Hydrogen

MCQ (Single Correct Answer)

Q.1 Hydrogen peroxide reacts with iodine in basic medium to give :

A IO_4^-

B IO^-

C I^-

D IO_3^-

1st Sept Evening Shift 2021

Q.2 Which one of the following statements is incorrect?

A Atomic hydrogen is produced when H_2 molecules at a high temperature are irradiated with UV radiation.

B At around 2000 K, the dissociation of dihydrogen into its atoms is nearly 8.1%

C Bond dissociation enthalpy of H_2 is highest among diatomic gaseous molecules which contain a single bond.

D Dihydrogen is produced on reacting zinc with HCl as well as $NaOH_{(aq)}$.

31st Aug Evening Shift 2021

Q.3 The oxide that gives H_2O_2 most readily on treatment with H_2O is :

A PbO_2

B Na_2O_2

C SnO_2

D $BaO_2 . 8H_2O$

27th Aug Evening Shift 2021

Q.4 Deuterium resembles hydrogen in properties but :

A reacts slower than hydrogen

B reacts vigorously than hydrogen

C reacts just as hydrogen

D emits β^+ particles

27th Aug Morning Shift 2021

Q.5 Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Heavy water is used for the study of reaction mechanism.
Reason (R) : The rate of reaction for the cleavage of O - H bond is slower than that of O - D bond.
Choose the most appropriate answer from the options given below :

A Both (A) and (R) are true but (R) is not the true explanation of (A).

B Both (A) and (R) are true and (R) is the true explanation of (A).

C (A) is false but (R) is true.

D (A) is true but (R) is false.

26th Aug Evening Shift 2021

Q.6 Which one of the following methods is most suitable for preparing deionized water?

A Synthetic resin method

B Clark's method

C Calgon's method

D Permutit method

26th Aug Morning Shift 2021

Q.7 The conversion of hydroxyapatite occurs due to presence of F^- ions in water. The correct formula of hydroxyapatite is :

A $[3Ca_3(PO_4)_2 . Ca(OH)_2]$

B $[3Ca(OH)_2 . CaF_2]$

C $[Ca_3(PO_4)_2 . CaF_2]$

D $[3Ca_3(PO_4)_2 . CaF_2]$

26th Aug Morning Shift 2021

Q.8 Which one of the following when dissolved in water gives coloured solution in nitrogen atmosphere?

A $CuCl_2$

B AgCl

C $ZnCl_2$

D Cu_2Cl_2

26th Aug Morning Shift 2021

Q.9 Number of Cl = O bonds in chlorous acid, chloric acid and perchloric acid respectively are :

A 3, 1 and 1

B 4, 1 and 0

C 1, 1 and 3

D 1, 2 and 3

27th July Evening Shift 2021

Q.10 To an aqueous solution containing ions such as Al^{3+}, Zn^{2+}, Ca^{2+}, Fe^{3+}, Ni^{2+}, Ba^{2+} and Cu^{2+} was added conc. HCl, followed by H_2S.
The total number of cations precipitated during this reaction is/are :

A 1

B 3

C 4

D 2

27th July Evening Shift 2021

Q.11 The number of neutrons and electrons, respectively, present in the radioactive isotope of hydrogen is :

A 1 and 1

B 3 and 1

C 2 and 1

D 2 and 2

27th July Evening Shift 2021

Q.12 At 298.2 K the relationship between enthalpy of bond dissociation (in kJ mol^{-1}) for hydrogen (E_H) and its isotope, deuterium (E_D), is best described by :

A $E_H = \frac{1}{2}E_D$

B $E_H = E_D$

C $E_H \simeq E_D - 7.5$

D $E_H = 2E_D$

25th July Morning Shift 2021

Q.13 The water having more dissolved O_2 is :

A boiling water

B water at 80°C

C polluted water

D water at 4°C

22th July Evening Shift 2021

Q.14 The single largest industrial application of dihydrogen is :

A Manufacture of metal hybrides

B Rocket fuel in space research

C In the synthesis of ammonia

D In the synthesis of nitric acid

20th July Evening Shift 2021

Q.15 Given below are two statements : One is labelled as Assertion A and other is labelled as Reason R.

Assertion A : The dihedral angles in H_2O_2 in gaseous phase is 90.2^0 and in solid phase is 111.5^0.

Reason R : The change in dihedral angle in solid and gaseous phase is due to the difference in the intermolecular forces.

Choose the most appropriate answer from the options given below for A and R.

A A is correct but R is not correct.

B Both A and R are correct but R is not the correct explanation of A.

C Both A and R are correct and R is the correct explanation of A.

D A is not correct but R is correct.

