DPP-2 (Solutions)

Thermochemical Equation & Hess Law

Q1. In Kirchhoff's equation which factor affects the heat of reaction?

(1) Pressure (2) Temperature (3) Volume (4) Atomicity

> Kirchhoff's law batata hai ki reaction ka enthalpy change ΔH temperature ke sath vary karta hai. Pressure aur volume ka effect negligible hota hai agar state same ho.

Solution:

$$\Delta H_T = \Delta H_{T_0} + \int_{T_0}^{T} \Delta C_p \, dT$$

$\Rightarrow$ ΔH depends on Temperature only.

Correct Option: (2)

Q2. For the reaction $H_2(g) + \frac{1}{2}O_2(g) \to H_2O(l)$, $\Delta C_p = 7.63$ cal deg^{-1} and $\Delta H_{298} = 68.3$ kcal. Find ΔH at 100°C.

> Temperature change hone par ΔH adjust hota hai using Kirchhoff's equation: $\Delta H_T = \Delta H_{298} + \Delta C_p(T - 298)$. Dhyaan: units same karna zaruri hai (kcal vs cal).

Solution:

$$\begin{aligned}
\Delta H_{373} &= \Delta H_{298} + \Delta C_p(373 - 298) \\
&= 68.3 + (7.63 \times 10^{-3})(75) \qquad \text{[Convert cal to kcal: 1 cal} = 10^{-3}\text{ kcal]} \\
&= 68.3 + 0.572 \\
&\approx \mathbf{68.9\ kcal}
\end{aligned}$$

Correct Option: (3)

Q3. The enthalpy of a reaction at 273 K is –3.57 kJ. What will be the enthalpy at 373 K if $\Delta C_p = 0$?

> Agar $\Delta C_p = 0$, matlab heat capacity difference nahi hai. To ΔH temperature ke sath change nahi karega.

Solution:

$$\begin{aligned}
\Delta H_{373} &= \Delta H_{273} + \int_{273}^{373} 0 \, dT \\
&= -3.57 \,\text{kJ}
\end{aligned}$$

Correct Option: (1)

Q4. Which of the following is NOT applicable for a thermochemical equation?

Thermochemical eqn batati hai: - Physical states - Exothermic/Endothermic nature - Allotropic form Lekin spontaneity Gibbs free energy se decide hoti hai, ΔH se nahi.

Correct Option: (2)

Q5. The correct thermochemical equation is:

Thermochemical equation me har reactant/product ka state likhna zaruri hai. Aur ΔH ka sign exothermic ke liye negative hota hai.

Correct Option: (3) **$C(s) + O_2(g) \rightarrow CO_2(g)$, $\Delta H = -94$ kcal**

Q6. According to $C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g)$, $\Delta H = -26.4$ kcal:

Compound ki enthalpy of formation negative hai $\Rightarrow$ uski formation exothermic hai.

Correct Option: (2) **CO is an exothermic compound.**

Q7. Which of the following represents an exothermic reaction?

Exothermic = ΔH ya ΔE negative hona chahiye. Sirf option (4) me $\Delta E = -693.8$ kJ diya hai.

Correct Option: (4)

Q8. Heat change during reaction 24 g C and 128 g S forming CS_2, $\Delta H = 22$ kcal is:

Balanced reaction: C (12 g) + 2S (64 g) $\rightarrow$ CS_2 (76 g), $\Delta H = 22$ kcal. Yani ek mole CS_2 banane par 22 kcal. 24 g C = 2 mol, 128 g S = 4 mol $\Rightarrow$ 2 mol CS_2 banega.

Solution:

$$\text{Heat evolved} = 2 \times 22 = \mathbf{44\ kcal}$$

Correct Option: (3)

Q9. If heat of reaction A + 5B → 2C + 3D is –50 kJ, find heat of 2A + 10B → 4C + 6D.

Stoichiometry double karne par ΔH bhi double ho jaata hai.

