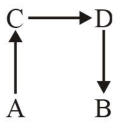
PREVIOUS YEARS' QUESTIONS — EXERCISE-II

THERMODYNAMICS

1. A process $A \longrightarrow B$ is difficult to occur directly instead it takes place in three successive steps. **[JEE 2006]**



$\Delta S\ (A \longrightarrow C) = 50$ e.u.

$\Delta S\ (C \longrightarrow D) = 30$ e.u.

$\Delta S\ (B \longrightarrow D) = 20$ e.u.

Where e.u. is entropy unit.

Then the entropy change for the process $\Delta S\ (A \longrightarrow B)$ is :-

(1) + 100 e.u. (3) – 60 e.u.

(3) – 100 e.u. (4) + 60 e.u.

2. Assuming that water vapour is an ideal gas, the internal energy change (ΔU) when 1 mol of water is vapourised at 1 bar pressure and 100°C, (Given : Molar enthalpy of vapourisation of water at 1 bar and 373 K = 41 kJ mol^{-1} and R = 8.3 J mol^{-1} K^{-1} will be) :- **[AIEEE-2007]**

(1) 4.100 kJ mol^{-1} (2) 3.7904 kJ mol^{-1}

(3) 37.904 kJ mol^{-1} (4) 41.00 kJ mol^{-1}

3. In conversion of lime-stone to lime,

$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

the values of $\Delta H°$ and $\Delta S°$ are +179.1 kJ mol^{-1} and 160.2 J/K respectively at 298 K and 1 bar. Assuming that $\Delta H°$ and $\Delta S°$ do not change with temperature, temperature above which conversion of limestone to lime will be spontaneous is :- **[AIEEE-2007]**

(1) 1008 K (2) 1200 K

(3) 845 K (4) 1118 K

4. For the process H_2O (l) (1 bar, 373 K) $\longrightarrow H_2O(g)$ (1 bar, 373 K), the correct set of thermodynamic parameters is :- **[JEE 2007]**

(1) $\Delta G = 0,\ \Delta S = +$ ve

(2) $\Delta G = 0,\ \Delta S = -$ ve

(3) $\Delta G = +$ ve, $\Delta S = 0$

(4) $\Delta G = -$ ve, $\Delta S = +$ve

5. Among the following, the state function(s) is (are) **[JEE 2009]**

(1) Internal energy

(2) Irreversible expansion work

(3) Reversible expansion work

(4) Molar enthalpy

6. For a particular reversible reaction at temperature T, ΔH and ΔS were found to be both +ve. If T_e is the temperature at equilibrium, then reaction would be spontaneous when :- **[AIEEE-2010]**

(1) $T = T_e$

(2) $T_e > T$

(3) $T > T_e$

(4) T_e is 5 times T

7. The value of enthalpy change (ΔH) for the reaction

$C_2H_5OH_{(\ell)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(\ell)}$

at 27°C is –1366.5 kJ mol^{-1}. The value of internal energy change for the above reaction at this temperature will be :- **[AIEEE-2011]**

(1) –1371.5 kJ

(2) –1369.0 kJ

(3) –1364.0 kJ

(4) –1361.5 kJ

8. The entropy change involved in the isothermal reversible expansion of 2 moles of an ideal gas from a volume of 10 dm^3 to a volume of 100 dm^3 at 27°C is :- **[AIEEE-2011]**

(1) 32.3 J mol^{-1} K^{-1}

(2) 42.3 J mol^{-1} K^{-1}

(3) 38.3 J mol^{-1} K^{-1}

(4) 35.8 J mol^{-1} K^{-1}

9. The incorrect expression among the following is :- **[AIEEE-2012]**

(1) $K = e^{-\Delta G°/RT}$

(2) $\dfrac{\Delta G_{system}}{\Delta S_{total}} = -T$

(3) In isothermal process, $W_{reversible} = -nRT \ln \dfrac{V_f}{V_i}$

(4) $\ln K = \dfrac{\Delta H° - T\Delta S°}{RT}$

10. The difference between the reaction enthalpy change ($\Delta_r H$) and reaction internal energy change ($\Delta_r U$) for the reaction : **[JEE-MAINS(online)-2012]**

$2C_6H_6(\ell) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(\ell)$ at 300 K is (R = 8.314 J mol^{-1} K^{-1})

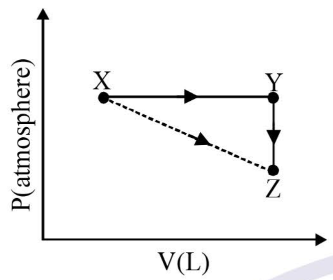
(1) 0 J mol^{-1}

(2) 2490 J mol^{-1}

(3) –2490 J mol^{-1}

(4) –7482 J mol^{-1}

11. For an ideal gas, consider only P-V work in going from an initial state X to the final state Z. The final state Z can be reached by either of the two paths shown in the figure. Which of the following choice(s) is (are) correct ? [take ΔS as change in entropy and w as work done] **[JEE 2012]**



