

**TEST INFORMATION**

DATE : 19.04.2015

CUMULATIVE TEST (CT) - 01

**Syllabus :** Mole concept, Equivalent Concept, Ionic equilibrium, Electrochemistry, Inorganic Nomenclature, Periodic table, Chemical bonding and Coordination compounds, Organic Nomenclature, Isomerism, Stereoisomerism, GOC, POC, Tautomerism, Acids & Bases.

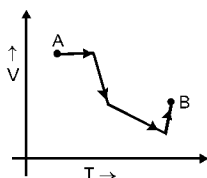
**DPP No. # 04 (JEE-ADVANCED)**

Total Marks : 169

Max. Time : 137 min.

Single choice Objective (–1 negative marking) Q.1 to Q.15	(3 marks 2½ min.)	[45, 37½]
Multiple choice objective (–1 negative marking) Q.16 to Q.20	(4 marks, 3 min.)	[20, 15]
Assertion and Reason (‘–1’ negative marking) Q.21 to Q.23	(3 marks 2½ min.)	[09, 7½]
Comprehension (–1 negative marking) Q.24 to Q.32	(3 marks 2½ min.)	[27, 22½]
Single Digit Subjective Questions (no negative marking) Q.33 to Q.37	(4 marks 2½ min.)	[20, 12½]
Double Digits Subjective Questions (no negative marking) Q.38 to Q.41	(4 marks 2½ min.)	[16, 10]
Match the column (4 vs 4) (no negative marking) Q.42 to Q.44	(8 marks, 8 min.)	[24, 24]
Match the column (4 vs 5) (no negative marking) Q.45	(8 marks, 8 min.)	[08, 08]

1. For the following V-T plot for a gas undergoing a process from state A to state B, select the correct alternative(s).



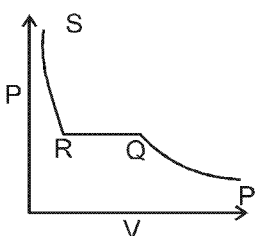
- (A) Pressure constantly increases (B) Pressure first increases, then decreases  
 (C) Final pressure is less than initial pressure (D) Pressure first decreases then increases.
2. In which of the following cases, the work done in an ideal gas system with constant moles 'n' be represented by  $-nR\Delta T$  ?  
 (A) Isochoric reversible heating. (B) Isobaric reversible expansion  
 (C) Isothermal reversible expansion. (D) Adiabatic irreversible expansion.
3. At temperature above 85 K, decarboxylation of acetic acid becomes a spontaneous process under standard state conditions. What is the standard entropy change (in J/K-mol) of the reaction.  
 $\text{CH}_3\text{COOH}(\text{aq}) \longrightarrow \text{CH}_4(\text{g}) + \text{CO}_2(\text{g})$   
 Given :

$$\Delta H_f^\circ [\text{CH}_3\text{COOH}(\text{aq})] = -484 \text{ kJ/mole}$$

$$\Delta H_f^\circ [\text{CO}_2(\text{g})] = -392 \text{ kJ/mole}$$

$$\Delta H_f^\circ [\text{CH}_4(\text{g})] = -75 \text{ kJ/mole}$$

- (A) 100 J/K mole (B) 200 J/K mole (C) 300 J/K mole (D) 400 J/K mole

4. A monoatomic ideal gas at 1200 K is expanded adiabatically from 1 L to 8L, such that its final temperature is 280 K. Which of the following statements is/are true for this process ?  
 (A) This is free adiabatic expansion. (B) This is reversible adiabatic expansion  
 (C) This is irreversible adiabatic expansion (D) This is an impossible process
5. The enthalpy of formation of  $C_2H_6$  is  $-84$  kJ/mol. For  $C_3H_8$ , it is  $-105$  kJ/mol. What is the enthalpy of formation of n-pentane ?  
 (A) Data is insufficient (B)  $-147$  kJ/mol (C)  $-187$  kJ/mol (D)  $-114$  kJ/mol
6. In hcp (ABAB...) and ccp (ABCABC...) structures made up of spheres of equal size, the volume occupied per sphere (including the empty spaces) is ( $a$  = radius of sphere) :  
 (A)  $5.66 a^3$  (B)  $1.33 a^3$  (C)  $2.66 a^3$  (D)  $7.40 a^3$
7. What is the maximum number of layers of atoms in close packed planes that will lie within two imaginary parallel planes having a distance between them of  $13\sqrt{\frac{2}{3}} R$  in the copper crystal (FCC) ? Consider the atoms to be within the parallel planes if their centres are on or within the two parallel planes. [ $R$  = radius of sphere]  
 (A) 5 (B) 6 (C) 7 (D) 8
8. The number of atoms in 100 g of an FCC crystal with density  $d = 10$  gcm $^{-3}$  and cell edge of 200 pm is equal to  
 (A)  $3 \times 10^{25}$  (B)  $5 \times 10^{24}$  (C)  $1 \times 10^{25}$  (D)  $2 \times 10^{25}$
9. Ionic solid  $B^+A^-$  crystallizes in rock salt type of structure. 1.32 gm ionic solid salt  $B^+A^-$  is dissolved in water to make one litre solution. The pH of the solution is measured to be 6.0. If the length of face diagonal in the unit cell of  $B^+A^-$  be  $600\sqrt{2}$  pm. Calculate the density of ionic solid. ( $T = 298$  K),  $K_b$  for BOH is  $10^{-5}$ .  
 [Avogadro Number =  $6.022 \times 10^{23}$ , HA = strong acid]  
 (A) 5 g/cc (B) 4 g/cc (C) 4.5 g/cc (D) 5.5 g/cc
10. 
- The above isotherm was observed for a monoatomic gas at certain temperature. Which of the following is correct ?  
 (A) The gas is behaving ideally  
 (B) The gas is above its critical temperature  
 (C) In the horizontal QR, the pressure is more than critical pressure  
 (D) The gas shows negative deviation from ideal gas in PQ and QR.
11. 10 ml of gaseous hydrocarbon is exploded with 100 ml oxygen. The residual mixture on cooling is found to measure 95 ml, of which, 20 ml is absorbed by KOH and remaining by alkaline pyrogallol. It is known that alkaline pyrogallol absorbs  $O_2$ . Predict the formula of hydrocarbon :  
 (A)  $C_2H_6$  (B)  $C_2H_4$  (C)  $C_2H_2$  (D)  $C_4H_8$
12. If the number of molecules of  $SO_2$  (atomic weight = 64) effusing through an orifice of unit area of cross-section in unit time at  $0^\circ C$  and 1 atm pressure is  $n$ , the number of He molecules (atomic weight = 4) effusing under similar conditions at  $273^\circ C$  and 0.25 atm is :  
 (A)  $\frac{n}{\sqrt{2}}$  (B)  $n\sqrt{2}$  (C)  $2n$  (D)  $\frac{n}{2}$