Solution:

$$\Delta H = 2 \times (-50) = \mathbf{-100\ kJ}$$

Correct Option: (3)

Q10. The process $CH_3COOH \rightarrow CH_3COO^- + H^+$ should be:

Bond breaking aur ionisation ke liye energy chahiye hoti hai. Isliye process endothermic hota hai.

Correct Option: (2)

Q11. The enthalpy change of a reaction does not depend on:

Hess's Law: ΔH depends only on initial and final states. It is independent of pathway (intermediate reactions).

Correct Option: (3)

Q12. From: C(graphite)+$\frac{1}{2}O_2 \rightarrow CO$, $\Delta H = -110.5$ kJ
$CO+\frac{1}{2}O_2 \rightarrow CO_2$, $\Delta H = -283.2$ kJ
Find heat of C(graphite)+$O_2 \rightarrow CO_2$.

Add dono reactions: intermediate CO cancel ho jayega ⇒ net eqn milega.

$$\Delta H = -110.5 + (-283.2) = -393.7 \text{ kJ}$$

Correct Option: (2)

Q13. If $H_2+Cl_2 \rightarrow 2HCl$, $\Delta H = -44$ kcal and $2Na+2HCl \rightarrow 2NaCl+H_2$, $\Delta H = -152$ kcal, then $Na+0.5Cl_2 \rightarrow NaCl$, $\Delta H =?$

Target reaction banane ke liye equations ko combine karte hain.

Add: $\frac{1}{2}(H_2 + Cl_2 \rightarrow 2HCl, \Delta H = -44/2 = -22)$
$+\frac{1}{2}(\ 2Na + 2HCl \rightarrow 2NaCl + H_2, \Delta H = -152/2 = -76)$
$\Delta H = -22 + (-76) = -98$

Answer: –98 kcal (option 3).

Q14. $Zn+HgO \rightarrow ZnO+Hg$. Given heats: $Zn+0.5O_2 \rightarrow ZnO$, –84,000 cal $Hg+0.5O_2 \rightarrow HgO$, –21,700 cal

Subtract second eqn from first to get target.

$$\begin{aligned}\Delta H &= -84,000 - (-21,700) \\ &= -62,300 \text{ cal}\end{aligned}$$

Correct Option: (4)

Q15. Heat change for NH_3+HCl→NH_4Cl using data.

Apply Hess's Law. Add first 3 steps and subtract dissolution step.

$$\begin{aligned}\Delta H &= (-8.4) + (-17.3) + (-12.5) - (3.9) \\ &= -42.1 \text{ kcal}\end{aligned}$$

Correct Option: (1)

Q16. A+O_2→AO_2, given steps: A+0.5O_2→AO, –50 kcal AO+0.5O_2→AO_2, +100 kcal

Add dono steps directly.

$$\Delta H = -50 + 100 = +50 \text{ kcal}$$

Correct Option: (1)

Q17. Given: C+O_2→CO_2, –94 kcal CO+0.5O_2→CO_2, –67.7 kcal. Find C+0.5O_2→CO.

Subtract second eqn from first.

$$\Delta H = -94 - (-67.7) = -26.3 \text{ kcal}$$

Correct Option: (2)

Q18. Enthalpy of vaporisation of water from data: H_2+0.5O_2→H_2O(l), –285.77 kJ H_2+0.5O_2→H_2O(g), –241.84 kJ

Subtract two eqns: liquid → gas enthalpy difference.

$$\begin{aligned}\Delta H_{vap} &= -241.84 - (-285.77) \\ &= +43.93 \text{ kJ mol}^{-1}\end{aligned}$$

Correct Option: (1)

Q19. Fe_2O_3+3CO→2Fe+3CO_2, –26.8 kJ FeO+CO→Fe+CO_2, –16.5 kJ. Find ΔH for Fe_2O_3+CO→2FeO+CO_2.

