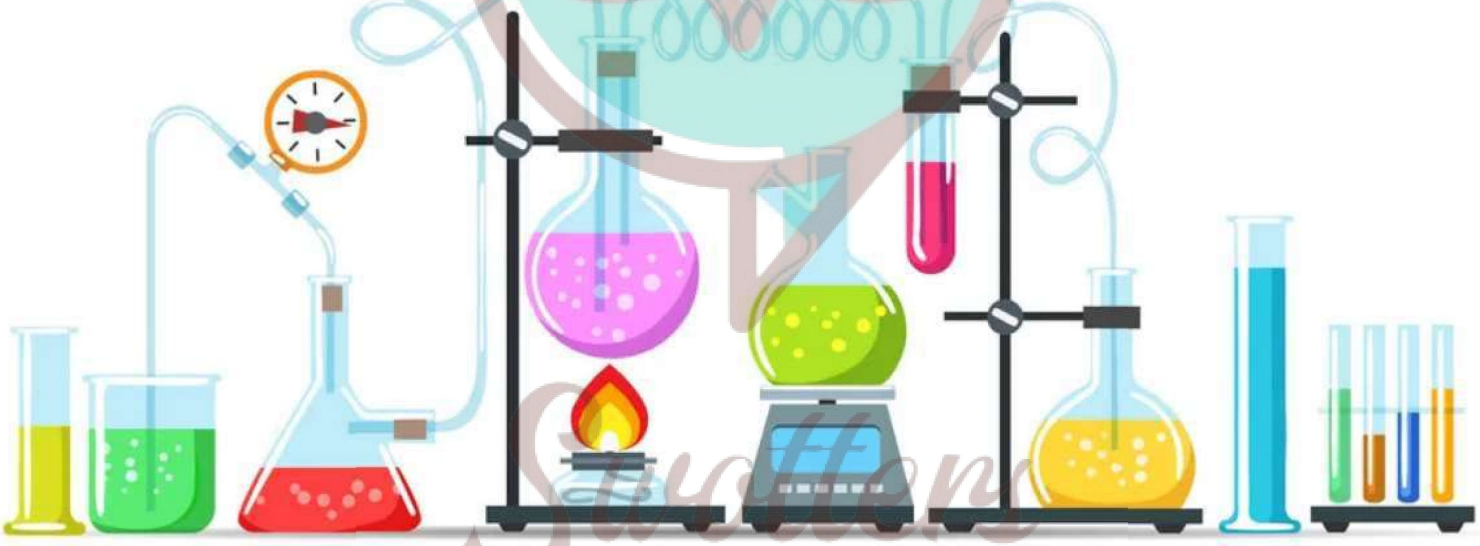
CHEMISTRY



Important Questions

Multiple Choice questions-

Question 1When water is dropped over sodium peroxide, the colourless gas produced is:

(a) DiNitrogen

(b) DiOxygen

(c) DiHydrogen

(d) Hydrogen Peroxide

Question 2. The atomic weights of isotopes of all element are different due to different number of _____.

(a) Protons

(b) Electrons

(c) Neutrons

(d) None of Above

Question 3. During the reaction of natural gas and steam the catalyst used is

(a) Fe

(b) Zn

(c) Ni

(d) Cr

Question 4. Cavendish in 766 discovered.

(a) Nitrogen

(b) Oxygen

(c) Hydrogen

(d) Helium

Question 5. Dihydrogen gas may be prepared by heating caustic soda on

(a) Cu

(b) Zn

(c) Na

(d) Ag

Question 6. Hydrogen set free at the time of its preparation from its compound in atomic form are called _____.

(a) Nascent Molecular Hydrogen

(b) Nascent Atomic Hydride

(c) Both (1) and (2)

(d) Nascent Hydrogen

Question 7. Which substance does not speed up decomposition of H_2O_2

(a) Glycerol

(b) Pt

(c) Gold

(d) MnO_2

Question 8. Water shows anomalous behavior between

(a) 0 to 4 °C

(b) 0 to 5 °C

(c) 0 to -4 °C

(d) 4 to 0 °C

Question 9. Which of the following pair of substance will not evolve H_2 gas?

