JARS EDUCATION
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Practice Paper

Time : 2 Hour | 11th standard (JEE BASED) | Total Marks : 200

THERMODYNAMICS AND THERMOCHEMISTRY

Chemistry

*** SECTION - A** [160]

1. For the reaction $NH_2COONH_{4(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)}$. If equilibrium pressure is $3X$ bar then ΔG_r^o will be

   (A) $-RT\,ln\,9 - 3RT\,ln\,X$ (B) $RT\,ln\,4 - 3RT\,ln\,X$ (C) $-3RT\,ln\,X$ (D) None of these

2. For the reaction at $25\,^oC$, $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ if ΔG_f^o for N_2O_4 and NO_2 are 23.49 and $12.39\,KCal$ respectively then K_p for the reaction is

   (A) $0.78\,atm$ (B) $0.6\,atm$ (C) $0.1132\,atm$ (D) $0.0566\,atm$

3. For the reaction $PCl_5 \rightarrow PCl_3 + Cl_2, \Delta H = 75\,KJ\,mol^{-1}$ and $\Delta S = 120\,JK^{-1}\,mol^{-1}$. At which temperature reaction is spontaneous.....K

   (A) 625 (B) 610 (C) 630 (D) 600

4. Calculate $\Delta G^o(kJ/mol)$ at $127\,^oC$ for a reaction with $K_{equilibrium} = 10^5$

   (A) -38.294 (B) -16.628 (C) -9.16 (D) None of these

5. Gibb's free enrgy (G) is defined as

   (A) $\Delta G = \Delta H - T\Delta S$ (B) $\Delta G = \Delta H + \frac{T}{\Delta S}$

   (C) $\Delta H = \Delta G - T\Delta S$ (D) $\Delta G = \Delta H + T.C_p$

6. Which of the following expression for an irreverssible process.

   (A) $dS > \frac{dq}{T}$ (B) $dS = \frac{dq}{T}$ (C) $dS < \frac{dq}{T}$ (D) $dS = \frac{dU}{T}$

7. For a cell,

   $4B(s) + 3O_2\,(g) \rightarrow 2B_2O_3\,(g)$; $E_{cell}^o = 1.433\ volt$ What is molar entropy (in J/K) of oxygen gas

   Given $(\Delta_f H^o)_{B_2O_3}\,(g) = -840\,\frac{KJ}{mol}$

   $(S_m^o)_{B_2O_3}\,(g) = 280J/K - mol$

   $(S_m^o)_B\ (s) = 10\,J/K - mol$

   (A) 0.1963 (B) 1.963 (C) 15.03 (D) 150.3

8. The enthalpy change for the transition of liquid water to steam, $\Delta H_{vap} = 37.3\, kJ\, mol^{-1}$ at $373\, K$. The entropy change for the process is..... $J\, mol^{-1} K^{-1}$

(A) 111.9 (B) 37.3 (C) 100 (D) 74.6

9. If the enthalpy of formation and enthalpy of solution of $HCl\,(g)$ are $-92.3\, kJ/mol$ and $-75.14\, kJ/mol$ respectively then find enthalpy of formation of $Cl^{-}(aq)$ [Assume $\Delta H_{f(H^{+})} = 0$] .....kJ/mol

(A) -17.16 (B) -167.44 (C) 17.16 (D) None of these

10. For the reaction $OF_{2(g)} \rightarrow O_{(g)} + 2F_{(g)}$, $\Delta_{rxn} H$ is $368\, kJ$. What is the average $O—F$ bond energy ? ....kJ

(A) 184 (B) 368 (C) 536 (D) 736

11. Based on the value of $B.E.$ given, $\Delta_f H^o$ of $N_2H_4\,(g)$ is

Given : $N - N = 159\ kJ\ mol^{-1}$; $H - H = 436\ kJ\ mol^{-1}$

$N \equiv N\ = 941\ kJ\ mol^{-1}$; $N - H = 398\ kJ\ mol^{-1}$ .....$kJ\ mol^{-1}$

(A) 711 (B) 62 (C) -98 (D) -711

12. For $N_2 + 3H_2 \rightarrow 2NH_3, \Delta H = -22\ kcal$, and $E_a = 70\ kcal$. Hence E_a for $2NH_3 \rightarrow N_2 + 3H_2$ is.....$kcal$