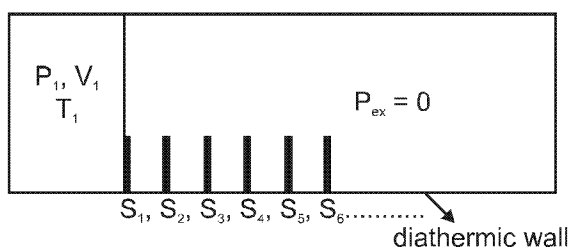
13. A gas 'X' undergoes physisorption on charcoal. If the magnitude of enthalpy change and entropy change were observed to be 20 kJ/mol and 75 J/mol-K, then the temperature range at which adsorption takes place spontaneously is :
- (A)  $T = 287.5 \text{ K}$  (B)  $T > 287.5 \text{ K}$   
 (C)  $T < 287.5 \text{ K}$  (D) At any temperature adsorption will be spontaneous

14. At 70 K, the adsorption of  $\text{N}_2$  gas at iron surface obeys freundlich adsorption isotherm. The experimental data is :

P(bar)	4	25	64
$\frac{x}{m}$	0.2	0.5	0.8

where  $\frac{x}{m}$  is the mass of  $\text{N}_2$  in gram, adsorbed per gram of iron at P bar pressure . The mass of  $\text{N}_2$  gas adsorbed by 5g of Fe at 36 bar and 70 K is :

- (A) 0.6 g (B) 3g  
 (C) 0.8 g (D) Cannot be found from given data
15. Which of the following statements is not correct ?  
 (A) Higher is the gold number of a lyophilic sol, lesser is its coagulating power.  
 (B) An electrolyte can coagulate both positive sol and negative sol.  
 (C) Impurities present in a colloid makes it more stable.  
 (D) Dialysis is a process to remove impurities of ions and molecules from a solution colloid.
16. Which of the following are correct statements ?  
 (A) vander Waals constant 'a' is a measure of attractive force  
 (B) van der Waals constant 'b' is also called co-volume or excluded volume  
 (C) 'b' is expressed in  $\text{L mol}^{-1}$   
 (D) 'a' is expressed in  $\text{atm L}^2 \text{ mol}^{-2}$
17. The origin of charge on colloidal solution is  
 (A) Self dissociation (in soaps and detergents) (B) Electron capture during Bredig's arc method  
 (C) Selective adsorption of ion on their surface (D) It is due to addition of protective colloids
18. Consider the process carried out for an ideal gas.



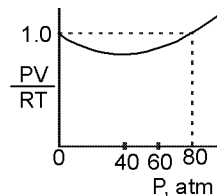
One by one, stoppers  $S_1, S_2, S_3, \dots$  are removed slowly and the gas expands to  $V_2, \text{ L}$  with final pressure  $P_2$  and final temperature  $T_2$ . Which of the following is/are correct for the above process.

