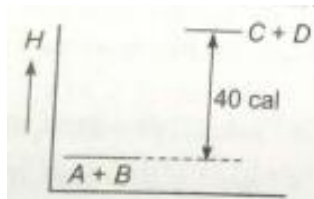


**Exercise 2** (Going step – by – Step)**Enthalpy of Reaction**

1.  $A + B + 40 \text{ cal} \rightarrow C + D$ . In this reaction



- (a) heat is absorbed
- (b) temperature of the surrounding falls
- (c) can be represented as in figure

**(d) All of the above**

2.  $N_2 + 3H_2 \rightarrow 2NH_3 + 22 \text{ kcal}$

Select the correct alternate about this reaction

(a) it is an endothermic reaction

**(b) it is an exothermic reaction**

(c) system gets heated

(d) None of the above

3.  $2SO_2 + O_2 \rightarrow 2SO_3$

In this reaction some of the following facts are observed

I : Surroundings get heated

II : Increase in temperature favours dissociation of  $SO_3$  hence.

(a) This is an endothermic reaction

**(b) This is an exothermic reaction**

(c) Pressure has no effect on this reaction

(d) Concentration has no effect on this reaction

4. Dissolution of  $\text{NH}_4\text{Cl}$  in  $\text{H}_2\text{O}$  is

- (a) an exothermic reaction
- (b) an endothermic reaction**
- (c) a reaction with  $\Delta H = 0$
- (d) a reaction with  $\Delta S = 0$

5.  $A + B + x_1 \rightarrow C + D + x_2$

Select the correct statement

- (a) If  $x_1 > x_2$ , the reaction is exothermic
- (b) If  $x_2 > x_1$ , the reaction is exothermic
- (c) If  $x_2 > x_1$ , the reaction is exothermic**
- (d) If  $x_2 = x_1$ , the reaction is exothermic

6.  $\text{N}_2 + \text{O}_2 \rightarrow 2\text{NO}$ ,  $\Delta H = 43.2 \text{ kcal}$

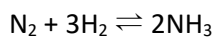
Based on the reaction shown, which statement is true?

- (a) 43.2 kcal are consumed when 1.00 g of  $\text{N}_2$  reacts
- (b) 43.2 kcal are consumed when 1.00 g of  $\text{O}_2$  reacts
- (c) 43.2 kcal are consumed when 1.00 mol of  $\text{O}_2$  reacts**
- (d) 43.2 kcal are consumed when 2.00 mol of  $\text{NO}$  are formed

7. If liquid is converted into solid state then

- (a) Heat is absorbed
- (b) Heat is evolved**
- (c) No enthalpy change
- (d) Heat change depends on nature of solvent

8. For the following reaction



increase in temperature favours dissociation of  $\text{NH}_3$ , hence this reaction is

(a) exothermic in forward direction and endothermic in backward direction

(b) endothermic in forward direction and exothermic in backward direction

(c) exothermic in forward direction

(d) endothermic in forward direction

9. Consider the following changes

I : adsorption

III : freezing

II : fusion

IV : vaporization

Exothermic changes are

(a) I, II

(b) I, III

(c) I, IV

(d) II, IV

10. Endothermic changes in (Q. 9) above are

(a) II, III

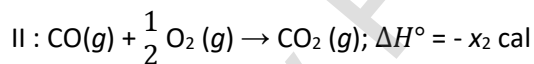
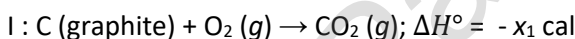
(b) III, IV

(c) I, II

(d) II, IV

### Enthalpy of Formation

11. Consider the following reaction



Based on the above data,  $\Delta H^\circ_f (\text{CO}_2)$  is

(a)  $-x_1 \text{ cal}$

(b)  $-x_2 \text{ cal}$

(c)  $(x_2 - x_1) \text{ cal}$

(d)  $(x_1 - x_2) \text{ cal}$

12. From Q. (11) above,  $\Delta H^\circ_f (\text{CO})$  is

(a)  $-x_1$

(b)  $-x_2$

(c)  $x_2 - x_1$

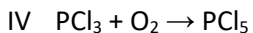
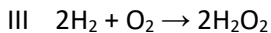
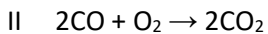
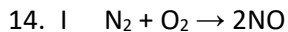
(d)  $x_1 - x_2$

13.  $\Delta H^\circ_f [\text{H}_2\text{O}(g)]$  is  $-58 \text{ kcal mol}^{-1}$  and  $\Delta H^\circ_f [\text{H}_2\text{O}(l)]$  is  $-68 \text{ kcal mol}^{-1}$ . Hence  $\Delta S^\circ$  (vaporization) of  $\text{H}_2\text{O}(l)$  to  $\text{H}_2\text{O}(g)$  at 1 atm pressure ( $100^\circ\text{C}$ ) is

(a)  $10 \text{ cal mol}^{-1} \text{ K}^{-1}$

(b)  $10 \text{ kcal mol}^{-1} \text{ K}^{-1}$

(c) 126 kcal mol<sup>-1</sup>                      **(d) 27 cal mol<sup>-1</sup> K<sup>-1</sup>**



In which case (S),  $\Delta H_t^\circ = \frac{\Delta H}{2}$  ?