(A) 92 (B) 70 (C) 48 (D) 22

13. Which of the following reaction can be used to define the heat of formation of $CO_2(g)$

(A) $C(\text{graphite}) + O_2(g) = CO_2(g)$

(B) $CH_4(g) + 2O_2(g) = CO_2(g) + 2H_2O(l)$

(C) $CO(g) + \frac{1}{2} O_2(g) = CO_2(g)$

(D) $C_6H_6(l) + 7\frac{1}{2} O_2(g) = 6CO_2 + 3H_2O(l)$

14. $4\, g$ NH_4NO_3 were dissolved in $196\, g$ water at constant pressure in calorimeter with heat capacity $160\, J\, K^{-1}$. The temperature fell by $1.3\, K$. Specific heat of solution is $4.2\, J\, K^{-1}\, g^{-1}$. Enthalpy of solution of NH_4NO_3 is.....$kJ\, mol^{-1}$

(A) 36 (B) -26 (C) 26 (D) 2.6

15. $10\ mole$ of ideal gas expands isothermally and reversibly from a pressure of $10\ atm$ to $1\ atm$ at $300\ K$. What is the largest mass which can be lifted through a height of $100\ meter$ by energy obtained in this process

(A) 31842 (B) 58.55 (C) 342.58 (D) 5855

16. 6 moles of an ideal gas expand isothermally and reversibly from a volume of 1 litre to a volume of 10 litres at $27^{o}C$. What is the maximum work done

(A) $47\ kJ$ (B) $100\ kJ$ (C) $0\ kJ$ (D) $34.465\ kJ$

17. What is Δn for combustion of 1 mole of benzene, when both the reactants and the products are gas at $298\,K$

(A) 0 (B) $+3/2$ (C) $-3/2$ (D) $+1/2$

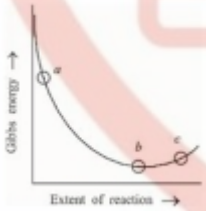
18. For the reaction$CH_3COOH(l)+2O_2(g) \rightleftharpoons 2CO_2(g)+2H_2O(l)$ at $25\,^oC$ and $1\,atm$. pressure, $\Delta H=-874\,kJ$. Then the change in internal energy (ΔE) is ....kJ

(A) -874 (B) -871.53 (C) -876.47 (D) $+874$

19. For complete combustion of ethene.
$C_2H_4(g)+3O_2(g) \rightarrow 2CO_2(g)+2H_2O(l)$ the amount of heat produced as measured in bomb calorimeter is $1406\,kJ\,mol^{-1}$ at $300\,K$. The minimum value of $T\Delta S$ needed to reach equilibrium is $(-)\ldots\ldots\,kJ$. (Nearest integer) Given : $R=8.3\,JK^{-1}mol^{-1}$

(A) 1411 (B) 1412 (C) 1413 (D) 1414

20. Consider the graph of $Gibbs$ free energy G vs Extent of reaction. The number of statement/s from the following which are true with respect to points $(a),(b)$ and (c) is .....
A.Reaction is spontaneous at (a) and (b)
B.Reaction is at equilibrium at point (b) and nonspontaneous at point (c)
C.Reaction is spontaneous at (a) and nonspontaneous at (c)
D.Reaction is non-spontaneous at (a) and (b)



(A) 6 (B) 4 (C) 8 (D) 2

21. For complete combustion of methanol
$CH_3OH(1)+\frac{3}{2}O_2(g) \rightarrow CO_2(g)+2H_2O(1)$
the amount of heat produced as measured by bomb calorimeter is $726\,kJ\,mol^{-1}$ at $27^{\circ}C$. The enthalpy of combustion for the reaction is $-x\,kJ\,mol^{-1}$, where x is ..... (Nearest integer)
(Given : $R=8.3\,J\,K^{-1}\,mol^{-1}$)

(A) 314 (B) 632 (C) 552 (D) 727

22. While performing a thermodynamics experiment, a student made the following observations, $HCl+NaOH \rightarrow NaCl+H_2O\Delta H=-57.3\,kJ\,mol^{-1}$
$CH_3COOH+NaOH \rightarrow CH_3COONa+H_2O \quad (\Delta H=-55.3\,kJ\,mol^{-1})$ The enthalpy of ionization of CH_3COOH as calculated by the student is $kJmol^{-1}$. (nearest integer)

