SOLUTIONS

Module - 2 / JEE-2022

IN-CHAPTER EXERCISES	Chemistry	Thermochemistry

EXERCISE

1. $\Delta_r H^\ominus = -6.6 = 2\Delta_f H^\ominus_{Fe} + 3\Delta_f H^\ominus_{CO_2} - \Delta_f H^\ominus_{Fe_2O_3} - 3\Delta_f H^\ominus_{CO}$

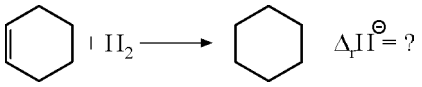
$= 2 \times 0 + 3(-94.1) - \Delta_f H^\ominus_{Fe_2O_3} - 3(-26.4) \Rightarrow \Delta_f H^\ominus_{Fe_2O_3} = -196.5\,kcal/mol$

2. $\Delta_r H^\ominus = \Delta_f H^\ominus_{Fe_2O_3} - 2\Delta_f H^\ominus_{FeO} - \frac{1}{2}\Delta_f H^\ominus_{Fe} = -822.2 - 2(-267.9) = -286.4\,kJ/mol$

3. 120 gm glucose $\equiv \frac{120}{180} = \frac{2}{3}$ moles $\Rightarrow$ Max. distance that can be covered $= \frac{\frac{2}{3} \times 2880 \times \frac{25}{100}}{100} = 4.8\,km$

4. g_{H_2O} to be perspired $= \left(\frac{1760 \times \frac{20}{100}}{44}\right) \times 18gm = 144\,gm$

5. $\Delta_r H^\ominus = \Delta_f H^\ominus_{CO_2} + 4\Delta_f H^\ominus_{HCl} - \Delta_f H^\ominus_{CCl_4} - 2\Delta_f H^\ominus_{H_2O} = (-393.7) + 4(-92.5) - (-106.7) - 2(-241.8) = -173.4\,kJ/mol$

6.  $\Delta_r H^\ominus = ?$

(i) $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(\ell)$ $\qquad \Delta_r H^\ominus_1 = -241\,kJ/mol$

(ii) $C_6H_{10}(\ell) + \frac{17}{2}O_2(g) \longrightarrow 6CO_2(g) + 5H_2O(\ell)$ $\qquad \Delta_r H^\ominus_2 = -3800\,kJ/mol$

(iii) $C_6H_{12}(\ell) + 9O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(\ell)$ $\qquad \Delta_r H^\ominus_3 = -3920\,kJ/mol$

$\Delta_r H^\ominus = -241 + (-3800) - (-3920) - 121\,kJ/mol$

7. **(i)** $\Delta_r H^\ominus = \Delta_f H^\ominus_{HBr} - \Delta_f H^\ominus_H - \Delta_f H^\ominus_{Br} = -36.4 - 218 - 111.8 = -366.2\,kJ/mol$

(ii) $\Delta_r H^\ominus = \Delta_f H^\ominus_{HBr} + \Delta_f H^\ominus_{Br} - \Delta_f H^\ominus_H - \Delta_f H^\ominus_{Br_2(\ell)} - 36.4 + 111.8 - 218 - 0 = -142.6\,kJ/mol$

8. $Fe_2O_3(s) + 2Al(s) \longrightarrow Al_2O_3(s) + 2Fe(s)$

$\Delta_r H^\ominus = \Delta_f H^\ominus_{Al_2O_3} - \Delta_f H^\ominus_{Fe_2O_3} = (-1675.7) - (-825.5) = -850.2\,kJ/mol$

9. $K(s) + \frac{1}{2}O_2(g) + \frac{1}{2}H_2(g) \longrightarrow KOH(s)$

$\Delta_r H^{\ominus}[\equiv \Delta_r H_1 + \Delta_r H_2 - \Delta_r H_3] = (-200.8) + (-286.3) - (-58.6) = -428.5\,kJ/mol$

10. $\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \longrightarrow HCl(g)$