(a) I, II, III                      (b) IV                      (c) II, III                      **(d) I**

15. For the following gaseous phase reaction at 298 K

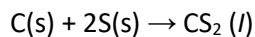


If  $\Delta H_t^\circ$  (HF) = - 64.2 kcal mol<sup>-1</sup> then  $\Delta H^\circ$  (HCl) is

(a) 20.2 kcal mol<sup>-1</sup>                      **(b) - 20.2 kcal mol<sup>-1</sup>**

(c) - 20.2 kcal mol<sup>-1</sup>                      (d) + 20.2 kcal mol<sup>-1</sup>

16. The heat change for the reaction



is known as

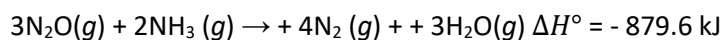
(a) heat of transition of C

(b) heat of fusion of CS<sub>2</sub> (l)

**(c) heat of formation of CS<sub>2</sub> (l)**

(d) heat of vaporization of CS<sub>2</sub> (l)

17. For the reaction,



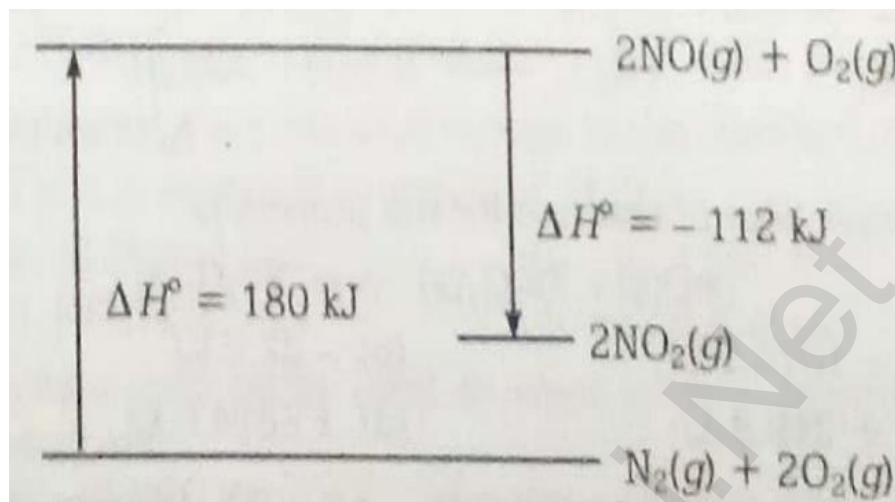
If  $\Delta H_f^\circ$  of NH<sub>3</sub>(g) = - 45.9 kJ mol<sup>-1</sup>,

H<sub>2</sub>O(g) = - 241.8 kJ mol<sup>-1</sup> then  $\Delta H_f^\circ$  of N<sub>2</sub>O(g) is (in kJ mol<sup>-1</sup>)

(a) +246                                      **(b) +82**

(c) -82                                        (d) -246

18. The diagram below shows the enthalpy change for the chemical reactions between  $N_2$ ,  $O_2$ ,  $NO$  and  $NO_2$



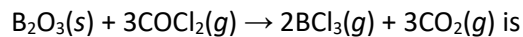
Select the correct statement.

- (a) The standard heat of formation of  $NO_2$  is  $68 \text{ kJ mol}^{-1}$   
**(b) The oxidation reaction of  $N_2$  to  $NO_2$  is endothermic**  
 (c) The standard heat of formation of  $NO$  is  $90 \text{ kJ mol}^{-1}$   
 (d) The oxidation reaction of  $NO$  to  $NO_2$  is endothermic
19. Which of these species has standard enthalpy of formation equal to zero?

- (a)  $F_2(g)$  (b)  $F(g)$   
 (c)  $HF(aq)$  (d)  $F^-(aq)$

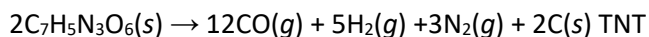
20. Given,	$\Delta H_f^\circ, \text{ kJ mol}^{-1}$
$B_2O_3(s)$	- 1272.8
$COCl_2(g)$	- 218.8
$BCl_3(g)$	- 403.8
$CO_2(g)$	- 393.5

Thus,  $\Delta H^\circ$  of the reaction



- (a) 694.3 kJ                      (b) - 3917.3 kJ  
 (c) -59.7 kJ                      (d) 354.9 kJ

21. In the explosion of two moles of TNT with a volume of approximately 274 mL produces gases with a volume of 448 L at room temperature and at 1 atm



Hence,  $pV$  work done during explosion is

- (a) 45.34 kJ                      (b) 0.45 kJ  
 (c)  $8.314 \times 10^{-3}$  kJ                      (d) 8.314 kJ

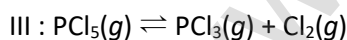
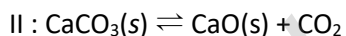
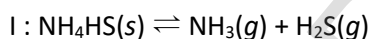
22. Heat of vaporization of  $A(l)$  is  $x_1$  cal and heat of fusion of  $A(s)$  is  $x_2$  cal. Hence, heat of sublimation of  $A(s)$  is

- (a)  $x_1 - x_2$                       (b)  $x_2 - x_1$   
 (c)  $x_1 + x_2$                       (d)  $-(x_1 - x_2)$

23. Which of the following has the highest enthalpy content?

- (a)  $\text{H}_2\text{O}(l)$                       (b)  $\text{H}_2\text{O}(s)$   
 (c)  $\text{H}_2\text{O}(g)$                       (d) Equal

24. Consider the following reactions



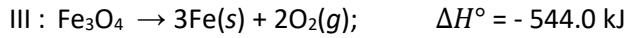
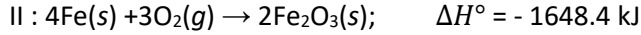
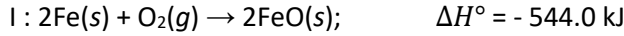
In which case(s)  $\Delta H - \Delta E = RT$ ?

- (a) I, II, III                      (b) I, II  
 (c) II, III                      (d) I, III

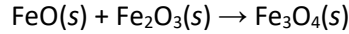
25. Enthalpy content is zero in which of the the following?

