Miscellaneous Exercise Question Bank

1. A reversible isothermal evaporation of 90 g of water is carried out at $100°C$. Heat of evaporation of water is 9.72 kcal/mol. Assuming water vapour to behave like an ideal gas, what is the change in internal energy of the system?

(A) 48.6 kcal **(B)** 52.33 kcal **(C)** 44.87 kcal **(D)** 56.06 kcal

2. Heat of neutralization of oxalic acid is $-53.35\,kJ / mol$ using NaOH. Hence ΔH of

$H_2C_2O_4 \rightleftharpoons C_2O_4^{2-} + 2H^+$ is :

(A) 5.88 kJ **(B)** $-5.88 kJ$ **(C)** $-13.7\,kcal$ **(D)** 7.5 kJ

***3.** At $25°C$ and 1 atm which one (s) of the following has non zero $\Delta H_f°$?

(A) Fe **(B)** O **(C)** Ne **(D)** C(diamond)

For Question No. 4 – 7

(A) Statement-I is True, Statement-II is True and Statement-II is a correct explanation for Statement-I.

(B) Statement-I is True, Statement-II is True and Statement-II is NOT a correct explanation for Statement-I.

(C) Statement-I is True, Statement-II is False.

(D) Statement-I is False, Statement-II is True.

4. **Statement : I** ΔE is state function of the system.

Statement : II Because it depend upon the final and initial state of the system.

5. **Statement : I** The enthalpy of neutralization of 1 equivalent of HF and 1 equivalent of NaOH is 14 kcal. mol, which is higher than HCl and NaOH.

Statement : II This is because the enthalpy of hydration of F^- is higher that of its heat enthalpy of dissociation.

6. **Statement : I** The enthalpy of formation of $H_2O(\ell)$ is greater than that of $H_2O(g)$.

Statement : II Enthalpy change is negative for condensation reaction $H_2O(g) \longrightarrow H_2O(\ell)$

7. **Statement : I** Pressure, volume and temperature are extensive properties.

Statement : II Extensive property depends on the amount of substance.

8. The heat of neutralization of 0.1 mol HF with 0.1 mole NaOH is 5.91 kJ. If the enthalpy of ionization of HF is $2 kJ\ mol^{-1}$. What is the heat of hydration of F^- ions in $kJ\ mol^{-1}$?

9. $S(rhombic) + O_2 \longrightarrow SO_2$, $\Delta H = -297.5$ kJ

$S(monoclinic) + O_2 \longrightarrow SO_2$, $\Delta H = -300$ kJ

This data indicates :

(A) Rhombic sulphur is yellow in colour

(B) monoclinic sulphur is more stable

(C) monoclinic sulphur has metallic lustre

(D) The process $S(rhombic) \rightarrow S(monoclinic)$ is endothermic

10. Calculate the enthalpy change when 50 ml of 0.01 M $Ca(OH)_2$ reacts with 25 mL of 0.01 M HCl. Given that ΔH° neutralisation of a strong acid and strong base is 140 kcal/equiv?

(A) 14 cal **(B)** 35 cal **(C)** 10 cal **(D)** 7.5 cal

11. In the reaction $CS_2(\ell) + 3O_2(g) \longrightarrow CO_2(g) + 2SO_2(g) \quad \Delta H = -265$ kcal

The enthalpies of formation of CO_2 and SO_2 are both negative and are in the ratio 4 : 3. The enthalpy of formation of CS_2 is + 26 kcal/mol. Calculate the enthalpy of formation of SO_2.

(A) – 90 kcal/mol **(B)** – 52 kcal mol

(C) – 78 kcal/mol **(D)** – 71.7 kcal/mol

12. For the given reactions

$$SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O, \Delta H = -10.17 \text{ kcal}$$

$$SiO_2 + 4HCl \longrightarrow SiCl_4 + 2H_2O, \Delta H = 36.7 \text{ kcal}$$

It may be concluded that

(A) HF will attack SiO_2 and HCl will not **(B)** HCl will attack SiO_2 and HF will not

(C) HF and HCl both attack SiO_2 **(D)** None attack SiO_2

13. A heated iron block at 127°C loses 300 J of heat to the surroundings which are at a temperature of 27°. Total entropy change in this process is 0.05 x JK^{-1}. Find the value of x.