20th July Morning Shift 2021

Q.16 In basic medium, H_2O_2 exhibits which of the following reactions?
(A) $Mn^{2+} \rightarrow Mn^{4+}$
(B) $I^2 \rightarrow I^-$
(C) $PbS \rightarrow PbSO_4$
Choose the most appropriate answer from the options given below :

A (B) only

B (A), (B) only

C (A) only

D (A), (C) only

18th March Evening Shift 2021

Q.17 Given below are two statements : One is labelled as Assertion A and the other labelled as reason R
Assertion A : During the boiling of water having temporary hardness, $Mg(HCO_3)_2$ is converted to $MgCO_3$.
Reason R : The solubility product of $Mg(OH)_2$ is greater than that of $MgCO_3$.
In the light of the above statements, choose the most appropriate answer from the options given below :

A Both A and R are true but R is not the correct explanation of A

B A is true but R is false

C Both A and R are true and R is the correct explanation of A

D A is false but R is true

18th March Morning Shift 2021

Q.18 The functional groups that are responsible for the ion-exchange property of cation and anion exchange resins, respectively, are :

A $-SO_3H$ and $-NH_2$

B $-NH_2$ and COOH

C $-NH_2$ and $-SO_3H$

D $-SO_3H$ and $-COOH$

17th March Evening Shift 2021

Q.19 The INCORRECT statement(s) about heavy water is (are)
(A) used as a moderator in nuclear reactor
(B) obtained as a by-product in fertilizer industry
(C) used for the study of reaction mechanism
(D) has a higher dielectric constant than water
Choose the correct answer from the options given below :

A (D) only

B (B) and (D) only

C (B) only

D (C) only

17th March Morning Shift 2021

Q.20 The correct statements about H_2O_2 are :
(A) used in the treatment of effluents.
(B) used as both oxidising and reducing agents.
(C) the two hydroxyl groups lie in the same plane.
(D) miscible with water.
Choose the correct answer from the options given below :

A (A), (C) and (D) only

B (A), (B), (C) and (D)

C (A), (B) and (D) only

D (B), (C) and (D) only

16th March Evening Shift 2021

Q.21 Given below are two statements :
Statement I : H_2O_2 can act as both oxidising and reducing agent in basic medium.
Statement II : In the hydrogen economy, the energy is transmitted in the form of dihydrogen.
In the light of the above statements, choose the correct answer from the options given below :

A Both statement I and statement II are false

B Statement I is false but statement II is true

C Statement I is true but statement II is false

D Both statement I and statement II are true

16th March Morning Shift 2021

Q.22 Statements about heavy water are given below :
(A). Heavy water is used in exchange reactions for the study of reaction mechanisms.
(B). Heavy water is prepared by exhaustive electrolysis of water.
(C) Heavy water has higher boiling point than ordinary water.
(D) Viscosity of H_2O is greater than D_2O.
Choose the most appropriate answer from the options given below :

A A, B, and C only

B A and C only

C A and D only

D A and B only

26th Feb Morning Shift 2021

Q.23 Water does not produce CO on reacting with :

A C

B CH_4

C C_3H_8

D CO_2

25th Feb Evening Shift 2021

Q.24 Match List - I with List - II.

	List I (Salt)		**List II (Flame colour wavelength)**
(a)	LiCl	(i)	455.5 nm
(b)	NaCl	(ii)	670.8 nm
(c)	RbCl	(iii)	780.0 nm
(d)	CsCl	(iv)	589.2 nm

Choose the correct answer from the options given below :

A (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

B (a)-(iv), (b)-(ii), (c)-(iii), (d)-(i)

C (a)-(i), (b)-(iv), (c)-(ii), (d)-(iii)

D (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)

24th Feb Evening Slot 2021

MCQ Answer Key

1. Ans. (C)	**9. Ans. (D)**	**17. Ans. (D)**
2. Ans. (B)	**10. Ans. (A)**	**18. Ans. (A)**
3. Ans. (B)	**11. Ans. (C)**	**19. Ans. (A)**
4. Ans. (A)	**12. Ans. (C)**	**20. Ans. (C)**
5. Ans. (D)	**13. Ans. (D)**	**21. Ans. (D)**
6. Ans. (A)	**14. Ans. (C)**	**22. Ans. (A)**
7. Ans. (A)	**15. Ans. (D)**	**23. Ans. (D)**
8. Ans. (A)	**16. Ans. (B)**	**24. Ans. (D)**

MCQ Explanation

Ans 1. $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$

Ans 2. Atomic hydrogen is produced at high temperature in an electric are or under ultraviolet radiations.
The dissociation of dihydrogen at 2000 K is only 0.081%.
H-H bond dissociation enthalpy is highest for a single bond for any diatomic molecule.
Dihydrogen can be produced on reacting Zn with dil. HCl as well as NaOH (aq.)