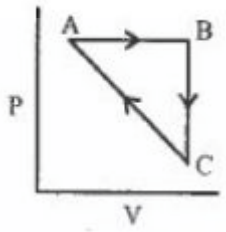
(A) 5 (B) 2 (C) 4 (D) 3

23. An ideal gas undergoes a cyclic process as shown in Figure

$\Delta U_{BC} = -5\,kJ\,mol^{-1}, q_{AB} = 2\,kJ\,mol^{-1}$

$\Delta W_{AB} = -5\,kJ\,mol^{-1}, W_{CA} = 3\,kJ\,mol^{-1}$

Heat absorbed by the system during process CA is.....$kJ\,mol^{-1}$



(A) -5 (B) $+5$ (C) 18 (D) -18

24. A gas undergoes change from state A to state B. In this process, the heat absorbed and work done by the gas is $5\,J$ and $8\,J$, respectively. Now gas is brought back to A by another process during which $3\,J$ of heat is evolved. In this reverse process of B to A

(A) $10\,J$ of the work will be done by the gas

(B) $6\,J$ of the work will be done by the gas

(C) $10\,J$ of the work will be done by the surrounding on gas

(D) $6\,J$ of the work will be done by the surrounding on gas.

25. A reaction at $1\,bar$ is non-spontaneous at low temperature but becomes spontaneous at high temperature. Identify the correct statement about the reaction among the following

(A) ΔH is negative while ΔS is positive

(B) Both ΔH and are ΔS negative

(C) ΔH is positive while ΔS is negative

(D) Both ΔH and ΔS are positive

26. If $100\,mole$ of H_2O_2 decomposes at $1\,bar$ and $300\,K$, the work done (kJ) by one mole of $O_2(g)$ as it expands against $1\,bar$ pressure is..... kJ

$2H_2O_2(l) \rightleftharpoons H_2O(l) + O_2(g)$

$(R = 83\,JK^{-1}\,mol^{-1})$

(A) 124.50 (B) 249 (C) 498 (D) 62.25

27. Which of the following statements/ relationships is not correct in thermodynamic changes ?

(A) $\Delta U = 0$ (isothermal reversible expansion of a gas)

(B) $w = -nRT \ln \frac{V_2}{V_1}$ (isothermal reversible expansion of an ideal gas)

(C) $w = nRT \ln \frac{V_2}{V_1}$ (isothermal reversible expansion of an ideal gas)

(D) For a system of constant volume heat involved directly changes to internal energy.

28. The standard enthalpies of formation of $CO_2(g), H_2O(l)$ and glucose(s) at $25^\circ C$ are $-400\ kJ/mol, -300\ kJ/mol$ and $-1300\ kJ/mol$, respectively. The standard enthalpy of combustion per gram of glucose at $25^\circ C$ is

(A) $+2900\ kJ$ (B) $-2900\ kJ$ (C) $-16.11\ kJ$ (D) $+16.11\ kJ$

29. The ΔG in the process of melting of ice at $-15\,^oC$ is

(A) $\Delta G = -ive$ (B) $\Delta G = +ive$ (C) $\Delta G = 0$ (D) All of these

30. A plot of $ln\,K$ against $\frac{1}{T}$ ($x-$ axis) is expected to be a straight line, with intercept on $Y-$ axis equal to

(A) $\frac{\Delta S^o}{2.303R}$ (B) $\frac{\Delta S^o}{R}$ (C) $-\frac{\Delta S^o}{R}$ (D) $R \times \Delta S^o$

31. The entropy during melting of Ice to water ?

(A) zero (B) decreases (C) Increases (D) remain same

32. The enthalpy of neutralization is about $57.3\,kJ$ for the pair

(A) HCl and NH_4OH (B) NH_4OH and HNO_3

(C) HCl and $NaOH$ (D) CH_3COOH and $NaOH$

33. The internal energy of an ideal gas increases during an isothermal process when the gas is

(A) Expanded by adding more molecule to it.

(B) Expanded by adding more heat to it.

(C) Expanded against zero pressure.

(D) Compressed by doing work on it.

34. Which is not the correct relation between enthalpy $(\Delta H)$and intrinsic energy (ΔE)

(A) $\Delta H = \Delta E + P\,\Delta V$ (B) $\Delta H = \Delta E + n\,RT$

(C) $\Delta H = \Delta E - P\,\Delta V$ (D) $\Delta E = \Delta H - P\,\Delta V$

35. Which of the following is true for an adiabatic process

(A) $\Delta H = 0$ (B) $\Delta W = 0$ (C) $\Delta Q = 0$ (D) $\Delta V = 0$

36. If a chemical reaction is accompanied by the evolution of heat, it is

(A) Catalytic (B) Photochemical (C) Endothermic (D) Exothermic

37. The bond energies of $C-C, C=C, H-H$ and $C-H$ bonds are $350, 600, 400$ and $410\,kJ$ per mole respectively. The heat of hydrogenation of ethylene (C_2H_4) is ..... $kJ\,mol^{-1}$

(A) -170 (B) -260 (C) -400 (D) -450

38. The bond dissociation enthalpy of $H_2(g)$ and $N(g)$ are $436\,kJ\,mol^{-1}$ and $940\,kJ\,mol^{-1}$ and enthaply of formation of NH_3 is $-45\,kJ\,moI^{-1}$. The enthaply of atomisation of NH_3 is.....$kJ\,mol^{-1}$

(A) -1079 (B) -1169 (C) 1079 (D) 1169

39. Assertion : Absolute values of internal energy of substances cannot be determined.

Reason : It is impossible to determine exact values of constituent energies of the substances.