- (A)  $T_1 = T_2$  (B)  $P_1 = P_2$  (C)  $U_1 = U_2$  (D)  $w = 0, q = 0$
19. Which of the following statement(s) is/are **false** ?  
 (A)  $\Delta_r S$  for  $\frac{1}{2} \text{Cl}_2(\text{g}) \rightarrow \text{Cl}(\text{g})$  is positive  
 (B)  $\Delta E < 0$  for combustion of  $\text{CH}_4(\text{g})$  in a sealed container with rigid adiabatic system  
 (C)  $\Delta G$  is always zero for a reversible process in a closed system  
 (D)  $\Delta G^\circ$  for an ideal gas reaction is a function of pressure

20. The Vander waal's equation of state for a non-ideal gas can be rearranged to give

$$\frac{PV}{RT} = \frac{V}{V-b} - \frac{a}{VRT} \text{ for 1 mole of gas. The constants } a \text{ \& } b \text{ are positive numbers.}$$

When applied to  $H_2$  at 80K, the equation gives the curve as shown in the figure. Which one of the following statements is(are) correct :



- (A) The two terms  $\frac{V}{(V-b)}$  and  $\frac{a}{VRT}$  are never equal
- (B) At 80 atm, the two terms  $1 + \frac{V}{(V-b)}$  &  $a/VRT$  are equal.
- (C) At a pressure greater than 80 atm, the term  $V/(V-b)$  is greater than  $(a/VRT+1)$ .
- (D) At 60 atm, the term  $V/(V-b)$  is smaller than  $1 + \frac{a}{VRT}$ .
21. **Statement-1** : Gases like  $N_2$ ,  $O_2$  behave as ideal gases at high temperature and low pressure.  
**Statement-2** : Molecular interaction diminishes at high temperature and low pressure .  
 (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
 (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
 (C) Statement-1 is True, Statement-2 is False.  
 (D) Statement-1 is False, Statement-2 is True.
22. **Statement-1** : Tyndall effect is due to scattering of light & not shown by true solution  
**Statement-2** : In a true solution there are no particles of sufficiently large diameter to scatter light & hence the beam is invisible.  
 (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
 (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
 (C) Statement-1 is True, Statement-2 is False.  
 (D) Statement-1 is False, Statement-2 is True.
23. **Statement-1** : In ZnS crystal,  $Zn^{2+}$  ions are placed at 50% of tetrahedral voids (at alternate positions) created by  $S^{2-}$  ion in c.c.p. lattice.  
**Statement-2** : Ratio of number of  $S^{2-}$  ion and number of tetrahedral voids is 2 : 1 where as ratio of number of  $S^{2-}$  ion and number of  $Zn^{2+}$  ion is 1 : 1 in zinc blende.  
 (A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.  
 (B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.  
 (C) Statement-1 is True, Statement-2 is False.  
 (D) Statement-1 is False, Statement-2 is True.

### Comprehension # 1

The speed of a molecule of a gas changes continuously as a result of collisions with other molecules and with the walls of the container. The speeds of individual molecules therefore change, but it is expected that the distribution of molecular speeds does not change with time.

A direct consequence of the distribution of speeds is that the average kinetic energy is constant for a given temperature.

The average K.E, is defined as

$$\overline{KE} = \frac{1}{N} \left( \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 + \dots + \frac{1}{2}mv_N^2 \right) = \frac{1}{2N} m(v_1^2 + v_2^2 + \dots + v_N^2) = \frac{1}{2} m \overline{V^2}$$

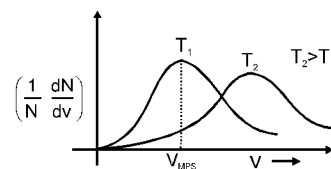


Alternatively it may be defined as  $\overline{KE} = \frac{1}{N} \left( \frac{1}{2} m \sum_i dN_i v_i^2 \right) = \frac{1}{2} m \left( \sum_i \frac{dN_i}{N} \cdot v_i^2 \right)$

where  $\frac{dN_i}{N}$  is the fraction of molecules having speeds between  $v_i$  and  $v_i + dv$  and as proposed by Maxwell

$$\frac{dN}{N} = 4\pi \left( \frac{m}{2\pi KT} \right)^{3/2} \exp(-mv^2/2kT) \cdot v^2 \cdot dv$$

The plot of  $\left( \frac{1}{N} \frac{dN}{dv} \right)$  is plotted for a particular gas at two different



temperatures against 'v' as shown.

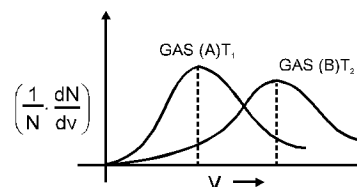
The majority of molecules have speeds which cluster around  $v_{MPS}$  in the middle of the range of v. The area under the curve between any two speeds  $v_1$  and  $v_2$  is the fraction of molecules having speeds between  $v_1$  and  $v_2$ . The speed distribution also depends on the mass of the molecule. As the area under the curve is the same (equal to unity) for all gas samples, samples which have the same  $v_{MPS}$  will have identical Maxwellian plots. On the basis of the above passage answer the questions that follow.

24. For the following graph drawn for two different samples of gases at two different temperatures  $T_1$  and  $T_2$ , which of the following statements is necessarily true :

- (A) If  $T_2 > T_1$ ,  $M_A$  is necessarily greater than  $M_B$   
 (B) If  $T_1 > T_2$ ,  $M_B$  is necessarily greater than  $M_A$

(C)  $\frac{T_2}{M_B} > \frac{T_1}{M_A}$

- (D) Nothing can be predicted



25. If two gases 'A' and 'B' and at temperature  $T_A$  and  $T_B$  respectively have identical Maxwellian plots, then which of the following statements are true ?