- (a)  $\text{H}(g)$                       (b)  $\text{CaCO}_3(s)$   
 (c)  $\text{H}_2\text{O}(l)$                       (d)  $\text{Na}(s)$

26. Given,



Hence, heat of reaction for the process is



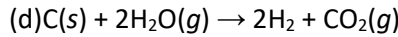
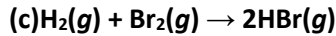
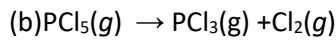
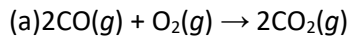
(a) - 1074.0 kJ

(b) - 1074.0 kJ

(c) + 1074.0 kJ

(d) + 1074.0 kJ

27. For which reaction will  $\Delta H - \Delta E = 0$ ? Assume that each reaction is carried out in an open container.



28. Heat of reaction  $A(s) + B(g) \rightarrow 2C(g)$  is 40 kJ at 300 K and constant volume. Hence, heat of reaction at constant pressure and at 300 K is,

**(a) 42.5 kJ**

(b) 37.5 kJ

(c) 40.0 kJ

(d) 30.0 kJ

29. Heat of reaction is independent of

(a) Temperature

(b) pressure

(c) physical state

**(d) path adopted**

30. Heat of reaction varies with temperature as given by

(a)  $\Delta H_2 = \Delta H_1 + \Delta C_p \int_{T_1}^{T_2} dT$

(b)  $\Delta H_2 = \Delta H_1 + \Delta C_v \int_{T_1}^{T_2} dT$

(c)  $\Delta E_2 = \Delta E_1 + \Delta C_p \int_{T_1}^{T_2} dT$

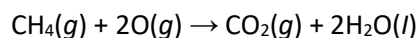
(d) All of the above are correct

### Enthalpy of Combustion

31. Heat of combustion of  $\text{CH}_4$ ,  $\text{C}_2\text{H}_6$  and  $\text{C}_3\text{H}_8$  are respectively  $-210$ ,  $-368.4$  and  $-526.3$  kcal  $\text{mol}^{-1}$ . Hence, heat of combustion of  $\text{C}_8\text{H}_{16}$  is respectively

- (a)  $-1310$  kcal  $\text{mol}^{-1}$       (b)  $-684$  kcal  $\text{mol}^{-1}$   
 (c)  $-840$  kcal  $\text{mol}^{-1}$       (d)  $-1000$  kcal  $\text{mol}^{-1}$

32. Heat of combustion of  $\text{CH}_4$  at  $25^\circ\text{C}$  and  $1$  atm constant pressure is  $-210$  kcal  $\text{mol}^{-1}$



Hence, heat of combustion at constant volume is

- (a)  $-210$  kcal  $\text{mol}^{-1}$       (b)  $-198$  kcal  $\text{mol}^{-1}$   
 (c)  $-208.8$  kcal  $\text{mol}^{-1}$       (d)  $-211$  kcal  $\text{mol}^{-1}$

33. Heat of combustion of  $\text{C}_6\text{H}_6(l)$ ,  $\text{H}_2\text{O}(l)$  and  $\text{CO}_2(g)$  is, if heat of formation of  $\text{C}_6\text{H}_6(l)$ ,  $\text{H}_2\text{O}(l)$  and  $\text{CO}_2(g)$  are  $-x_1$ ,  $-x_2$  and  $-x_3$  cal respectively

- (a)  $x_1 - x_2 - x_3$       (b)  $x_1 - 6x_2 - 3x_3$   
 (c)  $x_1 - x_2 - x_3$       (d)  $x_1 - 3x_2 - 6x_3$

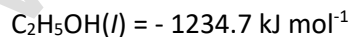
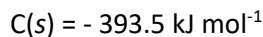
34. Heat of combustion of  $\text{CH}_4$ ,  $\text{C}_2\text{H}_6$  and  $\text{C}_3\text{H}_8$  are respectively  $-210$ ,  $-368.4$  and  $-526.3$  kcal  $\text{mol}^{-1}$ . Hence, maximum calorific value is of

- (a)  $\text{C}_3\text{H}_8$       (b)  $\text{C}_2\text{H}_6$   
 (c)  $\text{CH}_4$       (d) equal

35. Calorific value of  $\text{H}_2$  is  $-143$  kJ  $\text{g}^{-1}$ . Hence,  $\Delta H^\circ_f$  of  $\text{H}_2\text{O}$  is

- (a)  $-143$  kJ  $\text{mol}^{-1}$       (b)  $-286$  kJ  $\text{mol}^{-1}$   
 (c)  $+143$  kJ  $\text{mol}^{-1}$       (d)  $+286$  kJ  $\text{mol}^{-1}$

36. Heat of combustion of  $\text{H}_2(g) = -241.8$  kJ  $\text{mol}^{-1}$

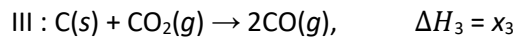
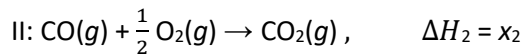
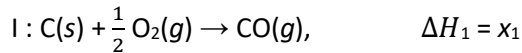


Hence, heat of formation of  $\text{C}_2\text{H}_5\text{OH}(l)$  is

- (a)  $-2747.1$  kJ  $\text{mol}^{-1}$       (b)  $-277.7$  kJ  $\text{mol}^{-1}$   
 (c)  $277.7$  kJ  $\text{mol}^{-1}$       (d)  $2747.1$  kJ  $\text{mol}^{-1}$

37. Consider the following reaction,





Select the correct statements.