Ans 3. (a) $PbO_2 + 2H_2O \rightarrow Pb(OH)_4$
(b) $Na_2O_2 + 2H_2O \rightarrow 2NaOH + H_2O_2$
this reaction is possible at room temperature
(c) $SnO_2 + 2H_2O \rightarrow Sn(OH)_4$
(d) Acidified $BaO_2 . 8H_2O$ gives H_2O_2 after evaporation.

Ans 4. The bond dissociation energy of D_2 is greater than H_2 and therefore D_2 reacts slower than H_2.

Ans 5. D_2O in used for the study of reaction mechanism. Rate of reaction for the cleavage of O-H bond > O-D bond.

Ans 6. Pure demineralised (de-ionized) water free from all soluble mineral salts is obtained by passing water successively through a cation exchange (in the H^+ form) and an anion exchange (in the OH^- form) resins.

Ans 7. The F^Θ ions make the enamel on teeth much harder by converting hydroxyapatite, $[3Ca_3(PO_4)_2] . Ca(OH)_2]$, the enamel on the surface of the teeth into much harder fluroappatite. $[3Ca_3(PO_4)_2 . CaF_2]$

Ans 8.

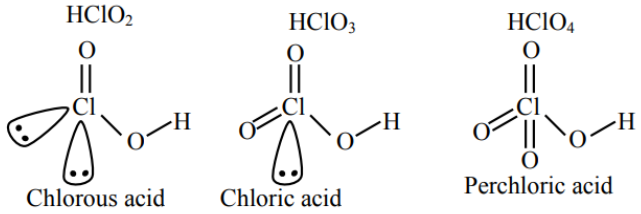
(a) $CuCl_2 + nH_2O \rightarrow Cu^{+2}_{(aq.)}$ (blue colour)

(b) $AgCl + nH_2O \rightarrow$ Insoluble

(c) $ZnCl_2 + nH_2O \rightarrow Zn^{+2}_{(aq.)}$ Colourless

(d) $Cu_2Cl_2 + nH_2O \rightarrow$ Insoluble

Ans 9. Number of Cl = O bonds



Ans 10. Al^{3+} and Fe^{3+} sulphides hydrolyse in water.
Ni^{2+} and Zn^{2+} require basic medium with H_2S to form ppt
Ca^{2+} and Ba^{2+} sulphides are soluble
hence, we will receive only CuS ppt.

Ans 11.

Radioactive isotope of hydrogen is Tritium ($_1^3T$)

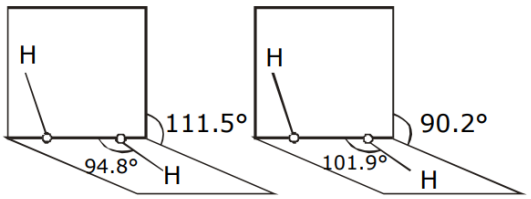
No. of neutrons (A − Z) = 3 − 1 = 2
No. of electrons = 1

Ans 12. Enthalpy of bond dissociation (kJ/mole) at 298.2 K
For, Hydrogen = 435.88
For, Deuterium = 443.35
$\therefore E_H \simeq E_D - 7.5$

Ans 13. On heating concentration of O_2 in water decreases. So boiling water and water at 80^0C having less O_2 concentration. Polluted water also having less O_2 concentration. So water at 4^0C having maximum O_2 concentration.

Ans 14. The single largest industrial application of dihydrogen is in the synthesis of ammonia which is mainly used in the manufacture of fertiliser.

Ans 15.



(a) Gas phase (a) Solid phase

(a) H_2O_2 structure in gas phase, dihedral angle is 111.5°.
(b) H_2O_2 structure in solid phase at 110K, dihedral angle is 90.2°
Hence given statement (A) is not correct.
But statement (B) is correct.

Ans 16. In basic medium, oxidising action of H_2O_2.
$Mn^{2+} + H_2O_2 \rightarrow Mn^{+4} + 2OH^-$
In basic medium, reducing action of H_2O_2.
$I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$
In acidic medium, oxidising action of H_2O_2.
$PbS(s) + 4H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$

Ans 17. A : For temporary hardness,

$Mg(HCO_3)_2 \xrightarrow{heating} Mg(OH)_2 + 2CO_2$ Assertion is false. $MgCO_3$ has high solubility product than $Mg(OH)_2$.

R : $MgCO_3$ is more water soluble than $Mg(OH)_2$.
$K_{SP(Mg(OH)2)} = 1.8 \times 10^{-11}$
$K_{SP(MgCO3)} = 3.5 \times 10^{-8}$

Ans 18. Cation exchange resins contain large organic a molecule with $-SO_3H$ group.
In the cation exchange process H^+ exchanges for Na^+, Ca^{2+}, Mg^{2+} and other cations present in water.
While anion exchange resins contain $-NH_2$ in form of $-NH_3^+ OH^-$ where
OH^- exchanges for anions like Cl^-, HCO_3^-, SO_4^{2-}, etc.