14. Why is the enthalpy of sublimation equal to the sum of enthalpy of fusion and enthalpy of vaporization ?

15. The enthalpy change for a given reaction at 298 K is $-x \, J \, mol^{-1}$ (x being positive). If reaction occurs spontaneously at 298 K, the entropy change at that temperature.

(A) can be negative but numerically larger than x/298

(B) can be negative but numerically smaller that x/298

(C) cannot be negative

(D) cannot be positive

16. The heat of combustion of ethyl alcohol is –300 kcal. If the heats of formation of $CO_2(g)$ and $H_2O(\ell)$ are –94.3 and –68.5 kcal respectively, calculate the heat of formation of ethyl alcohol.

17. The standard enthalpy of decomposition of the yellow complex H_3NSO_2 into NH_3 and SO_2 is +40 kJ mol^{-1}. Calculate the standard enthalpy of formation of H_3NSO_2. $\Delta H_f^0(NH_3) = -46.17$ kJ mol^{-1}, $\Delta H_f^0(SO_2) = -296.83$ kJ/mol.

18. Calculate the bond energy of Cl—Cl bond from the following data :

$CH_4(g) + Cl_2(g) \longrightarrow CH_3Cl(g) + HCl(g); \Delta H = -100.3$ kJ. Also the bond enthalpies of C–H, C–Cl, H–Cl bonds are 413, 326 and 431 kJ mol^{-1} respectively.

19. Calculate ΔH_r° for the reaction $CH_2Cl_2(g) \longrightarrow C(g) + 2H(g) + 2Cl(g)$. The average bond enthalpies of C–H and C–Cl bonds are 414 kJ mol^{-1} and 330 kJ mol^{-1}.

20. Calculate the enthalpy change (ΔH) of the following reaction

$2C_2H_2(g) + 5O_2(g) \longrightarrow 4CO_2(g) + 2H_2O(g)$ given average bond enthalpies of various bonds,

i.e., C–H, $C \equiv C$, $O = O$, $C = O$, $O - H$ as 414, 814, 499, 724 and 640 kJ mol^{-1} respectively.

21. Calculate the standard enthalpy of solution of AgCl(s) in water

$\Delta H_f^0(AgCl, s) = -127.07\ kJ\,mol^{-1}$, ΔH_f^0, $(Ag^+, aq) = 105.58\ kJ\ mol^{-1}$,

$\Delta H_f^0(Cl^-, aq) = -167.35\,kJ\ mol^{-1}$.

22. Enthalpies of solution of $BaCl_2(s)$ and $BaCl_2.2H_2O(s)$ are –20 kJ/mole and 8.0 kJ/mole respectively. Calculate heat of hydration of $BaCl_2(s)$.

23. 10 mL of each 1M HCl and 1M H_2SO_4 are neutralized by 1M NaOH solution that liberate the heat of a kJ/equivalent and b kJ/equivalent respectively. What is relation between a and b.

24. 150 mL of 0.5 N HCl solution at 25°C was mixed with 150 mL of 0.5 N NaOH solution at same temperature. Calculate heat evolved in this reaction if final temperature was recorded to be 29°C. $(\rho_{H_2O} = 1\,g / mL)$

25. The enthalpy of neutralization of 1 M HCl by 1M NaOH is – 57 kJ/mol. The enthalpy of formation of water is –285 kJ mole. The enthalpy of formation of OH^- ion is :

26. In the reaction, $CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$; $\Delta H = 2.8\,kJ$, ΔH represents

(A) Heat of reaction **(B)** Heat of combustion

(C) Heat of formation **(D)** Heat of solution

27. For the following reaction, C (diamond) $+O_2 \longrightarrow CO_2(g)$; $\Delta H = -94.3$ kcal/mol

C (graphite) $+O_2 \longrightarrow CO_2(g)$; $\Delta H = -97.6$ kcal/mol

The heat required to change 1g $C(diamond) \longrightarrow C(graphite)$ is

(A) 1.59 kcal **(B)** 0.1375 kcal

(C) 0.55 kcal **(D)** 0.275 kcal

28. The heat of combustion of sucrose $(C_{12}H_{22}O_{11})$ is 1350 kcal/mol. How much of heat will be liberated when 17.1 g of sucrose is burnt ?

