

1. 4. The number of atoms present in one mole of an element is equal to Avogadro number. Which of the following elements contains the greatest number of atoms?

- (a) 4g He (b) 46g Na (c) 0.40 g Ca (d) 12 g He

2. 5. If the concentration of glucose ( $C_6H_{12}O_6$ ) in blood is  $0.9 \text{ g L}^{-1}$ , what will be the molarity of glucose in blood?

- (a) 5 M  
(b) 50 M  
(c) 0.005 M  
(d) 0.5 M

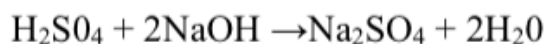
3. 8. What is the mass per cent of carbon in carbon dioxide?

- (a) 0.034%  
(b) 27.27%  
(c) 3.4%  
(d) 28.7%

4. 9. The empirical formula and molecular mass of a compound are  $CH_2O$  and 180g respectively. What will be the molecular formula of the compound?

- (a)  $C_9H_{18}O_9$ ,  
(b)  $CH_2O$   
(c)  $C_6H_{12}O_6$   
(d)  $C_2H_4O_2$

5. 14. Sulphuric acid reacts with sodium hydroxide as follows:



When 1 L of 0.1 M sulphuric acid solution is allowed to react with 1 L of 0.1 M sodium hydroxide solution, the amount of sodium sulphate formed and its molarity in the solution obtained is

- (a)  $0.1 \text{ mol L}^{-1}$   
(b) 7.10 g  
(c)  $0.025 \text{ mol L}^{-1}$   
(d) 3.55 g

# Structure of atom

1. Which of the following is responsible to rule out the existence of definite paths or trajectories of electrons?  
6 (a) Pauli's exclusion principle. (b) Heisenberg's uncertainty principle.  
(c) Hund's rule of maximum multiplicity. (d) Aufbau principal
2. Number of angular nodes for 4d orbital is \_\_\_\_\_.  
7 (a) 4 (b) 3 (c) 2 (d) 1
3. For which of the following sets of quantum numbers, an electron will have the highest energy?  
8 (a) 3, 2, +1, +1/2 (b) 4, 2, -1, +1/2  
(c) 4, 1, 0, -1/2 (d) 5, 0, 0, +1/2
6. The total number of orbitals in a shell having principal quantum number  $n$  is  
9 (a)  $2n$  (b)  $n^2$  (c)  $2n^2$  (d)  $n+1$
7. Azimuthal quantum number defines:  
10 (a)  $e/m$  ratio of electron (b) spin of electron  
(c) angular momentum of electron (d) magnetic momentum of electron

# Thermodynamics

- Q1 Which of the following property cannot be used to describe the state of a system?  
11 (a) pressure (b) volume (c) temperature (d) universal gas constant
- Q2 The open system allows the transfer of \_\_\_\_\_.  
12 (a) Only mass (b) only energy  
(c) both mass and energy (d) neither mass and energy
- Q3 During the process of conversion of ice into the water the specific heat capacity is given by \_\_\_\_\_.  
13 Zero (b) positive (c) infinity (d) negative
- Q4. Which of the following is not a spontaneous process?  
14 (a) Sugar dissolves in water (b) melting of iron  
(c) rusting of iron (d) evaporation of water
- Q5. Spontaneous reactions that occur are mostly  
15 (a) Endothermic (b) exothermic  
(c) both endothermic and exothermic  
(d) neither endothermic nor exothermic

# Equilibrium

5. The pH of a solution is a measure of its:

- 16 a) Solubility
- b) Ionization energy
- c) Hydrogen ion concentration
- d) Density

6. Which salt, when dissolved in water, will produce a basic solution?

- 17 a) NaCl
- b) KNO<sub>3</sub>
- c) Na<sub>2</sub>CO<sub>3</sub>
- d) NH<sub>4</sub>Cl

7. Which of the following pairs can form a buffer solution?

- 18 a) HCl and NaCl
- b) NH<sub>3</sub> and NH<sub>4</sub>Cl
- c) NaOH and NaCl
- d) H<sub>2</sub>SO<sub>4</sub> and KHSO<sub>4</sub>

8. For the buffer system of acetic acid (CH<sub>3</sub>COOH) and sodium acetate (CH<sub>3</sub>COONa), the Henderson-Hasselbalch equation is:

