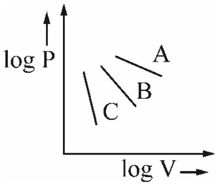
Miscellaneous Exercise Question Bank

1. A mono atomic gas X and a diatomic gas Y both initially at the same temperature and pressure are compressed adiabatically and reversibly from a volume V to $\frac{V}{2}$. Which gas will be at higher temperature.

(A) X **(B)** Y
(C) Both the same **(D)** Cannot be determined

2. Curve A, B and C describe the log P versus log V relation for He, Hydrogen, O_3 and PH_3 during adiabatic process. Curve C is for :



(A) He **(B)** H_2
(C) O_3 **(D)** PH_3

***3.** Which of the following expressions represent the criterion of spontaneity ?

(A) $(\partial S)_{E,V} < 0$ **(B)** $(\partial G)_{T,P} < 0$ **(C)** $(\partial H)_{T,P} < 0$ **(D)** $(\partial E)_{S,V} < 0$

***4.** Which of the following is/are **CORRECT**?

(A) Absolute value of heat content of system can be determined using calorimetry
(B) Absolute value of entropy cannot be known
(C) Absolute value of internal energy cannot be known
(D) Value of $\Delta G_f°$ cannot be determined

***5.** According to IInd law of thermodynamics

(A) Energy of universe is constant
(B) Entropy of universe is continuously increasing
(C) Mass and energy can be interconverted to each other
(D) All spontaneous processes are thermodynamically irreversible

***6.** Which of the given relations is/are **CORRECT**?

(A) $G = H - TS$ **(B)** $\Delta E = q + W$ **(C)** $\Delta H = \Delta E + \Delta n_g RT$ **(D)** $H = E + PV$

***7.** In which process entropy decreases?

(A) Boiling of egg **(B)** Combustion of benzene at 27°C
(C) Stretching of rubber band **(D)** Dissolution of sugar in water

***8.** The **CORRECT** statement is:

(A) Work done in reversible isothermal expansion is always more than the work done in irreversible isothermal expansion
(B) $\Delta G°$ is always zero at equilibrium
(C) ΔG and ΔS_{Total} is always zero at equilibrium
(D) $H_P < H_R$ for exothermic reaction

9. A process is spontaneous at all temperatures if

(A) $\Delta H > 0$ and $\Delta S > 0$ **(B)** $\Delta H > 0$ and $\Delta S < 0$
(C) $\Delta H = 0$ and $\Delta S < 0$ **(D)** $\Delta H < 0$ and $\Delta S > 0$

For Question No. 10 – 14

(A) Statement-I is True, Statement-II is True and Statement-II is a correct explanation for Statement-I

(B) Statement-I is True, Statement-II is True and Statement-II is NOT a correct explanation for Statement-I

(C) Statement-I is True, Statement-II is False **(D)** Statement-I is False, Statement-II is True

10. **Statement I :** $C_P - C_V = R$ for an ideal gas.

Statement II : Average kinetic energy of an ideal gas depends only on temperature.

11. **Statement I :** Since for cyclic process $\Delta S, \Delta G$ and ΔH are zero.

Statement II : Because S, G and H are state functions.

12. **Statement I :** The thermodynamics function which determines the spontaneity of a process is the free energy. For a process to be spontaneous change its free energy must be negative.

Statement II : The change in free energy is related to the change in enthalpy and change in entropy.

13. **Statement I :** An exothermic process which is non-spontaneous at high temperature may become spontaneous at low temperature.

Statement II : With decrease in temperature randomness decreases.

14. **Statement I :** A reaction which is spontaneous and accompanied by decrease of randomness must be exothermic.

Statement II : All exothermic reactions are accompanied by decrease of randomness.

15. Match the following

Column I		**Column II**	
(A)	RMS velocity	**(p)**	Increase if $\Delta U > 0$
(B)	K.E.	**(q)**	Decreases if gas does adiabatic work
(C)	PV	**(r)**	Decreases if gas undergoes dimerization
(D)	$\frac{1}{T_C}$ (T_C = Critical Temperature)	**(s)**	Increases if gas undergoes dissociation
		(t)	Remains constant if gas does isothermal work

16. Match the following

Column I		**Column II**	
(A)	Clausius – Clapeyron equation	**(p)**	$\Delta G = \Delta H + T\left[\frac{\partial(\Delta G)}{\partial T}\right]_P$
(B)	Kirchhoff's equation	**(q)**	$\frac{d\ell n K_P}{dT} = \frac{\Delta H^\circ}{RT^2}$
(C)	Gibb's Helmholtz equation	**(r)**	$\left[\frac{\partial(\Delta G)}{\partial T}\right] = \Delta C_p$
(D)	Van't Hoff Isochore	**(s)**	$\ln \frac{P_2}{P_1} = \frac{\Delta H_v}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$
		(t)	$\Delta G = \Delta U + T\left(\frac{\partial(\Delta G)}{\partial t}\right)_V$