(A) 67.5 kcal **(B)** 13.5 kcal **(C)** 40.5 kcal **(D)** 25.5 kcal

29. When a certain amount of ethylene was combusted, 5644 kJ heat was evolved. If heat of combustion of ethylene is 1411 kJ, the volume of O_2 (at NTP) that entered into the reaction is:

(A) 268.8 ml **(B)** 268.8 L **(C)** 6226 × 22.4 L **(D)** 22.4 L

30. If enthalpy of dissociation of CH_4 and C_2H_6 are 320 and 600 calories respectively then bond energy of C–C bond is

(A) 80 cal **(B)** 40 cal **(C)** 60 cal **(D)** 120 cal

31. Heat of hydrogenation of ethene is x_1 and that of benzene is x_2. Hence, resonance energy is :

(A) $x_1 - x_2$ **(B)** $x_1 + x_2$ **(C)** $3x_1 - x_2$ **(D)** $x_1 - 3x_2$

32. The bond dissociation energy of gaseous H_2, Cl_2 and $\Delta H_f^{\ominus}$ HCl are 104, 58 and –22 kcal mol^{-1} respectively. The bond dissociation energy of HCl is :

(A) – 103.0 kcal **(B)** + 103.0 kcal **(C)** 22.0 kcal **(D)** 44.0 kcal

33. One mole of anhydrous $MgCl_2$ dissolves in water and librates 25 cal/mol of heat. $\Delta H_{hydration}$ of $MgCl_2 = -30$ cal/mol. Heat of dissolution of $MgCl_2.H_2O$ is :

(A) + 5 cal/mol **(B)** – 5 cal/mol **(C)** 55 cal/mol **(D)** – 55 cal/mol

34. Born-Haber cycle is used to determine :

(A) Lattice energy **(B)** Electron affinity

(C) Crystal energy **(D)** All of these

35. For which one of the following reaction does the molar enthalpy change of a reaction corresponds to Lattice energy of KBr ?

(A) $KBr(s) \longrightarrow K(s) + 1/2\,Br_2(g)$ **(B)** $KBr(g) \longrightarrow K(g) + Br(g)$

(C) $KBr(s) \longrightarrow K^+(g) + Br^-(g)$ **(D)** $KBr(g) \longrightarrow K^+(g) + Br^-(g)$

36. The enthalpy of neutralization of which of the following acid & base is nearly –13.6 kcal.

(A) HCN and NaOH **(B)** CH_3COOH and NH_4OH

(C) HCl and KOH **(D)** HCl and NH_4OH

37. Equal volume of HCOOH and NaOH are mixed. If x is the heat of formation of water, then heat evolved due to neutralization is :

(A) More than x **(B)** Equal to x **(C)** Twice of x **(D)** Less than x

38. If $CH_3COOH + OH^- \to CH_3COO^- + H_2O + q_1$

$H^+ + OH^- \to H_2O + q_2$

then the enthalpy change for the reaction $CH_3COOH \to CH_3COO^- + H^+$ is equal to :

(A) $(q_1 + q_2)$ **(B)** $(q_1 - q_2)$ **(C)** $(q_2 - q_1)$ **(D)** $-(q_1 + q_2)$

39. Match the Column

Column -1		**Column –II**	
(A)	C (s, graphite) $+O_2(g) \longrightarrow CO_2(g)$	**(p)**	$\Delta H^{\circ}_{combustion}$
(B)	C (s, graphite) $\longrightarrow C(g)$	**(q)**	$\Delta H^{\circ}_{formation}$
(C)	$CO(g) + \frac{1}{2}O_2(g) \longrightarrow CO_2(g)$	**(r)**	$\Delta H^{\circ}_{atomization}$
(D)	$CH_4(g) \longrightarrow C(g) + 4H(g)$	**(s)**	$\Delta H^{\circ}_{sublimation}$

40. When 12.0 g of carbon reacted with limited quantity of oxygen, 57.5 kcal of heat was produced, Calculate the number of moles of CO produced $(\Delta_f H(CO_2) = -94.05$ kcal, $\Delta_f H(CO) = -21.41$ kcal.