(A)  $T_B = T_A$

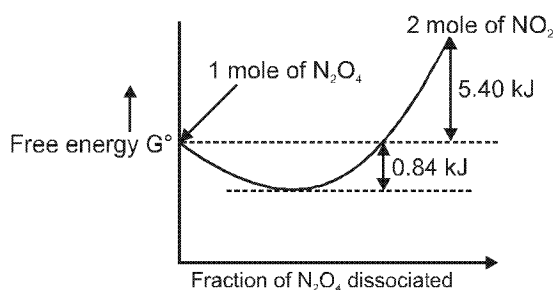
(B)  $M_B = M_A$

(C)  $\frac{T_A}{T_B} = \frac{M_B}{M_A}$

- (D) Gases A and B may be  $O_2$  and  $SO_2$  at  $27^\circ C$  and  $327^\circ C$  respectively.

## Comprehension # 2

A reaction is spontaneous if free energy change,  $\Delta G$ , for the reaction is negative. The question arises, how we can explain the spontaneity of reversible reactions. Let us take the example of dissociation equilibrium of  $N_2O_4 \rightleftharpoons 2NO_2(g)$ . The variation of free energy with the fraction of  $N_2O_4$  dissociated under standard conditions is shown in the figure below :



26. The standard free energy change for the conversion of 1 mole of  $N_2O_4$  into 2 moles of  $NO_2$  is :  
 (A) 5.40 kJ (B) -5.40 kJ (C)  $(5.40 + 0.84)$  kJ (D)  $(5.40 + 2 \times 0.84)$  kJ

27. When 1 mole of  $N_2O_4$  changes into the equilibrium mixture, the value of  $\Delta G$  is :  
 (A) 0.84 kJ (B) -0.84 kJ  
 (C)  $5.40 - 0.84$  kJ (D)  $0.84 - 5.40$  kJ
28. When 2 moles of  $NO_2$  change into equilibrium mixture, the value of  $\Delta G$  is  
 (A)  $(5.40 + 0.84)$  kJ (B)  $(5.40 - 0.84)$  kJ  
 (C)  $(-5.40 - 0.84)$  kJ (D) -5.40 kJ

### Comprehension # 3

Zeta potential is a scientific term for electrokinetic potential in colloidal dispersions. It is usually denoted by using greek letter zeta ( $\zeta$ ) It is the potential difference between dispersion medium and the stationary layer of fluid attached to the dispersed particle.

29. What does a high value of zeta potential indicate :  
 (A) High degree of repulsion between colloidal particles and medium  
 (B) High degree of repulsion between colloidal particles  
 (C) Easy coagulation  
 (D) Electrically unstable colloid.
30. Zeta potential approaches zero  
 (A) in acidic medium (B) basic medium  
 (C) at pH = 7 (D) at pH of isoelectric point

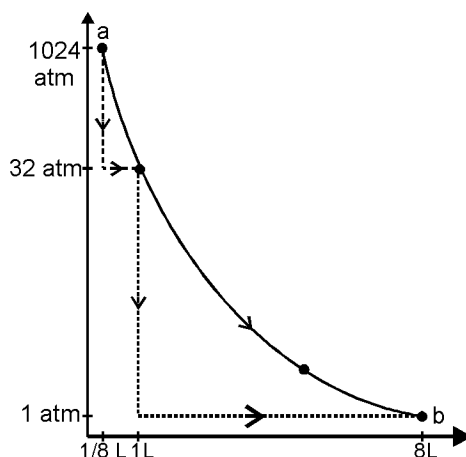
### Comprehension # 4

Minerals having the formula  $AB_2O_4$  and crystallising in cubic system with  $O^{2-}$  ion forming fcc and  $A^{2+}$  &  $B^{3+}$  occupying octahedral & tetrahedral sites are generally termed as spinels.

Spinel is mainly two types : normal and inverse. In normal spinels,  $A^{2+}$  occupy one tetrahedral void and  $B^{3+}$  occupy two octahedral voids per fcc unit cell of  $O^{2-}$ . But in inverse spinel,  $A^{2+}$  occupy 1 octahedral void and  $B^{3+}$  occupy one tetrahedral and one octahedral void per fcc unit cell of  $O^{2-}$  ion.

31.  $MgAl_2O_4$  is having normal spinel structure.  $Mg^{2+}$  and  $Al^{3+}$  are isoelectronic then which of the following statements is correct for  $MgAl_2O_4$  ?  
 (A)  $Mg^{2+}$  being larger in size fits in octahedral void  
 (B)  $Al^{3+}$  being larger in size fits in octahedral void  
 (C)  $Al^{3+}$  occupy tetrahedral and octahedral void equally  
 (D)  $Mg^{2+}$  occupy tetrahedral void irrespective of the larger size than  $Al^{3+}$ .
32. Some spinels have distribution of  $A^{2+}$  and  $B^{3+}$  ions in tetrahedral and octahedral voids. If the formula is  $(A_{1-x}B_x)\left(\frac{A_xB_y}{2}\right)_2O_4$  then y is :-  
 (A) 1 (B) x (C)  $1 - \frac{x}{2}$  (D)  $2 - x$
33. The density of gas A is twice that of a gas B at the same temperature. The molecular weight of gas B is thrice that of A. The ratio of the pressure acting on A and B will be :
34. KCl has NaCl type face centred cubic crystal structure and CsF has CsCl type cubic crystal structure. Calculate the ratio of densities of CsF and KCl. It is given that the molar mass of CsF is twice that of KCl and edge length of KCl unit cell is 2 times that for CsF.