Ans 19. Heavy water (D_2O) is obtained as a by-product in the fertilizer industry. It is used as a moderator in nuclear reactors and for the study of the reaction mechanisms. Its dielectric constant is lower than that of H_2O.

Ans 20. H_2O_2 act as both oxidising and reducing agent.
H_2O_2 is miscible with water
due to open book like structure both -OH group are not in the same plane
H_2O_2 used in the treatment of effluents.

Ans 21. Oxidising action in basic medium
$2Fe^{2+} + H_2O_2 \rightarrow 2Fe^{3+} + 2OH^-$
Reducing action in basic medium
$I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$
Advantage of hydrogen economy is that energy is transmitted in the form of dihydrogen and not as electric power

Ans 22. Viscosity of D_2O is greater than H_2O.
B.P. of D_2O is greater than H_2O.

Ans 23. $CO_2 + H_2O \rightarrow H_2CO_3$
$C + H_2O(steam) \rightarrow CO + H_2$
$CH_4 + H_2O \rightarrow CO + 3H_2$
$C_3H_8 + H_2O \rightarrow 3CO + H_2$

TOPIC 1 Preparation and Properties of Hydrogen

1. Dihydrogen of high purity (> 99.95%) is obtained through: **[Sep. 06, 2020 (II)]**

(a) the reaction of Zn with dilute HCl.
(b) the electrolysis of acidified water using Pt electrodes.
(c) the electrolysis of bringe solution.
(d) the electrolysis of warm $Ba(OH)_2$ solution using Ni electrodes.

2. The equation that represents the water-gas shift reaction is: **[Sep. 05, 2020 (I)]**

(a) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270K} CO(g) + 3H_2(g)$

(b) $2C(s) + O_2(g) + 4N_2(g) \xrightarrow{1273K} 2CO(g) + 4N_2(g)$

(c) $C(s) + H_2O(g) \xrightarrow{1270K} CO(g) + H_2(g)$

(d) $CO(g) + H_2O(g) \xrightarrow[Catalyst]{673K} CO_2(g) + H_2(g)$

3. 5 g of zinc is treated separately with an excess of
(A) dilute hydrochloric acid and
(B) aqueous sodium hydroxide.
The ratio of the volumes of H_2 evolved in these two reactions is: **[Jan. 09, 2020 (II)]**

(a) 1 : 2 (b) 1 : 1 (c) 1 : 4 (d) 2 : 1

4. Hydrogen has three isotopes (A), (B) and (C). If the number of neutron(s) in (A), (B) and (C) respectively, are (x), (y) and (z), the sum of (x), (y) and (z) is: **[Jan. 08, 2020 (II)]**

(a) 3 (b) 2 (c) 4 (d) 1

5. The metal that gives hydrogen gas upon treatment with both acid as well as base is : **[April 12, 2019 (I)]**

(a) magnesium (b) mercury
(c) zinc (d) iron

6. The correct statements among (a) to (d) are : **[April 10, 2019 (II)]**

(i) saline hydrides produce H_2 gas when reacted with H_2O.
(ii) reaction of $LiAlH_4$ with BF_3 leads to B_2H_6.
(iii) PH_3 and CH_4 are electron – rich and electron – precise hydrides, respectively,
(iv) HF and CH_4 are called as molecular hydrides.

(a) (i), (ii), (iii) and (iv) (b) (iii) and (iv) only
(c) (i), (iii) and (iv) only (d) (i), (ii) and (iii) only

7. The correct statements among (a) to (d) regarding H_2 as a fuel are : **[Jan. 11, 2019 (I)]**

(i) It produces less pollutants than petrol.
(ii) A cylinder of compressed dihydrogen weighs ~ 30 times more than a petrol tank producing the same amount of energy.
(iii) Dihydrogen is stored in tanks of metal alloys like $NaNi_5$.
(iv) On combustion, values of energy released per gram of liquid dihydrogen and LPG are 50 and 142 kJ, respectively.

(a) (ii) and (iv) only (b) (i) and (iii) only
(c) (ii), (iii) and (iv) only (d) (i), (ii) and (iii) only

8. NaH is an example of: **[Jan. 11, 2019 (I)]**

(a) Electron-rich hydride (b) Metallic hydride
(c) Saline hydride (d) Molecular hydride

9. The total number of isotopes of hydrogen and number of radioactive isotopes among them, respectively, are: **[Jan. 10, 2019 (I)]**

(a) 3 and 1 (b) 3 and 2 (c) 2 and 1 (d) 2 and 0

10. Among the following reactions of hydrogen with halogens, the one that requires a catalyst is: **[Jan. 10, 2019 (II)]**

(a) $H_2 + I_2 \rightarrow 2\,HI$ (b) $H_2 + Cl_2 \rightarrow 2\,HCl$
(c) $H_2 + Br_2 \rightarrow 2\,HBr$ (d) $H_2 + F_2 \rightarrow 2\,HF$