17. Match the following

Column I		Column II	
(A)	Standard free energy change	**(p)**	$nR\ln\frac{V_2}{V_1}$ (at constant temperature)
(B)	Enthalpy change	**(q)**	$-RT \ln K$
(C)	Entropy change	**(r)**	$\Delta E + P\Delta V$
(D)	Free energy change	**(s)**	$-nFE$
		(t)	$\Delta n_g RT$

18. At 0°C, ice and water are in equilibrium. The values of ΔG and ΔS for the conversion of ice to liquid water are (heat of fusion of ice = 6000 J/mol)

(A) 0 and 21.98 JK^{-1} $mole^{-1}$ **(B)** –ve and zero

(C) +ve and 21.98 JK^{-1} $mole^{-1}$ **(D)** zero and zero

19. A chemical reaction cannot occur at all if its

(A) ΔH value is positive and ΔS value is negative **(B)** ΔH value is negative and ΔS value is positive

(C) ΔH and ΔS values are negative but $\Delta H > T\Delta S$ **(D)** ΔH and ΔS values are positive but $\Delta H > T\Delta S$

20. The enthalpy change involved in the oxidation of glucose is –2880 kJ mol^{-1}. Twenty five per cent of this energy is available for muscular work. If 100 kJ of muscular work is needed to walk one kilometer, what is the maximum distance that a person will be able to walk after eating 120 g of glucose?

(A) 4.0 km **(B)** 5.8 km **(C)** 4.8 km **(D)** 6.9 km

21. **Statement 1 :** For reversible adiabatic process, entropy change is zero.

Statement 2 : For reversible adiabatic process work done is a state function.

Statement 3 : Heat capacity is an intensive property.

(A) FFT **(B)** FFF **(C)** FTT **(D)** TFF

22. For the reaction at $25^\circ C,\ X_2O_4(\ell) \longrightarrow 2XO_2(g)$

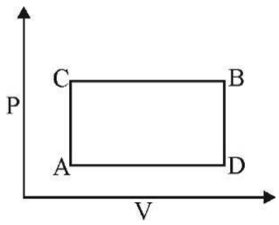
$\Delta H = 2.1$ kcal and $\Delta S = 20\,\text{cal}\,K^{-1}$. The reaction would be :

(A) spontaneous **(B)** non-spontaneous **(C)** at equilibrium **(D)** unpredictable

23. If one mole of an ideal gas $\left(C_{p,m} = \frac{5}{2}R\right)$ is expanded isothermally at 300 K until it's volume is tripled, then change in entropy for the gas is R ln 3 if above expansion is carried out freely (P_{ext} = 0), then find ΔS ?

(A) – R ln 3 **(B)** R ln 2 **(C)** R ln 3 **(D)** None of these

24. When a system is taken from state B to state A along path BDA as shown in figure below, 60 J of heat flows out of the system and 10 J of work is done on the system. If $E_B - E_C = 30$ J and 20 J of work is done by the system along path ACB, then the heat corresponding to the processes AC and BC is respectively :



(A) $q_{AC} = -20\,J\ \&\ q_{BC} = -50\,J$ **(B)** $q_{AC} = -20\,J\ \&\ q_{BC} = 50\,J$

(C) $q_{AC} = 20\,J\ \&\ q_{BC} = 50\,J$ **(D)** $q_{AC} = 20\,J\ \&\ q_{BC} = -50\,J$

25. In a system, a piston caused an expansion against an external pressure of 1.25 bar giving a change in volume of 32 L for which $\Delta E = -51 kJ$. What was the value of heat evolved :

(A) –55 kJ **(B)** –100 cal **(C)** $-47 kJ$ **(D)** –91 kJ

26. If 1 mole of an ideal gas expands isothermally at $37^\circ C$ from 15 litres to 25 litres, the maximum work obtained is :

(A) 1316 J **(B)** 131.6 J **(C)** 8.57 J **(D)** 2.92 J

27. What are the signs of the entropy change $(+ \text{ or } -)$ in the following :

I. A liquid crystallises into solid
II. Temperature of crystalline solid is raised from 0 K to 115 K
III. $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$
IV. $H_2(g) \rightarrow 2H(g)$

