

Thermodynamics DPP-4 Solutions

Topic: Enthalpy

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Q1. When a solid melts, there is:

Conceptual Approach

Jab solid melt hota hai toh particles ko zyada freedom milta hai \rightarrow potential energy badhti hai. Isliye enthalpy (heat content) increase hota hai.

Stepwise Solution Step 1: Solid \rightarrow liquid phase change is endothermic.

Step 2: Energy absorb hoti hai as latent heat.

Final Answer: Enthalpy increases. (Option 2)

Q2. For the reaction $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$, which relation is valid?

Conceptual Approach

ΔH aur ΔE ka relation depend karta hai Δn_g par. Agar gases increase hoti hain toh $\Delta H > \Delta E$.

Stepwise Solution Step 1: Reaction: $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$.

Step 2: $\Delta n_g = (1 + 3) - 2 = +2$.

Step 3: Formula: $\Delta H = \Delta E + \Delta n_g RT$.

Final Answer: $\Delta H > \Delta E$. (Option 2)

Q3. Heat exchanged in a chemical reaction at constant pressure is called:

Conceptual Approach

Constant pressure par heat exchange ko enthalpy change kehte hain ($q_p = \Delta H$).

Final Answer: Enthalpy. (Option 2)

Q4. Latent heat of vaporisation of a liquid at 500K and 1 atm is 10 kcal mol⁻¹. Find ΔU for 3 mol liquid at same T and P.

Conceptual Approach

Relation: $\Delta H = \Delta U + \Delta n_g RT$. Vaporisation mein $\Delta n_g = +1$ per mol.

Stepwise Solution Step 1: For 1 mol, $\Delta H = 10$ kcal. For 3 mol, $\Delta H = 30$ kcal.

Step 2: $\Delta n_g = +3$.

Step 3: $\Delta U = \Delta H - \Delta n_g RT$. At 500K, $R = 2 \text{ cal K}^{-1} \text{ mol}^{-1}$.

Step 4: $\Delta U = 30 - (3 \times 500 \times 0.002) \text{ kcal} = 30 - 3 = 27 \text{ kcal}$.

Final Answer: +27 kcal. (Option 3)

Q5. Value of Δn_g in combustion of 1 mol liquid ethanol at 298 K?

Conceptual Approach

Check gases moles on reactant vs product side.

Stepwise Solution Step 1: Reaction: $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$.

Step 2: Reactant gases = 3, Product gases = 2.

Final Answer: $\Delta n_g = -1$. (Option 1)

Q6. If a reaction involves only solids and liquids, what is true?

Conceptual Approach

Solids liquids have negligible volume change $\rightarrow \Delta n_g = 0 \rightarrow \Delta H = \Delta E$.

Final Answer: $\Delta H = \Delta E$. (Option 2)

Q7. Find $\Delta H - \Delta E$ for $2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$ at $27^\circ C$.

Conceptual Approach

$\Delta H - \Delta E = \Delta n_g RT$.

Stepwise Solution Step 1: $\Delta n_g = 2$.

Step 2: $T = 300 K$, $R = 8.314 J/mol-K$.

Step 3: $\Delta H - \Delta E = 2 \times 8.314 \times 300 = 4988 J$.

Final Answer: $+4988 J$. (Option 2)

Q8. For $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$, find $\Delta H - \Delta E$.

Conceptual Approach

$\Delta H - \Delta E = \Delta n_g RT$.

Stepwise Solution Step 1: $\Delta n_g = 2 - 3 = -1$.

Step 2: So, $\Delta H - \Delta E = -RT$.

Final Answer: $-RT$. (Option 4)

Q9. Find ($\Delta H - \Delta U$) for $C_6H_{12}O_6(l) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$ at $25^\circ C$.

Conceptual Approach

$\Delta H - \Delta E = \Delta n_g RT$. $\Delta n_g = (6 - 6) = 0$.