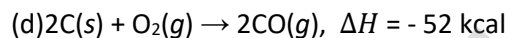
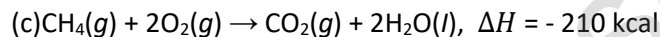
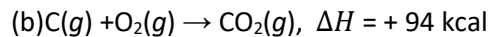
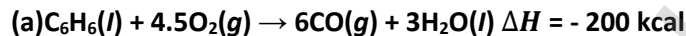
(a) Heat of formation of  $\text{CO}_2$  is  $(x_1 + x_2)$

(b) Heat of combustion of C is  $(x_1 + x_2)$

(c)  $\Delta H_3 = \Delta H_1 - \Delta H_2$

**(d) All of the above are correct statements**

38. Which represents enthalpy of combustion?



39. Heat of combination of  $\text{C(s)}$ ,  $\text{H}_2(\text{g})$  and  $\text{CH}_4(\text{g})$  are  $-x_1$ ,  $-x_2$  and  $-x_3$  Hence, heat of formation of  $\text{CH}_4(\text{g})$  is

(a)  $-x_1 - x_2, -x_3$

(b)  $-x_1 - 2x_2, -x_3$

(c)  $-x_1 - x_2 + 2x_3$

**(d)  $-x_1 - 2x_2, -x_3$**

40. In the complete combustion of  $\text{C}_2\text{H}_6$  54 g of  $\text{H}_2\text{O}$  is formed and 370 kcal of heat is evolved

Hence, heat of combustion of  $\text{C}_2\text{H}_6$  is

(a) 370 kcal mol<sup>-1</sup>

**(b) - 370 kcal mol<sup>-1</sup>**

(c) - 6.61 kcal mol<sup>-1</sup>

(d) 6.61 kcal mol<sup>-1</sup>

### Enthalpy of Neutralisation

41. The heat released on neutralization of  $\text{CsOH}$  with all strong acids is 13.4 kcal mol<sup>-1</sup>. The heat released on neutralization of  $\text{CsOH}$  with  $\text{HF}$  (weak acid) is 16.4 kcal mol<sup>-1</sup>.  $\Delta H^\circ$  of ionization of  $\text{HF}$  in water is

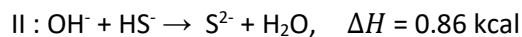
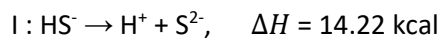
(a) 39.8 kcal

(b) - 39.8 kcal

(c)– 3.0 kcal

(d) + 3.0 kcal

42. For the reactions,

Hence,  $\Delta H$  of the reaction,  $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$  is

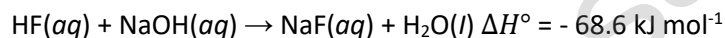
(a) 15.08 kcal

(b) – 15.08 kcal

(c) 13.36 kcal

**(d) – 13.36 kcal**43. If  $\Delta H^\circ_f(\text{H}_2\text{O})$  is  $-286.20 \text{ kJ mol}^{-1}$  then  $\Delta H^\circ_f(\text{OH}^-)$  is**(a)– 228.88 kJ mol<sup>-1</sup>**(b) + 228.88 kJ mol<sup>-1</sup>(c) – 343.52 kJ mol<sup>-1</sup>(d) + 345.52 kJ mol<sup>-1</sup>

44. In the following reaction, involving neutralization of HF (a weak acid) with NaOH (strong base).

This value is much higher than the heat of neutralization of strong acid with strong base (=  $-57.3 \text{ kJ mol}^{-1}$ ). This is due to

(a) In aqueous solution, HF behaves as a strong acid

**(b) There is hydration of  $\text{F}^-$  ion in aqueous solution, and the process is exothermic**

(c) Both (a) and (b)

(d) None of the above

45. Enthalpy change when 1 mole of  $\text{H}_2\text{SO}_4$  is completely neutralized by NaOH is

(a)– 13.7 kcal

**(b) – 27.4 kcal**

(c)– 6.85 kcal

(d) + 27.4 kcal

46. 30 mL of 0.10 M  $\text{Ba}(\text{OH})_2(aq)$  is added to 30 mL of 0.10 M  $\text{H}_2\text{SO}_4(aq)$ . The rise in temperature is  $\Delta T_1$ . If experiment is repeated by taking 90 mL of each solution, the rise in temperature is  $\Delta T_2$ . Hence(a)  $\Delta T_2 = 3\Delta T_1$ **(b)  $\Delta T_1 = \Delta T_2$** (c)  $\Delta T_1 = 3\Delta T_2$ (d)  $\Delta T_1 = 2\Delta T_2$

47. Heat of dissociation of  $\text{CH}_3\text{COOH}$  is  $0.005 \text{ kcal g}^{-1}$ , hence enthalpy change when 1 mole of  $\text{Ca(OH)}_2$  is completely neutralized by  $\text{CH}_3\text{COOH}$  is
- (a) – 27.4 kcal                      (b) – 13.6 kcal  
 (c) – 26.8 kcal                      (d) – 27.1 kcal
48. When 30 mL of 0.10 M NaOH reacts with 10 mL of 0.10 M HCl, enthalpy change is – 13.7 cal. When 20 mL of 0.10 M HCl, is further added, enthalpy change would be
- (a) – 13.7 cal                      (b) – 27.4 cal  
 (c) 13.7 cal                      (d) 27.4 cal
49. What is enthalpy change when 100 mL of 1 M  $\text{H}_2\text{SO}_4$  is completely neutralized by 100 mL 1 M  $\text{Ca(OH)}_2$ ?
- (a) – 13.7 kcal                      (b) – 27.4 kcal  
 (c) – 1.37 kcal                      (d) – 2.74 kcal
50.  $\text{Ca(OH)}_2 + \text{HCl} \rightarrow \text{Ca(OH)Cl} + \text{H}_2\text{O} \quad \Delta H_1$   
 $\text{Ca(OH)Cl} + \text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} \quad \Delta H_2$   
 $\Delta H_1$  and  $\Delta H_2$  for 1:1 molar ratio of each reactant are
- (a) – 6.85 kcal, - 6.85 kcal      (b) – 13.7 kcal, - 13.7 kcal  
 (c) – 27.4 kcal, - 27.4 kcal      (d) – 6.85 kcal, - 13.7 kcal