(A) 0.5 mol **(B)** 0.46 mol **(C)** 0.64 mol **(D)** 0.74 mol

41. The average Xe–F bond energy is 34 kcal/mol, first I.E. of Xe is 279 kcal/mol, electron affinity of F is 85 kcal/mol and bond dissociation energy of F_2 is 38 kcal/mol. Then, the enthalpy change for the reaction $XeF_4 \longrightarrow Xe^+ + F^- + F_2 + F$ will be :

(A) 367 kcal/mole
(B) 425 kcal/mole
(C) 292 kcal/mole
(D) 392 kcal/mole

42. Equal volumes of molar hydrochloric acid and sulphuric acid are neutralized by dil. NaOH solution and x kcal and y kcal of heat are liberated respectively. Which of the following is true?

(A) $x = y$
(B) $x = \frac{1}{2}y$
(C) $x = 2y$
(D) None of these

43. Given $\Delta_{ioniz}H^o(HCN) = 45.2$ kJ mol^{-1} and $\Delta_{ioniz}H^o(CH_3COOH) = 2.1$ kJ/mol. Which one of the following facts is true?

(A) $pK_a(HCN) = pK_a(CH_3COOH)$
(B) $pK_a(HCN) > pK_a(CH_3COOH)$
(C) $pK_a(HCN) < pK_a(CH_3COOH)$
(D) $pK_a(HCN) = (45.17 / 2.07)\, pK_a(CH_3COOH)$

44. 50.0 mL of 0.10 M HCl is mixed with 50.0 mL of 0.10 M NaOH. The solution's temperature rises by 3.0^oC. Calculate the enthalpy of neutralization per mole of HCl. (Assuming density of sol. = 1 g/ml & specific heat of water = 4.18 Jg^{-1} k^{-1})

(A) -2.5×10^2 kJ/mole
(B) -1.3×10^2 kJ/mole
(C) -8.4×10^1 kJ/mole
(D) -6.3×10^1 kJ/mole

45. Enthalpy of polymerisation of ethylene, as represented by the reaction, $nCH_2 = CH_2 \longrightarrow (-CH_2 - CH_2-)_n$ is -100kJ per mole of ethylene. Given bond enthalpy of $C = C$ bond is 600 kJ mol^{-1}, enthalpy of $C - C$ bond (in kJ mol) will be:

(A) 116.7
(B) 350
(C) 700
(D) indeterminate

46. The average energy required to break a $P - P$ bond in P_4 (s) into gaseous atoms is 53.2 kcal mol^{-1}. The bond dissociation energy of $H_2(g)$ is 104.2 kcal mol^{-1}; ΔH_f^0 of $PH_3(g)$ from P_4 (s) is 5.5 kcal mol^{-1}. The $P - H$ bond energy in kcal mol^{-1} is [Neglect presence of Van der Waals forces in P_4 (s)]

(A) 85.2
(B) 57.6
(C) 76.9
(D) 63.3

47. If heat of reaction for the given acid-base reaction: $HA + NaOH \rightarrow NaA + H_2O;\ \Delta H = -4.7$ kcal. The heat of dissociation of HA is ____________.

48. The enthalpy of combustion at 25^oC of H_2 (g), cyclohexane and cyclohexene are $-241, -3920$ and -3717 kJ mole^{-1} respectively. The heat of hydrogenation of cyclohexene is (Kcal/mole) approximate integer:

49. Calculate the resonance energy of isoprene (C_5H_8) from the data given.

Given that $\Delta H_{C=C} = 615\text{ kJ mole}^{-1}$; $\Delta H_{C-C} = 348\text{ kJ mole}^{-1}$;

$\Delta H_{C-H} = 413\text{ kJ mole}^{-1}$; $\Delta H_{H-H} = 435\text{ kJ mol}^{-1}$

The standard heat of sublimation of graphite is 718 kJmole^{-1} and heat of formation of $C_5H_8(g)$ is 79 kJmole^{-1}. (Give your answer in kcal mole^{-1} ; approximate integer).