35. One mole of a monoatomic ideal gas is taken from **a** to **b** by expansion along two paths denoted by the solid and dashed line, as shown in the graph below. If  $w_A$  is work done along solid line path and  $w_B$  is work done along dotted line path then find  $\frac{|w_A|}{|w_B|}$ .



36. A cubic unit cell contains ' $A^{x+}$ ' ions at the corners and ' $B^{y-}$ ' ions at the centre of each face.  
 (i) The difference of coordination number of A and B = p  
 (ii) If all atoms along one of the  $C_4$  axis are removed, then the formula becomes  $A_qB_r$   
 Find  $p \times q/r$ .
37. 1 g of charcoal adsorbs 100 mL of 0.5 M  $CH_3COOH$  to form mono layer and there by the molarity of  $CH_3COOH$  reduces to 0.49 M. Calculate the surface area of the charcoal adsorbed by each molecule of  $CH_3COOH$ . Surface area of charcoal =  $3.01 \times 10^2 \text{ m}^2/\text{gm}$ . Give your answer by multiplying with  $10^{19}$ .
38. The nonstoichiometric oxide of iron called Wustite has empirical formula  $Fe_xO$ . It has a density of  $5.75 \text{ g/cm}^3$ , a cubic unit cell with cell constant of 431 pm and an FCC arrangement of oxygen atoms. Find the percentage of occupied iron sites ( $Fe \equiv 56$ )
39. The compression factor (compressibility factor) for 1 mole of a van der Waals' gas at  $727^\circ\text{C}$  and 100 atmosphere pressure is found to be 0.5. Assuming that the volume of gas molecule is negligible, calculate the van der Waal's constant  $a$ . [ $R = 0.082 \text{ atm} \times \text{litre/mol K}$ ]
40. The average energy required to break a  $P-P$  bond in  $P_4(s)$  into gaseous atoms is  $53.2 \text{ kcal mol}^{-1}$ . The bond dissociation energy of  $H_2(g)$  is  $104.2 \text{ kcal mol}^{-1}$ ;  $\Delta H_f^\circ$  of  $PH_3(g)$  from  $P_4(s)$  is  $5.5 \text{ kcal mol}^{-1}$ . The  $P-H$  bond energy in  $\text{kcal mol}^{-1}$  is [Neglect presence of Van der Waals forces in  $P_4(s)$ ]
41. The difference between  $\Delta H$  and  $\Delta E$  on a molar and magnitude basis for the combustion of n-octane at  $25^\circ\text{C}$  would be :

42. Note : In answering this problem, do not neglect vanderwaal's forces in condensed state of matter.

Column I	Column II
(X)	(Y)
(A) $\frac{1}{2}\text{H}_2(\text{g}) \longrightarrow \text{H}(\text{g})$	(p) Enthalpy of formation of Y.
(B) $\text{C}(\text{graphite}) \longrightarrow \text{C}(\text{Diamond})$	(q) X and Y are allotropes
(C) $\text{S}(\text{rhombic}) \longrightarrow \text{S}(\text{g})$	(r) X and Y are two different phases
(D) $\frac{2}{3}\text{O}_3(\text{g}) \longrightarrow \text{O}_2(\text{g})$	(s) The enthalpy change can be used to calculate bond energy in X (without other data)

Column I	Column II
(A) simple cubic and face-centred cubic	(p) have these cell parameters $a = b = c$ and $\alpha = \beta = \gamma$
(B) cubic and rhombohedral	(q) are two crystal systems
(C) cubic and tetragonal	(r) have only two crystallographic angles of $90^\circ$
(D) hexagonal and monoclinic	(s) belong to same crystal system

Column-I	Column-II
	Name of method by which sol is prepared
(A) $\text{As}_2\text{O}_3 + \text{H}_2\text{S} \longrightarrow \text{As}_2\text{S}_3(\text{sol}) + \text{H}_2\text{O}$	(p) Hydrolysis
(B) $\text{AuCl}_3 + \text{HCHO} + \text{H}_2\text{O} \longrightarrow \text{Au}(\text{sol}) + \text{HCOOH} + \text{HCl}$	(q) Double decomposition
(C) $\text{FeCl}_3 + \text{H}_2\text{O} \longrightarrow \text{Fe}(\text{OH})_3(\text{sol}) + \text{HCl}$	(r) Reduction
(D) $\text{Fe}(\text{OH})_3(\text{Fresh ppt}) \xrightarrow[\text{(little)}]{+\text{FeCl}_3} \text{Fe}(\text{OH})_3(\text{sol})$	(s) Peptization

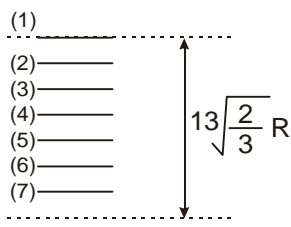
45. Match the processes given in column-I performed on an ideal gas sample with changes in column-II :

Column-I	Column-II
(A) Isothermal expansion against constant external pressure	(p) $\Delta S_{\text{univ}} > 0$
(B) Free expansion against vacuum under isothermal conditions.	(q) $\Delta S_{\text{sys}} = 0$
(C) Reversible adiabatic compression	(r) $\Delta S_{\text{surr}} = 0$
(D) Free expansion against vacuum under adiabatic conditions.	(s) $\Delta S_{\text{sys}} > 0$
	(t) $\Delta G_{\text{sys}} < 0$



