9

HYDROGEN

MCQs with One Correct Answer

1. When same amount of zinc is treated separately with excess of sulphuric acid and excess of sodium hydroxide solution the ratio of volumes of hydrogen evolved is

(a) 1 : 1 (b) 1 : 2

(c) 2 : 1 (d) 9 : 4

2. 2 g of aluminium is treated separately with excess of dilute H_2SO_4 and excess of NaOH. The ratio of the volumes of hydrogen evolved is

(a) 2 : 3 (b) 1 : 1

(c) 2 : 1 (d) 1 : 2

3. Consider the following statements :

1. Atomic hydrogen is obtained by passing hydrogen through an electric arc.
2. Hydrogen gas will not reduce heated aluminium oxide.
3. Finely divided palladium adsorbs large volume of hydrogen gas
4. Pure nascent hydrogen is best obtained by reacting Na with C_2H_5OH

Which of the above statements is/are correct ?

(a) only 1 (b) only 2

(c) 1, 2 and 3 (d) 2, 3 and 4

4. Which hydride is an ionic hydride?

(a) H_2S (b) $TiH_{1.73}$

(c) NH_3 (d) NaH

5. The reagent commonly used to determine hardness of water titrimetrically is

(a) oxalic acid

(b) sodium thiosulphate

(c) sodium citrate

(d) disodium salt of EDTA

6. Pure water can be obtained from sea water by

(a) centrifugation

(b) plasmolysis

(c) reverse osmosis

(d) sedimentation

7. Chemical A is used for water softening to remove temporary hardness. A reacts with sodium carbonate to generate caustic soda. When CO_2 is bubbled through a solution of A, it turns cloudy. What is the chemical formula of A.

(a) $CaCO_3$

(b) CaO

(c) $Ca(OH)_2$

(d) $Ca(HCO_3)_2$

8. Which of the following statements do not define the characteristic property of water "Water is a universal solvent"
(a) It can dissolve maximum number of compounds
(b) It has very low dielectric constant
(c) It has high liquid range
(d) None of these

9. The amount of H_2O_2 present in 1 litre of 1.5 N H_2O_2 solution, is
(a) 25.5 g (b) 3.0 g
(c) 8.0 g (d) 2.5 g

10. The volume strength of 1.5 N H_2O_2 solution is
(a) 8.4 (b) 8.0
(c) 4.8 (d) 3.0

11. In lab H_2O_2 is prepared by
(a) cold $H_2SO_4 + BaO_2$
(b) $HCl + BaO_2$
(c) conc. $H_2SO_4 + Na_2O_2$
(d) $H_2 + O_2$

12. The strength in volumes of a solution containing 30.36 g/L of H_2O_2 is
(a) 10 V (b) 5 V
(c) 20 V (d) None of these

13. 20 Volume H_2O_2 solution has a strength of about
(a) 30% (b) 6%
(c) 3% (d) 10%

14. H_2O_2 is a
(a) weak acid (b) weak base
(c) neutral (d) None of these

15. $H_2O_2 \rightarrow 2H^+ + O_2 + 2e^-$; $E^\circ = -0.68$ V. This equation represents which of the following behaviour of H_2O_2 ?
(a) Reducing (b) Oxidising
(c) Acidic (d) Catalytic

16. Heavy water reacts respectively with CO_2, SO_3, P_2O_5 and N_2O_5 to give the compounds
(a) D_2CO_3, D_2SO_4, D_3PO_2, DNO_2
(b) D_2CO_3, D_2SO_4, D_3PO_4, DNO_2
(c) D_2CO_3, D_2SO_3, D_3PO_4, DNO_2
(d) D_2CO_3, D_2SO_4, D_3PO_4, DNO_3

17. A, 6 volume sample of H_2O_2
(a) will contain 6% V/V of H_2O_2
(b) will contain 6% W/V of H_2O_2
(c) would give 6 volumes of oxygen per unit volume of H_2O_2 sample at STP
(d) would give 6 volumes of oxygen per unit weight of H_2O_2 sample at STP

