DPP-6 – Solutions

Other Enthalpies (Thermochemistry)

"Concept samjho, formula khud yaad ho jaayega."

Q1. Heat of combustion of C_2H_4, C_2H_6, and H_2 are –1409.5, –1558.3 and –285.6 kJ mol^{-1}. Find heat of hydrogenation of ethene.

Ethene hydrogenates to ethane:

$$C_2H_4 + H_2 \rightarrow C_2H_6$$

Apply Hess's Law using combustion data.

$$\Delta H_{\text{hydrog.}} = \Delta H_c(C_2H_6) - [\Delta H_c(C_2H_4) + \Delta H_c(H_2)]$$

$$\begin{aligned}\Delta H &= (-1558.3) - [(-1409.5) + (-285.6)] \\ &= -1558.3 - (-1695.1) = +136.8 \text{ kJ}\end{aligned}$$

Final Answer: (1) –136.8 kJ mol^{-1} (exothermic).

Q2. Given: ΔH_c of cyclohexane, cyclohexene, H_2 are –3920, –3800, –241 kJ mol^{-1}. Find $\Delta H_{\text{hydrog.}}$ of cyclohexene.

Reaction: $C_6H_{10} + H_2 \rightarrow C_6H_{12}$ By Hess's law:

$$\Delta H_{\text{hydrog.}} = \Delta H_c(C_6H_{12}) - [\Delta H_c(C_6H_{10}) + \Delta H_c(H_2)]$$

$$\Delta H = (-3920) - [(-3800) + (-241)] = -3920 - (-4041) = +121 \text{ kJ}$$

Final Answer: (1) –121 kJ mol^{-1}.

Q3. $Cl_2(g) \rightarrow 2Cl(g)$. Sign of ΔH?

Bond breaking process hai $\Rightarrow$ energy absorbed $\Rightarrow$ ΔH positive.

Final Answer: (1) Positive.

Q4. If $H_2(g) \rightarrow 2H(g)$; $\Delta H = 104$ kcal, then heat of atomisation of hydrogen is:

1 mol H–H gives 2 atoms $\Rightarrow$ per mole of atoms $= \frac{104}{2} = 52$ kcal.

Final Answer: (1) 52 kcal mol^{-1}.

Q5. $I(g) + I(g) \rightarrow I_2(g)$: sign of ΔH?

Bond formation releases energy exothermic ΔH negative.

Final Answer: (2) –ve.

Q6. Vaporisation process is always:

Liquid → gas requires energy to overcome intermolecular forces endothermic.

Final Answer: (2) Endothermic.

Q7. Fusion of ice is:

Solid → liquid needs heat absorption endothermic.

Final Answer: (2) Endothermic change.

Q8. For process $C_{(s)} \rightarrow C_{(g)}$, enthalpy represents:

Solid → gas (direct) sublimation.

Final Answer: (4) Sublimation.

Q9. Heat of combustion: yellow P = –9.91 kJ, red P = –8.78 kJ. Find $\Delta H_{\text{transition}}$ (yellow → red).

$$\Delta H_{\text{transition}} = \Delta H_c(\text{red}) - \Delta H_c(\text{yellow})$$

Less negative value → less heat released → more stable.

$$\Delta H = (-8.78) - (-9.91) = +1.13 \text{ kJ}$$

Final Answer: (2) +1.13 kJ mol^{-1}.

Q10. Graphite & diamond combustion: C(graphite) + $O_2 \rightarrow CO_2$ ($\Delta H = -x_1$) C(diamond) + $O_2 \rightarrow CO_2$ ($\Delta H = -x_2$). Find ΔH(graphite→diamond).

By Hess's law,

$$\text{C(graphite)} \rightarrow CO_2 \rightarrow \text{C(diamond)}$$

$$\Delta H = (-x_2) - (-x_1) = x_1 - x_2$$

Final Answer: (3) $x_1 - x_2$.

Q11. For C(diamond)→C(graphite); $\Delta H = -1.89$ kJ. If 6 g each burnt separately, heat in first case is:

1 mol C = 12 g. 6 g = 0.5 mol → difference = $0.5 \times 1.89 = 0.945$ kJ.