50. How many of the following have standard heat of formation equal to zero?

(i) $Br_{2(\ell)}$
(ii) $CO_{2(g)}$
(iii) $C_{(graphite)}$
(iv) $Cl_{2(\ell)}$
(v) $Cl_{2(g)}$
(vi) $F_{2(g)}$
(vii) $F_{(g)}$
(viii) $I_{2(g)}$
(ix) $S_{(monoclinic)}$
(x) $N_{2(g)}$
(xi) $P_{(Black)}$
(xii) $P_{(red)}$
(xiii) CH_4

51. Standard enthalpy of combustion of cyclopropane is -2091 kJ/mole at 25^oC then calculate the enthalpy of formation of cyclopropane. If $\Delta H_f^o(CO_2) = -393.5\text{ kJ / mole}$ and $\Delta H_f^o(H_2O) = -285.8\text{ kJ/mole}$.

52. Bond energies of $N \equiv N$; $H-H$ and $N-H$ bonds are 945, 435, 391 kJ mol^{-1} respectively, the enthalpy of the following reactions is: $N_2(g) + 3H_2(g) \to 2NH_3(g)$

53. The enthalpy of neutralization of a weak acid in 1 M solution with a strong base is –56.1 kJ mol^{-1}. If the enthalpy of ionization of the acid is 1.5 kJ mol^{-1} and enthalpy of neutralization of the strong acid with a strong base is –57.3 kJ equiv^{-1}, what is the % ionization of the weak acid in molar solution (assume the acid to be monobasic)?

54. For a reversible adiabatic ideal gas expansion $\frac{dP}{P}$ is equal to :

(A) $\gamma\frac{dV}{V}$ **(B)** $-\gamma\frac{dV}{V}$ **(C)** $\left(\frac{\gamma}{\gamma-1}\right)\frac{dV}{V}$ **(D)** $\frac{dV}{V}$

***55.** Heat of reaction depend upon:

(A) Physical state of reactants and products
(B) Whether the reaction is carried out at constant pressure or at constant volume
(C) Method by which the final products are obtained from the reactants
(D) Temperature of the reaction

***56.** Select the correct statements:

(A) All combustion reactions are exothermic **(B)** Heat of combustion is always negative

(C) $N_2 + O_2 \to 2NO$; $\Delta H = +ve$ **(D)** $F_2 + \frac{1}{2}O_2 \to F_2O$; $\Delta H = +ve$

***57.** Which of the following reaction cannot be use to define the heat of formation of $CO_2(g)$.

(A) $CO(g) + \frac{1}{2}O_2 \longrightarrow CO_2(g)$ **(B)** $C_6H_6(\ell) + \frac{7}{2}O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(\ell)$

(C) $C\text{ (diamond)} + 2O_2(g) \longrightarrow CO_2(g)$ **(D)** $C\text{ (graphite)} + O_2(g) \longrightarrow CO_2(g)$

***58.** Heat of formation of CH_4 are:

If given heat: $C(s) + O_2(g) \longrightarrow CO_2(g)$ $\Delta H = -393.5$ kJ

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(\ell)$ $\Delta H = -285.8$ kJ

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell)$ $\Delta H = -890.3$ kJ

(A) – 74.8 kJ **(B)** – 17.87 kcal **(C)** +74.8 kJ **(D)** –52.26 kJ

***59.** Heat of neutralization of the acid-base reaction is 57.32 kJ for:

(A) $HCOOH + KOH$ **(B)** $CH_3COOH + NaOH$

(C) $HNO_3 + LiOH$ **(D)** $HCl + NaOH$

***60.** For which of the following reaction $\Delta H^o_{reaction}$ is not equal to ΔH^o_f of product ?

(A) $2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$

(B) $N_2(g) + O_3(g) \longrightarrow N_2O_3(g)$

(C) $CH_4(g) + 2Cl_2(g) \longrightarrow CH_2Cl_2(\ell) + 2HCl(g)$

(D) $Xe(g) + 2F_2(g) \longrightarrow XeF_4(g)$

***61.** The following is(are) endothermic reaction(s):

(A) Combustion of methane **(B)** Decomposition of water

(C) Dehydrogenation of ethane to ethylene **(D)** Conversion of graphite to diamond

Paragraph for Question No. 62 – 64

Enthalpy of neutralization is defined as the enthalpy change when 1 mole of acid/base is completely neutralized by base/acid in dilute solution.