## CHEMISTRY

- Can be seen by drawing isochore lines in the PV graph, greater the volume in isochoric process smaller will be the slope of that isochoric line. Hence the result can be obtained.
- $w = -nR\Delta T$  when ( $p_{\text{gas}}$  is constant  $\approx p_{\text{ex}}$ )  
 $w = -p_{\text{ex}} \Delta V$   
 $= -p_{\text{gas}} \Delta V$   
 $= -nR\Delta T$  ; Hence in isobaric system only, this is possible.
- 85 K is equilibrium temperature. ;  $\Delta H_f = -75 - 392 + 484$   
 $= 17 \text{ KJ/mol}$   
 $\Delta G = 0$   
 $17000 - 85 \times \Delta S = 0 \Rightarrow \Delta S = \frac{17000}{85} = 200 \text{ J/mol-K}$
- If the process was reversible adiabatic  
 then  $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$   
 $1200 \times (1)^{2/3} = T_2 \times (8)^{2/3} \Rightarrow 1200 \times \left(\frac{1}{8}\right)^{2/3} = T_2 \Rightarrow \frac{1200}{4} = T_2 = 300 \text{ K}$   
 We know that for a system of ideal gas, during adiabatic expansion, temperature become least for reversible process. But here it is stated that temperature is 280 K. This is not possible for ideal gas.  
 This can also be concluded by  $\Delta S$  calculation for the change.
- $\Delta_f H^\circ$  of  $\text{H}_3\text{C}-\text{CH}_3$  is  $-84 \text{ kJ/mol}$   
 $\Delta_f H^\circ$  of  $\text{H}_3\text{C}-\text{CH}_2-\text{CH}_3$  is  $-105 \text{ kJ/mol}$  ;  $\Delta_f H^\circ$  per  $\text{CH}_2 = -105 + 84 = -21 \text{ kJ/mol}$   
 for pentane  $\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3$ , the ; Value is  $3 \times (-21) + (-84) = -147 \text{ kJ/mol}$ .
- Volume of unit cell in ccp =  $\left(\frac{4a}{\sqrt{2}}\right)^3$  ; so volume per spheric/atom =  $\frac{1}{4} \times \frac{64a^3}{2\sqrt{2}} = 5.66a^3$ .
- Parallel layer are at a distance of  $2\sqrt{\frac{2}{3}} R$



- $a = 200 \text{ pm} = 200 \times 10^{-10} \text{ cm} = 2 \times 10^{-8} \text{ cm}$   
 volume =  $(2 \times 10^{-8})^3$   
 No. of atoms =  $\frac{Z \times A}{d \times a^3} = \frac{4 \times 100}{10 \times (2 \times 10^{-8})^3} = 5 \times 10^{24}$

9.  $B^+A^-$ , salt is be SAWB type for which  $pH = \frac{1}{2}pK_w - \frac{1}{2}pK_b - \frac{1}{2}\log 'c'$ .

$$\therefore 6.00 = 7.0 - \frac{5}{2} - \frac{1}{2}\log 'c' = 5 - \frac{1}{2}\log 'c'.$$

$$\text{or } \frac{1}{2}\log 'c' = -1 \text{ or } \log c = -2 = \log 10^{-2} \quad \therefore c = 10^{-2}$$

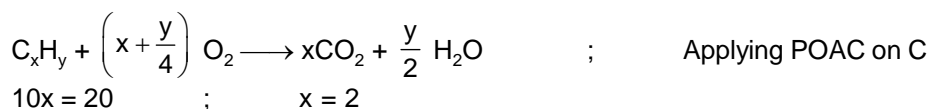
$$\Rightarrow \text{moles} = 10^{-2} \times 1 = 10^{-2} \quad \therefore \frac{1.32}{MM} = \frac{1}{100}$$

$$\text{or mol. wt. of salt} = 132 \quad ; \quad \text{Now } d = \frac{Z}{N_A} \left( \frac{M}{a^3} \right) \quad ; \quad \text{for rock salt } 600 \sqrt{2} = \sqrt{2} a$$

$$\therefore a = 600 \text{ pm} = 600 \times 10^{-10} \text{ cm.} \quad ; \quad d = \frac{4}{6.022 \times 10^{23}} \left[ \frac{132}{(600)^3 \times 10^{-30}} \right] = 4.06 \text{ gm/cc.}$$