(a) Iron and aqueous H_2SO_4

(b) Copper and HCl(aq)

(c) Sodium and Ethanol

(d) Iron and Steam

Question 10. Tritium _____ radio active isotope.

(a) Beta-Emitting

(b) Alpha – Emitting

(c) Gamma-Emitting

(d) None of the Above

Question 11. The maximum density of water at 40C is:

(a) 1.0 g / cm^3

(b) 0.998 g / cm^3

(c) 0.918 g / cm^3

(d) 1.2 g / dm^3

Question 12. Water gas is mixture of hydrogen H_2 and

(a) CO

(b) CO_2

(c) Cl_2

(d) SO_2

Question 13. The volume of oxygen gas evolved at STP by decomposition of 0.68 g "20 volume" hydrogen peroxide is:

(a) 112 ml

(b) 224 ml

(c) 56 ml

(d) 336 ml

Question 14. Which of the following statements regarding hydrogen peroxide is/are incorrect?

(a) As aerating agent in production of sponge rubber

(b) As an antichlor

(c) For restoring white colour of blackened lead painting

(d) All of the above

Question 15. _____ on water decolourises H_2O_2

(a) O_3

(b) Acidic $KMnO_4$ solution

(c) Black Suspension of Lead Sulphide(PbS)

(d) None of these

Very Short:

1. Which gaseous compound on treatment with dihydrogen produces methanol?
2. What are the constituents of water gas?
3. Arrange H_2, D_2, T_2 in the decreasing order of their

(i) Boiling point

(ii) Heat of fusion.

4. Which isotope of hydrogen

(i) does not contain neutron

(ii) is radioactive?

5. Out of the following metals which can be used to liberate H2 gas on reaction with dil. hydrochloric acid?

(i) Cu,

(ii) Zn,

(iii) Iron,

(iv) Silver,

(v) Magnesium

6. Name one compound each of hydrogen in which it exists in:

(i) Positive oxidation state

(ii) Negative oxidation state.

7. What is the importance of heavy water in nuclear power generation?

8. State two properties in which hydrogen resembles alkali metals.

9. Give an example of each anionic and covalent hydride.

10. Why is H_2O_2 concentrated at low pressure?

Short Questions:

1. Hydrogen forms three types of bonds in its compounds. Describe each type of bonding using suitable examples.
2. Name one example of a reaction in which dihydrogen acts as

   (i) an oxidizing agent

   (ii) a reducing agent.
3. The process $\frac{1}{2} H_2(g) + e- \rightarrow H-(g)$ is endothermic (DH = +151 kJ mol^{-1}), yet salt- like hydrides are known. How do you account for this?
4. Find the volume strength of 1.6 N H_2O_2 solution.
5. A sample of hard water is allowed to pass through an anion exchanger. Will it produce lather with soap easily?
6. Anhydrous Ba02 is not used for preparing H_2O_2 Why?

Long Questions:

1. (a) Compare atomic hydrogen with nascent hydrogen.

   (b) What is (i) active hydrogen

   (ii) heavy hydrogen? How are they formed?
2. How is the solution of H_2O_2 concentrated?
3. What are the different methods used for the softening of hard water? Explain the principle of each method.

4. Show how hydrogen peroxide can function both as an oxidising and a reducing agent
5. Calculate the percentage strength & strength in g/L of 10 volume hydrogen peroxide solution.

Assertion Reason Questions:

1. In the following questions, a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

   Assertion (A) : Permanent hardness of water is removed by treatment with washing soda.

   Reason (R) : Washing soda reacts with soluble magnesium and calcium sulphate to form insoluble carbonates.

   (i) Statements A and R both are correct and R is the correct explanation of A.

   (ii) A is correct but R is not correct.

   (iii) A and R both are correct but R is not the correct explanation of A.

   (iv) A and R both are false.

2. In the following questions, a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

   Assertion (A) : Some metals like platinum and palladium, can be used as storage media for hydrogen.

   Reason (R) : Platinum and palladium can absorb large volumes of hydrogen.

