

JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- CHEMISTRY

CLASS :- 11th

PAPER CODE :- CWT-5

CHAPTER :- THERMODYNAMICS & THERMOCHEMISTRY

ANSWER KEY

1. (D)	2. (A)	3. (C)	4. (D)	5. (B)	6. (A)	7. (A)
8. (C)	9. (C)	10. (D)	11. (B)	12. (B)	13. (D)	14. (A)
15. (C)	16. (A)	17. (B)	18. (D)	19. (A)	20. (A)	21. 100
22. 130	23. 4	24. 436	25. 3	26. 416	27. 427	28. 5.6
29. 20	30. 2					

SOLUTIONS

1. (D)

Sol. $\Delta G = \Delta G^0 + RT \ln \frac{P_{NH_3}^2}{P_{N_2} \times P_{H_2}^3}$

$$\Delta G = -33000 + 8.314 \times 2.303 \log \frac{(0.02)^2}{1 \times 3^3} = -60.5 \text{ kJ/mole]}$$

2. (A)

Sol. For Adiabatic process,

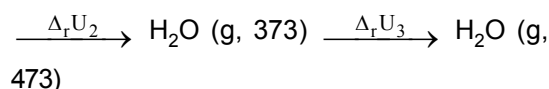
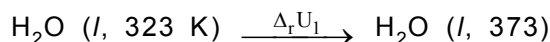
$$T_2 = T_1 \left[\frac{P_1}{P_2} \right]^{\frac{1-\gamma}{\gamma}}$$

$$= 300 \left(\frac{1}{1.01325} \right)^{\frac{1-1.66}{1.66}}$$

$$= \frac{300}{0.348} = 866.2 \text{ K]}$$

3. (C)

Sol. $H_2O (l, 323 \text{ K}) \longrightarrow H_2O (g, 473 \text{ K})$



(for solid and liquid $C_p \approx C_v$)

and $\Delta_r U = \Delta_r U_1 + \Delta_r U_2 + \Delta_r U_3$

$$= C_{V,m} \Delta T + (\Delta_r H_2 - \Delta n_g RT) + C_{V,m} \Delta T$$

$$= \frac{75.3 \times 50}{1000} + \left(40.7 - \frac{1 \times 8.314 \times 398}{1000} \right) +$$

$$\frac{(33.314 - 8.314) \times 100}{1000}$$

$$\Delta_r U \approx 43.86 \text{ kJ/mol]}$$

4. (D)

Sol. $\Delta n = -3$

$$\Delta H^\circ = \Delta E^\circ + (\Delta n)RT$$

$$\Rightarrow -6542 = \Delta E^\circ + (-3)(8.31)(298) \times 10^{-3}$$

$$\Rightarrow \Delta E^\circ = -6534 \text{ kJ]$$

5. (B)

Sol. Boyle temperature, $T_b = \frac{a}{Rb} = 20^\circ\text{C} = 293 \text{ K}$

inversion temperature, $T_i = \frac{2a}{Rb} = 586 \text{ K} =$

313°C

\therefore at $50^\circ\text{C} < T_i$, on expansion cooling occurs]

6. (A)

Sol. $Hg(l) | Hg(s) \quad \Delta_r G = \Delta G_f^0 [Hg(g)]$

$$P_{Hg} = K_p = 10^{\left\{ \frac{\Delta G_f^0}{2.303RT} \right\}} = 10^{-5.44} \text{]}$$

7. (A)

Sol. $W_{AB} = -2R(300)/n(1/2)$

$$W_{BC} = -2R(400-300)$$

$$W_{CD} = -2R \times 400/n2$$

$$W_{DA} = -2R(300-400)$$

$$W_{NET} = W_{AB} + W_{BC} + W_{CD} + W_{DA}$$

$$= -2R(300)/n(1/2) - 2R \times 400/n2 = -100R/n4 \text{]}$$

8. (C)

Sol. $d(\Delta G) = (\Delta V)dP - (\Delta S)dT$

$$\therefore P \text{ is constant, } \int_{298}^{310} d(\Delta G^\circ) = -$$

$$\int_{298}^{310} (\Delta S^\circ) dT$$

$$\Rightarrow -(\Delta G^\circ_{310} - \Delta G^\circ_{298}) = \Delta S^\circ [310 - 298] = 24 \text{ KJ/mol]}$$

9. (C)