18. In water-gas shift reaction, hydrogen gas is produced from the reaction of steam with
(a) methane (b) coke
(c) carbon monoxide (d) carbon dioxide

19. Treatment with lime can remove hardness of water caused by
(a) $CaCl_2$ (b) $CaSO_4$
(c) $Ca(HCO_3)_2$ (d) $CaCO_3$

20. Permanent hardness of water can be removed by
(a) heating
(b) treating with sodium acetate (CH_3CO_2Na)
(c) treating with $Ca(HCO_3)_2$
(d) treatment with sodium hexametaphosphate ($Na_6P_6O_{18}$)

Numeric Value Answer

21. At room temperature, the ratio of ortho to para hydrogen is n : 1. what is the value of n?

22. If 1 L of hard water (contains $CaSO_4$) requires 0.286 g of washing soda ($Na_2CO_3 . 10H_2O$) for softening process. What is the hardness of water in ppm?

23. 3 Samples of H_2O_2 are labelled as 10 vol., 15 vol. and 20 vol. 100 mL. of each sample is mixed. What is the volume strength of resulting solution?

24. Ordinary water contains traces of heavy water. This is about 1part in $n \times 1000$ parts. What is the integer value of n?

25. What is the amount of energy released (in KJ) on combustion of 1 g of H_2 gas?

ANSWER KEY

1	(a)	**4**	(d)	**7**	(c)	**10**	(a)	**13**	(b)	**16**	(d)	**19**	(c)	**22**	(100)	**25**	(143)
2	(b)	**5**	(d)	**8**	(b)	**11**	(a)	**14**	(a)	**17**	(c)	**20**	(d)	**23**	(15)		
3	(c)	**6**	(c)	**9**	(a)	**12**	(a)	**15**	(a)	**18**	(c)	**21**	(3)	**24**	(6)		

Hints & Solutions

CHAPTER 9

Hydrogen

1. **(a)** $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

$\therefore$ Ratio of volumes of H_2 evolved is 1 : 1

2. **(b)** $2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$

$2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

The ratio of volumes of hydrogen evolved is 1:1.

3. **(c)** Pure hydrogen is evolved by reacting absolute alcohol and Na

$C_2H_5OH + Na \rightarrow C_2H_5ONa + \frac{1}{2}H_2$

other statements are correct.

4. **(d)** All metal hydrides are ionic in nature.

5. **(d)** It forms calcium and magnesium complex with Ca^{2+} and Mg^{2+} ions present in hard water.

6. **(c)** Sea water is purified by reverse osmosis.

7. **(c)** $Ca(OH)_2$ is used for the softening of temporary hard water.

$$Ca(OH)_2(aq) \xrightarrow[\text{Cloudiness}]{} CaCO_3(s) + H_2O(l)$$

8. **(b)** Water has high dielectric constant i.e., 78.39 C^2/Nm^2, high liquid range and can dissolve maximum number of compounds. That is why it is used as universal solvent.

9. **(a)** Molecular weight of $H_2O_2 = 34$

Equivalent weight of $H_2O_2 = 17$

$\therefore$ 1 L of 1 N H_2O_2 has = 17 g of H_2O

$\therefore$ 1 L of 1.5 N H_2O_2 has $= 1.5 \times 17 = 25.5$ g of H_2O_2

10. **(a)** Normality of $H_2O_2 = \dfrac{\text{Vol. strength}}{5.6}$

Volume of normal (1N) H_2O_2 solution = 5.6 volumes.

$\therefore$ Volume of strength of 1.5 N H_2O_2

$= 1.5 \times 5.6 = 8.4$ volumes.