   (i) Statements A and R both are correct and R is the correct explanation of A.

   (ii) A is correct but R is not correct.

   (iii) A and R both are correct but R is not the correct explanation of A.

   (iv) A and R both are false.

Case Study Based Question:

1. Read the passage given below and answer the following questions :

   Hydrogen can exist in three isotopic forms, viz., protium, deuterium and tritium, which differ from each other in the number of neutrons.

   Out of these three isotopes, tritium is formed in the upper atmosphere by reaction induce by cosmic rays. It decays to emit low energy β-particles.

$$\underset{\text{Tritium}}{{}_{1}^{3}\mathrm{H}} \longrightarrow {}_{2}^{3}\mathrm{He} + \underset{\beta\text{-particle}}{{}_{-1}e^{0}}$$

Tritium is used for making thermonuclear devices and for carrying out researches in fusion reactions as a source of energy. It is also used as a radioactive tracer as it is relatively cheap and easy to work with.

(1) The relative atomic mass of isotopes of hydrogen is:

(a) 1 : 2 : 3

(b) 1 : 1 : 2

(c) 2 : 4 : 5

(d) 1 : 2 : 4

(2) The n/ p ratio for ${}_{1}H^{2}$ is:

(a) 1 : 2

(b) 1 : 1

(c) 2 : 1

(d) 2 : 3

(3) Which is the most reactive isotope of hydrogen?

(a) Tritium

(b) Deuterium

(c) Protium

(d) All are equally reactive

(4) What type of reactions are generated by tritium?

(a) Chemical reaction

(b) Radioactive reaction

(c) Addition reaction

(d) All of these

2. Read the passage given below and answer the following questions:

Water is the main constituent of earth's hydrosphere and fluids of all known living organisms. It is vital for all known forms of life, even though it provides no chlorines or organic nutrients.

Water cover approximately 70.9% of earth's surface, mostly in seas and oceans. Water plays

an important role in the world economy. Approximately 70% of the fresh water used by humans goes to agriculture. Water is the excellent solvent for a wide variety of substance both mineral and organic; as such it is widely used in industrial processes and in cooking and washing. Water, ice and snow are also central to many sports and other forms of entertainment pure water has a low electrical conductivity, which increases with the dissolution of a small amount of ionic material such as common salt.

(1) Which one of the following statements about water is incorrect?

(a) Water can act both as an acid and as a base

(b) Water can be easily reduced to dihydrogen by highly electronegative elements.

(c) Ice formed by heavy water sinks in normal water

(d) Presence of water can be detected by adding a drop to anhydrous $CuSO_4$

(2) In nuclear reactors, ordinary water is not used as a moderator because

(a) it cannot slow down the fast moving neutrons

(b) it cannot remove the heat from the reactor core

(c) it has corrosive action on the metallic parts of the nuclear reactor

(d) None of the above

(3) Consider the following statements about intermolecular and intramolecular hydrogen bonding.

I. Both types of H-bonds are temperature dependent.

II. Water exhibits amphoteric nature.

III. The boiling points of compounds having intramolecular H-bond are lower than those having intermolecular H-bond.

Which of the statements given above are correct?

(a) I and III

(b) Both II and III

(c) I and II

(d) All of these

(4) Consider the following statements regarding water.

I. There is extensive hydrogen bonding between water molecules .

II. Water has high melting point in comparison to H_2S and H_2Se.

III. High heat of vaporisation and heat capacity of water are responsible for moderation of climate and body temperature of living beings.

IV. Covalent compounds like alcohol and carbohydrates dissolve in water.

Select the correct statements among above.

(a) Both I and II

(b) Both II and IV

(c) I, II and III

(d) All of these

Answer Key:

MCQ

1. (b) DiOxygen
2. (c) Neutrons
3. (c) Ni
4. (c) Hydrogen
5. (b) Zn
6. (a) Nascent Molecular Hydrogen
7. (b) Pt
8. (a) 0 to 4 °C
9. (b) Copper and HCl(aq)
10. (a) Beta-Emitting
11. (a) 1.0 g / cm^3
12. (a) CO
13. (b) 224 ml
14. (d) All of the above
15. (c) Black Suspension of Lead Sulphide (PbS)

Very Short Answer:

1. Carbon monoxide (CO).

2. Carbon monoxide and hydrogen.

3. T2 > D2 > H2
   T2 > D2 > H2.

4. Protium
   Tritium.

5. Only Zn, Fe, Mg.

6. HCl

   NaH.