(A)	I	II	III	IV	**(B)**	I	II	III	IV
	–	+	+	+		–	–	+	+
(C)	I	II	III	IV	**(D)**	I	II	III	IV
	–	–	–	+		+	–	–	–

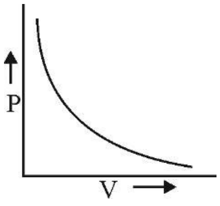
28. If $HA + NaOH \longrightarrow NaA + H_2O \quad \Delta H = -12 kcal$

and $HB + NaOH \longrightarrow NaB + H_2O \quad \Delta H = -11 kcal$

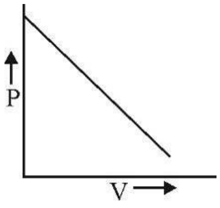
then equimolar solution of which acid has higher pH :

(A) HA **(B)** HB
(C) both have same pH **(D)** information insufficient

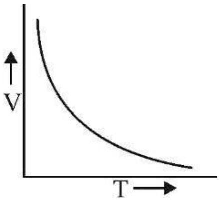
29. In the following processes, identify the irreversible process :



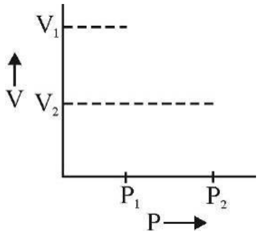
(A)



(B)



(C)



(D)

30. One mole of non-ideal gas undergoes a change of state (1.0 atm, 3.0 L, 200 K) to (4.0 atm, 5.0 L, 250 K) with a change in internal energy $(\Delta U) = 40 L-atm$. The change in enthalpy of the process in L-atm;

(A) 43 **(B)** 57 **(C)** 42 **(D)** None of these

31. The equilibrium constant for $A(g) + B_2(g) \rightleftharpoons AB_2(g) \quad K_p = 100$ at $522 K$. Structure of AB_2 is like H_2O.

If bond energy of A – B bond is 200 kJ/mol and that B – B bond is 100 kJ/mol, find ΔS° of above reaction :

(A) $-0.53 J/mol-K$ **(B)** $-536 J/mol-K$
(C) $-550 J/mol-K$ **(D)** $-5.36 J/mol-K$

32. When 1 L of NaOH (1 M) is mixed with 1 L of HCl (1 M) the temperature of reaction mixture rises by $10^\circ C$. When 1 L of NaOH (1 M) is mixed with 2 L (0.5 M) HCl, the temperature of reaction mixture rises approximately by :

(A) $10^\circ C$ **(B)** $5^\circ C$ **(C)** $6.67^\circ C$ **(D)** $3.33^\circ C$

33. At $0^\circ C$, $\Delta H^\circ_{fus} = 6 kJ/mol$, change of entropy for freezing of one mole of water will be :

(A) ∞ **(B)** 0

(C) –21.98 J/mol-K **(D)** –13.6 J/mol-K

34. At $27^\circ C$, N_2O_4 has vapour density $= \frac{230}{6}$. If the equilibrium pressure is 0.96 atm, then find ΔG°. (given log 2 = 0.3).

(A) 1.1 Kcal **(B)** 193 Kcal **(C)** 79.3 Kcal **(D)** 8.041 Kcal/mol

35. $\Delta S = \frac{q_{rev}}{T}$, so

(A) ΔS is defined only for reversible process

(B) For irreversible process, ΔS is calculated by considering the process irreversible

(C) For irreversible process, $A \to B$ and same process taking place reversible, ΔS is same

(D) ΔS_{sys} is always zero for irreversible process

36. A 10 g piece of iron $(C = 0.45 J/g^\circ C)$ at $100^\circ C$ is dropped into 25 g of water $(C = 4.2 J/g^\circ C)$ at $27^\circ C$. Find temperature of the iron and water system at thermal equilibrium.

(A) $30^\circ C$ **(B)** $33^\circ C$ **(C)** $40^\circ C$ **(D)** None of these

37. What is the final temperature of 0.10 mole monoatomic ideal gas that performs 75 cal of work adiabatically if the initial temperature is $227^\circ C$? (use R = 2 cal/K-mol)

(A) 250 K **(B)** 300 K **(C)** 350 K **(D)** 750 K

38. The molar heat capacity of a monatomic ideal gas undergoing the process $PV^{1/2}$ = constant is

(A) $\frac{15}{2}R$ **(B)** $\frac{23}{2}R$ **(C)** $\frac{7}{2}R$ **(D)** Zero

39. What is the change in entropy when 2.5 mole of water is heated from $27^\circ C$ to $87^\circ C$? Assume that the heat capacity is constant $(C_p)_m$ (H_2O) = 4.2 J/g-K, $\ell n(1.2) = 0.18$)

(A) 16.6 J/K **(B)** 9 J/K

(C) 34.02 J/K **(D)** 1.89 J/K

40. Calculate standard entropy change in the reaction

$$Fe_2O_3(s) + 3H_2(g) \longrightarrow 2Fe(s) + 3H_2O(\ell)$$

Given: $S^0_m(Fe_2O_3, s) = 87.4$, $S^0_m(Fe, s) = 27.3$, $S^0_m(H_2, g) = 130.7$, $S^0_m(H_2O, \ell) = 69.9\ JK^{-1}mol^{-1}$