(A) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(B) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(C) If the Assertion is correct but Reason is incorrect.

(D) If both the Assertion and Reason are incorrect.

40. Work done during isothermal expansion of one mole of 1 mole of an ideal gas from $10\ atm$ to 1 atm at $300\,K$ is.....cal (Gas constant $= 2$)

(A) 938.8 (B) 1138.8 (C) 1381.8 (D) 1581.8

*** SECTION - B** **[40]**

41. Solid $KClO_3$ is taken in a container maintained at constant pressure of $1\,atm$. Upon heating following equilibrium is obtained

$2KClO_3\,(s) \rightleftharpoons 2KCl\,(s) + 3O_2\,(g)$

If $\Delta H^o = 25\,kcal/mol$ and $\Delta S^o = 50\,cal/K$, at what temperature equilibrium will be established in the container. (Ignore variation of ΔH^o and ΔS^o with temperature.).....K

42. The enthalpy change for the transition of liquid water to steam, $\Delta H_{vap} = 37.3\,kJ\,mol^{-1}$ at $373\,K$. The entropy change for the process is..... $J\,mol^{-1}K^{-1}$

43. The enthalpies of formation of N_2O and NO are 28 and $90\,kJ\,mol^{-1}$ respectively. The enthalpy of the reaction, $2N_2O(g) + O_2(g) \rightarrow 4NO(g)$ is equal to.....kJ

44. The molar enthalpies of combustion of $C_2H_2(g), C$ (graphite) and $H_2\,(g)$ are $-1300, -394$ and $-286\,kJ\,mol^{-1}$, respectively. The standard enthalpy of formation of $C_2H_2\,(g)$ is.....$kJ\,mol^{-1}$

45. One mol of methanol when burnt in excess of O_2 gives out $723\,kJ\,mol^{-1}$ Heat. If $1\,mol$ of O_2 is used, what will be the amount of heat evolved.....kJ

46. What is entropy of vaporisation of water at $100\,^oC$, If molar heat of vaporisation is $9710\,cal/mol$ .....$cal/K/mol$

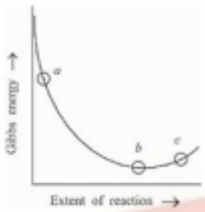
47. Consider the graph of $Gibbs$ free energy G vs Extent of reaction. The number of statement/s from the following which are true with respect to points $(a),(b)$ and (c) is .....

A.Reaction is spontaneous at (a) and (b)

B.Reaction is at equilibrium at point (b) and nonspontaneous at point (c)

C.Reaction is spontaneous at (a) and nonspontaneous at (c)

D.Reaction is non-spontaneous at (a) and (b)



48. During compression of a spring the work done is $10\,kJ$ and $2\,kJ$ escaped to the surroundings as heat. The change in internal energy, ΔU (in kJ) is

49. Tin is obtained from cassiterite by reduction with coke. Use the data given below to determine the minimum temperature (in K) at which the reduction of cassiterite by coke would take place.

At $298K: \Delta_f H^\circ(SnO_2(s)) = -581.0 kJ mol^{-1}, \Delta_{fH} H^\circ(CO_2(g)) = -394.0 kJ mol^{-1}$

$S^\circ(SnO_2(s)) = 56.0 JK^{-1} mol^{-1}, S^\circ(Sn(s)) = 52.0 JK^{-1} mol^{-1}$

$S^\circ(C(s)) = 6.0 JK^{-1} mol^{-1}, S^\circ(CO_2(g)) = 210.0 JK^{-1} mol^{-1}$

Assume that the enthalpies and the entropies are temperature independent.

50. The standard enthalpies of combustion of $C_6H_{6(l)}, C_{(graphite)}$ and $H_{2(g)}$ are respectively $-3270\,kJ\,mol^{-1}, -394\,kJ\,mol^{-1}$ and $-286\,kJ\,mol^{-1}$. What is the standard enthalpy of formation of $C_6H_{6(l)}$ in $kJ\,mol^{-1}$?

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