7. It is used as a moderator in nuclear reactions to slow down the speed of fast-moving neutrons.

8. Both form unipositive ion

   Both have one electron in their s orbital (ns1).

9. Ionic Hydride NaH Covalent hydride NH_3.

10. Because it decomposes at ordinary pressure or on heating.

Short Answer:

Ans: 1. Hydrogen forms compounds in three different ways:

1. By loss of electrons as in the reactions of H_2 with CuO

$$CuO(s) + H_2(g) \xrightarrow{Heat} Cu(s) + H_2O(g)$$

[Hydrogen bonding]

2. By gain of electrons as in reactions of H_2 with metals.

$$Na(s) + H_2(g) \xrightarrow{Heat} 2NaH(s)$$

[Ionic bonding]

$$Ca(s) + H_2(g) \xrightarrow{Heat} CaH_2$$

3. By sharing of electrons as in the reactions of H_2 with halogens

$$H_2(g) + F_2(g) \longrightarrow 2H-F(l)$$

[Covalent bonding]

$$H_2(g) + Cl_2(g) \longrightarrow 2H-Cl(g)$$

Ans: 2. As an oxidizing agent

$$2Na(s) + H_2(g) \xrightarrow{Heat} 2Na^+H^-(s)$$

Here Na has been oxidized to Na while dihydrogen has been reduced to H^+ ion.

(ii) a reducing agent.

$$CuO(s) + H_2(g) \xrightarrow{Heat} Cu(s) + H_2O(g)$$

Here CuO has been reduced to copper and H_2 has been oxidized to H_2O.

Ans: 3. This is due to the reason that high lattice energy released (energy released during the formation of solid metal hydride from their corresponding gaseous ions, i.e., M^+ and H^+) more than compensates the energy, needed for the formation of H– ions from H_2 gas.

Ans: 4. Strength = Normality × EQuestion wt.

Eq. wt.of H_2O_2 = 17

∴ Strength of 1.6N H_2O_2 solution = 1.6 × 17g L^{-1}

Now 68g of H_2O_2 gives 22400 mL O_2 at NTP/STP

∴ 1.6 × 17g of H_2O_2 will give = $\frac{22400}{68} \times 1.6 \times 17$

= 8960 mL of O_2 at STP

But 1.6 × 17g of H_2O_2 are present in 1000 mL of H_2O_2 solution

Hence 1000 mL of H_2O_2 solution gives 8960 mL of O_2 at STP 1 mL of H_2O_2 will give = 8.96 mL of O_2 at STP.

Hence the volume strength of 1.6N H_2O_2 solution is = 8.96 volume

Ans: 5. No. Ca^{2+} and Mg^{2+} ions are still present, and these will react with soap to form curdy white ppt. Therefore, it will not produce lather with soap solution easily.

Ans: 6. $BaSO_4$ formed during the reaction of BaO_2 with H_2SO_4 forms a protective layer around unreacted BaO2 and the reaction stops after some time.

Long Answer:

Ans: 1. Comparison of atomic and nascent hydrogen

The main point of differences are:

1. Nascent hydrogen can be produced even at room temperature, but atomic hydrogen is produced only at very high temperature.

2. Nascent hydrogen can never be isolated, but atomic hydrogen can be isolated.

3. The reducing power of atomic hydrogen is much greater than that of nascent hydrogen.

In general reactivity of the three forms of hydrogen increases in order.
Molecular hydrogen (H_2) < Nascent hydrogen < Atomic hydrogen.