10. The graph represents liquefaction of gas. Hence  $Z < 1$   
The gas is below critical temperature.

11. Volume of oxygen used =  $100 - 75 = 25 \text{ ml}$  ; Volume of  $CO_2$  produced =  $20 \text{ ml}$



$$\text{Also, ratio of } O_2 \text{ to hydrocarbon} \quad ; \quad \frac{25}{10} = x + \frac{y}{4}$$

$$\Rightarrow 2.5 = 2 + \frac{y}{4} \quad \Rightarrow 0.5 = \frac{y}{4} \quad \Rightarrow y = 2 \quad \Rightarrow C_2H_2$$

$$12. \quad r_{SO_2} \propto \frac{1}{\sqrt{273 \times 64}} \quad ; \quad r_{He} \propto \frac{1}{4 \times \sqrt{546 \times 4}}$$

$$\Rightarrow \frac{r_{SO_2}}{r_{He}} = \frac{n}{?}$$

$$\Rightarrow \frac{r_{He}}{n} = \frac{1}{4 \times \sqrt{546 \times 4}} \times \frac{\sqrt{273 \times 64}}{1} = \frac{1}{\sqrt{2}}$$

$$13. \quad \Delta H = -20 \text{ kJ/mol} \quad ; \quad \Delta S = -70 \text{ J/mol K} \quad ; \quad \Delta G = \Delta H - T\Delta S < 0$$

$$\Rightarrow -20000 + T \times 70 < 0$$

$$T \times 70 < 20000 \quad ; \quad T < \frac{20000}{70} \quad ; \quad < 285.7$$

$$14. \quad \frac{x}{m} = k (P)^{1/n}$$

$$0.2 = k (4)^{1/n} \quad \dots(1) \quad ; \quad 0.5 = k (25)^{1/n} \quad \dots(2)$$

$$\Rightarrow \frac{2}{5} = \left(\frac{4}{25}\right)^{1/n} \quad ; \quad \left(\frac{2}{5}\right)^1 = \left(\frac{2}{5}\right)^{2/n}$$

$$\Rightarrow \frac{2}{n} = 1 \quad \Rightarrow n = \frac{1}{2} \quad \Rightarrow 0.2 = k (4)^{1/2} \quad \Rightarrow 0.2 = 2k$$

$$\Rightarrow k = 0.1 \quad \Rightarrow \text{At } 70 \text{ k and } 36 \text{ bar} \quad ; \quad \frac{x}{m} = 0.1 \times (36)^{1/2} \quad ; \quad \frac{x}{m} = 0.6$$

Hence mass of  $N_2$  adsorbed by  $5 \text{ g}$  of  $Fe = 5 \times 0.6 = 3 \text{ g}$

15. Facts

16. Factual Question

17. Facts to remember.

18. It look as if process is reversible as it is carried out in small steps. But  $P_{ex} = 0$ , so  $w = 0$

The wall is diathermic, so process is isothermal.

$$\text{Hence, } T_1 = T_2 \quad ; \quad \text{So, } \Delta U = 0 \quad ; \quad \text{So, } U_2 = U_1$$

As gas has expanded without change in temperature, so pressure has decreased.

$$\Delta U = q + w \quad ; \quad \text{So, } q = 0$$



19. (A) Gaseous moles increases, enthalpy increases (B) In isolated system,  $\Delta U = 0$   
 (C) It can be negative or positive also, as in isothermal expansion of ideal gas in a closed system.  
 (D)  $\Delta G^\circ$  is a constant.
20. (A)  $\frac{PV}{RT} \neq 0$  at any point in the graph ; So,  $\frac{V}{V-b} \neq \frac{a}{VRT}$   
 (B) At 80 atm ;  $\frac{PV}{RT} = 1 \Rightarrow \frac{V}{V-b} = 1 + \frac{a}{VRT}$   
 (C) At  $P > 80$  atm ;  $\frac{PV}{RT} > 1 \Rightarrow \frac{V}{V-b} > 1 + \frac{a}{VRT}$   
 (D) Similar explanation as in C
21. Statement-1 and statement-2 are true and statement-2 is correct explanation of 1.
23.  $S^{2-}$  ion : number of tetrahedral void  
 1 : 2
25. If two gases have identical Maxwellian plot then their all the speeds will also be identical.  
 Hence  $\frac{T_A}{M_A} = \frac{T_B}{M_B}$ . Since all the speeds are proportional to  $\sqrt{\frac{T}{M}}$
26.  $\Delta G = G$  for 2 moles of  $NO_2$  –  $G$  for 1 mole of  $N_2O_4$ . = 5.40 kJ  
 Hence, (A) is the correct answer.
27. The lowest point of the plot represents equilibrium mixture. When 1 mole of  $N_2O_4$  changes into equilibrium mixture, free energy is lowered by 0.84 kJ,  $\Delta G = -0.84$  kJ.  
 Hence, (B) is the correct answer.
28. When 2 moles of  $NO_2$  change into equilibrium mixture, free energy is lowered by  $(5.40 + 0.84)$  kJ = 6.24  
 $\Delta G = -6.24$  kJ  
 Hence, (C) is the correct answer.
29. More is the zeta potential, more is the repulsion between charged colloidal particles.
30. At isoelectric point, charged colloidal species do not exist.  
 Hence, zeta potential tends to zero.
31. Clear from comprehension that  $A^{2+}$  occupy tetrahedral void in normal spinel.
32.  $x + 2y = 2 \Rightarrow 2y = 2 - x$  ;  $y = 1 - \frac{x}{2}$
33.  $\frac{d_A}{d_B} = \frac{2}{1} = \frac{P_A M_A}{P_B M_B} = \frac{P_A M_A}{P_B \times 3 \times M_A}$  ;  $\frac{P_A}{P_B} = \frac{6}{1}$
34.  $a_{KCl} = 2 a_{CsF}$  ;  $2M_{KCl} = M_{CsF}$   
 $\rho_{KCl} = \frac{4M_{KCl}}{N_A a_{KCl}^3}$  ;  $\rho_{CsF} = \frac{1M_{CsF}}{N_A a_{CsF}^3}$  ;  $\frac{\rho_{CsF}}{\rho_{KCl}} = \frac{M_{CsF}}{a_{CsF}^3} \cdot \frac{a_{KCl}^3}{4M_{KCl}} = \frac{2}{4} \times \left(\frac{2}{1}\right)^3 = 4$   
 $\frac{\rho_{CsF}}{\rho_{KCl}} = 4$
35. The process denoted by solid line is not isothermal as  $1024 \times \frac{1}{8} \neq 32 \times 1 \neq 8 \times 1$   
 $\gamma = \frac{5}{3}$  ;  $1024 \times \left(\frac{1}{8}\right)^{5/3} = 1024 \times \frac{1}{2^5} = 32$  ;  $32 \times (1)^{5/3} = 32$  ;  $1 \times (8)^{5/3} = 32$   
 i.e.  $PV^\gamma = \text{constant}$  ; Hence, process denoted by solid line is reversible adiabatic.