Sol. For heat engine A: $\eta_A = \frac{1000 - T_2}{1000}$

$$\eta_B = \frac{T_2 - 360}{T_2}$$

$$\eta_A = \eta_B \text{ so } \frac{1000 - T_2}{1000} = \frac{T_2 - 360}{T_2}$$

$$T_2 = \sqrt{360 \times 1000} = 600 \text{ K Ans.}$$

10. (D)

Sol. Maximum non P-V work = $|\Delta G_R|$

$$\Rightarrow \Delta G = \Delta H - T\Delta S$$

$$\Rightarrow \Delta G = -6000 - \frac{300 \times 180}{1000} \quad (\text{for 1 mole})$$

$$\Rightarrow \Delta G = -6054 \text{ kJ}$$

$$\Rightarrow |\Delta G| \text{ for 0.01 moles of sucrose}$$

$$\Rightarrow 60.54 \text{ kJ}$$

option (D)]

11. (B)

Sol. Because they will make no contribution to the enthalpy of reaction.

12. (B)

Sol. may be positive or negative

13. (D)

Sol. initial and final conditions of the reacting substances

14. (A)

Sol. The most stable state of carbon is graphite.

15. (C)

Sol. $\text{NH}_4\text{NO}_3(\text{s}) \rightarrow \text{N}_2\text{O}(\text{g}) + 2\text{H}_2\text{O}$; $\Delta H = -37 \text{ kJ/mol}$

molecular weight of $\text{NH}_4\text{NO}_3 = 80 \text{ g}$

Energy released from combustion of 80 g

$\text{NH}_4\text{NO}_3 = -37 \text{ kJ/mol}$

$$\text{from } 2.5 \text{ g} = \frac{37}{80} \times 2.5 = 1.16 \text{ kJ}$$

16. (A)

Sol. $\text{A}(\text{g}) + \text{B}(\text{g}) \rightarrow \text{C}(\text{g}) + \text{D}(\text{g})$

$$\Delta n_g = 0, \Delta H = \Delta U + \Delta n_g RT$$

$$\Delta H = \Delta U$$

17. (B)

Sol. $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$

$$\Delta H = 176 \text{ kJ}$$

$$\Delta n_g = 1$$

$$\Delta H = \Delta U + \Delta n_g RT$$

$$\Delta U = \Delta H - \Delta n_g RT$$

$$= 176 - RT = 176 - 8.31 \times 10^{-3} \times 1240$$

$$= 165.6 \text{ kJ}$$

18. (D)

Sol. If $\Delta n_g = 0 \Rightarrow \Delta H = \Delta E$

19. (A)

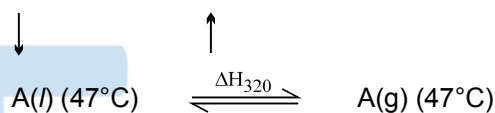
Sol. Hess's law

20. (A)

Sol. $\Delta H = H_B - H_A = 40 - 80 = -40$

21. 100

Sol. $\text{A}(\text{l}) (42^\circ\text{C}) \xrightarrow{\Delta H = 32 \text{ kJ/mole}} \text{A}(\text{g}) (42^\circ\text{C})$



$$\Delta H_{320} = \Delta H_{315} + \Delta rC_p \cdot (5)$$

$$\Delta S_{320} = \frac{\Delta H_{315} + \Delta rC_p \cdot 5}{320}$$

$$\Delta S_{320} - \Delta S_{315} = \Delta rC_p \ln \left(\frac{320}{315} \right)$$

$$\Delta S_{315} = \Delta S_{320} - \Delta rC_p \ln \left(\frac{320}{315} \right)$$

$$= \frac{\Delta H_{315}}{320} + \frac{\Delta rC_p \cdot (5)}{320} + \Delta rC_p \cdot \ln \left(\frac{315}{320} \right)$$

$$= \frac{\Delta H_{315}}{320} + \Delta rC_p \cdot \left(\frac{5}{320} - \frac{5}{320} \right)$$

$$= \frac{32000}{320} = 100 \text{ J/K mole Ans.]}$$

22. 130

Sol. $\Delta_r H^\circ = -635 - 394 - (-1207) = 178 \text{ kJ/mole}$

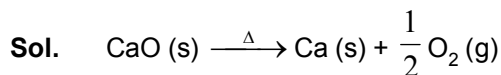
$$\Delta_r S^\circ = S^\circ(\text{CaO}) + S^\circ(\text{CO}_2) - S^\circ(\text{CaCO}_3)$$