### Enthalpy of Solution

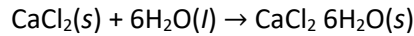
51.  $\Delta H_f^\circ$  for chloride ion from the following data is
- $$\frac{1}{2} \text{H}_2(g) + \frac{1}{2} \text{Cl}_2(g) \rightarrow \text{HCl}(g), \Delta H_f^\circ = - 22.1 \text{ kcal}$$
- $$\text{HCl}(g) + n\text{H}_2\text{O} \rightarrow \text{H}^+(aq) + \text{Cl}^-(aq), \Delta H_{298\text{K}}^\circ = - 17.9 \text{ kcal}$$
- (a) – 40.0 kcal                      (b) + 40.0 kcal  
 (c) + 17.9 kcal                      (d) + 22.1 kcal
52.  $\Delta H_f^\circ [\text{K}^+(aq)]$ ,  $\Delta H_f^\circ [\text{Cl}^-(aq)]$  and  $\Delta H_f^\circ (\text{HCl})$  are respectively – 6004, - 400 and – 104.18 kcal  
 Hence,  $\Delta H^\circ$  for the process at  $25^\circ\text{C}$  of dissolving 1.00 mol of KCl in large excess of water
- $$\text{KCl}(s) \rightarrow \text{K}^+(aq) + \text{Cl}^-(aq) \text{ is}$$
- (a) – 4.14 kcal                      (b) + 4.14 kcal

- (c) + 20.04 kcal                      (d) – 20.04 kcal

53. Based on  $\Delta H^\circ$  value of Q (2) above, given process is

- (a) Ionisation                              **(b) dissolution**  
 (c) Both (a) and (b)                      (d) None of these

54. The dissolution of  $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$  in large volume of water is endothermic to the extent of 3.5 kcal mol<sup>-1</sup>. For the reaction



$\Delta H = - 23.2$  kcal. Hence, heat of solution of  $\text{CaCl}_2$  (anhydrous) in a large volume of water is

- (a) 26.7 kcal                              (b) – 26.7 kcal  
 (c) 19.7 kcal                              **(d) – 19.7 kcal**

55.  $\Delta H^\circ_f [\text{HCl}](g) = - 22.1$  kcal mol<sup>-1</sup>, and  $\Delta H^\circ_f [\text{Cl}^-(aq)] = - 40$  kcal mol<sup>-1</sup>, then enthalpy change in the standard state when  $\text{HCl}(g)$  is dissolved in excess of  $\text{H}_2\text{O}$  is

- (a) – 179 kcal mol<sup>-1</sup>**                      (b) – 62.1 kcal mol<sup>-1</sup>  
 (c) + 62.1 kcal mol<sup>-1</sup>                      (d) + 17.9 kcal mol<sup>-1</sup>

56. Instant cold packs used to treat athletic injuries contain water and

- (a) solid  $\text{NH}_4\text{Cl}$                               **(b) solid  $\text{NH}_4\text{NO}_3$**   
 (c) solid  $\text{NH}_4\text{HCO}_3$                       (d) solid  $(\text{NH}_4)_2\text{C}_2\text{O}_4$

57. Lattice energy of  $\text{NaCl}(s)$  is 788 kJ mol<sup>-1</sup> and enthalpy of  $\text{NaCl}(s)$  is

- (a) 4 kJ mol<sup>-1</sup>**                              (b) – 4 kJ mol<sup>-1</sup>  
 (c) – 1572 kJ mol<sup>-1</sup>                      (d) 1572 kJ mol<sup>-1</sup>

58. Solubility of  $\text{CaO}(s)$  in water increases on lowering the temperature. Thus, dissolution process is

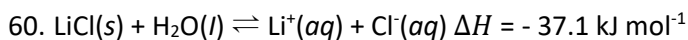
- (a) endothermic                              **(b) exothermic**  
 (c) nonthermic                              (d) Can't be decided

59. If a certain solution process is endothermic and the solution is subsequently diluted

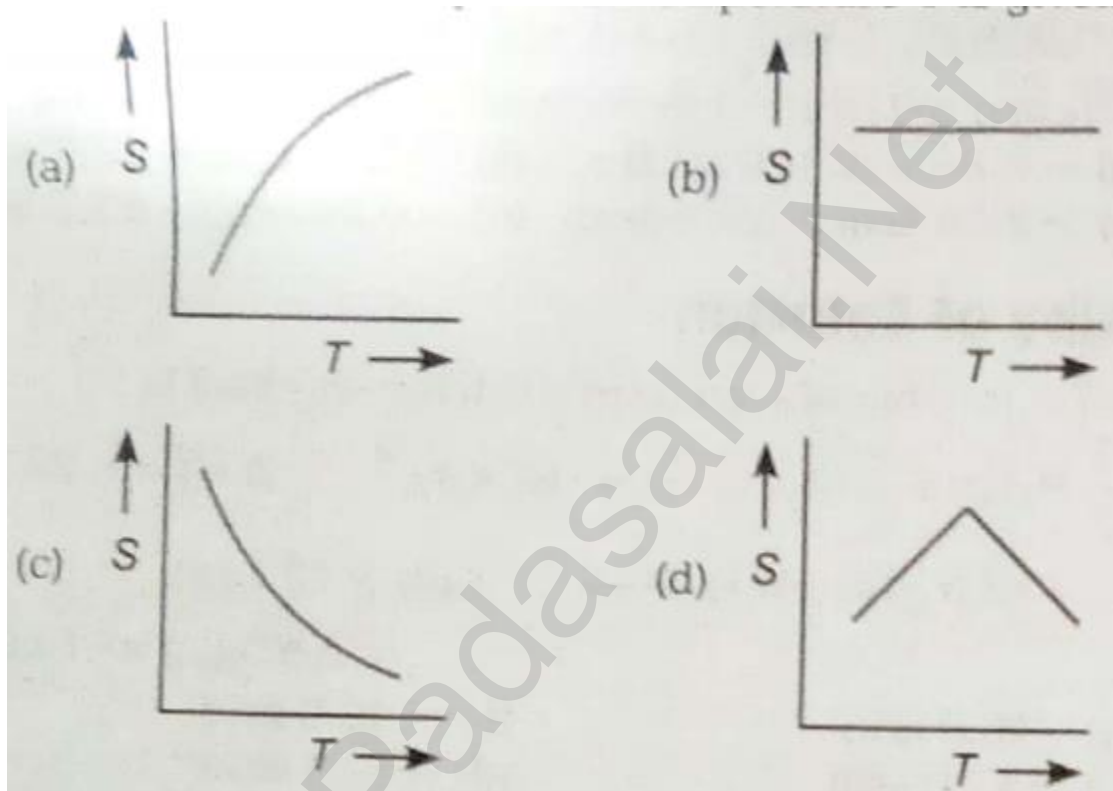
- (a) more heat will be absorbed by the same solution from the surroundings**  
 (b) more heat will be liberated to the surroundings