(A) $-212.5\ JK^{-1}mol^{-1}$ **(B)** $-215.2\ JK^{-1}mol^{-1}$

(C) $-120.9\ JK^{-1}mol^{-1}$ **(D)** None of these

41. For isothermal expansion in case of an ideal gas :

(A) $\Delta G = \Delta S$ **(B)** $\Delta G = \Delta H$ **(C)** $\Delta G = -T.\Delta S$ **(D)** None of these

42. Calculate the entropy change when 3.6 g of liquid water is completely converted into vapour at $100^\circ C$. The molar heat of vaporization is 40.85 kJ mol^{-1}

(A) $6.08\ JK^{-1}$ **(B)** $109.5\,JK^{-1}$ **(C)** $21.89\,JK^{-1}$ **(D)** $-21.89\,JK^{-1}$

43. The molar entropy content of 1 mole of oxygen (O_2) gas at 300 K and 1 atm is $250\,J\,mole^{-1}K^{-1}$. Calculate ΔG when 1 mole of oxygen is expanded reversibly and isothermally from 300 K, 1 atm to double its volume (Take $R = 8.314\ J\ mole^{-1}\,K^{-1}$, $\log e = 2.303$)

(A) $1.728\ kJ\ mole^{-1}\,K^{-1}$ **(B)** 0

(C) $-1.728\ kJ\,mole^{-1}\,K^{-1}$ **(D)** $0.75\,kJ\,mole^{-1}K^{-1}$

44. How many of the given statements are correct:

I : Molar entropy of a substance follows the order $(S_m)_{Solid} < (S_m)_{liquid} < (S_m)_{gas}$

II : Entropy change of system for the reaction $H_2(g) \longrightarrow 2H(g)$ is +ve.

III : Molar entropy of a non-crystalline solid will be zero at absolute zero.

IV : If the path of an irreversible process is reversed, then both system and surroundings shall be restored to their original states.

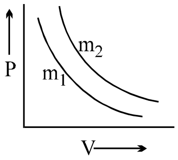
V : Refractive index and molarity are intensive properties.

(A) 2 **(B)** 3 **(C)** 4 **(D)** 5

45. One mole of an ideal monoatomic gas at $27^\circ C$ is subjected to a reversible isoentropic compression until final temperature reached to $327^\circ C$. If the initial pressure was 1.0 atm, then find the value of in $\ell n\, P_2$. (Given : ln 2 = 0.7).

(A) 1.75 atm **(B)** 0.176 atm **(C)** 1.0395 atm **(D)** 2.0 atm

46. Two different isotherms representing the relationship between pressure *P* and volume *V* at a same temperature of the same ideal gas are shown for masses m_1 and m_2 of the gas respectively in the figure given, then:



(A) $m_1 > m_2$ **(B)** $m_1 = m_2$

(C) $m_1 < m_2$ **(D)** All of the above are possible

47. Match the following

	Column I		Column II
(A)	Isothermal process (reversible)	**(p)**	$w = -2.303\ nRT\ \log\left(\frac{P_1}{P_2}\right)$
(B)	Adiabatic process (reversible)	**(q)**	w= 0
(C)	Adiabatic free expansion	**(r)**	$w = -2.303nRT\log\left(\frac{V_2}{V_1}\right)$
(D)	Isothermal free expansion	**(s)**	$w = \frac{nR}{(\gamma-1)}(T_2 - T_1)$

***48.** The poisson's ratio for O_2 is 1.4. Which of the following are **CORRECT** for O_2 ?

(A) $C_V = 5\text{cal}$ **(B)** $C_V = 0.156$ cal **(C)** $C_P = \frac{R\gamma}{\gamma - 1}$ **(D)** $C_V = \frac{R}{(\gamma - 1)}$

49. Temperature of 1 mol of a gas is increased by 1°C at constant pressure. The work done is:

(A) –R **(B)** –2R **(C)** –R/2 **(D)** –3/R

50. The dissolution of NH_4Cl in water is endothermic even though NH_4Cl dissolves in water spontaneously. Which one of the following best explains this behaviour?

(A) The bonds in solid NH_4Cl are weak
(B) the entropy-driving force causes dissolution
(C) Endothermic processes are energetically favourable
(D) The dissolving process is unrelated to energy

51. For hypothetical reversible reaction $\frac{1}{2}A_2(g) + \frac{3}{2}B_2(g) \longrightarrow AB_3(g)\,;\, \Delta H = -20\text{kJ}$ if entropies of A_2, B_2, and AB_3 are 60, 40, and $50\,\text{J}\,\text{K}^{-1}\text{mol}^{-1}$, respectively the above reaction will be at equilibrium at.