(1) $\Delta S_{x\to z} = \Delta S_{x\to y} + \Delta S_{y\to z}$

(2) $W_{x\to z} = W_{x\to y} + W_{y\to z}$

(3) $W_{x\to y\to z} = W_{x\to y}$

(4) $\Delta S_{x\to y\to z} = \Delta S_{x\to y}$

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

[JEE-MAINS(online)-2014]

(1) $q = -nRT\ \ell n \frac{V_2}{V_1}$ (isothermal reversible expansion of an ideal gas)

(2) For a system at constant volume, heat involved merelv changes to internal energy.

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

(4) ΔU = 0 (isothermal reversible expansion of a gas)

13. The molar heat capacity (C_p) of CD_2O is 10 cals at 1000 K. The change in entropy associated with cooling of 32 g of CD_2O vapour from 1000 K to 100 K at constant pressure will be

[JEE-MAINS-(online) 2014]

(D = deuterium, at. mass = 2u)

(1) –23.03 cal deg^{-1}

(2) 2.303 cal deg^{-1}

(3) 23.03 cal deg^{-1}

(4) –2.303 cal deg^{-1}

14. The entropy (S°) of the following substances are

[JEE-MAINS-(online) 2014]

CH_4 (g) 186.2 J K^{-1} mol^{-1}

O_2 (g) 205.0 J K^{-1} mol^{-1}

CO_2 (g) 213.6 J K^{-1} mol^{-1}

H_2O (l) 69.9 J K^{-1} mol^{-1}

The entropy change (ΔS°) for the reaction

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O\ (\ell)$ is:-

(1) –312.5 JK^{-1} mol^{-1}

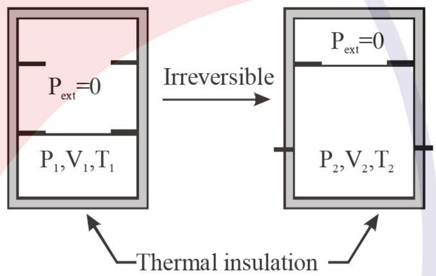
(2) – 37.6 JK^{-1} mol^{-1}

(3) – 108.1 JK^{-1} mol^{-1}

(4) – 242.8 JK^{-1} mol^{-1}

15. An ideal gas in thermally insulated vessel at internal pressure = P_1, volume = V_1 and absolute temperature = T_1 expands irrversibly against zero external pressure, as shown in the diagram. The final internal pressure, volume and absolute temperature of the gas are P_2, V_2 and T_2, respectively. For this expansion,

[JEE 2014]



(1) q = 0 (2) $T_2 = T_1$

(3) $P_2V_2 = P_1V_1$ (4) $P_2V_2^{\gamma} = P_1V_1^{\gamma}$

16. ΔU is equal to **[JEE-MAINS(offline)-2017]**

(1) Isochoric work (2) Isobaric work

(3) Adiabatic work (4) Isothermal work

17. The enthalpy change on freezing of 1 mol of water at 5°C to ice at –5°C is :

[JEE-MAINS(online)-2017]

(Given $\Delta_{fus}H$ = 6 kJ mol^{-1} at 0°C,

$C_P(H_2O, l)$ = 75.3 J mol^{-1} K^{-1},

$C_P(H_2O, s)$ = 36.8 J mol^{-1} K^{-1})

(1) 6.56 kJ mol^{-1} (2) 5.81 kJ mol^{-1}

(3) 6.00 kJ mol^{-1} (4) 5.44 kJ mol^{-1}

18. An ideal gas undergoes isothermal expansion at constant pressure. During the process:-

[JEE-MAINS-(online) 2017]

(1) enthalpy remains constant but entropy increases.

(2) enthalpy increases but entropy decreases.

(3) Both enthalpy and entropy remain constant.

(4) enthalpy decreases but entropy increases.