11. The isotopes of hydrogen are: **[Jan. 9, 2019 (I)]**

(a) Tritium and protium only
(b) Protium and deuterium only
(c) Protium, deuterium and tritium
(d) Deuterium and tritium only

12. Which physical property of dihydrogen is wrong ? **[Online April 11, 2015]**
(a) Odourless gas (b) Tasteless gas
(c) Colourless gas (d) Non–inflammable gas

13. Very pure hydrogen (99.9) can be made by which of the following processes ? **[2012]**
(a) Reaction of methane with steam
(b) Mixing natural hydrocarbons of high molecular weight
(c) Electrolysis of water
(d) Reaction of salts like hydrides with water

14. In context with the industrial preparation of hydrogen from water gas ($CO + H_2$), which of the following is the correct statement? **[2008]**
(a) CO and H_2, are fractionally separated using differences in their densities
(b) CO is removed by absorption in aqueous Cu_2Cl_2 solution
(c) H_2 is removed through occlusion with Pd
(d) CO is oxidised to CO_2 with steam in the presence of a catalyst followed by absorption of of CO_2 in alkali

15. Which of the following statements in relation to the hydrogen atom is correct ? **[2005]**
(a) 3*s*, 3*p* and 3*d* orbitals all have the same energy
(b) 3*s* and 3*p* orbitals are of lower energy than 3*d* orbital
(c) 3*p* orbital is lower in energy than 3*d* orbital
(d) 3*s* orbital is lower in energy than 3*p* orbital

TOPIC 2 Preparation and Properties of Water

16. The one that is NOT suitable for the removal of permanent hardness of water is : **[Sep. 05, 2020 (II)]**
(a) Clark's method
(b) Ion-exchange method
(c) Calgon's method
(d) Treatment with sodium carbonate

17. The hardness of a water sample containing 10^{-3} M $MgSO_4$ expressed as $CaCO_3$ equivalents (in ppm) is _____ .
(molar mass of $MgSO_4$ is 120.37 g/mol)
[NV, Jan. 09, 2020 (I)]

18. Amongst the following, the form of water with the lowest ionic conductance at 298 K is : **[Jan. 09, 2020 (II)]**
(a) distilled water
(b) saline water used for intravenous injection
(c) water from a well
(d) sea water

19. In comparison to the zeolite process for the removal of permanent hardness, the synthetic resins method is: **[Jan. 07, 2020 (I)]**
(a) less efficient as it exchanges only anions
(b) more efficient as it can exchange both cations as well as anions
(c) less efficient as the resins cannot be regenerated
(d) more efficient as it can exchange only cations

20. The temporary hardness of a water sample is due to compound X. Boiling this sample converts X to compound Y. X and Y, respectively, are : **[April 12, 2019 (II)]**
(a) $Mg(HCO_3)_2$ and $Mg(OH)_2$
(b) $Ca(HCO_3)_2$ and $Ca(OH)_2$
(c) $Mg(HCO_3)_2$ and $MgCO_3$
(d) $Ca(HCO_3)_2$ and CaO

21. The synonym for water gas when used in the production of methanol is : **[April 10, 2019 (I)]**
(a) natural gas (b) fuel gas
(c) laughing gas (d) syn gas

22. The number of water molecules(s) not coordinated to copper ion directly in $CuSO_4.5H_2O$, is: **[April 9, 2019 (I)]**
(a) 2 (b) 3 (c) 1 (d) 4

23. 100 mL of a water sample contains 0.81 g of calcium bicarbonate and 0.73 g of magnesium bicarbonate. The hardness of this water sample expressed in terms of equivalents of $CaCO_3$ is:
(molar mass of calcium bicarbonate is 162 g mol^{-1} and magnesium bicarboante is 146 g mol^{-1}) **[April 8, 2019 (I)]**
(a) 5,000 ppm (b) 1,000 ppm
(c) 100 ppm (d) 10,000 ppm

24. The hardness of a water sample (in terms of equivalents of $CaCO_3$) containing 10^{-3}M $CaSO_4$ is:
(molar mass of $CaSO_4$=136 g mol^{-1}) **[Jan. 12, 2019 (I)]**
(a) 10 ppm (b) 50ppm (c) 90 ppm (d) 100ppm

25. The temporary hardness of water is due to: **[Jan. 9, 2019 (II)]**
(a) Na_2SO_4 (b) NaCl
(c) $Ca(HCO_3)_2$ (d) $CaCl_2$

26. Which one of the following statements about water is **FALSE**? **[2016]**
(a) There is extensive intramolecular hydrogen bonding in the condensed phase.
(b) Ice formed by heavy water sinks in normal water.
(c) Water is oxidized to oxygen during photosynthesis.
(d) Water can act both as an acid and as a base.