(A) 400K **(B)** 500 K **(C)** 250 K **(D)** 200 K

52. Under which of the following condition is the relation $\Delta H = \Delta U + P\Delta V$ valid for a closed system at

(A) Constant pressure
(B) Constant temperature
(C) Constant temperature, and pressure
(D) Constant temperature, pressure, and composition

For Question No. 53 – 68

(A) Statement-I is True, Statement-II is True and Statement-II is a correct explanation for Statement-I.
(B) Statement-I is True, Statement-II is True and Statement-II is NOT a correct explanation for Statement-I.
(C) Statement-I is True, Statement-II is False.
(D) Statement-I is False, Statement-II is True.
(E) If both I & II are false]

53. **Statement : I** The endothermic reactions are favoured at lower temperature and the exothermic reactions are favoured at higher temperature.

Statement : II When a system in equilibrium is disturbed by changing the temperature, it will tend to adjust itself so as to overcome the effect of the change.

54. **Statement : I** $C_p - C_V = R$ for an ideal gas.

Statement : II $\left[\frac{\partial E}{\partial V}\right]_T = 0$ for an ideal gas.

55. **Statement : I** When hydrogen gas at high pressure and room temperature expands adiabatically into a region of low pressure, there is a decrease in temperature.

Statement : II Hydrogen gas at room temperature is above its inversion temperature.

56. **Statement : I** The thermodynamic factor which determines the spontaneity of a process is the free energy. For a process to be spontaneous the free energy must be negative.

Statement : II The change in free energy in relation to the change in a process must always be positive if it is spontaneous.

57. **Statement : I** The Joules – Thomson coefficient for an ideal gas is zero.

Statement : II There are no intermolecular attractive forces in an ideal gas.

58. **Statement : I** Enthalpy of graphite is lower than that of diamond.

Statement : II Entropy of graphite is lower than that of diamond.

59. **Statement : I** The enthalpy of formation of gaseous oxygen molecules at 298 K and under a pressure of 1 atm is zero.

Statement : II The entropy of formation of gaseous oxygen molecules under the same condition is zero.

60. **Statement : I** Decreases in free energy cause spontaneous reaction.

Statement : II Spontaneous reactions are invariably exothermic.

61. **Statement : I** Many endothermic reactions that are not spontaneous at room temperature become spontaneous at high temperature.

Statement : II Entropy of the system increases with increase in temperature.

62. **Statement : I** The enthalpy of formation of $H_2O(\ell)$ is greater than that of $H_2O(g)$

Statement : II Enthalpy change is negative for the condensation reaction $H_2O(g) \longrightarrow H_2O(\ell)$

63. **Statement : I** Pressure, volume, and temperature are all extensive properties.

Statement : II Extensive properties depend upon the amount and nature of the substance.

64 **Statement : I** When a gas at high pressure expands against vacuum, the work done is maximum.

Statement : II Work done in expansion depends upon the pressure inside the gas and increase in volume.

65. **Statement : I** When a real gas is allowed to expand adiabatically through a pin hole from a region of high pressure to a region of low pressure, the temperature of the gas falls.

Statement : II Work is done at the cost of internal energy of the gas.

66. **Statement : I** Internal energy change in a cyclic process is zero.

Statement : II Internal energy is a state function.

67. **Statement : I** An exothermic process, non-spontaneous at high temperature, may become spontaneous at low temperature.

Statement : II With decrease in temperature, randomness (entropy) decreases.

68. **Statement : I** A reaction which is spontaneous and accompanied by decreases of randomness must be exothermic.

Statement : II All exothermic reaction are accompanied by decrease of randomness.

69. Heat of combustion of ethanol at constant pressure and at temperature T K(= 298 K) is found to be – q J mol^{-1}. Hence, heat of combustion (in J mol^{-1}) of ethanol at the same temperature at constant volume will be:

(A) RT – q **(B)** – (q + RT) **(C)** q – RT **(D)** q + RT

70. Which statement regarding entropy is correct?

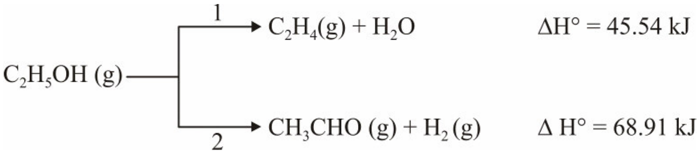
(A) A completely ordered deck of cards has more entropy than a shuffled deck in which cards are arranged randomly

(B) A perfect ordered crystal of solid nitrous oxide has more entropy than a disordered crystal in which the molecules are oriented randomly

(C) 1 mole N_2 gas at STP has more entropy than 1 mole N_2 gas at 273 K in a volume of 11.2 litre

