil.  $\text{H}_2\text{SO}_4$  are-

A.  $-1$

B.  $-2$

C.  $0$

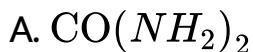
D.  $+1$

Answer: A::B



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56. Which of the following compounds decreases the rate of decomposition of  $H_2O_2$  -



Answer: A::B



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57. Which of the following produce  $H_2O_2$  on hydrolysis-

- A. pernitric acid
- B. perchloric acid
- C. perdisulphuric acid
- D. Caro's acid

**Answer: A::C::D**



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58. Choose the correct statements-

A. concentration of 20 volume  $H_2O_2$  solution is 60.7g.

$$L^{-1}$$

B. volume strength of 2(N) $H_2O_2$  solution is 15

C. volume strength of 2(N) $H_2O_2$  solution is 11.2

D. concentration of 20 volume  $H_2O_2$  solution is 50.7g

$$\cdot L^{-1}$$

**Answer: A::C**



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**59.** Choose the correct alternative-

A. mixture of  $\text{HCl}$  and  $\text{HClO}$  is formed when chlorine reacts with cold water

B. orange colour of  $\text{K}_2\text{Cr}_2\text{O}_7$  solution turns blue when, it reacts with  $\text{H}_2\text{O}_2$

C. under low pressure isopropyl alcohol reacts with small amount of  $\text{H}_2\text{O}_2$  to produce formaldehyde

D. hydrolith produce black coloured product when it reacts with  $\text{PbSO}_4$

**Answer: A::B::D**



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60. Which of the following alternatives are not true-

- A. correct order of reactivity of  $H_2$  towards the halogens is :  $Cl_2 > Br_2 > I_2 > F_2$
- B. concentration of  $H_2O_2$  used in rocket is 90%
- C.  $H_2$  gets more readily absorbed on the surface of pt-metal than  $D_2$
- D. conversion of atomic hydrogen into molecular hydrogen is an exothermic process

**Answer: A::B::C**



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## Exercise Very Short Type Questions

1. Which is the lightest gas known?



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2. Which isotope of hydrogen is radioactive?



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3. Give examples of an ionic, a covalent and a metallic hydride.



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4. What is hydrolith?



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5. Name the two nuclear spin isomers of dihydrogen.



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6. Give example of an electron-deficient hydride in which three centre-two electron bonds are present.



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7. Which gaseous compound on treatment with dihydrogen produces methanol?



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8. How will you prove that a colourless liquid is water?



**Watch Video Solution**

9. What is the unit for expressing the degree of hardness of water?



**Watch Video Solution**

**10.** Write the names of two chemical substances which are used for removing dissolved oxygen from water meant for boiler.



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**11.** Why is heavy water used in atomic reactors?



**Watch Video Solution**

**12.** Name a solid and a liquid absorbent of water.



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13. Which chemical is commercially known as 'perhydrol'?



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14. What is called 'hyperol or artizone'?



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15. What is the volume strength of a molar solution of  $H_2O_2$ ?



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16. Which organic reagent is used for the manufacture of  $H_2O_2$  ?



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17. 10 volume of  $H_2O_2 = x(N)H_2O_2$ . What is the value of x?



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18. What are the ways in which water molecules are bonded to the anhydrous salt to form hydrates?



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## Fill In The Blanks

1. The radioactive isotope of hydrogen is \_\_\_\_\_



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2. When NaH is electrolysed, \_\_\_\_\_ is obtained at the anode.



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3. Syngas is the mixture of hydrogen and \_\_\_\_\_



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4. para-hydrogen is \_\_\_\_\_ stable than ortho-hydrogen.



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5. The oxygen atom in the water molecule is \_\_\_\_\_ hybridised.



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6.  $H_2O$  undergoes electrolysis \_\_\_\_\_ than  $D_2O$ .



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7. Heavy water is used as a \_\_\_\_\_ in nuclear reactors.



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8. Temporary hardness is also known as \_\_\_\_\_ hardness.



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9. Rainwater is \_\_\_\_\_ water but sea water is \_\_\_\_\_ water.



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10. The reaction between  $\text{CaC}_2$  and  $D_2O$  forms \_\_\_\_\_.





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11.  $D_2O_2$  can be prepared by electrolysis of \_\_\_\_\_ by  $D_2O$ .



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12.  $H_2O_2$  is slightly \_\_\_\_\_ acid than water.



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13. Decomposition of  $H_2O_2$  is suppressed by \_\_\_\_\_.



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14. Boiling point of  $H_2O_2$  is \_\_\_\_ than water.



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15. The mixture of \_\_\_\_ &  $H_2O_2$  is known as Fenton's reagent.