- 19 a)  $\text{pH} = \text{pK}_a + \log\left(\frac{[\text{CH}_3\text{COOH}]}{[\text{CH}_3\text{COONa}]}\right)$
- b)  $\text{pH} = \text{pK}_a + \log\left(\frac{[\text{CH}_3\text{COONa}]}{[\text{CH}_3\text{COOH}]}\right)$
- c)  $\text{pH} = 14 - \text{pK}_a$
- d)  $\text{pH} = 7 + \log\left(\frac{[\text{CH}_3\text{COONa}]}{[\text{CH}_3\text{COOH}]}\right)$

10. The solubility product expression for BaSO<sub>4</sub> is:

- 20 a)  $K_{\text{sp}} = [\text{BaSO}_4]$
- b)  $K_{\text{sp}} = [\text{Ba}^{2+}][\text{SO}_4^{2-}]$
- c)  $K_{\text{sp}} = \frac{[\text{Ba}^{2+}][\text{SO}_4^{2-}]}{[\text{BaSO}_4]}$
- d)  $K_{\text{sp}} = [\text{Ba}^{2+}]^2[\text{SO}_4^{2-}]^2$

## Redox

21 1- Identify disproportionation reaction

- a)  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
- b)  $\text{CH}_4 + 4\text{Cl}_2 \rightarrow \text{CCl}_4 + 4\text{HCl}$
- c)  $2\text{F}_2 + 2\text{OH}^- \rightarrow 2\text{F}^- + \text{OF}_2 + \text{H}_2\text{O}$
- d)  $2\text{NO}_2 + 2\text{OH}^- \rightarrow \text{NO}_2^- + \text{NO}_3^- + \text{H}_2\text{O}$

22 2- The more positive the value of E, the greater the tendency of the species to get reduced. Using the standard electrode potential of redox couples given below find out which of the following is the strongest oxidising agent.

E values:  $\text{Fe}^{3+} / \text{Fe}^{2+} = +0.77$ ;  $\text{I}_2(\text{s}) / \text{I}^- = +0.54$ ;

$\text{Cu}^{2+} / \text{Cu} = +0.34$ ;  $\text{Ag}^+ / \text{Ag} = +0.80 \text{ V}$

- (a) Fe<sup>3+</sup>
- (b) I<sub>2</sub>(s)
- (c) Cu<sup>2+</sup>
- (d) Ag<sup>+</sup>

23 11-The oxidation number of an element in a compound is evaluated on the basis of certain rules. Which of the following rules is not correct in this respect?

- (a) The oxidation number of hydrogen is always +1.
- (b) The algebraic sum of all the oxidation numbers in a compound is zero.
- (c) An element in the free or the uncombined state bears oxidation number zero.
- (d) In all its compounds, the oxidation number of fluorine is -1.

24 12-In which of the following compounds, 'Mn' exhibits highest oxidation state?

- (a)  $\text{KMnO}_4$
- (b)  $\text{K}_2\text{MnO}_4$
- (c)  $\text{MnO}_2$
- (d)  $\text{MnO}$

25 13- $\text{H}_2\text{SO}_4$  acts as a strong oxidising agent. In which of the reaction, is it not acting as an oxidising agent?

- (a)  $\text{C} + 2\text{H}_2\text{SO}_4 \rightarrow \text{CO}_2 + 2\text{SO}_2 + 2\text{H}_2\text{O}$
- (b)  $\text{CaF}_2 + 2\text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + 2\text{HF}$
- (c)  $\text{S} + 2\text{H}_2\text{SO}_4 \rightarrow 3\text{SO}_2 + \text{H}_2\text{O}$
- (d)  $\text{Cu} + 2\text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{SO}_2 + 2\text{H}_2\text{O}$

2marks

24. Hydrogen gas is prepared in the laboratory by reacting dilute HCl with granulated zinc.

26. Following reaction takes place:



Calculate the volume of hydrogen gas liberated at STP when 22.65 g of zinc

27. 6. Which one of the following electronic configurations is correct for chromium?

a)  $[\text{Ar}] 4s^2 3d^4$  or b)  $[\text{Ar}] 4s^1 3d^5$ ? Justify your answer.

28. 19. In a process, 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in the internal energy for the process?