27. Identify the incorrect statement regarding heavy water : **[Online April 9, 2016]**
(a) It reacts with SO_3 to form deuterated sulphuric acid (D_2SO_4).
(b) It is used as a coolant in nuclear reactors.
(c) It reacts with CaC_2 to produce C_2D_2 and $Ca(OD)_2$.
(d) It reacts with Al_4C_3 to produce CD_4 and $Al(OD)_3$.

28. Permanent hardness in water cannot be cured by : **[Online April 10, 2015]**
(a) Treatment with washing soda
(b) Boiling
(c) Calgon's method
(d) Ion exchange method

29. The numbers of protons, electrons and neutrons in a molecule of heavy water are respectively : **[Online April 23, 2013]**
(a) 8, 10, 11 (b) 10, 10, 10
(c) 10, 11, 10 (d) 11, 10, 10

TOPIC 3 Preparation and Properties of Hydrogen Peroxide

30. Hydrogen peroxide, in the pure state, is :
[Sep. 05, 2020 (II)]
(a) non-planar and almost colorless
(b) linear and blue in color
(c) linear and almost colorless
(d) planar and blue in color

31. The volume strength of 8.9 M H_2O_2 solution calculated at 273 K and 1 atm is _____. ($R = 0.0821$ L atm K^{-1} mol^{-1}) (rounded off to the nearest integer) **[NV, Sep. 03, 2020 (I)]**

32. The strengths of 5.6 volume hydrogen peroxide (of density 1 g/ mL) in terms of mass percentage and molarity (M), respectively, are : **[Sep. 03, 2020 (II)]**
(Take molar mass of hydrogen peroxide as 34 g/ mol)
(a) 1.7 and 0.5 (b) 0.85 and 0.25
(c) 1.7 and 0.25 (d) 0.85 and 0.5

33. Among statements (A)-(D), the correct ones are:
[Jan. 07, 2020 (II)]
(A) Decomposition of hydrogen peroxide gives dioxygen.
(B) Like hydrogen peroxide, compounds, such as $KClO_3$, $Pb(NO_3)_2$ and $NaNO_3$ when heated liberate dioxygen.
(C) 2-Ethylanthraquinone is useful for the industrial preparation of hydrogen peroxide.
(D) Hydrogen peroxide is used for the manufacture of sodium perborate.
(a) (A) (B), (C) and (D) (b) (A), (B) and (C) only
(c) (A), (C) and (D) only (d) (A) and (C) only

34. The strength of 11.2 volume solution of H_2O_2 is : [Given that molar mass of H = 1 g mol^{-1} and O = 16 g mol^{-1}]
[April 8, 2019 (II)]
(a) 13.6% (b) 3.4% (c) 34% (d) 1.7%

35. The volume strength of 1M H_2O_2 is :
(Molar mass of H_2O_2 = 34 g mol^{-1}) **[Jan. 12, 2019 (II)]**
(a) 5.6 (b) 16.8 (c) 11.35 (d) 22.4

36. The chemical nature of hydrogen peroxide is:
[Jan. 10, 2019 (I)]
(a) Oxidising agent in acidic medium, but not in basic medium.
(b) Reducing agent in basic medium, but not in acidic medium.
(c) Oxidising and reducing agent in acidic medium, but not in basic medium.
(d) Oxidising and reducing agent in both acidic and basic medium.

37. Hydrogen peroxide oxidises $[Fe(CN)_6]^{4-}$ to $[Fe(CN)_6]^{3-}$ in acidic medium but reduces $[Fe(CN)_6]^{3-}$ to $[Fe(CN)_6]^{4-}$ in alkaline medium. The other products formed are respectively:
(a) $(H_2O + O_2)$ and H_2O **[2018]**
(b) $(H_2O + O_2)$ and $(H_2O + OH^-)$
(c) H_2O and $(H_2O + O_2)$
(d) H_2O and $(H_2O + OH^-)$

38. From the following statements regarding H_2O_2, choose the incorrect statement : **[2015]**
(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

39. In which of the following reactions H_2O_2 acts as a reducing agent? **[2014]**

(i) $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$

(ii) $H_2O_2 - 2e^- \rightarrow O_2 + 2H^+$

(iii) $H_2O_2 + 2e^- \rightarrow 2OH^-$

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

(a) (i), (iii) (b) (ii), (iv) (c) (i), (ii) (d) (iii), (iv)

40. Hydrogen peroxide acts both as an oxidising and as a reducing agent depending upon the nature of the reacting species. In which of the following cases H_2O_2 acts as a reducing agent in acid medium? **[Online April 12, 2014]**

(a) MnO_4^- (b) $Cr_2O_7^{2-}$ (c) SO_3^{2-} (d) KI

Hints & Solutions

1. **(d)** Dihydrogen of high purity (> 99.95%) is obtained by the electrolysis of $Ba(OH)_2$ using Ni electrodes.