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16. Volume strength of 1.5(N)  $H_2O_2$  is \_\_\_\_.



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1. How can dihydrogen be obtained from nitric acid?



**Watch Video Solution**

2. Concentrated  $H_2SO_4$  cannot be used for drying  $H_2$  gas\_\_ why?



**Watch Video Solution**

3. What do you mean by occlusion of hydrogen?



**Watch Video Solution**

4. What is atomic hydrogen torch? Explain its principle.



**Watch Video Solution**

5. What are non-stoichiometric hydrides ? Give examples.



**Watch Video Solution**

6. What do you understand by the term 'hydrogen economy'?



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7. What is syngas? What is syngas-shift reaction?



**Watch Video Solution**

8. Mention two reactions in which  $H_2$  acts as a reducing agent and an oxidising agent respectively.



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9. Explain the meaning of the term 'hydride gap'.



**Watch Video Solution**

**10.** What type of hydrides can be formed by each of the following elements: Li, Zr, P , Hf, N, Ca ?



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**11.** What are the different types of bonds formed by hydrogen in its compounds.



**Watch Video Solution**

**12.** Describe any one industrial preparation of dihydrogen.



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13. Explain why ice floats on water.



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14. A fishy smell is obtained when  $F_2$  is passed through water- why?



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15. Give example of a reaction in which  $H_2O$  acts oxidising agent.



Watch Video Solution

**16.** How can the hardness of water be expressed?



**Watch Video Solution**

**17.** Hard water cannot be used in boilers -why?



**Watch Video Solution**

**18.** It is necessary to use calculated amount of lime for the removal of temporary hardness of water by Clark's method-why?



**Watch Video Solution**

19. Explain why water is called 'universal solvent'.



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20. What is heavy water? Why is it so called? How can it be prepared?



Watch Video Solution

21. Which one will readily undergo electrolysis?  
 $H_2O$ ,  $D_2O$ .



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22. Explain the structure of the common form of ice.



Watch Video Solution

23. Describe some unusual properties of water.



Watch Video Solution

24.  $H_2O_2$  has both oxidising and reducing properties-  
why?



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25. The boiling point of  $H_2O_2$  is higher than that of  $H_2O$  - why?



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26. Water and hydrogen peroxide are kept in two separate bottles. How will you identify them?



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27. How does  $H_2O_2$  display its bleaching property?



Watch Video Solution

28. In the preparation of  $H_2O_2$ ,  $MnO_2$  or  $PbO_2$  cannot be used instead of  $BaO_2$  - why?



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29. Why is  $H_2O_2$  used to restore the original colour of oilpaintings?



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30. Explain why a solution of  $H_2O_2$  cannot be stored in an ordinary glass bottle in the laboratory rack.



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31. What do you mean by 'x volume'  $H_2O_2$  solution?



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32. Explain why in the laboratory preparation of  $H_2O_2$  :

It is better to use syrupy phosphoric acid instead of dilute sulphuric acid.



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33. How can  $H_2O_2$  be preserved in the laboratory?



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**34.** What are the limitations of the process used for the laboratory preparation of hydrogen peroxide?



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## Numerical Problems

1. 1L of a sample of hard water contains 1 mg  $\text{CaCl}_2$  and 1 mg  $\text{MgCl}_2$ . Estimate the degree of hardness of this sample of water.



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2. Determine the strength of '30 volume'  $H_2O_2$  in normality.



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3. Determine the volume (in litre) of  $O_2$  obtained at STP when 0.1 litre of 2(M)  $H_2O_2$  solution is decomposed.



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4. When 100 ml of a tube-well water is titrated using methyl orange as indicator, it requires 15 ml of 0.01 (N) HCl. Estimate the hardness. Of that sample of water.



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5. Calculate the amount of  $H_2O_2$  present in 600 mL of 10 volume  $H_2O_2$  solution.



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6. An excess of acidic KI solution is added to 25 mL of a  $H_2O_2$  solution when iodine is liberated. 20 mL of 0.1 (N) sodium thio-sulphate solution is required to titrate the liberated iodine. Calculate the percentage strength, volume strength and strength in normality of the  $H_2O_2$  solution.



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1. What is calgon?



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2. What is syngas?



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3. A sample of water containing KCL does not behave as hard water, but a sample of water containing  $\text{CaCl}_2$  and  $\text{MgCl}_2$  behaves as hard water - why ?



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4. Do you expect different product in solution when aluminium (III) chloride and potassium chloride are treated separately with (1) normal water, (2) acidified water and (3) alkaline water? Write equation wherever necessary.



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5. Why does dihydrogen occur in diatomic form than in monoatomic form under normal condition.?



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