Active Hydrogen: It is obtained by subjecting a stream of molecular hydrogen at ordinary temperature to silent electric discharge at about 30,000 volts. It is very reactive in nature (half-life = 0.33 second, and combines directly at ordinary temperatures with Pb and S forming their hydrides

Heavy hydrogen: It is manufactured by the electrolysis of heavy water containing a little of IT SO, or NaOH to make the solution conducting.

$$\underset{\text{(Heavy water}}{3D_2O(l)} \longrightarrow \underset{\text{at cathode}}{2D_2(g)} + \underset{\text{at anode}}{O_2(g)}$$

In the laboratory, it can be prepared by the action of heavy water on sodium metal.

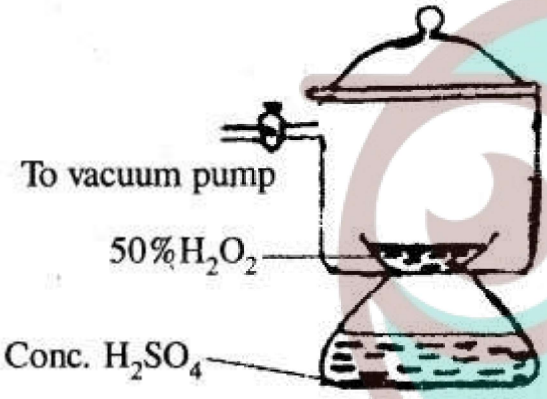
$2D_2O(l) + 2Na(s) \rightarrow 2NaOD(aq) + D_2(g)$.

Ans: 2. The concentration of hydrogen peroxide: Hydrogen peroxide obtained by any method is always in the form of a dilute solution. Great care is to be taken for concentrating its solution because it is unstable and decomposes on heating.
$2H_2O_2 \rightarrow 2H_2O + O_2$

The decomposition of H_2O_2 is catalysed by the ions of heavy metals present as impurities.

The solution of H_2O_2 is concentrated by the following methods.
1. By careful evaporation on a water bath: A dilute solution of H_2O_2 is taken in a shallow evaporating dish and is heated at 313K – 323 K. Water evaporates slowly and a hydrogen-peroxide solution of about 15 – 50% strength is obtained.

2. By dehydration in a vacuum desiccator: The dilute (50 %) solution of H_2O_2 obtained as above, is further concentrated by placing the same in a vacuum desiccator containing concentrated H_2SO_4 as a dehydrating agent. Here, water vapours are absorbed by concentrated sulphuric acid. This is shown in the diagram



(Concentration of H_2O_2 in vacuum desiccator)

3. By distillation under reduced pressure: The solution of hydrogen peroxide is further concentrated by subjecting it to distillation under reduced pressure. The solution is distilled at 308 – 313 K under a reduced pressure of 15 mm Hg. Water present in the solution distils over leaving behind about 98 – 99% concentrated solution of hydrogen peroxide.

4. By crystallization: The last traces of water present in H_2O are removed by freezing it in a freezing mixture of solid CO_2 and others. The crystals of hydrogen peroxide separate out. These crystals are removed, dried and then remitted to obtain 100% pure hydrogen peroxide.

5. Storage of hydrogen peroxide: In order to check the decomposition of hydrogen peroxide, a small amount of acetanilide (i.e. negative catalyst) is added to it before storing the hydrogen peroxide.

Hydrogen peroxide cannot be concentrated by distillation at ordinary pressure because it undergoes decomposition into water and oxygen as it is a highly unstable liquid. It decomposes even on long-standing or on heating.

Ans: 3. Hard water can be softened by the following methods depending upon the nature of hardness.

(a) Temporary hardness:

1. By boiling: It can be removed by merely boiling the water. Boiling decomposes the bicarbonates to give carbon dioxide and insoluble carbonates, which can be removed by filtration.

$$Ca(HCO_3)_2 \xrightarrow{heat} \underset{\text{white ppt.}}{CaCO_3} + H_2O + CO_2$$

$$Mg(HCO_3)_2 \xrightarrow{heat} \underset{\text{white ppt.}}{MgCO_3} + H_2O + CO_2$$

2. Clark's process: Temporary hardness can be removed by the addition of a calculated amount of lime, whereupon magnesium and/or calcium carbonates is precipitated.