For strong acid and strong base neutralization net chemical change is

$H^+(aq) + OH^-(aq) \longrightarrow H_2O(l);$ $\Delta_r H^o = -55.84$ kJ/mol

$\Delta H^o_{ionization}$ of aqueous solution of strong acid and strong base is zero.

When a dilute solution of a weak acid or base is neutralized, the enthalpy of neutralization is some what less because of the absorption of heat in the ionization of the weak acid or base, for weak acid/base

$\Delta H^o_{neutralization} = \Delta H^o_{ionization} + \Delta_r H^o \quad (H^+ + OH^- \rightarrow H_2O)$

62. If enthalpy of neutralization of CH_3COOH by NaOH is – 49.86 kJ/mol then enthalpy of ionization of CH_3COOH is:

(A) 5.98 kJ/mol **(B)** –5.98 kJ/mol **(C)** 105.7 kJ/mol **(D)** None of these

63. What is ΔH^o for complete neutralization of strong diacidic base $A(OH)_2$ by HNO_3 ?

(A) –55.84 kJ **(B)** –111.68 kJ **(C)** 55.84 kJ/mol **(D)** None of these

64. Under the same condition how many mL of 0.1 M NaOH and 0.05 M H_2A (strong diprotic acid) solution should be mixed for a total volume of 100 mL produce the highest rise in temperature:

(A) 25 : 75 **(B)** 50 : 50 **(C)** 75 : 25 **(D)** 66.66 : 33.33

Paragraph for Question No. 65 – 67

Use the data (all values in kJ per mole at $25°C$) given below to answer the following ;

$\Delta_f H^{\ominus}_{CH_3CN} = +88$

$\Delta_f H\, C_3H_8 = -85$

$\Delta_{sub} H^{\ominus}_{C(graphite)} = 719$

$\Delta_{diss} H^{\ominus}_{(N_2)} = 948$

$\Delta_{diss} H^{\ominus}_{(H_2)} = 435$

Bond enthalpies $C-H = 414$
$C-N = 378$
$N-H = 426$

65. The bond enthalpy of $C-C$ bond (kJ/mol) is :

(A) 250 **(B)** 335 **(C)** 223.3 **(D)** 248.5

66. The bond enthalpy of $C \equiv N$ bond (kJ/mol) is :

(A) 987.5 **(B)** 811.5 **(C)** 899.5 **(D)** 890.0

67. The enthalpy of hydrogenation of CH_3CN (kJ/mol) is :

(A) –288.5 **(B)** +288.5 **(C)** –89.5 **(D)** +89.5

68. Among them intensive property is:

(A) Mass **(B)** Volume **(C)** Surface tension **(D)** Enthalpy

69. The relation between ΔU and ΔH is :

(A) $\Delta H = \Delta U - P\Delta V$ **(B)** $\Delta H = \Delta U + P\Delta V$

(C) $\Delta U = \Delta V + \Delta H$ **(D)** $\Delta U = \Delta H + P\Delta V$

70. A coffee cup calorimeter initially contains 125 g water, at a temperature of 24.2°C. 8g of ammonium nitrate (NH_4NO_3), also at 24.2°C, is added to the water, and the final temperature is 18.2°C. What is the heat of solution of ammonium nitrate in kJ/mol? The specific heat capacity of the solution is 4.2 J/°C g.

(A) 33.51 kJ/mol **(B)** 39.5 kJ/mol

(C) 32.2 kJ/mol **(D)** 37.3 kJ/mol

71. When 1.0 g of oxalic acid $(H_2C_2O_4)$ is burned in a bomb calorimeter whose heat capacity is 8.75 kJ/K, the temperature increases by 0.312 K. The enthalpy of combustion of oxalic acid at 27°C is:

(A) – 245.7 kJ/mol **(B)** – 244.452 kJ/mol

(C) – 241.947 kJ/mol **(D)** None of these

72. When 1 mole of ice melt at 0^oC and at constant pressure of 1 atm. 1440 calories of heat are absorbed by the system. The molar volumes of ice and water are 0.0196 and 0.0180 litre respectively. Calculate ΔE for the reaction.