$\Delta_r H = \frac{1}{2}(435) + \frac{1}{2}(242) - 430 = -91.5\,kJ/mol$

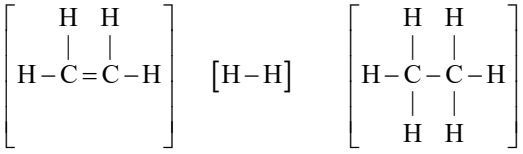
11. Heat liberated per mol of $CH_4 = \frac{18 \times 0.5}{0.01}\ \frac{kJ}{mol} = +900\,kJ/mol$

$\Rightarrow \quad \Delta_r U = -900\,kJ/mol$

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell)$

$\Delta_r H = \Delta_r U + \Delta n_g RT = -900 - (2) \times 8.314 \times 300 \times 10^{-3} = -905\ kJ/mol$

12. $C_2H_4(g) + H_2(g) \longrightarrow C_2H_6(g) \quad \Rightarrow \Delta_r H = [145 + 4 \times 99 + 104] - [6 \times 99 + 80] = -29\,kcal/mol$



13. $\Delta_r H = \Delta_{bond} H_{C=C} - 2\Delta_{bond} H_{C-C} = 590 - 2 \times 331 = -72\,kJ/mol$ [One C = C bond is broken and 2 C–C bond are formed]

14. $Na^+(g) + Cl^-(g) \longrightarrow NaCl(s)$; $\Delta_r H = -120 + 87.3 - 98.2 - 26 - \frac{1}{2} \times 58 = -185.9\,kcal/mol$

15. $\Delta U = \frac{(298.35 - 298) \times 2.5\,kJ}{3.5/28\,mol} = -7\,kJ/mol$

16. $X + F_2 \longrightarrow Y \equiv F_xCl_y \equiv ClF_3$

F : 61.7	61.7/19	3.247	3.0
Cl : 38.3	38.3/35.5	1.079	1.0

$F_2(g) + ClF(g) \longrightarrow ClF_3(g)$; $\Delta_r H = \frac{1}{2}(205 - 533 + 2 \times 24.7) = -139.3\ kJ/mol$

17. $C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(\ell) \quad \Delta_r H = -330\ kcal\,mol^{-1}$

$\Rightarrow \quad -330 = 2 \times (-94.2) + 2(-61) - 0 - (x) \quad \Rightarrow \quad x = -19.6\,kcal\,mol^{-1} \equiv \Delta_f H^{\ominus}_{C_2H_4}$

$2C(s) + 2H_2(g) \longrightarrow H - \underset{H}{\overset{|}{C}} = \underset{H}{\overset{|}{C}} - H$

$\Delta_f H^{\ominus} = [2 \times 150 + 2 \times 104] - [\Delta_{bond} C=C + 4 \times 93.6] \quad \Rightarrow \quad \Delta_{bond\,C=C} = +153.2\,kcal/mol$

18. $H_2(g) + S(s) + 2O_2(g) \longrightarrow H_2SO_4(\ell)$; $\Delta_f H^{\ominus} = -68.5 - 71 + (-23.5) - 31.2 = -194.2\,Kcal/mol$

19.(ACD) **20. (CD)**

21.(B) $25 = H_B - H_A \quad \Rightarrow \quad H_B = H_A + 25$ and $-18 = H_C - H_B \quad \Rightarrow \quad H_C = H_B - 18$ Thus, $H_B > H_C > H_A$

22.(D) $\frac{1}{2}B_2(g)+\frac{3}{2}F_2(g)\longrightarrow BF_3(g)$ $\Delta_f H^\ominus = -271.8 = 134 + 118.9\times 3 - 3x \Rightarrow x = 254.2$ Kcal/mol

23.(C) $C_2H_6(g)+\frac{7}{2}O_2(g)\longrightarrow 2CO_2(g)+3H_2O(\ell)$ $\Rightarrow$ $-1560 = 2\Delta_f H^\ominus_{CO_2} + 3\Delta_f H^\ominus_{H_2O} - \Delta_f H^\ominus_{C_2H_6}$