29. 6. 0.2 mole of  $\text{CH}_3\text{COOH}$  are half neutralised by adding NaOH solution. If  $K_a$  for  $\text{CH}_3\text{COOH}$  is  $1.3 \times 10^{-8}$ , calculate the pH of the solution.

30. 1- Calculate the oxidation number of each sulphur atom in the following compounds:

(a)  $\text{Na}_2\text{SO}_3$

(b)  $\text{Na}_2\text{SO}_4$

3 marks

31

44. If 4 g of NaOH dissolves in 36 g of H<sub>2</sub>O, calculate the mole fraction of each component in the solution. Also, determine the molarity of solution (specific gravity of solution is 1 g ml<sup>-1</sup>)

32

2. What is the uncertainty in locating its position? [Given,  $m_e = 9.11 \times 10^{-31}$  kg] An electron speed of 40 ms<sup>-1</sup> accurate up to 99.9 percent.

33

30. The  $\Delta H$  and  $\Delta S$  for  $2\text{Ag}_2\text{O}(s) \rightarrow 4\text{Ag}(s) + \text{O}_2(g)$  are given +61.17 kJ mol<sup>-1</sup> and +132 J K<sup>-1</sup> mol<sup>-1</sup> respectively. Above what temperature will the reaction be spontaneous?

34

10. The ionization constant of phenol is  $1.0 \times 10^{-10}$ . What is the concentration of phenolate ion in 0.05M solution of phenol? What will be its degree of ionization if the solution is also 0.01M in sodium phenolate?

35

1-Balance the following equation in basic medium by ion electron method and oxidation number method and identify the oxidising agent and the reducing agent.



**Case-Based Questions carrying 4 Marks**

36.

46. The mass of one mole of a substance in grams is called its molar mass. The molar mass in grams is numerically equal to atomic molecular/formula mass in u. An empirical formula represents the simplest whole number ratio of various atoms present in a compound, whereas, the molecular formula shows the exact number of different types of atoms present in a molecule of a compound. If the mass per cent of various elements present in a compound is known, its empirical formula can be determined. Molecular formula can further be obtained if the molar mass is known. Many a time, reactions are carried out with the Amounts of reactants that are different than The amounts as

required by a balanced chemical reaction. In such situations, one Reactant is in more amount than the amount required by balanced chemical reaction. The reactant which is present in the least amount Many a time, reactions are carried out with the amounts of reactants that are different than the amounts as required by a balanced chemical reaction. In such situations, one reactant is in more amount than the amount required by balanced chemical reaction. The reactant which is present in the least amount gets consumed after sometime and after that further reaction does not take place whatever be the amount of the other reactant. Hence, the reactant, which gets consumed first, limits the amount of product formed and is, therefore, called the limiting reagent.

**I)** One atomic mass unit (amu) is defined as a mass exactly equal to one-twelfth of the mass of one .....atom.

- (a) Hydrogen – 1 (b) carbon – 12 (c) Oxygen -12 (d) Chlorine – 35

**II)** The mass of one mole of a substance in grams is called its.....

- (a) Atomic mass (b) Molecular Weight (c) Molecular mass (d) molar mass.

**III)** .....is the sum of atomic masses of the elements present in a molecule.

- (a) Atomic mass (b) Molecular Weight (c) Molecular mass (d) molar mass

**IV)** One mole contains exactly .....elementary entities.

- (a)  $6.022 \times 10^{21}$  (b)  $6.022 \times 10^{22}$  (c)  $6.022 \times 10^{23}$  (d)  $6.022 \times 10^{24}$

37.

3. Read the following passage and answer the questions that follow:

The presence of positive charge on the nucleus is due to the protons in the nucleus. As established earlier, the charge on the proton is equal but opposite to that of electron. Atomic number ( $Z$ ) = number of protons in the nucleus of an atom = number of electrons in a neutral atom. protons and neutrons present in the nucleus are collectively known as nucleons. The total number of nucleons is termed as mass number ( $A$ ) of the atom. mass number ( $A$ ) = number of protons ( $Z$ ) + number of neutrons ( $n$ ). Isobars are the atoms with same mass number but different atomic number for example,  $6\ ^{14}\text{C}$  and  $7\ ^{14}\text{N}$ . On the other hand, atoms with identical atomic number but different atomic mass number are known as Isotopes. For example, considering of hydrogen atom again, 99.985% of hydrogen atoms contain only one proton. This isotope is called protium ( $1\ ^1\text{H}$ ). Rest of the percentage of hydrogen atom contains two other isotopes, the one containing 1 proton and 1neutron is called deuterium ( $2\ ^2\text{D}$ , 0.015%) and the other one possessing 1 proton and 2neutrons is called tritium ( $1\ ^3\text{T}$ ). The studies of interactions of radiations with matter have provided immense information regarding the structure of atoms and molecules. Neils Bohr utilized these results to improve upon the model proposed by Rutherford. Two developments played a major role in the formulation of Bohr's model of atom.