Target obtained by subtracting 2×(second eqn) from first.

$$\begin{aligned}\Delta H &= -26.8 - [2(-16.5)]\\ &= -26.8 + 33.0 = +6.2 \text{ kJ}\end{aligned}$$

Correct Option: (3)

Q20. For: 0.5A→B, +150 kJ
3B→2C+D, –125 kJ
E+A→2D, +350 kJ. Find ΔH for B+D→E+2C.

Reverse + add eqns carefully to get target.

$$\begin{aligned}\text{Step1: } 0.5A \to B,\ \Delta H = +150 \ &\Rightarrow\ A \to 2B, +300\\ \text{Step2: } 3B \to 2C + D, -125&\\ \text{Step3: } 2D \to &E + A, -350\end{aligned}$$

Combine: $B + D \to E + 2C$
$\Delta H = -175kJ$

Correct Option: (3)

Q21. Heat of combustion of C_3H_6 from given data.

Use Hess's Law: (C_3H_6+H_2→C_3H_8) + (combustion of C_3H_8) – (H_2 combustion).

$$\begin{aligned}\Delta H &= [-2220] + [+124] + [+285]\\ &= -2059 \text{ kJ mol}^{-1}\end{aligned}$$

Correct Option: (1)

Q22. For: A→X =50 kJ, Y→X=20 kJ, B→Y=30 kJ. Find A→B.

Target: A→B. Work with enthalpy cycles.

$$\begin{aligned}\Delta H(A \to X) &= 50, \quad \Delta H(Y \to X) = 20 \Rightarrow X \to Y = -20\\ \Delta H(B \to Y) &= 30 \Rightarrow Y \to B = -30\\ \Delta H(A \to B) &= (A \to X) + (X \to Y) + (Y \to B)\\ &= 50 - 20 - 30 = 0\end{aligned}$$

Correct Option: (3)

Q23. For: $2Cr+1.5O_2 \rightarrow Cr_2O_3$, –1130 kJ $C+0.5O_2 \rightarrow CO$, –110 kJ. Find ΔH for $Cr_2O_3+3C \rightarrow 2Cr+3CO$.

> Reverse chromium oxide formation, add 3×carbon combustion.

$$\begin{aligned}\Delta H &= (+1130) + 3(-110)\\ &= +800 \text{ kJ}\end{aligned}$$

Correct Option: (3)

Q24. Three eqns: (i) $C+O_2 \rightarrow CO_2$, $\Delta H = x$ (ii) $C+0.5O_2 \rightarrow CO$, $\Delta H = y$ (iii) $CO+0.5O_2 \rightarrow CO_2$, $\Delta H = z$. Which relation is correct?

> Adding (ii)+(iii) gives (i).

$$y + z = x$$
$$\mathbf{x = y + z}$$

Correct Option: (3)

Q25. Graph for $C+0.5O_2 \rightarrow CO$ missing value.

> Given data: $\Delta H = -110.5$ kJ. Directly missing enthalpy is –110.5.

Correct Option: (3)

Q26. For reactions: A→B, $\Delta H_1 = x_1$; B→C, $\Delta H_2 = ?$; C→D, $\Delta H_3 = x_3$; A→D, $\Delta H = x$.

> Hess's law cycle: $x = x_1 + x_2 + x_3$.

$$x_2 = x - (x_1 + x_3)$$

Correct Option: (1)

Q27. $4NO_2$+O_2→$2N_2O_5$(g), $\Delta H = -111$ kJ. If solid N_2O_5 formed ($\Delta H_{sub} = 54$).

Gas→solid releases extra heat: add (–2×54).

$$\Delta H = -111 - 108 = -219 \text{ kJ}$$

Correct Option: (4)

Q28. From data: C+O_2→CO_2, –393.5
H_2+0.5O_2→H_2O, –285.8
CO_2+2H_2O→CH_4+2O_2, +890.3. Find ΔH for C+2H_2→CH_4.

Add first two eqns, then add third.

$$\begin{aligned}\Delta H &= (-393.5) + 2(-285.8) + (+890.3)\\ &= -74.8 \text{ kJ mol}^{-1}\end{aligned}$$

Correct Option: (3)