$\Rightarrow$ $-1560 = 2(-393.5)+3(-285.8) - \Delta_f H^\ominus_{C_2H_6} \Rightarrow \Delta_f H^\ominus_{C_2H_6} = -83.3\,kJ/mol$

24.(A) $\Delta_r H^\ominus = -4(-229.3) - 4\times 74.2 - 12(52.1) = -4.8$ kcal/mol

25.(D) $S(s) + O_2(g) \longrightarrow SO_2(g)$; $\Delta_r H^\ominus = \Delta_f H^\ominus = \frac{1}{2}\times 197.8 - 395.7 = -296.8\,kJ/mol$

26.(A) $\Delta_r H^\ominus = (-1941) - (-2220) - 571 = -292$ kJ/mol

27.(A) Clearly : $\Delta_r H = -(ii) + (i) + \frac{1}{2}(iii)$

28.(B) $K(s)\longrightarrow K(g)$; $\Delta_a H^\ominus = 90$; $F_2(g)\longrightarrow 2F(g)$ $\Delta_a H^\ominus = 58$; $K(s) + \frac{1}{2}F_2(g)\longrightarrow KF(s)$

$K(g)\longrightarrow K^+(g) + e^-$; $\Delta_{IE}H^\ominus = 419$; $F(g) + e^-\longrightarrow F^-(g)$; $\Delta_{EA}H^\ominus = -328$ $\Delta_f H^\ominus = -567$

$\Rightarrow$ $\Delta_{lattice}H^\ominus_{KF} = -419 - (-328) - 567 - 158\times\frac{1}{2} - 90 = -827\,kJ/mol$

29.(C) $\Delta_f H^\ominus = \frac{1}{2}(-3352) = -1676\,kJ/mol$

30.(A) $\text{Energy released} = \left(-47.8\,\frac{kJ}{g}\right)\times(1000\,ml)\times 0.74\,\frac{g}{ml} = -35372\,kJ$

31.(B) $C_3H_8(g) + 5O_2(g)\longrightarrow 3CO_2(g) + 4H_2O(\ell)$ $\Delta_C H^\ominus = -2220.1\,kJ\,mole^{-1}$

$H_2O(\ell)\longrightarrow H_2O(g)$ $\Delta_{vap}H^\ominus = 44\,kJ\,mole^{-1}$

$\Rightarrow$ $\Delta_r H^\ominus = -2220.1 + 4(44) = -2044.1$ kJ

32.(D) $CH_4(g)\longrightarrow C(g)+4H(g)$ $\Delta_r H = 360\,kcal/mol$

$C_2H_6(g)\longrightarrow 2C(g) + 6H(g)$ $\Delta_r H = 620$ kcal/mol

$\Rightarrow$ $4\Delta_{bond}H_{C-H} = 360 \Rightarrow \Delta_{bond}H_{C-H} = 90$ kcal/mol

and $6\Delta_{bond}H_{C-H} + \Delta_{bond}H_{C-C} = 620 \Rightarrow \Delta_{bond}H_{C-C} = 620 - 90\times 6 = 80$ kcal/mol

33.(A) $F-O-F(g)\longrightarrow 2F(g)+O(g)$ $\Delta_r H = 368\,kJ = 2\Delta_{bond}H_{O-F} \Rightarrow \Delta_{bond}H_{O-F} = 184\,kJmol^{-1}$

34.(B) $N_2(g)+2H_2(g)\longrightarrow N_2H_4(g)$

$\Rightarrow$ $\Delta_f H^\ominus = [1\times 941 + 2\times 436] - [4\times 398 - 159] = 62\,kJmol^{-1}$

35.(D) $H_2(g) + Cl_2(g)\longrightarrow 2HCl(g)$ $\Delta n_g = 0 \Rightarrow \Delta_r U^\ominus = \Delta_r H^\ominus = -185\times 3 = -555\,kJ/mol$