$$\text{So, } w_{\text{adiabatic reversible}} = \frac{8 \times 1 - \frac{1}{8} \times 1024}{\frac{5}{3} - 1} = \frac{8 - 128}{\frac{2}{3}} = -\frac{120}{2} \times 3 = -180 \text{ L atm}$$

$$\text{and } w_B \text{ along dotted line} = 32 \times \left(1 - \frac{1}{8}\right) + 1(8 - 1) = 32 \times \frac{7}{8} + 7 = 28 + 7 = 35 \text{ atm}$$

$$\Rightarrow \frac{w_A}{w_B} = \frac{180}{35} = \frac{36}{7} = 5.11 \approx 5$$

36. C.N. of  $A^{x+} = 12$

C.N. of  $B^{y-} = 4$

$\Rightarrow$  difference = 8 = p

$C_4$  axis passes through centre of opposite faces. Hence B atoms are removed. Formula becomes  $AB_2$ . So q

$$= 1, r = 2. \quad ; \quad \frac{8 \times 1}{2} = 4.$$

37. 100 ml of 0.5  $CH_3COOH$  contains = 0.05 mole ; after adsorption,  $CH_3COOH$  present = 0.049 mole  
acetic acid adsorbed by 1 gm charcoal =  $0.05 - 0.049 = 0.001 \text{ mole} = 6.023 \times 10^{20} \text{ molecule}$   
surface area of 1 gm charcoal =  $3.01 \times 10^2$   
surface area of charcoal adsorbed by each molecule =  $3.01 \times 10^2 / 6.023 \times 10^{20} = 5 \times 10^{-19} \text{ m}^2$ .

$$38. 5.75 = \frac{(56x + 16) 4}{(4.31 \times 10^{-8})^3 \times 6.02 \times 10^{23}} \Rightarrow x = 0.95$$

For each O, there should be one Fe in normal FeO. But here we have only 0.95 Fe per O. This means that 95% of sites are occupied by Fe.

$$39. \text{ We know that, Compressibility factor, } Z = \frac{PV}{RT} \Rightarrow 0.5 = \frac{100 \times V}{0.082 \times 1000} \therefore V = 0.41 \text{ L}$$

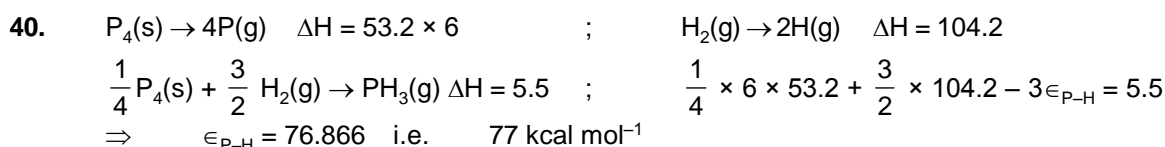
Further when volume of a gas molecule is negligible, van der Waal's equation becomes  $\left(P + \frac{a}{V^2}\right)(V - 0) = RT$

$$\text{or } PV = RT - \frac{a}{V} \quad \text{or } a = RTV - PV^2$$

Substituting the values

$$a = (0.082 \times 0.41 \times 1000) - (100 \times 0.41 \times 0.41) = 33.62 - 16.81 = 16.81 \text{ atm L}^2\text{mol}^{-2}.$$

**Ans. 17**



$$41. \Delta H - \Delta E = -4.5 \times 8.315 \times 298 \text{ J} = -11.15 \text{ kJ}$$

42. (A) It is formation of H.

$H_2(g)$  and  $H(g)$  are both gases, so in same phase,  $H(g)$  is not allotrope of  $H_2$  and  $\epsilon_{H-H} = 2\Delta H_f$ .

(B) It is formation of diamond. It is allotropic change. They are allotropes and also two different solid phases. Bond energy cannot be calculated from only  $\Delta H$  of given reaction.

(C) It is formation of sulphur (g).

They are not allotropes. They are two different phases as S(rhombic) is solid. The  $\Delta H_f$  can't be used to calculate bond energy in X due to vanderwaal's forces.

(D) It is not formation. They are allotropes. They both are gases, so same phase. Bond energy can't be calculated from  $\Delta_f H$ .

43. Refer Notes

44. Fact based