(D) 1 mole N_2 gas at STP has more entropy than 1 mole of N_2 gas at 273 K and 0.25 atm

71. Ethanol can undergo decomposition to form two sets of products.



If the molar ratio of C_2H_4 to CH_3CHO is 8 : 1 in a set product gases, then the energy involved in the decomposition of 1 mole of ethanol is

(A) 65.98 kJ **(B)** 48.137 kJ **(C)** 48.46 kJ **(D)** 57.22 kJ

72. Calculate $\Delta_r G^o$ for (NH_4Cl, s) at 310 K.

Given : $\Delta_f H^o(NH_4Cl, s) = -314.5\ kJ/mol$; $\Delta_r H_c = 0$

$S^o_{N_2(g)} = 192\ JK^{-1}\ mol^{-1}$; $S^o_{H_2(g)} = 130.5\ JK^{-1}\ mol^{-1}$;

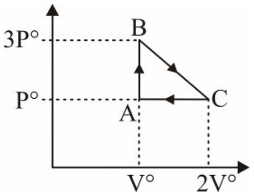
$S^o_{Cl_2}(g) = 233\ JK^{-1}\ mol^{-1}$; $S^o NH_4Cl(s) = 99.5\ JK^{-1}\ mol,^{-1}$

All given data are at 300 K.

(A) –198.56 kJ/mol **(B)** –426.7 kJ/mol

(C) –202.3 kJ/mol **(D)** None of these

73. One mole of ideal monoatomic gas is carried through the reversible cyclic process as shown in figure. Calculate the maximum temperature attained by the gas during the cycle.



(A) $\frac{25}{8}\left(\frac{P°V°}{R}\right)$ **(B)** $-\frac{25}{8}\left(\frac{P°V°}{R}\right)$

(C) $\frac{35}{8}\left(\frac{P°V°}{R}\right)$ **(D)** $-\frac{35}{8}\left(\frac{P°V°}{R}\right)$

74. The enthalpy of neutralization of a weak monoatomic acid (HA) in 1M solution with a strong base is $-55.95\,kJ/mol$. If the unionized acid requires $1.4\,kJ/mol$ heat for it's complete ionization and enthalpy of neutralization of the strong monobasic acid with a strong monoacidic base is $-57.3\,kJ/mol$. What is the % ionization weak acid in molar solution ?

(A) 1% **(B)** 3.57% **(C)** 35.7% **(D)** 10%

75. For a perfectly crystalline solid $C_{p.m.} = aT^3$, where a is constant. If $C_{p.m.}$ is $0.42\,J/K-mol$ at 10K, molar entropy at 10k is:

(A) $0.42\,J/K$ - mol **(B)** $0.14\,J/K$ - mol

(C) $4.2\,J/K$ - mol **(D)** zero

***76.** **Statement-I :** The gas undergoes an isothermal process.

Statement-II : The gas undergoes a process such that its initial temperature equal to its final temperature.

(A) If 1st is true, 2 nd may be false. **(B)** If 2nd is true, 1st may be false.

(C) If 1st is true, 2 nd must be true. **(D)** If 2nd is true, 1st must be true.

77. Fixed amount of an ideal mono atomic gas contained in a sealed rigid vessel (V = 24.6 litre) at 1.0 bar heated reversibly from 27°C to 127°C. Determine change in Gibb's energy (in Joule) if entropy of gas $S = 10 + 10^{-2}T\,(J/K)$

(A) 530 J **(B)** 378.5 J **(C)** 1778.5 J **(D)** 3778.5 J

***78.** Which of the following statement(s) is/are true?

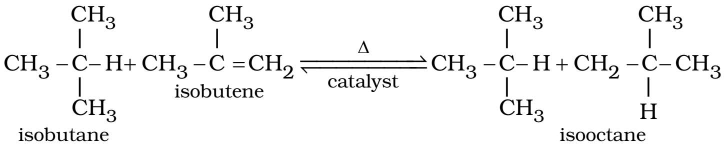
(A) $\Delta E = 0$ for combustion of $C_2H_6(g)$ in a sealed rigid adiabatic container

(B) $\Delta_r H°$ (S, monoclinic) $\neq 0$

(C) If dissociation energy of CH_4 (g) is 1656 kJ/mol, and C_2H_6(g) is 2812 kJ/mol then value of C – C bond energy will be 328 kJ/mol

(D) If $\Delta H_f(H_2O, g) = -242$ kJ/mol; $\Delta H_{vap}(H_2O, l) = 44$ kJ/mol then $\Delta_f H^0(OH^-, aq.)$ will be –142 kJ/mol

79. The following is an example of an alkylation reaction that is important in the production of isooctane (2, 2, 4-trimethylpentane) from two components of crude oil, isobutane and isobutene. Iso-octane is an antiknock additive for gasoline.