Final Answer: (1) Less by 0.945 kJ.

Q12. S(rhombic)+O_2→SO_2 ($\Delta H = -297.5$); S(monoclinic)+O_2→SO_2 ($\Delta H = -300$). Predict stability.

More exothermic combustion less stable form monoclinic less stable transition Rh→Mono is endothermic.

Final Answer: (4) ΔH transition S_R→S_M endothermic.

Q13. A(s)→A(ℓ); $\Delta H = x$; A(ℓ)→A(g); $\Delta H = -y$. Heat of sublimation = ?

A(s)→A(g) = (A(s)→A(ℓ)) + (A(ℓ)→A(g)) = x + (–y) = x – y.

Final Answer: (2) x – y.

Q14. Given: ΔH(H_2O(s)→H_2O(ℓ)) = –285.9, ΔH(H_2O(l)→H_2O(g)) = –241.8. Find ΔH_{vap} of water.

Vaporisation: $H_2O(\ell) \rightarrow H_2O(g)$.

$$\Delta H = (-241.8) - (-285.9) = +44.1 \text{ kJ mol}^{-1}$$

Final Answer: (3) 44.1 kJ mol^{-1}.

Q15. Given: $CuSO_4$ + aq → $CuSO_4$(aq), $\Delta H_1 = -66.4$ kJ; $CuSO_4 \cdot 5H_2O$ + aq → $CuSO_4$(aq), $\Delta H_2 = +11.7$ kJ. Find ΔH for $CuSO_4 + 5H_2O \rightarrow CuSO_4 \cdot 5H_2O$.

Reverse (ii) and add with (i):

$$\Delta H = (-66.4) - (+11.7) = -78.1 \text{ kJ}$$

Final Answer: Enthalpy of hydration = –78.1 kJ mol^{-1}.

Q16. $CuSO_4$(s) + 5H_2O(l) → $CuSO_4 \cdot 5H_2O$(s); $\Delta H = -x$ represents:

Solid salt combining with water molecules → **enthalpy of hydration**.

Final Answer: (2) Enthalpy of hydration.

Q17. Magnitude of heat of solution on addition of solvent:

On further dilution, heat of solution decreases in magnitude (approaches constant value).

Final Answer: (1) Decreases.

Q18. Which reaction shows $\Delta H_{hydration}$?

Only dissolution in water to form hydrated ions (aqueous) = hydration.

Final Answer: (1) $CuSO_4(s) + aq \rightarrow CuSO_4(aq)$.

Q19. Given u, v, w for ΔH_{sol}, ΔH_{hydr}, ΔH_{latt}; relation?

$$\text{AB(s)} \xrightarrow{w} \text{ions(g)} \xrightarrow{v} \text{ions(aq)} \Rightarrow u = w + v$$

Final Answer: (2) $u = w + v$.

Q20. Enthalpy of solution of $BaCl_2$ and $BaCl_2 \cdot 2H_2O$ are –x, y. Enthalpy of hydration?

Hydration: $\Delta H = \Delta H_{\text{sol(anhyd)}} - \Delta H_{\text{sol(hydrated)}} = -x - (+y) = -(x + y)$.

Final Answer: (3) –(x + y) kJ mol^{-1}.

Q21. Given: $\Delta H_{hydrog.}$(cyclohexene) = –119.5 kJ, resonance energy of benzene = –150.4 kJ. Find $\Delta H_{hydrog.}$(benzene).

Without resonance: 3 double bonds $3\times(-119.5) = -358.5$ kJ. Actual less exothermic by resonance energy:

$$-358.5 + 150.4 = -208.1 \text{ kJ}$$

Final Answer: (2) –208.1 kJ mol^{-1}.

Q22. Use data for LiF formation to find electron gain enthalpy of F.

By Born–Haber cycle:

$$\Delta H_f = \text{sublimation} + \text{ionisation} + \tfrac{1}{2}\text{bond dissoc} + \text{electron gain} + \text{lattice}$$

$$-617 = 161 + 520 + 77 + x - 1047 \Rightarrow x = -328 \text{ kJ mol}^{-1}$$

Final Answer: (2) –328 kJ mol^{-1}.