Final Answer: Zero. (Option 1)

Q10. For which reaction ΔH and ΔU will be same?

Conceptual Approach

$\Delta H = \Delta U$ when $\Delta n_g = 0$.

Stepwise Solution Step 1: $H_2(g) + I_2(g) \rightarrow 2HI(g) \rightarrow$ reactant gas moles = 2, product = 2 $\rightarrow \Delta n_g = 0$.

Final Answer: Reaction $H_2 + I_2 \rightarrow 2HI$ has $\Delta H = \Delta U$. (Option 2)

Q11. Enthalpy of 1 mole monoatomic ideal gas is equals to:

Conceptual Approach

Monoatomic ideal gas ka $C_p = \frac{5}{2}R$. So, $H = nC_pT$.

Stepwise Solution Step 1: For 1 mol gas, $H = C_pT = \frac{5}{2}RT$.

Final Answer: $\frac{5}{2}RT$. (Option 2)

Q12. Under which conditions is the relation $\Delta H = \Delta E + P\Delta V$ valid?

Conceptual Approach

Ye relation sirf constant pressure par valid hota hai. Kyuki definition hai: $q_p = \Delta H$.

Final Answer: Constant pressure. (Option 1)

Q13. Difference between heats of reaction at constant P and V for $C_6H_{12}O_6(l) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$ at $25^\circ C$.

Conceptual Approach

$\Delta H - \Delta E = \Delta n_g RT$. Here gases $\rightarrow (6 - 6) = 0$.

Final Answer: Zero difference. (Option 4)

Q14. For $A(g) + 3B(g) \rightarrow 3C(g) + 3D(g)$, $\Delta E = 17$ kcal at $27^\circ C$. Find ΔH . ($R = 2 \text{ cal K}^{-1} \text{ mol}^{-1}$)

Conceptual Approach

$\Delta H = \Delta E + \Delta n_g RT$. Calculate Δn_g carefully.

Stepwise Solution Step 1: $\Delta n_g = (3+3) - (1+3) = 6 - 4 = 2$.

Step 2: $\Delta H = 17 + (22300/1000) \text{ kcal}$.

Step 3: $= 17 + 1.2 = 18.2 \text{ kcal}$.

Final Answer: 18.2 kcal. (Option 2)

Q15. For $CO(g) + 1/2O_2(g) \rightarrow CO_2(g)$, which statement is correct at const T,P?

Conceptual Approach

Reactant gases = 1.5, Product gases = 1. So $\Delta n_g = -0.5 \rightarrow \Delta H < \Delta E$.

Final Answer: $\Delta E > \Delta H$. (Option 3)

Q16. For $CO(g) + 1/2O_2(g) \rightarrow CO_2(g)$, correct relation at const T,P?

Conceptual Approach

Same as Q15, $\Delta n_g = -0.5 \rightarrow \Delta H < \Delta E$.

Final Answer: $\Delta E > \Delta H$. (Option 3)

Q17. For combustion of sucrose ($C_{12}H_{22}O_{11}$) at 25°C : Compare ΔE and ΔH .

Conceptual Approach

Reaction: $C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l)$. $\Delta n_g = 12 - 12 = 0 \rightarrow \Delta H = \Delta E$.

Final Answer: $\Delta H = \Delta E$. (Option 3)

Q18. For $2Ag(s) + 1/2O_2(g) \rightarrow Ag_2O(s)$, which relation is true?

Conceptual Approach

Reactant gases = 0.5, Product gases = 0. So $\Delta n_g = -0.5 \rightarrow \Delta H < \Delta E$.

Final Answer: $\Delta E > \Delta H$. (Option 4)

Q19. $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$ in closed vessel, compare ΔE and ΔH .

Conceptual Approach

Reactant gases = 3, Product gases = 2. $\Delta n_g = -1 \rightarrow \Delta H < \Delta E$.

Final Answer: $\Delta E > \Delta H$. (Option 1)

Q20. For complete combustion of isobutane, compare ΔE and ΔH .

