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CHAPTER 9

Hydrogen

1. Which of the following species is diamagnetic in nature?

(a) H_2^- (b) H_2^+ **[2005]**

(c) H_2 (d) He_2^+

2. Which of the following statements in relation to the hydrogen atom is correct ? **[2005]**

(a) 3s, 3p and 3d orbitals all have the same energy

(b) 3s and 3p orbitals are of lower energy than 3d orbital

(c) 3p orbital is lower in energy than 3d orbital

(d) 3s orbital is lower in energy than 3p orbital

3. 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

4. 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

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

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

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

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

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

6. From the following statements regarding H_2O_2, choose the incorrect statement : **[JEE M 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

7. Which one of the following statements about water is **FALSE** ? **[JEE M 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.

8. The concentration of fluoride, lead, nitrate and iron in a water sample from an underground lake was found to be 1000 ppb, 40 ppb, 100 ppm and 0.2 ppm, respectively. This water is unsuitable for drinking due to high concentration of : **[JEE M 2016]**

(a) Nitrate (b) Iron

(c) Fluoride (d) Lead

Answer Key														
1	2	3	4	5	6	7	8							
(c)	(a)	(d)	(d)	(d)	(c)	(a)	(a)							

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SOLUTIONS

1. (c) **TIPS / Formulae**

A diamagnetic substance contains no unpaired electron.

H_2 is diamagnetic as it contains all paired electrons

$$\underset{\text{(diamagnetic)}}{H_2 = \sigma_b^2}\ ,\quad \underset{\text{(paramagnetic)}}{H_2^+ = \sigma_b^1},\quad \underset{\text{(paramagnetic)}}{H_2^- = \sigma_b^2},$$

$$\underset{\text{(paramagnetic)}}{\sigma_a^{*1}};\ \underset{\text{(paramagnetic)}}{He_2^+} = \underset{\text{(paramagnetic)}}{\sigma_b^2, \sigma_a^{*1}}$$

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

Hence answer (d)

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

$= 4p \Rightarrow 4d = 4g$

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

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

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

From the above it is clear that CO is first oxidised to CO_2 which is then absorbed in NaOH.

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

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

(very pure Hydrogen)

5. (d) The reducing agent loses electron during redox reaction i.e. oxidises itself.

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

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

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

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

6. (c) has oxidizing and reducing properties both.

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

8. (a) The maximum limit of nitrate in drinking water is 50 ppm. Excess nitrate in drinking water can cause disease such as methemoglobinemia ('blue baby' syndrome).