(c) no heat will be absorbed or liberated

(d) enthalpy data is also required



Variation of solubility  $S$  with temperature  $T$  is given by



ans:(c)

### Bond Enthalpy

61. Bond energies of  $\text{N} \equiv \text{N}$  bond,  $\text{H}-\text{H}$  bond and  $\text{N}-\text{H}$  bond are respectively  $x_1$ ,  $x_2$  and  $x_3$   $\text{kJ mol}^{-1}$ . Hence,  $\Delta H_f^\circ(\text{NH}_3)$  is

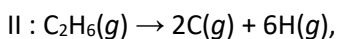
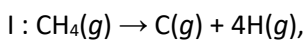
(a)  $x_1 + x_2 - x_3$

(b)  $x_1 + x_2 - 3x_3$

(c)  $\frac{x_1}{2} + \frac{3}{2}x_2 - 3x_3$

(d)  $x_1 + 3x_2 - 6x_3$

62. For the reaction,



From I and II, bond energy of C—C bond is

- (a)  $x_1 - x_2$  (b)  $x_2 - x_1$   
 (c)  $x_2 + 1.5 x_1$  (d)  $x_1 - 1.5 x_1$

63.  $\Delta H$  of the following reaction,

$2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(l)$ , is determined by

- (a) BE of H—H, BE of O=O and BE of H—O band  
 (b) all the values is (a) and heat of vaporization of  $\text{H}_2\text{O}(l)$   
 (c)  $\Delta H^\circ_f(\text{H}_2)$ ,  $\Delta H^\circ_f(\text{O}_2)$  and  $\Delta H^\circ_f(\text{H}_2\text{O})$

**(d) alternates (b) and (c) are correct**

64.  $\text{C}(\text{graphite}) + \frac{1}{2} \text{O}_2(g) + 2\text{H}_2(g) \rightarrow \text{CH}_3\text{OH}(l)$ ; for this reaction  $\Delta H$  is to be calculated. Some of the values given below can be taken

I : Heat of atomization of C (graphite)

II : BE of O=O bond

III : BE of H—H bond

IV : BE of C—H bond

V : BE of O—H bond

VI : BE of C—O bond

VII : Heat of vaporization of  $\text{CH}_3\text{OH}(l)$

Hence, correct alternates are

- (a) I to VII all (b) all except I and VII  
 (c) all except VII (d) all except I, VI and VII

65.  $\text{H}_2\text{O}(g) \rightarrow \text{H}(g) + \text{OH}(g)$ ,

$\text{OH}(g) \rightarrow \text{H}(g) + \text{O}(g)$ ,

Based on these value, Be of O—H bond is

- (a)  $x_1 + x_2$  (b)  $\frac{x_1 + x_2}{2}$  (c)  $\frac{x_1 + x_2}{2}$  (d)  $2(x_1 - x_2)$

66. Bond energies of H—H and Cl—Cl bonds are  $430 \text{ kJ mol}^{-1}$  and  $242 \text{ kJ mol}^{-1}$  respectively. If heat of formation of HCl is  $-91 \text{ kJ mol}^{-1}$ , the bond energy of HCl (in  $\text{kJ mol}^{-1}$ )

(a)  $430 + 242 - 91$  (b)  $430 + 242 + 91$

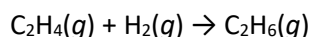
(c)  $215 + 121 - 91$  (d)  **$215 + 121 + 91$**

67. The enthalpy of hydrogenation of 1-pentene is  $+126 \text{ kJ mol}^{-1}$ . The enthalpy of hydrogenation of 1,3-pentadiene is  $+230 \text{ kJ mol}^{-1}$ . Hence, resonance (delocalization) energy of 1,3-pentadiene is

(a)  **$22 \text{ kJ}$**  (b)  $104 \text{ kJ}$

(c)  $252 \text{ kJ}$  (d)  $11 \text{ kJ}$

68. The value of  $\Delta H$  for a reaction can be found by appropriate combination of bond enthalpies (the energy required to break a particular bond, represented a BE). Which expression will give  $\Delta H$  for this reaction?



(a)  **$\text{BE}(\text{C}=\text{C}) + \text{BE}(\text{H}-\text{H}) - [\text{BE}(\text{C}-\text{C}) + 2\text{BE}(\text{C}-\text{H})]$**

(b)  $\text{BE}(\text{C}-\text{C}) + \text{BE}(\text{C}-\text{H}) - [\text{BE}(\text{C}=\text{C}) + 2\text{BE}(\text{H}-\text{H})]$

(c)  $\left(\frac{1}{2}\right)\text{BE}(\text{C}=\text{C}) + \text{BE}(\text{H}-\text{H}) - 2\text{BE}(\text{C}-\text{H})$

(d)  $2\text{BE}(\text{C}-\text{H}) + \text{BE}(\text{H}-\text{H}) - \left(\frac{1}{2}\right)\text{BE}(\text{C}=\text{C})$