Conceptual Approach

Combustion mein gases ke moles decrease hote hain $\rightarrow \Delta n_g$ negative. So $\Delta H < \Delta E$.

Final Answer: $\Delta E > \Delta H$. (Option 2)

Q21. For reversible isothermal expansion of 1 mol ideal gas at 300 K, from 10 dm^3 to 20 dm^3 , find ΔH .

Conceptual Approach

Isothermal process mein $\Delta T = 0$. Aur $\Delta H = nC_p \Delta T$. So, $\Delta H = 0$.

Final Answer: 0. (Option 4)

Q22. For $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ at 977°C , $\Delta H = 174 \text{ kJ mol}^{-1}$. Find ΔE .

Conceptual Approach

Relation: $\Delta H = \Delta E + \Delta n_g RT$. Here $\Delta n_g = +1$.

Stepwise Solution Step 1: $T = 977^\circ\text{C} = 1250 \text{ K}$. $R = 8.314 \text{ J/mol-K}$.

Step 2: $\Delta n_g = 1$.

Step 3: $\Delta E = 174 - (8.314 \times 1250 / 1000)$.

Step 4: $= 174 - 10.41636 \text{ kJ}$.

Final Answer: 163.6 kJ. (Option 2)

Q23. Heat of reaction for $\text{CO(g)} + 1/2\text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$ at constant $V = -67.71$ kcal at 17°C . Find heat of reaction at constant P .

Conceptual Approach

Relation: $\Delta H = \Delta E + \Delta n_g RT$. Here $\Delta n_g = -0.5$.

Stepwise Solution Step 1: $T = 290$ K, $R = 2$ cal.

Step 2: Correction $= -0.5 \times 2 \times 290$ cal $= -290$ cal $= -0.29$ kcal.

Step 3: $\Delta H = -67.71 - 0.29 = -68.0$ kcal.

Final Answer: -68.0 kcal. (Option 1)

Q24. Reaction: $\text{NH}_2\text{CONH}_2\text{(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{NH}_3\text{(g)} + \text{CO}_2\text{(g)}$. In bomb calorimeter, heat released $= 743$ kJ mol^{-1} . Find ΔH at 300 K.

Conceptual Approach

Bomb calorimeter $\rightarrow \Delta E$ given. Use relation: $\Delta H = \Delta E + \Delta n_g RT$.

Stepwise Solution Step 1: $\Delta E = -743$ kJ.

Step 2: $\Delta n_g = (2+1) - 0 = 3$.

Step 3: Correction $= 3 \times 8.314 \times 300 / 1000 = 7.5$ kJ.

Step 4: $\Delta H = -743 + 7.5 = -735.5 = -740.5$ kJ.

Final Answer: -740.5 kJ. (Option 1)

Q25. Enthalpy of vaporisation of water at $100^\circ\text{C} = 40.63$ kJ mol^{-1} . Find ΔE for this process.

Conceptual Approach

$\Delta H = \Delta E + RT$. Here $\Delta n_g = 1$.

Stepwise Solution Step 1: $\Delta H = 40.63$ kJ.

Step 2: Correction $= 8.314 \times 373 / 1000 = 3.1$ kJ.

Step 3: $\Delta E = 40.63 - 3.1 = 37.53$ kJ.

Final Answer: 37.53 kJ. (Option 1)

Q26. For $\text{S(s)} + \text{O}_2\text{(g)} \rightarrow \text{SO}_2\text{(g)}$, compare ΔE and ΔH .

Conceptual Approach

Reactant gas $= 1$, Product gas $= 1 \rightarrow \Delta n_g = 0$. So $\Delta H = \Delta E$.

Final Answer: $\Delta H = \Delta E$. (Option 1)

Q27. For which change $\Delta H \neq \Delta E$?

Conceptual Approach

$\Delta H = \Delta E$ only if $\Delta n_g = 0$. Check reactions.