(A) $\Delta E = 720\,J$ **(B)** $\Delta E = 1440\,cal$

(C) $\Delta E = 1.4\,Kcal$ **(D)** $\Delta E = 0$

73. The enthalpy of combustion of propane (C_3H_8) gas in terms of given data is :

Bond energy (kJ/mol)

ε_{C-H}	$\varepsilon_{O=O}$	$\varepsilon_{C=O}$	ε_{O-H}	ε_{C-C}
$+x_1$	$+x_2$	$+x_3$	$+x_4$	$+x_5$

Resonance energy of CO_2 is –z kJ/mol and $\Delta H_{vaporization}\left[H_2O(\ell)\right]$ is y kJ/mol.

(A) $8x_1 + 2x_5 + 5x_2 - 6x_3 - 8x_4 - 4y - 3z$

(B) $6x_1 + x_5 + 5x_2 - 3x_3 - 4x_4 - 4y - 3z$

(C) $8x_1 + 2x_5 + 5x_2 - 6x_3 - 8x_4 - y - z$

(D) $8x_1 + x_5 + 5x_2 - 6x_3 - 8x_4 - 4y + 3z$

74. If x_1, x_2 and x_3 are enthalpies of $H-H, O=O$ and $O-H$ bonds respectively, and x_4 is the enthalpy of vaporisation of water, estimate the standard enthalpy of combustion of hydrogen.

(A) $x_1 + \frac{x_2}{2} - 2x_3 + x_4$

(B) $x_1 + \frac{x_2}{2} - 2x_3 - x_4$

(C) $x_1 + \frac{x_2}{2} - x_3 + x_4$

(D) $2x_3 - x_1 - \frac{x_2}{2} - x_4$

75. Setup of Born-Haber cycle ; calculate lattice energy MgO(s). The given values are :

Enthalpy of formation of MgO(s) = –602

Sublimation of Mg(s) = 148

1st and 2nd I.E. of Mg = 738 and 1450

Bond dissociation energy of O_2 = 498

1st and 2nd $\Delta_{eg}H$ of O = –141 and 844 (all in kJ mole^{-1})

(A) 3890 kJ / mole **(B)** –3890 kJ / mole

(C) 3641 kJ / mole **(D)** None of these

76. ΔH_f^o of water is – 285.5 kJ mol^{-1}. If enthalpy of neutralization of monoacidic strong base is – 57.3 kJ mol^{-1}, ΔH_f^o of OH^- ion will be :

(A) –228.5 kJ mol^{-1} **(B)** 228.5 kJ mol^{-1}

(C) 114.5 kJ mol^{-1} **(D)** –114.5 kJ mol^{-1}

77. Find the enthalpy of S–S bond from the following data.

(i) $C_2H_5 - S - C_2H_5(g)$ $\Delta H_f^o = -147.2$ kJ/mol

(ii) $C_2H_5 - S - S - C_2H_5(g)$ $\Delta H_f^o = -201.9$ kJ/mol

(iii) S (g) $\Delta H_f^o = 222.8$ kJ/mol

(A) – 168.1 kJ/mol **(B)** + 168.1 kJ/mol

(C) –277.5 kJ/mol **(D)** + 277.5 kJ/mol

78. calculate $\Delta G°$ (kJ/mol) at 127°C for a reaction with $K_{equilibrium} = 10^5$:

(A) –38.294 **(B)** –16.628 **(C)** –9.16 **(D)** None of these

79. Determine enthalpy of formation for $H_2O_2(\ell)$, using the listed enthalpies of reaction:

$$N_2H_4(\ell) + 2H_2O_2(\ell) \longrightarrow N_2(g) + 4H_2O(\ell); \quad \Delta_rH_1^\circ = -818\,kJ/mol$$

$$N_2H_4(\ell) + O_2(g) \longrightarrow N_2(g) + 2H_2O(\ell); \quad \Delta_rH_2^\circ = -622\,kJ/mol$$

$$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(\ell); \quad \Delta_rH_3^\circ = -285\,kJ/mol$$

(A) $-383\,kJ/mol$ **(B)** $-187\,kJ/mol$

(C) $-498\,kJ/mol$ **(D)** None of these

80. Calculate $\Delta_fG°$ for (NH_4Cl, s) at 310K.

Given: $\Delta_fH°(NH_4Cl, s) = -314.5\,kJ/mol$; $\Delta_rC_p = 0$

$S^\circ_{N_2}(g) = 192\,JK^{-1}\,mol^{-1}$; $S^\circ_{H_2}(g) = 130.5\,JK^{-1}\,mol^{-1}$;

$S^\circ_{Cl_2}(g) = 233\,JK^{-1}\,mol^{-1}$; $S^\circ_{NH_4Cl}(g) = 99.5\,JK^{-1}\,mol^{-1}$

All given data are at 300 K.