$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-H + CH_3-\overset{CH_3}{C}=CH_2 \underset{\text{catalyst}}{\overset{\Delta}{\rightleftharpoons}} CH_3-\underset{CH_3}{\overset{CH_3}{C}}-H + CH_2-\underset{H}{\overset{CH_3}{C}}-CH_3$$

The thermodynamic equilibrium constant, K, for this reaction at 25°C is 4.3×10^6, and $\Delta H°$ is –78.58 kJ/mol.

$\Delta G°$ of the above reaction at 25°C is

(A) –16.44 kJ mol^{-1} **(B)** +16.44 kJ mol^{-1}

(C) –37.85 kJ mol^{-1} **(D)** +37.85 kJ mol^{-1}

***80.** Which of the following statement(s) is/are false?

(A) All adiabatic processes are is entropic (or isentropic) processes

(B) When $(\Delta G_{system})_{T.P} < 0$; the reaction must be exothermic

(C) dG = VdP – SdT is applicable for closed system, both PV and non-PV work

(D) The heat of vaporization of water at 100°C is 40.6 kJ/mol. When 9 gm of water vapour condenses to liquid at 100°C of 1 atm, then $\Delta S_{system} = 54.42$ J/K

***81.** For the reaction $2Ag_2O(s) \longrightarrow 4Ag(s) + O_2(g)$, ΔH is 61.17 kJ mol^{-1} and ΔS is 132 J K^{-1} mol^{-1}. Compute the temperature above which the given reaction will be spontaneous.

(A) T > 463.4 K **(B)** T > 190.25°C

(C) T < 190.25°C **(D)** T < 463.4 K

***82.** Select the correct enthalpy at corresponding temperature using following data :

(i) Heat capacity of solid from 0 K to normal melting point 200 K

$C_{P,m}(s) = 0.035\ T \qquad JK^{-1}\ mol^{-1}$

(ii) Enthalpy of fusion = 7.5 kJ mol^{-1},

(iii) Enthalpy of vaporization = 30 kJ mol^{-1}

(iv) Heat capacity of liquid from 200 K to normal boiling point 300 K

$C_{P,m}(\ell) = 60 + 0.016\ T \quad JK^{-1}\ mol^{-1}$

(v) Heat capacity of gas from 300 K to 600 K at 1 atm

$C_{P,m}(g) = 50.0 \qquad JK^{-1}\ mol^{-1}$

(A) $S_{200(s)} = 7$ **(B)** $S_{300(\ell)} = 70.43$ **(C)** $S_{300(g)} = 170.43$ **(D)** $S_{600(g)} = 205.09$

83. Two moles of a perfect gas undergo the following processes:

(i) A reversible isobaric expansion from (1.0 atm, 20.0 L) to (1.0 atm, 40.0 L)

(ii) A reversible isochoric change of state from (1.0 atm, 40.0 L) to (1.0 atm, 20.0 L)

(iii) A reversible isothermal compression from (0.5 atm, 40.0 L) to (1.0 atm, 20.0 L)

Calculate the magnitude of work (W) done in L atm in each process

84. The enthalpy of combustion of mol. Wt. 180 glucose is – 2808 KJ mol^{-1} at 25°C. X and Y grams of glucose do you need to consume respective cases [Assume wt = 62.5 Kg].

(A) To climb a flight of stairs rising through 3M.

(B) To climb a mountain of altitude 3000 M?

Assume that 25% of enthalpy can be converted to useful work.
X and Y are related as X = mY; then find m.

85. A sample of certain mass of an ideal polyatomic gas is expanded against constant pressure of 1 atm adiabatically from volume 2 L, pressure 6 atm and temperature 300 K to state where its final volume is 8L. Then calculate entropy change (in J/K) in the process. (Neglect vibrational degrees of freedom) [1L atm = 100 J, log 2 = 0.3, log = 0.48, log e = 2.3] (approximate integer)

86. 1 mole of an ideal gas is allowed to expand isothermally at 27°C till its volume is tripled. If the expansion is carried out reversibly then the $\Delta S_{universe}$ will be?

Paragraph for Question No. 87 – 89

Concrete is produced from a mixture of cement, water, sand and small stones. It consists primarily of calcium sillicates and calcium aluminates formed by heating and grinding of clay and limestone. In later steps of cement production a small amount of gypsum, $CaSO_4.2H_2O$ is added to improve subsequent hardening of concrete. The use of elevated temperatures during the final production may lead to formation of unwanted hemihydrate, $CaSO_4.1/2H_2O$. Consider the following reaction : $CaSO_4.2H_2O(s) \longrightarrow CaSO_4.\frac{1}{2}H_2O(s) + \frac{3}{2}H_2O(g)$