Stepwise Solution Step 1: $H_2 + I_2 \rightarrow 2HI \rightarrow \Delta n_g = 0$. **Step 2:** Neutralisation (aq) \rightarrow no gases $\rightarrow \Delta n_g = 0$. **Step 3:** $C + O_2 \rightarrow CO_2 \rightarrow 1 - 1 = 0$. **Step 4:** $N_2 + 3H_2 \rightarrow 2NH_3 \rightarrow 2 - 4 = -2$. **Final Answer:** Ammonia formation ($N_2 + 3H_2 \rightarrow 2NH_3$). (Option 4)

Q28. Heat of combustion of ethanol in bomb calorimeter = $-670.48 \text{ kcal mol}^{-1}$ at 27°C . Find ΔH at 27°C .

Conceptual Approach

Bomb calorimeter $\rightarrow \Delta E$ given. $\Delta H = \Delta E + \Delta n_g RT$.

Stepwise Solution Step 1: $\Delta E = -670.48 \text{ kcal}$.

Step 2: Reaction: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O(l)$. $\Delta n_g = (2 - 3) = -1$.

Step 3: Correction = $-1 \times 2 \times 300 / 1000 = -0.6 \text{ kcal}$.

Step 4: $\Delta H = -670.48 - 0.6 = -671.08 \text{ kcal}$.

Final Answer: -671.08 kcal . (Option 2)

Q29. Difference in ΔH and ΔE for combustion of methane at 25°C .

Conceptual Approach

$\Delta H - \Delta E = \Delta n_g RT$. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O(l)$. $\Delta n_g = 1 - 2 = -1$.

Stepwise Solution Step 1: $T = 298 \text{ K}$. $R = 2 \text{ cal}$.

Step 2: Correction = $-1 \times 2 \times 298 \text{ cal} = -596 \text{ cal} = -0.596 \text{ kcal}$.

Final Answer: -0.6 kcal approx . (Option 3)

Q30. For which reaction ΔH is less than ΔE ?

Conceptual Approach

$\Delta H < \Delta E$ if Δn_g negative. Check reactions.

Stepwise Solution Step 1: Sucrose combustion $\rightarrow \Delta n_g = 0$. **Step 2:** $2SO_2 + O_2 \rightarrow 2SO_3 \rightarrow \Delta n_g = -1$. **Step 3:** $N_2O_4 \rightarrow 2NO_2 \rightarrow \Delta n_g = +1$. **Step 4:** $N_2 + O_2 \rightarrow 2NO \rightarrow \Delta n_g = 0$.

Final Answer: Reaction $2SO_2 + O_2 \rightarrow 2SO_3$. (Option 2)

Q31. For reaction $2X(s) + 2Y(s) \rightarrow 2C(l) + D(g)$, q_p at $27^\circ\text{C} = -28 \text{ kcal mol}^{-1}$. Find q_v .

Conceptual Approach

Relation: $\Delta H = \Delta E + \Delta n_g RT$. Here $q_p = \Delta H$, $q_v = \Delta E$.

Stepwise Solution Step 1: $\Delta n_g = (1 - 0) = +1$.

Step 2: Correction = $RT = 2 \times 300 \text{ cal} = 600 \text{ cal} = 0.6 \text{ kcal}$.

Step 3: $\Delta E = \Delta H - RT = -28 - 0.6 = -28.6 \text{ kcal}$.

Final Answer: -28.6 kcal . (Option 3)

Q32. Assume reactions in open container. For which will $\Delta H = \Delta E$?