$Ca(HCO3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$

$Mg(HCO3)_2 + Ca(OH)_2 \rightarrow CaCO3_3 + MgCO_3 + 2H_2O$

(b) Permanent hardness:

1. With sodium carbonate: On treatment with washing soda, Ca^{2+} and Mg^{2+} in hard water are precipitated. The precipitate of the insoluble carbonates thus formed is removed by filtration.

$$Ca^{2+} + CO_3^{2-} \longrightarrow \underset{\text{white ppt.}}{CaCO_3}$$

$$Mg^{2+} + CO_3^{2-} \longrightarrow MgCO_3$$

2. Ion-exchange method: The common substance used for this process is zeolite which is hydrated sodium aluminum silicate, $NaAl(SiO)_2$, The exchange occurs when passing over the zeolite bed, sodium ions from zeolite are replaced by calcium and magnesium ions. Thus

$Na(Ze) + Mg^{2+} \rightarrow (Ze)_2Ca + 2Na^+$

$2NaZe + Mg^{2+} \rightarrow (Ze)_2Mg + 2Na^+$

when all the sodium ions of the zeolite have been replaced, the zeolite is said to be exhausted. It can be regenerated by treatment with a strong solution of sodium chloride.

$2Na + (Ze)_2Ca \rightarrow 2ZeNa + Ca^{2+}$.

Ans: 4. Oxidising properties: H_2O_2 has a tendency to accept electrons in chemical reactions and thus behaves as an oxidising agent in both acidic and alkaline medium.

$H_2O_2 \rightarrow H_2O + O$

In acidic medium

$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$

In alkaline medium

$H_2O_2 + OH^- + 2e^- \rightarrow 3OH^-$

Example:

(a) In acidic medium:

$2Fe^{2+} + 2H^+ + H_2O_2 \rightarrow 2Fe^{3+} + 2H_2O$

(b) In alkaline medium:

$3Cr^{3+} + 4H_2O_2 + 100H^- \rightarrow 3CrO4^{2-} + 8H_2O$

Reducing properties: H_2O_2 can give electrons in a few reactions and thus behaves as a reducing agent.

In acidic medium

$H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$

In alkaline medium

$H_2O_2 + 2OH^- \rightarrow 2H_2O + O_2 + 2e^-$

Reducing property in acidic medium:

$2MnO4^{2-} + 6H+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$

Reducing property in basic medium:

$2Fe^{3+} + H_2O_2 + 2OH^- \rightarrow 2Fe^{2+} + O_2 + 2H_2O$

Ans: 5. H_2O_2 decomposes on heating according to the equation

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

$2 \times 34g$ 22.4 L at N.T.P.

or 22400 cm^3 at N.T.P.

From the equation

22.4L of O_2 at N.T.P are obtained from 68g of H_2O_2

∴ 10 ml of O_2 at N.T.P will be obtained from $\frac{68}{22400} \times 10$g of H_2O_2

But 10 ml of O_2 at N.T.P are produced from 1 ml. of 10 volume H_2O_2 solution.

Thus 1 ml of 10 volume H_2O_2 solution contains $\frac{68}{22400} \times 10$ g of H_2O_2

∴ 100 ml. of 10 volume H_2O_2 solution will contain

$\frac{68}{22400} \times \frac{10}{1} \times 100 = 3.036$g .

Thus a 10 volume H_2O_2 solution is approx. 3%

Alternatively, 1000 ml of 10 volume of H_2O_2will contain H_2O_2

$\frac{68}{22400} \times 10 \times 1000 = 30.36$g

Therefore, strength of H_2O_2 in 10 volume H_2O_2 is 30.36 g/L

Assertion Reason Answer:

1. (i) Statements A and R both are correct and R is the correct explanation of A.
2. (i) Statements A and R both are correct and R is the correct explanation of A.

Case Study Answer:

1. Answer:

(1) (a) 1 : 2 : 3

(2) (b) 1 : 1

(3) (a) Tritium

(4) (b) Radioactive reaction

2. Answer:

(1) (b) Water can be easily reduced to dihydrogen by highly electronegative elements.

(2) (d) None of the above

(3) (d) All of these

(4) (c) I, II and III