11. **(a)** $H_2SO_4 + BaO_2 \rightarrow BaSO_4 + H_2O_2$

12. **(a)** Equivalent weight $= \dfrac{\text{Molar mass}}{\text{Valence factor}}$

$$= \frac{1\times 2 + 16 \times 2}{2}$$

Eq. wt. of $H_2O_2 = 17$

$$N = \frac{30.36}{17} = 1.78 \text{ N}$$

Volume strength = 5.6 × normality

$= 5.6 \times 1.78 = 10$ V

13. **(b)** $\because$ 22.4L O_2 at S.T.P. is obtained from = 68 g H_2O_2

$\therefore$ 1L O_2 at S.T.P. is obtained from $= \dfrac{68}{22.4}$ g H_2O_2

$\therefore$ 20L O_2 at S.T.P. is obtained from

$$= \frac{68}{22.4} \times 20 \text{ g } H_2O_2 = 60.71 \text{ g of } H_2O_2$$

Therefore, strength of H_2O_2 in 20 volume H_2O_2 = 60.71g/L

$\therefore$ 1000 mL O_2 at S.T.P. is obtained from = 60.71 g H_2O_2

$\therefore$ 100 mL O_2 at S.T.P. is obtained from

$$= \frac{60.71}{1000} \times 100 = 6.071\% \text{ } H_2O_2$$

14. **(a)** $\underset{\text{weak acid}}{H_2O_2} \rightarrow H_2O + [O]$

15. **(a)** As H_2O_2 is loosing electrons so it is acting as reducing agent.

16. **(d)** The D_2O reacts with given compounds as follows:

$D_2O + CO_2 \rightarrow D_2CO_3$

$D_2O + SO_3 \rightarrow D_2SO_4$

$3D_2O + P_2O_5 \rightarrow 3D_3PO_4$

$D_2O + N_2O_5 \rightarrow 2DNO_3$

17. **(c)** 6 volume H_2O_2 would give 6 volumes of O_2 per unit volume of H_2O_2

18. **(c)** In water gas shift reaction carbon monoxide reacts with steam at high temperature to produce carbondioxide and hydrogen.

19. **(c)** Lime can remove temporary hardness of water which is caused due to bicarbonate salt of Ca and Mg.

20. **(d)** When sodium hexametaphosphate is added to hard water it combines with Ca^{2+}, Mg^{2+} ions present in hard water and forms a complex. These complexes with soap readily produce lather.

$$Na_2[Na_4(PO_3)_6] + 2Ca^{2+} \rightarrow Na_2[Ca_2(PO_3)_6] + 4Na^+$$

$$Na_2[Na_4(PO_3)_6] + 2Mg^{2+} \rightarrow Na_2[Mg_2(PO_3)_6] + 4Na^+$$

21. **(3)** The ratio of ortho to para hydrogen can never be more than 3 : 1.

22. **(100)** Molecular mass of $Na_2CO_3 . 10H_2O = 286$

Molecular mass of $CaCO_3 = 100$

$$CaSO_4 + Na_2CO_3 . 10H_2O \rightarrow CaCO_3 + Na_2SO_4 + 10H_2O$$

$$0.286\ g\ Na_2CO_3 . 10H_2O \equiv \frac{0 \cdot 286}{286} = 10^{-3} \text{moles}$$

Moles of $CaCO_3 = 10^{-3}$ moles

Mass of $CaCO_3 \equiv 10^{-3} \times 100 = 10^{-1}$g

1n 1000 g of hard water $\equiv 10^{-1}$g of $CaCO_3$

$$10^6 \text{g of hard water} \equiv \frac{10^{-1}}{1000} \times 10^6$$

$\equiv 100$g. of $CaCO_3$

ppm hardness = 100

23. **(15)** Volume strength $= 5.6 \times N$

$$\text{Thus} \quad N_1 = \frac{10}{5.6}, N_2 = \frac{15}{5.6}, N_3 = \frac{20}{5.6}$$

After mixing total volume = 300 mL

$N_1V_1 + N_2V_2 + N_3V_3 = NV$

$$\frac{10}{5.6} \times 0.1 + \frac{15}{5.6} \times 0.1 + \frac{20}{5.6} \times 0.1 = 0.3 \times N$$

$$N = \frac{10 + 15 + 20}{5.6} \times \frac{0.1}{0.3} = \frac{15}{5.6}$$

$$\text{Volume strength} = 5 \cdot 6 \times \frac{15}{5 \cdot 6} = 15$$

24. **(6)** 6000 parts of ordinary water (H_2O) contains 1 part of heavy water (D_2O).

25. **(143)** 1 g of H_2 gas, release 143 kJ of energy.