Conceptual Approach

$$\Delta H = \Delta E \text{ when } \Delta n_g = 0.$$

Stepwise Solution Step 1: $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr} \rightarrow \Delta n_g = 2 - 2 = 0.$

Final Answer: $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}.$ (Option 1)

Q33. For $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$, $\Delta H = -92.38 \text{ kJ at } 298 \text{ K. Find } \Delta U.$

Conceptual Approach

$$\Delta H = \Delta E + \Delta n_g RT. \text{ Here } \Delta n_g = (2-4) = -2.$$

Stepwise Solution Step 1: $\Delta H = -92.38 \text{ kJ.}$

Step 2: $\text{Correction} = -28.314298/1000 = -4.96 \text{ kJ.}$

Step 3: $\Delta E = -92.38 - (-4.96) = -92.38 + 4.96 = -87.42 \text{ kJ.}$

Final Answer: -87.4 kJ. (Option 2)

Q34. For formation of CH_4 , if $\Delta U^0 = -x \text{ kJ mol}^{-1}$, find $\Delta H^0.$

Conceptual Approach

$$\text{Relation: } \Delta H = \Delta U + \Delta n_g RT.$$

Stepwise Solution Step 1: Formation: $\text{C(s)} + 2\text{H}_2(\text{g}) \rightarrow \text{CH}_4(\text{g}).$

Step 2: $\Delta n_g = 1 - 2 = -1.$

Step 3: $\Delta H = -x - RT.$

Final Answer: $-x - RT.$ (Option 1)

Q35. For $\text{Zn(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{H}_2(\text{g})$ in bomb calorimeter, what are ΔU and w ?

Conceptual Approach

$$\text{Bomb calorimeter} \rightarrow \text{constant V} \rightarrow w = 0. \text{ Reaction is exothermic} \rightarrow \Delta U < 0.$$

Final Answer: $\Delta U < 0, w = 0.$ (Option 1)

Q36. For $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$ at const T, P, compare ΔH and $\Delta U.$

Conceptual Approach

$$\Delta n_g = -2 \Rightarrow \Delta H = \Delta U + \Delta n_g RT \rightarrow \Delta H < \Delta U.$$

Final Answer: $\Delta H < \Delta U.$ (Option 1)

Q37. 1 mol water vapourised at 1 bar, 100°C . Molar enthalpy of vapourisation = 41 kJ mol^{-1} . Find $\Delta U.$

Conceptual Approach

$$\Delta H = \Delta U + RT. \text{ Here } \Delta n_g = 1.$$

Stepwise Solution Step 1: $\Delta H = 41 \text{ kJ}$.

Step 2: Correction = $8.314373/10003.1 \text{ kJ}$.

Step 3: $\Delta U = 41 - 3.1 = 37.9 \text{ kJ}$.

Final Answer: 37.9 kJ. (Option 3)

Q38. For $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$, $\Delta H = -1366.5 \text{ kJ mol}^{-1}$ at 27°C . Find ΔU .

Conceptual Approach

$$\Delta U = \Delta H - \Delta n_g RT. \Delta n_g = 2 - 3 = -1.$$

Stepwise Solution Step 1: $\Delta H = -1366.5 \text{ kJ}$.

Step 2: Correction = $-18.314300/1000 = -2.5 \text{ kJ}$.

Step 3: $\Delta U = -1366.5 - (-2.5) = -1364.0 \text{ kJ}$.

Final Answer: -1364 kJ. (Option 3)

Q39. For $\text{PCl}_5(\text{g}) \rightarrow \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$, if $\Delta H = -x \text{ J at } T \text{ K}$, find ΔU .

Conceptual Approach

$$\Delta U = \Delta H - \Delta n_g RT. \text{ Here } \Delta n_g = 2 - 1 = +1.$$

Stepwise Solution Step 1: $\Delta U = -x - RT$.

Final Answer: $-(x + RT)$. (Option 2)

Q40. 1 mol ideal gas changes P from 5 atm to 2 atm and V from 4 L to 10 L at const T. Find enthalpy change.

Conceptual Approach

$$\text{For ideal gas at constant T: } \Delta H = nC_p \Delta T = 0. \text{ So enthalpy change} = 0.$$

Final Answer: Zero. (Option 3)