$$= 40 + 214 - 94 = 160 \text{ J/K}$$

$$\Delta_r G^\circ = \Delta_r H^\circ - T \cdot \Delta_r S^\circ = 178 - \frac{300 \times 160}{1000} =$$

$$178 - 48 = 130 \text{ kJ/mole]}$$

23. 4

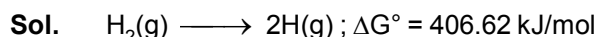


$$\Delta H = \Delta E + \Delta n_g RT$$

$$636 = \Delta E + \frac{1}{2} \times \frac{8.0 \times 300}{1000}$$

Mass of O_2 produced = 4.01 gm]

24. 436



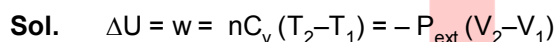
$$\Delta G^\circ = \Delta H - T\Delta S$$

$$406.62 = \Delta H - 298 \left\{ \frac{2 \times 114.6 - 130.6}{1000} \right\} ;$$

$$406.62 = \Delta H - \left(\frac{298(98.6)}{1000} \right)$$

$$406.62 = \Delta H - 29.38 ; \Delta H = 436 \text{ kJ/mol]}$$

25. 3



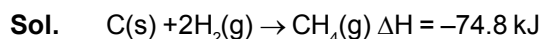
$$= n \cdot 3R (T_2 - 300) = -2 \left(\frac{nRT_2}{2} - \frac{nR(300)}{1} \right)$$

$$T_2 = 375 \text{ K}$$

$$\Delta H = n C_{p,m} \Delta T = 5 \times 8 (375 - 300) = 3000 \text{ cal}$$

or **3 kcal.]**

26. 416



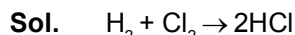
$$-74.8 \text{ kJ} = \Delta H_{\text{sub}}^\circ \text{C (s)} + 2 \sum \text{H-H} - 4 \sum \text{C-H}$$

$$= 718 + 2 \times 435.4 - 4 \sum \text{C-H}$$

$$4 \sum \text{C-H} = 718 + 870.8 + 74.8$$

$$\sum \text{C-H} = 416 \text{ kJ/mol}$$

27. 427



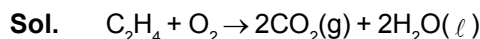
$$\Delta H = -182$$

$$-182 = \sum \text{H-H} + \sum \text{Cl-Cl} - 2 \sum \text{H-Cl}$$

$$= 430 + 242 - 2 \sum \text{H-Cl}$$

$$\sum \text{H-Cl} = 427 \text{ kJ/mol}$$

28. 5.6



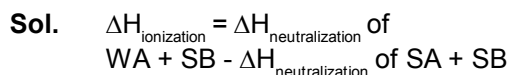
$$\Delta H = -1420 \text{ kJ}$$

$$1420 \text{ kJ} \dots\dots\dots 1 \text{ mol}$$

$$355 \text{ kJ} \dots\dots\dots \frac{1}{1920} \times 355 = 0.25 \text{ mol}$$

$$\text{Volume at S.T.P} = 0.25 \times 22.4 = 5.6 \text{ L}$$

29. 20

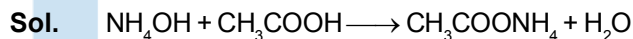


$$= -56.1 - (-57.3) = 1.2 \text{ KJ eq}^{-1}$$

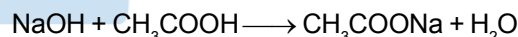
Enthalpy of ionization forming 100% ionization when there is no ionization at all = 1.5 KJ eq⁻¹

$$\therefore \% \text{ of ionization} = \frac{1.5 - 1.2}{1.5} \times 100 = 20\%$$

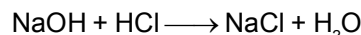
30. 2



$$\Delta H = -10.5 \text{ kcal}$$



$$\Delta H = -12.5 \text{ kcal}$$



$$\Delta H = -13.7 \text{ kcal}$$

$$\Delta H \text{ dissociation of } \text{CH}_3\text{COOH} = 13.7 - 12.5 = 1.2 \text{ kcal}$$

$$-10.5 = -[13.7 - 1.2 - y]$$

$$10.5 = 13.7 - 1.2 - y$$

$$y = 12.5 - 10.5$$

$$y = 2 \text{ kcal}$$