2. **(d)** $CO(g) + H_2O(g) \xrightarrow[\text{Catalyst}]{673K} CO_2(g) + H_2(g)$

This reaction is called water gas shift reaction.

3. **(b)** $Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

NaOH and HCl reacts with a certain amount of zinc to produce equal number of moles of H_2.

4. **(a)**

	^1_1H	$^2_1H(D)$	$^3_1H(T)$
Number of neutron	0	1	2
	(x)	(y)	(z)

Total number of neutrons in three isotopes of hydrogen $= 0 + 1 + 2 = 3$

5. **(c)** $Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

Zn is an amphoteric element.

6. **(a)** (i) Saline hydrides with water produces H_2 gas.

(ii) $3LiAlH_4 + 4BF_3 \rightarrow 2B_2H_6 + 3LiF + 3AlF_3$

(iii) PH_3 is electron rich whereas CH_4 is electron precise hydride.

(iv) HF and CH_4 are molecular hydrides as they are covalent molecules.

7. **(d)** option (i), (ii) and (iii) are correct.

8. **(c)** NaH is an ionic hydride which is also known as saline hydride.

9. **(a)** There are three isotopes of H out of which only tritium is radioactive, which emits low energy β^- particles. Its half life is 12.33 years.

10. **(a)** The reaction between I_2 and H_2 requires catalyst, whereas all other halogens react with H_2 without the requirement of a catalyst.

11. **(c)** Hydrogen has three isotopes:

Protium ($_1H^1$), deuterium ($_1H^2$) and tritium ($_1H^3$).

12. **(d)** H_2 is a highly inflammable gas.

13. **(d)** Very pure hydrogen can be prepared by the action of water on sodium hydride.

$NaH + H_2O \longrightarrow NaOH + H_2\uparrow$

14. **(d)** On the industrial scale, hydrogen is prepared from water gas according to following reaction sequence

$$\underbrace{CO + H_2}_{\text{water gas}} + \underbrace{H_2O}_{\text{(steam)}} \xrightarrow{\text{catalyst}} CO_2 + 2H_2$$

$$\xrightarrow[\text{(alkali)}]{2NaOH} Na_2CO_3 + H_2O$$

15. **(a)** **Note:** In one electron species, such as H-atom, the energy of orbital depends only on the principal quantum number, n.

i.e. is $< 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = 4f$

16. **(a)** Clark's method is used to remove temporary hardness, using lime water (or) $Ca(OH)_2$ from water.

17. **(100.00)**

10^{-3} molar $MgSO_4 \equiv 10^{-3}$ moles of $MgSO_4$ present in 1 L solutions.

10^{-3} M $MgSO_4 \equiv 10^{-3}$ M $CaCO_3$

10^{-3} M $CaCO_3 = 10^{-3} \times 100$g $CaCO_3$ in 1L water

$$ppm_{(\text{in term of CaCO3})} = \frac{10^{-3} \times 100}{1000} \times 10^6$$

$$ppm_{(\text{in term of CaCO3})} = 100 \text{ ppm}$$

18. **(a)** In distilled water, there are only neutral water molecules therefore, it does not conduct electricity.

19. **(b)** Synthetic resin method is more efficient than zeolite process as it can exchange both cations as well as anions.

20. **(a)** Temporary hardness is caused by bicarbonates of calcium and magnesium. On boiling following changes occurs,

$Mg(HCO_3)_2(aq) \xrightarrow{\text{Boiling}} Mg(OH)_2 \downarrow + 2CO_2 \uparrow$

$Ca(HCO_3)_2(aq) \xrightarrow{\text{Boiling}} CaCO_3 \downarrow + CO_2 \uparrow + H_2O$

21. **(d)** When steam is passed over red hot coke, an equimolar mixture of CO and H_2 is obtained.

$$\underset{\text{Steam}}{H_2O(g)} + \underset{\text{Red hot}}{C} \longrightarrow CO + H_2$$

The gaseous mixture thus obtained is called water gas or syn gas (synthesis gas).

22. **(c)** In $CuSO_4 \cdot 5H_2O$, four H_2O molecules are directly coordinated to the central metal ion while one H_2O molecule is hydrogen bonded.

23. **(d)** Moles of $Ca(HCO_3)_2 = \frac{0.81}{162} = 0.005$

Moles of $Mg(HCO_3)_2 = \frac{0.73}{146} = 0.005$

Hardness in terms of $CaCO_3$ in ppm

$= \frac{(0.005+0.005)\times 100}{100} \times 10^6$

$= 10^4$ ppm

24. **(d)** 10^{-3} M $CaSO_4 \equiv 10^{-3}$ M $CaCO_3$

$\Rightarrow 10^{-3}$ M $CaCO_3$ means 10^{-3} moles of $CaCO_3$ are present in 1 L

Molar mass of $CaCO_3 = 40 + 12 + 48 = 100$ g/mol

$$10^{-3}\text{ mol} = \frac{W}{100\text{ g/mol}}$$

$$W = 10^{-3} \times 100\text{ g} = 100\text{ mg}$$

i.e. 100 mg of $CaCO_3$ is present in 1 L solution.