69. Based on the values of BE given,  $\Delta H^\circ_f$  of  $\text{N}_2\text{H}_4(g)$  is

N—N  $159 \text{ kJ mol}^{-1}$  H—H  $436 \text{ kJ mol}^{-1}$

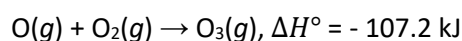
N=N  $418 \text{ kJ mol}^{-1}$  H—N  $389 \text{ kJ mol}^{-1}$

N≡N  $941 \text{ kJ mol}^{-1}$

(a)  $+711 \text{ kJ mol}^{-1}$  (b)  **$+98 \text{ kJ mol}^{-1}$**

(c)  $-98 \text{ kJ mol}^{-1}$  (d)  $-711 \text{ kJ mol}^{-1}$

70. For the reaction



Hence, the average bond energy in  $\text{O}_3$  is (assume O=O bond energy  $498.8 \text{ kJ mol}^{-1}$ )

(a)  $606.0 \text{ kJ mol}^{-1}$  (b)  $107.2 \text{ kJ mol}^{-1}$

- (c) 391.6 kJ mol<sup>-1</sup>                      **(d) 303.0 kJ mol<sup>-1</sup>**

### Hess's Law

71. Born-Haber cycle some of the following facts

I : It is used to determine lattice energy.

II : It is used to determine electron affinity.

III : It is based on Hess's law of constant heat summation hydrocarbons.

Correct fact are

- (a) I, II, III**                      (b) II, III, IV  
 (c) I, II                              (d) I, II, III, IV

72. If  $\Delta H_f^\circ(\text{NH}_3) = -46.1 \text{ kJ}$  and  $\Delta H^\circ$  of the reaction  $\text{N}_2\text{H}_4(g) + \text{H}_2(g) \rightarrow 2\text{NH}_3(g)$  is  $-187.6 \text{ kJ}$ , then  $\Delta H_f^\circ(\text{N}_2\text{H}_4)$  is

- (a)  $-95.4 \text{ kJ}$                       **(b) + 95.4 kJ**  
 (c)  $-141.5 \text{ kJ}$                       (d)  $-233.7 \text{ kJ}$

73. If  $\Delta H_f^\circ(\text{C}_2\text{H}_4)$ ,  $\Delta H_f^\circ(\text{C}_2\text{H}_6)$  are  $x_1$  and  $x_2 \text{ kcal mol}^{-1}$ , then heat of hydrogenation of  $\text{C}_2\text{H}_4$  is

- (a)  $x_1 + x_2$                       (b)  $x_1 - x_2$   
**(c)  $-(x_1 - x_2)$**                       (d)  $x_1 + 2x_2$

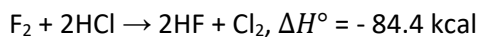
74.  $\Delta H_f^\circ(\text{NO}_2) = 33.48 \text{ kJ mol}^{-1}$

$\Delta H_f^\circ(\text{N}_2\text{O}_4) = 9.66 \text{ kJ mol}^{-1}$

hence, dimerisation of  $\text{NO}_2$  forming  $\text{N}_2\text{O}_4$

- (a) endothermic                      (b) isothermic  
**(c) exothermic**                      (d) isochoric

75. If for the following gaseous phase reaction,



if  $\Delta H_f^\circ(\text{HF}) = -64.2 \text{ kcal mol}^{-1}$ , then  $\Delta H_f^\circ(\text{HCl})$  is

- (a)  $+44 \text{ kcal mol}^{-1}$                       (b)  $+22 \text{ kcal mol}^{-1}$   
 (c)  $-44.0 \text{ kcal mol}^{-1}$                       **(d)  $-22.0 \text{ kcal mol}^{-1}$**

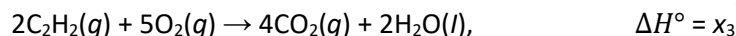
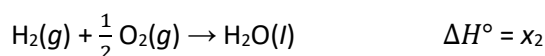
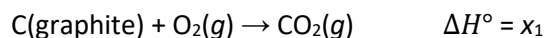


76. From the following data, calculate, bond energy of the  $F_2^-$  ion



- (a) 446.9 kJ      **(b) 113.9 kJ**      (c) 779.9 kJ      (d) 623.0 kJ

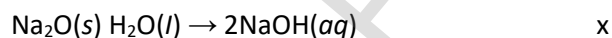
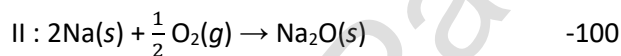
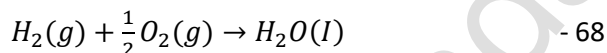
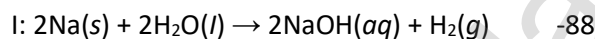
77. For the reactions,



