PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 52

Total Marks : 35

Max. Time : 40 min.

Topic : Thermodynamics & Thermochemistry

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.5	(3 marks, 3 min.)	[15, 15]
Subjective Questions ('–1' negative marking) Q.6 to Q.10	(4 marks, 5 min.)	[20, 25]

1. Given the following standard enthalpies of reaction :
(i) Enthalpy of formation of water = – 68.3 kCal/mol
(ii) Enthalpy of combustion of acetylene = – 310.6 kCal/mol
(iii) Enthalpy of combustion of ethylene = – 337.2 kCal/mol
Calculate the heat of reaction for the hydrogenation of acetylene at constant volume and 25°C.

2. The internal energy change of the comubstion of C_6H_6 (g) and C_2H_2 (g) at 300 K are – 800 Kcal/mole and – 300 Kcal/mole respectively. What is the enthlapy of polymerisation of C_2H_2 (g) to C_6H_6 (g) per mole of C_6H_6 (g) produced ? C_6H_6 (g), C_2H_2 (g) and C_2H_6 (g) behave ideally. R = 2 cal K^{-1} mol^{-1}.
(A) – 100 K Cal/mol (B) – 101.2 K Cal/mol (C) –98.8 K Cal/mol (D) – 103.6 K Cal/mol

3. The dissociation energy of CH_4 is 360 kCal/mol and of ethane is 620 kCal/mol. Calculate C – C bond energy.

4. Estimate $\Delta_r H$ for $2\,C_4H_{10}\,(g) \longrightarrow C_8H_{18}\,(g) + H_2\,(g)$. Given bond energy of C – C and C – H are 347 and 441 $kJmol^{-1}$. The enthalpy of formation of H (g) atom is 217.5 $kJmol^{-1}$.

5. The average energy required to break a P – P bond in P_4 (s) into gaseous atoms is 53.3 kcal mol^{-1}. The bond dissociation energy of H_2(g) is 104.3 $kcalmol^{-1}$; ΔH_f^0 of PH_3(g) from P_4(s) is 5.4 $kcalmol^{-1}$. The P-H bond energy in kcal mol^{-1} is : [Neglect presence of Vanderwaal forces in P_4(s)]
(A) 85.2 (B) 57.6 (C) 77 (D) 63.3

6. Using the data (all values are in kilocalories per mole at 25°C) given below, calculate the bond energy of C – H and C – C bonds.
$\Delta H^\circ_{\text{combustion (ethane) g}} = -372$; $\Delta H^\circ_{\text{combustion (propene) g}} = -530$
ΔH° for C (graphite) $\longrightarrow$ C (g) = 172 ; Bond energy of H – H bond = 104
ΔH_f° of H_2O (*l*) = – 68 ; ΔH_f° of CO_2 (g) = – 94

7. Determine the enthalpy change of the reaction : $C_3H_8\,(g) + H_2\,(g) \longrightarrow C_2H_6\,(g) + CH_4\,(g)$ at 25 °C , using the given enthalpy of combustion values under standard condition :

Compound	H_2 (g)	CH_4 (g)	C_2H_6 (g)	C (graphite)
ΔH° (kJ/mole)	– 286	– 890	– 1560	– 393.5

The standard enthalpy of formation of C_3H_8 (g) is – 104 kJ/mole.

8. The standard molar enthalpies of formation of cyclohexane (ℓ) and benzene (ℓ) at 25° C are –156 and +49 KJ mol^{-1} respectively. The standard enthalpy of hydrogenation of cyclohexene (ℓ) at 25°C is –119 KJ mol^{-1}. Use these data to estimate the resonance energy of benzene in KJ mol^{-1}.

9. The enthalpy of solution of anhydrous $CuSO_4$ is – 15.9 kCal/mol and that of $CuSO_4 . 5\,H_2O$ is 2.8 kCal/mol. Calculate the enthalpy of hydration of $CuSO_4$.

10. Calculate ΔH_f° for chloride ion (aq) from the following data :

$$\frac{1}{2}\,H_2\,(g) + \frac{1}{2}\,Cl_2\,(g) \longrightarrow HCl\,(g) \qquad \Delta H^\circ_f = -92.4\ kJ$$

$HCl\,(g) + n\,H_2O \longrightarrow H^+\,(aq) + Cl^-\,(aq)$ $\Delta H^\circ_{298} = -74.8$ kJ
$\Delta H^\circ_f\,(H^+)_{aq} = 0.0$ kJ

Answer Key

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1.	- 41.104 kCal.	**2.**	(B)	**3.**	80 kCal/mol.	**4.**	100 kJ/mol.	**5.**	(C)
6.	C - H = 99 kCal ; C - C = 82 kCal	**7.**	- 56.5 kJ.	**8.**	–152 KJ mol^{-1}				
9.	- 18.7 kCal	**10.**	- 167.2 kJ/mol.						

Hints & Solutions

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1. - 41.104 kCal.

2. $C_6H_6(g) + \frac{15}{2}O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(\ell)$ $\Delta_r u_1 = -800$ kcal/mole

$C_2H_2(g) + \frac{5}{2}O_2(g) \longrightarrow 2CO_2(g) + H_2O(\ell)$ $\Delta_r u_2 = -300$ kcal/mole

$\therefore$ $3C_2H_2(g) \longrightarrow C_6H_6(g)$ $\Delta_r u = -100$ kcal/mole

$\Delta_r H = \Delta_r u + (-2) \times 2 \times 300 \times 10^{-3}$

$\Delta_r H = -100 - 1.2 = -101.2$ kcal/mol.

3. 80 kCal/mol.

4. 100 kJ/mol.

5. $P_4(s) \rightarrow 4P(g)$ $\Delta H = 53.2 \times 6$

$H_2(g) \rightarrow 2H(g)$ $\Delta H = 104.2$

$\frac{1}{4}P_4(s) + \frac{3}{2}H_2(g) \rightarrow PH_3(g)$ $\Delta H = 5.5$

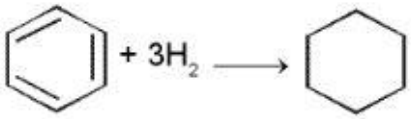
$\frac{1}{4} \times 6 \times 53.2 + \frac{3}{2} \times 104.2 - 3\epsilon_{P-H} = 5.5$

$\Rightarrow$ $\epsilon_{P-H} = 76.866$ i.e. 76.9 kcal mol^{-1}

6. C - H = 99 kCal ; C - C = 82 kCal

7. - 56.5 kJ.

8. -152 KJ mol^{-1}



$\Delta H_{calculated} = 3 \times (-119) = -357$ KJ mol^{-1}

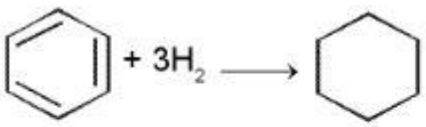
$$\Delta H_{experimental} = \sum(\Delta H°_f)_{product} - \sum(\Delta H°_f)_{reactant}$$

or $\Delta H_{expt} = -156 - (49 + 0) = -205$ KJ mol^{-1}
Resonance energy $= -357 - (-205) = -152$ KJ mol^{-1}

9. – 18.7 kCal

10. -167.2 kJ/mol.

8. -152 KJ mol^{-1}



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