THERMOCHEMISTRY

19. Which of the following is not an endothermic reaction? **[JEE 1999]**

(1) Combustion of methane

(2) Decomposition of water

(3) Dehydrogenation of ethene to acetylene

(4) Conversion of graphite to diamond

20. ΔH_f° for $CO_2(g)$, $CO(g)$ and $H_2O(g)$ are – 393.5, –110.5 and –241.8 kJ mol^{-1} respectively. The standard enthalpy change (in kJ) for the reaction $CO_2(g) + H_2(g) \longrightarrow CO(g) + H_2O(g)$ is **[JEE 2000]**

(1) 524.1 (2) 41.2

(3) –262.5 (4) – 41.2

21. The enthalpy changes for the following processes are listed below : **[AIEEE-2006]**

$Cl_2(g) = 2Cl(g)$, 242.3 kJ mol^{-1}

$I_2(g) = 2I(g)$ 151.0 kJ mol^{-1}

$ICl(g) = I(g) + Cl(g)$, 211.3 kJ mol^{-1}

$I_2(s) = I_2(g)$, 62.76 kJ mol^{-1}

Given that the standard states for iodine and chlorine are $I_2(s)$ and $Cl_2(g)$, the standard enthalpy of formation for ICl(g) is :-

(1) –16.8 kJ mol^{-1}

(2) +16.8 kJ mol^{-1}

(3) +244.8 kJ mol^{-1}

(4) –14.6 kJ mol^{-1}

22. Oxidising power of chlorine in aqueous solution can be determined by the parameters indicated below:

$$\frac{1}{2}Cl_2(g) \xrightarrow{\frac{1}{2}\Delta_{diss}H^\ominus} Cl(g) \xrightarrow{\Delta_{eg}H^\ominus} Cl^-(g) \xrightarrow{\Delta_{hyd}H^\ominus} Cl^-(aq)$$

[AIEEE-2008]

The energy involved in the conversion of $\frac{1}{2}Cl_2(g)$ to $Cl^-(aq)$

(using the data $\Delta_{diss}H^\ominus_{Cl_2} = 240$ kJ mol^{-1},

$\Delta_{eg}H^\ominus_{Cl} = -349$ kJ mol^{-1},

$\Delta_{hyd}H^\ominus_{Cl^-} = -381$ kJ mol^{-1})

will be:-

(1) –610 kJ mol^{-1}

(2) –850 kJ mol^{-1}

(3) +120 kJ mol^{-1}

(4) +152 kJ mol^{-1}

23. On the basis of the following thermochemical data $\left(\Delta G_f^0 H^+_{(aq)} = 0\right)$

$H_2O(\ell) \rightarrow H^+(aq) + OH^-(aq)$; $\Delta H = 57.32$ kJ

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell)$; $\Delta H = -286.20$ kJ

The value of enthalpy of formation of OH^- ion at 25°C is :- **[AIEEE-2009]**

(1) +228.88 kJ (2) –343.52 kJ

(3) –22.88 kJ (4) –228.88 kJ

24. In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is

$$CH_3OH(\ell) + \frac{3}{2}O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell)$$

At 298 K standard Gibb's energies of formation for $CH_3OH(\ell)$, $H_2O(\ell)$ and $CO_2(g)$ are –166.2, –237.2 and –394.4 kJ mol^{-1} respectively. If standard enthalpy of combustion of methanol is –726 kJ mol^{-1}, efficiency of the fuel cell will be **[AIEEE-2009]**

(1) 90% (2) 97%

(3) 80% (4) 87%

25. The standard enthalphy of formation of NH_3 is –46.0 kJ mol^{-1}. If the enthalpy of formation of H_2 from its atoms is –436 kJ mol^{-1} and that of N_2 is –712kJ mol^{-1}, the average bond enthalpy of N–H bond in NH_3 is :- **[AIEEE-2010]**

(1) –1102 kJ mol^{-1} (2) –964 kJ mol^{-1}

(3) + 352 kJ mol^{-1} (4) +1056 kJ mol^{-1}

26. Consider the reaction : **[AIEEE-2011]**

$4NO_2(g) + O_2(g) \rightarrow 2N_2O_5(g)$, $\Delta_rH = -111$kJ.

If $N_2O_5(s)$ is formed instead of $N_2O_5(g)$ in the above reaction, the Δ_rH value will be :-

(Given, ΔHof sublimation for N_2O_5 is 54 kJ mol^{-1})

(1) –165 kJ (2) +54 kJ

(3) +219 kJ (4) –219 kJ

27. The enthalpy of neutralisation of NH_4OH with HCl is –51.46 kJ mol^{-1} and the enthalpy of neutralisation of NaOH with HCl is –55.90 kJ mol^{-1}. The enthalpy of ionisation of NH_4OH is: **[JEE-MAINS (online) 2012]**

(1) +107.36 kJ mol^{-1}

(2) –4.44 kJ mol^{-1}

(3) –107.36 kJ mol^{-1}

(4) +4.44 kJ mol^{-1}

28. Using the data provided, calculate the multiple bond energy (kJ mol^{-1}) of a $C \equiv C$ bond in C_2H_2. That energy is (take the bond energy of a C–H bond as 350 kJ mol^{-1}.) **[JEE 2012]**