Hardness of water = Number of milligram of $CaCO_3$ per litre of water.

$\therefore$ Hardness of water = 100 ppm

25. **(c)** Only bicarbonates cause temporary hardness, whereas chlorides and sulphates cause permanent hardness.

26. **(a)** There is extensive intermolecular hydrogen bonding in the condensed phase instead of intramolecular H-bonding.

27. **(b)** Heavy water acts as moderator. This is used in nuclear reactors to slow down the speed of fast moving neutrons.

28. **(b)** Only temporary hardness which is due to HCO_3^- (bicarbonate) ions is removed by boiling.

29. **(b)** Heavy water is D_2O hence

number of electrons = 2 + 8 = 10

number of protons = 10

Atomic mass of $D_2O = 4 + 16 = 20$,

hence number of neutron

= atomic mass – number of protons

= 20 – 10 = 10

30. **(a)** H_2O_2 has open book like structure, which is non-planar. It is a colourless viscous liquid but in large quantity appears blue in colour.

31. **(100)**

$$\text{Molarity of } H_2O_2 \text{ solution} = \left\{\frac{\text{Volume strength}}{11.2}\right\}$$

Volume strength = $8.9 \times 11.2 = 99.68\text{ V} \simeq 100\text{ V}$

32. **(a)** For H_2O_2

$$\text{Molarity} = \frac{\text{Volume strength}}{11.2} = \frac{5.6}{11.2} = 0.5\text{ M}$$

$$\text{Molarity} = \frac{\%(w/w)\times 10\times d}{GMM}$$

$$\Rightarrow 0.5 = \frac{\%(w/w)\times 10\times 1}{34}$$

$$\Rightarrow \%(w/w) = \frac{0.5\times 34}{10} = 1.7.$$

33. **(a)** All the statements are correct.

34. **(b)** 11.2 V strength of H_2O_2 means,

11.2 L of O_2 is liberated at STP.

$$H_2O_2 \longrightarrow H_2O + \frac{1}{2}O_2$$

11.2 L of O_2 at STP = 0.5 mol

$\therefore$ No. of moles of $H_2O_2 = 1$ mol

i.e., 1 L of given H_2O_2 solution has 1 mole of H_2O_2 (i.e., 34 g)

$$\text{Strength} = \frac{34}{1000} \times 100 = 3.4\%$$

35. **(c)** Volume strength = 11.35 × molarity = 11.35

36. **(d)** H_2O_2 acts as oxidising agent as well as reducing agent in both acidic and basic medium.

H_2O_2 acts as oxidant:

$H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$ (acidic medium)

$H_2O_2 + 2e^- \rightarrow 2OH^-$ (basic medium)

H_2O_2 acts as reductant:-

$H_2O_2 \rightarrow 2H^+ + O_2 + 2e^-$ (acidic medium)

$H_2O_2 + 2OH^- \rightarrow 2H_2O + O_2 + 2e^-$ (basic medium)

37. **(c)** $[Fe(CN)_6]^{4-} + \frac{1}{2}H_2O_2 + H^+ \longrightarrow [Fe(CN)_6]^{3-} + H_2O$

$$[Fe(CN)_6]^{3-} + \frac{1}{2}H_2O_2 + OH^- \longrightarrow [Fe(CN)_6]^{4-} + H_2O + \frac{1}{2}O_2$$

38. **(c)** H_2O_2 has oxidizing and reducing properties both.

39. **(b)** The reducing agent loses electron during redox reaction i.e. oxidised itself.

(i) $\overset{-1}{H_2O_2} + 2H^+ + 2e^- \longrightarrow 2H_2\overset{-2}{O}$ (Red.)

(ii) $\overset{-1}{H_2O_2} \longrightarrow \overset{0}{O_2} + 2H^+ + 2e^-$ (Ox.)

(iii) $\overset{-1}{H_2O_2} + 2e^- \longrightarrow 2\overset{-2}{OH^-}$ (Red.)

(iv) $\overset{-1}{H_2O_2} + 2OH^- \longrightarrow \overset{0}{O_2} + H_2O + 2e^-$ (Ox.)

40. **(a)** H_2O_2 acts as a reducing agent only in presence of strong oxidising agents (i.e., MnO_4^-) in acidic as well as alkaline medium.

$$2KMnO_4 + 3H_2SO_4 + 5H_2O_2 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$$