1. The pair of ions having same electronic configuration is \_\_\_\_\_.

- (a)  $\text{Cr}^{3+}$ ,  $\text{Fe}^{3+}$                       (b)  $\text{Fe}^{3+}$ ,  $\text{Mn}^{2+}$                       (c)  $\text{Fe}^{3+}$ ,  $\text{Co}^{3+}$                       (d)  $\text{Sc}^{3+}$ ,  $\text{Cr}^{3+}$

2. They have same mass number, different atomic number. These are isobars. In which of the following pairs, the ions are isoelectronic?

- (a)  $\text{Na}^+$ ,  $\text{Mg}^{2+}$                       (b)  $\text{Al}^{3+}$ ,  $\text{O}^-$                       (c)  $\text{Na}^+$ ,  $\text{O}^{2-}$                       (d)  $\text{N}^{3-}$ ,  $\text{Cl}^-$

3. Two atoms are said to be isobars if.

- (a) they have same atomic number but different mass number.  
 (b) they have same number of electrons but different number of neutrons.  
 (c) they have same number of neutrons but different number of electrons.  
 (d) sum of the number of protons and neutrons is same but the number of protons is different.

38.

Q 37. Predict in which of the following the entropy increases or decreases:

- (a) A liquid crystallizes into a solid  
 (b) Temperature of a crystalline solid is raised from 0K to 115K  
 (c)  $2\text{NaHCO}_3(\text{s}) \rightarrow \text{Na}_2\text{CO}_3(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2(\text{g})$   
 (d)  $\text{H}_2(\text{g}) \rightarrow 2\text{H}(\text{g})$

39.

II. Phosphoric acid ( $\text{H}_3\text{PO}_4$ ) is a triprotic acid, meaning it can donate three protons ( $\text{H}^+$ ). It has three ionization constants:  $K_{a1} = 7.5 \times 10^{-3}$ ,  $K_{a2} = 6.2 \times 10^{-8}$ , and  $K_{a3} = 4.8 \times 10^{-13}$ , each corresponding to a stepwise loss of a proton.

- A. How many protons can  $\text{H}_3\text{PO}_4$  donate?  
 B. What does  $K_{a1}$  represent in the ionization of  $\text{H}_3\text{PO}_4$ ?  
 C. Which ionization constant indicates the weakest ionization step?  
 D. Why does  $K_{a3}$  have a much smaller value than  $K_{a1}$ ?

# 5 marks

40

52. A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 L (measured at STP) of this welding gas is found to weigh 11.6 g.

**Calculate** (i) empirical formula, (ii) molar mass of the gas, and (iii) molecular formula.

2. State and explain the following:

(i) Aufbau principle

(ii) Pauli exclusion principle.

(iii) Hund's rule of maximum multiplicity.

41

Q41

(a) Two litres of an ideal gas at a pressure of 10 atm expands isothermally into a vacuum until its total volume is 10 litres. How much heat is absorbed and how much work is done in the expansion ?

(b) Consider the same expansion, but this time against a constant external pressure of 1 atm.

(c) Consider the same expansion, to a final volume of 10 litres conducted reversibly.

42

2. A solution is saturated with calcium fluoride ( $\text{CaF}_2$ ). Calculate the molar solubility of  $\text{CaF}_2$  in water given that the solubility product constant ( $K_{sp}$ ) is  $3.9 \times 10^{-11}$ .

43

4- Consider the elements : Cs, Ne, I, F, and Fe

(a) Identify the element that exhibits only negative oxidation state.

(b) Identify the element that exhibits only positive oxidation state.

(c) Identify the element that exhibits both positive and negative oxidation states.

(d) Identify the element which exhibits neither the negative nor does the positive oxidation state.

e) Identify the element that exhibits which shows +2 and +3 oxidation state.