$2C(s) + H_2(g) \rightarrow C_2H_2(g)$ $\Delta H = 225$ kJ mol^{-1}

$2C(s) \longrightarrow 2C(g)$ $\Delta H = 1410$ kJ mol^{-1}

$H_2(g) \longrightarrow 2H(g)$ $\Delta H = 330$ kJ mol^{-1}

(1) 1165 (2) 837

(3) 865 (4) 815

29. Given : **[JEE-MAINS (online) 2013]**

(1) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$;

$\Delta H^o_{298K} = -285.9$ kJ mol^{-1}

(2) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g)$;

$\Delta H^o_{298K} = -241.8$ kJ mol^{-1}

The molar enthalpy of vapourisation of water will be :-

(1) 241. 8 kJ mol^{-1} (2) 527.7 kJ mol^{-1}
(3) 44.1 kJ mol^{-1} (4) 22.0 kJ mol^{-1}

30. Given **[JEE-MAINS (online) 2013]**

Reaction	Energy Change (in kJ)
$Li(s) \longrightarrow Li(g)$	161
$Li(g) \longrightarrow Li^+(g)$	520
$\frac{1}{2}F_2(g) \longrightarrow F(g)$	77
$F(g) + e^- \longrightarrow F^-(g)$	(Electron gain enthalpy)
$Li^+(g) + F^-(g) \longrightarrow LiF(s)$	–1047
$Li(s) + \frac{1}{2}F_2(g) \longrightarrow LiF(s)$	–617

Based on data provided, the value of electron gain enthalpy of fluorine would be :

(1) –300 kJ mol^{-1} (2) –328 kJ mol^{-1}
(3) –350 kJ mol^{-1} (4) –228 kJ mol^{-1}

31. For complete combustion of ethanol,

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

the amount of heat produced as measured in bomb calorimeter, is 1364.47 kJ mol^{-1} at 25ºC. Assuming ideality the Enthalpy of combustion, Δ_cH, for the raction will be (R = 8.314 kJ mol^{-1}) :-

[JEE-MAINS(offline)2014]

(1) –1460.50 kj mol^{-1}
(2) – 1350.50 kJ mol^{-1}
(3) – 1366.95 kJ mol^{-1}
(4) – 1361.95 kJ mol^{-1}

32. The standard enthalpy of formation ($\Delta_fH^o_{298}$) for methane, CH_4 is– 74.9 kJ mol^{-1}. In order to calculate the average energy given out in the formation of a C–H bond from this it is necessary to know which one of the following?

[JEE-MAINS(online) 2014]

(1) the dissociation energy of the hydrogen molecule, H_2.
(2) the dissociation energy of H_2 and enthalpy of sublimation of carbon (graphite).
(3) the first four ionisation energies of carbon and electron affinity of hydrogen.
(4) the first four ionisation energies of carbon.

33. The heats of combustion of carbon and carbon monoxide are – 393.5 and – 285.5 kJ mol^{-1}, respectively. The heat of formation (in kJ) of carbon monoxide per mole is :- **[JEE-MAINS(offline)2016]**

(1) – 110.5 (2) 110.5
(3) 676.5 (4) – 676.5

34. Given **[JEE-MAINS(offline)2017]**

$C_{(grahite)} + O_2(g) \rightarrow CO_2(g)$;
$\Delta_rH° = -393.5$ kJ mol^{-1}

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$;
$\Delta_rH° = -285.8$ kJ mol^{-1}

$CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g)$;
$\Delta_rH° = +890.3$ kJ mol^{-1}

Based on the above thermochemical equations, the value of $\Delta_rH°$ at 298 K for the reaction

$C_{(grahite)} + 2H_2(g) \rightarrow CH_4(g)$ will be :-

(1) +74.8 kJ mol^{-1} (2) +144.0 kJ mol^{-1}
(3) –74.8 kJ mol^{-1} (4) –144.0 kJ mol^{-1}

35. The enthalpy change on freezing of 1 mol of water at 5°C to ice at –5°C is :

(Given $\Delta_{fus}H = 6$ kJ mol^{-1} at 0°C,
$C_P(H_2O, l) = 75.3$ J mol^{-1} K^{-1},
$C_P(H_2O, s) = 36.8$ J mol^{-1} K^{-1})

[JEE-MAINS(online)2017]

(1) 6.56 kJ mol^{-1} (2) 5.81 kJ mol^{-1}
(3) 6.00 kJ mol^{-1} (4) 5.44 kJ mol^{-1}

PREVIOUS YEARS QUESTIONS — **ANSWER KEY** — Exercise-II

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	**4**	**3**	**4**	**1**	**1,4**	**3**	**3**	**3**	**4**	**4**
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	**1,3**	**1**	**1**	**4**	**1,2,3**	**3**	**1**	**1**	**1**	**2**
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	**1**	**1**	**4**	**2**	**3**	**4**	**4**	**4**	**3**	**2**
Que.	31	32	33	34	35					
Ans.	**3**	**2**	**1**	**3**	**1**					