(a)  $x_1 + x_2 - x_3$       **(b)  $2x_1 + x_2 - \frac{x_3}{2}$**

(c)  $-x_1 - x_2 + x_3$       (d)  $-x_1 - x_2 + \frac{x_3}{2}$

78. Consider the following chemical change       $\Delta H / \text{kcal}$



Value of x is

(a) -68 kcal      (b) -88 kcal

(c) -100 kcal      **(d) -56 kcal**

79. If F—F bond energy is x, then heat of formation of F(g) is

**(a)  $\frac{x}{2}$**       (b)  $-\frac{x}{2}$       (c) x      (d) -x

80. Enthalpy change in the formation of  $Cl^+Cl^-$  (imaginary) lattice from  $Cl_2$  based on following data is

Cl—Cl bond energy =  $x_1$ , ionisation energy of Cl =  $x_2$  electron

Electron affinity of Cl =  $x_3$ , lattice energy of  $Cl^+Cl^-$  =  $x_4$

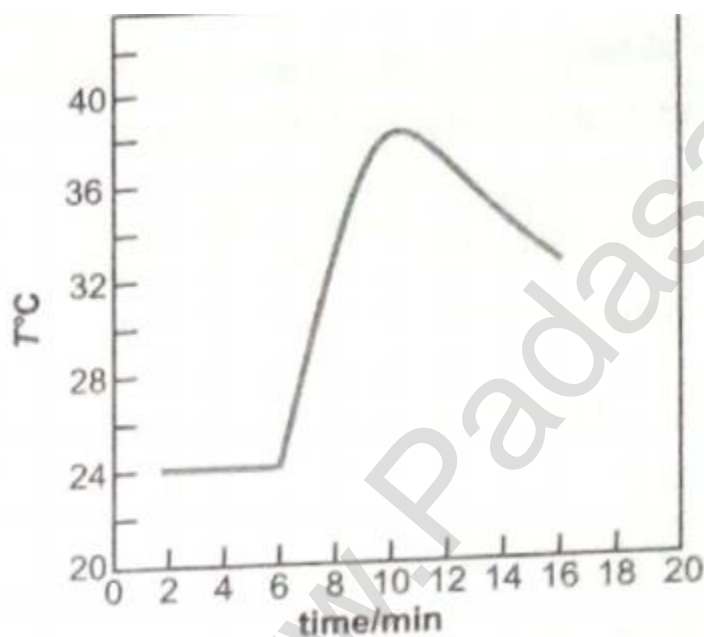
- (a)  $x_1 + x_2 + x_3 + x_4$                       (b)  $x_1 + x_2 - x_3 - x_4$   
 (c)  $-x_1 + x_2 - x_3 + x_4$                       (d)  $-(x_1 + x_2 + x_3 + x_4)$

### Heat Capacity

81. A bomb calorimeter has a heat capacity of  $783 \text{ J}^\circ\text{C}^{-1}$ , and contains 254 g of water which has a specific heat of  $4.184 \text{ g}^{-1} \text{ }^\circ\text{C}^{-1}$ . Heat absorbed/evolved by a reaction when the temperature changes from  $23.73^\circ\text{C}$  to  $26.01^\circ\text{C}$  is

- (a) 1.78 kJ absorbed                      (b) 2.42 kJ absorbed  
 (c) 1.78 kJ evolved                      (d) **4.21 kJ absorbed**

82. What value of  $\Delta T$  should be used for the calorimetry experiment that gives the following graphical results?



- (a)  $10^\circ\text{C}$                       (b)  $12^\circ\text{C}$   
 (c)  $18^\circ\text{C}$                       (d)  **$14^\circ\text{C}$**

83. Latent heat of fusion of ice is  $6.02 \text{ kJ mol}^{-1}$ . The heat capacity of water is  $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$ . 500 g of liquid water is to be cooled from  $20^\circ\text{C}$  to  $0^\circ\text{C}$ . Number of ice cubes (each of one mole) required are

- (a) 1                                      (b) **7**  
 (c) 14                                      (d) 125

84. Specific heat water is  $4.184 \text{ J/g}^\circ\text{C}$ . Hence molar heat capacity of water is

- (a)  $\frac{4.184}{18} \text{ J/mol}^\circ\text{C}$                       (b)  $4.184 \times 18 \text{ J/mol}^\circ\text{C}$   
 (c)  $4.184 \text{ J/mol}^\circ\text{C}$                       (d)  $\frac{18}{4.184} \text{ J/mol}^\circ\text{C}$

85. Temperature of 1 mol of water is raised by  $10^\circ$ . Amount of heat absorbed is

- (a) 10 cal                                      (b) 100 cal  
 (c) **180 cal**                                      (d) 18 kcal

86. Temperature of 12 g of substances is raised from  $20^\circ\text{C}$  to  $30^\circ\text{C}$  by absorption of 240 kJ of heat. Hence, specific heat of the substance is

- (a) **2 kJ/g $^\circ\text{C}$**                                       (b) 24 kJ/g $^\circ\text{C}$   
 (c) 20 kJ/g $^\circ\text{C}$                                       (d) 240 kJ/g $^\circ\text{C}$

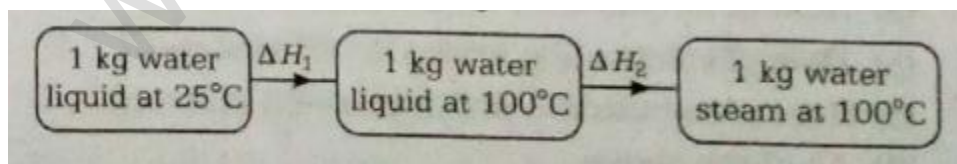
87. Specific heat of  $\text{N}_2$  at constant pressure is  $0.25 \text{ cal/g}^\circ\text{C}$ . Hence, specific heat at constant volume is

- (a)  $1.72 \text{ cal/g}^\circ\text{C}$   
 (b)  $0.25 \text{ cal/g}^\circ\text{C}$   
 (c)  $5.00 \text{ cal/g}^\circ\text{C}$   
 (d)  **$0.18 \text{ cal/g}^\circ\text{C}$**

88. Specific heat of water is  $1 \text{ cal/g}^\circ\text{C}$ . If 25 g of water absorbs 100 cal of heat, final temperature becomes  $44^\circ\text{C}$ . Thus, initial temperature is

- (a)  $48^\circ\text{C}$                                       (b)  **$40^\circ\text{C}$**   
 (c)  $36^\circ\text{C}$                                       (d)  $25^\circ\text{C}$

89. Consider the following change



Specific heat water =  $1 \text{ cal/g}^\circ\text{C}$

Latent heat of vaporization of water =  $10 \text{ kcal/mol}$ .  $\Delta H_1$  is

**(a) 75 kcal**

(b) 556 kcal

(c) 750 kcal

(d) 75 cal

90.  $\Delta H_2$  in the question is

(a) 75 cal

(b) 750 kcal

**(c) 556 kcal**

(d) None of these

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