The following thermodynamic data applies at 25°C, standard pressure : 1 bar

Compound	$\Delta H^o_{f(kJ/mol)}$	S°($kJ^{-1}mol^{-1}$)
$CaSO_4.2H_2O(s)$	– 2021.0	194.0
$CaSO_4.\frac{1}{2}H_2O(s)$	–1575.0	130.5
$H_2O(g)$	– 242.8	188.6

R = 8.314 $JK^{-1}\ mol^{-1}$

87. ΔH^o for the formation of 1.00 kg of $CaSO_4.\frac{1}{2}H_2O(s)$ from $CaSO_4.2H_2O(s)$ is

(A) +446 kJ **(B)** +484 kJ **(C)** – 446 kJ **(D)** – 484. kJ

88. Equilibrium pressure (in bar) of water vapour in closed vessel containing $CaSO_4.2H_2O(s)$, $CaSO_4.\frac{1}{2}H_2O(s)$, $H_2O(g)$ at 25°C

(A) 17.35×10^{-4} bar **(B)** 2.15×10^{-4} bar

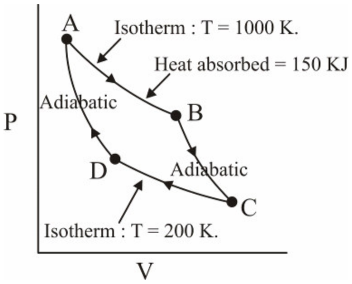
(C) 8.10×10^{-3} bar **(D)** 7.00×10^{-4} bar

89. Temperature at which the equilibrium water vapour pressure is 1.00 bar

(A) 107°C **(B)** 380°C **(C)** 215°C **(D)** 240°C

Paragraph for Question No. 90 – 92

The accompanying diagram represents a reversible carnot cycle for an ideal gas:



90. How much heat is rejected at the lower temperature, 200 K, during the isothermal compression?

(A) 150 kJ **(B)** 30 kJ

(C) 120 kJ **(D)** data not sufficient to calculate exact value

91. What is the entropy increase during isothermal expansion at 1000 K?

(A) 0.15 JK^{-1} **(B)** 150 kJ K^{-1} **(C)** 150 JK^{-1} **(D)** 750 JK^{-1}

92. What is the Gibbs free energy change during the process $A \rightarrow B$?

(A) 150 kJ **(B)** –150 kJ **(C)** 30 kJ **(D)** Data not sufficient

93. For the reaction :

$$C_2H_5OH(\ell) + 3O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(g)$$

If $\Delta U^\circ = -1373 \text{ kJ mol}^{-1}$ at 298 K. Calculate ΔH°

94. For a chemical reaction, ΔC_P is negative ($\Delta C_P < 0$).

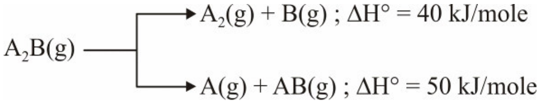
The heat required to increase temperature of reactants of this reaction by a certain amount $= q_1$ and heat required to increase temperature of products of the same reaction by same amount $= q_2$, Relate q_1 and q_2

95. Find out the heat evolved in combustion if 112 litres (at STP) of water gas (mixture of equal volume of $H_2(g)$ and $CO(g)$).

$$H_2(g) + 1/2\,O_2(g) \longrightarrow H_2O(g) \qquad \Delta H = -241.8 \text{ kJ}$$

$$CO(g) + 1/2\ O_2(g) \longrightarrow CO_2(g) \qquad \Delta H = -283 \text{ kJ}$$

96. Substance $A_2B(g)$ can undergoes decomposition to form two set of products :



If the molar ratio of $A_2(g)$ to A(g) is 5 : 3 in a set of product gases, calculate the energy involved in the decomposition of 1 mole of A_2B .

97. The free energy change for a reversible reaction at equilibrium is:

(A) Positive **(B)** Negative **(C)** Zero **(D)** Cannot say

98. Consider the reaction at 300 K $H_2(g) + Cl_2(g) \longrightarrow 2HCl(g); \ \Delta H = -185\,kJ.$

If 2 moles of H_2 completely react with 2 mole of Cl_2 to form HCl. What is $\Delta U°$ for this reaction?

(A) 0 **(B)** – 185 kJ **(C)** 370 kJ **(D)** – 370 kJ

99. For which of the following change $\Delta H \neq \Delta E$?

(A) $H_2(g) + I_2(g) \rightarrow 2HI(g)$ **(B)** $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(\ell)$

(C) $C(s) + O_2(g) \rightarrow CO_2(g)$ **(D)** $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

100. The difference between ΔH and ΔE (on a molar basis) for the combustion of n-octane (ℓ) at 25°C would be:

(A) – 13.6 kJ **(B)** – 1.14 kJ **(C)** – 11.15 kJ **(D)** + 11.15 kJ