(A) $-198.56\,kJ/mol$ **(B)** $-426.7\,kJ/mol$

(C) $-202.3\,kJ/mol$ **(D)** None of these

***81.** From the following data, mark the option(s) where ΔH is correctly written for the given reaction.

Given: $H^+(aq) + OH^-(aq) \longrightarrow H_2O(\ell); \Delta H = -57.3$ kJ

$\Delta H_{solution}$ of HA(g) = – 70.7 kJ/mol

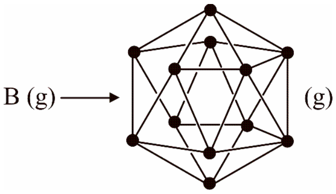
$\Delta H_{solution}$ of BOH(g) = 20 kJ/mol

$\Delta H_{ionization}$ of HA = 15 kJ/mol and BOH is a strong base.

	Reaction	ΔH_r **(kJ/mol)**
(A)	$HA(aq) + BOH(aq) \longrightarrow BA(aq) + H_2O$	–42.3
(B)	$HA(g) + BOH(g) \longrightarrow BA(aq) + H_2O$	–93
(C)	$HA(g) \longrightarrow H^+(aq) + A^-(aq)$	–55.7
(D)	$B^+(aq) + OH^-(aq) \longrightarrow BOH(aq)$	–20

82. The heat of combustion of acetylene is 312 kcal. If heat of formation of CO_2 and H_2O are –94 and –68 kcal respectively. Given that heat of atomisation of C and H are 150 & 50 kcal respectively and C – H bond energy is 93 kcal. Calculate $\frac{\Delta H_{C\equiv C}}{12}$.

83. Boron exist in different allotropic forms. All allotropic form contains icosahedral units (icosahedral is a regular shape with 12 corners & 20 faces) with boron atoms at all 12 corners and all bonds are equivalent.
Calculate heat evolved at constant pressure (in kJ) per mole of boron atoms undergoing above change if ΔH_{BE} (B–B) = 200 kJ/mol. Report your answer after dividing by 100



84. The enthalpy change for the reaction of 5 litre of ethylene with 5 litre of H_2 gas at 1.5 atm pressure is $\Delta H = -0.5\,\text{kJ}$. The value of ΔU will be : (1 atm Lt = 100 J)

(A) – 1.25 kJ **(B)** + 1.25 kJ **(C)** 0.25 kJ **(D)** – 0.25 kJ

85. If heat of dissociation of $CHCl_2COOH$ is 0.7 kcal/mole then ΔH for the reaction :

$$CHCl_2COOH + KOH \longrightarrow CHCl_2COOK + H_2O$$

(A) – 13 kcal **(B)** + 13 kcal **(C)** – 14.4 kcal **(D)** – 13.7 kcal

86. Match column-I to column-II standard entropy in kJ/K-molar at 25°C]

Column-I		Column-II	
1.	ΔH_{C-C}	**(p)**	733.48
2.	ΔH_{C-H}	**(q)**	97.81
3.	$\Delta H_{C=C}$	**(r)**	434.3
4.	$\Delta H_{C\equiv C}$	**(s)**	454.64
5.	$\Delta H_{C\equiv O}$	**(t)**	804.22

Using the data (all values are in kJ/mol at 25°C) given below:

$\Delta H^{o}_{combustion}$ (ethane) = – 1559.8 ; $\Delta H^{o}_{combustion}$ (ethene) = – 1410.9

$\Delta H^{o}_{combustion}$ (acetylene) = – 1299.7 ; $\Delta H^{o}_{combustion}$ (acetaldehyde) = – 1192.3

$\Delta H^{o}_{f} CO_2(g) = -393.5$; ΔH^{o}_{f} of $H_2O(\ell) = -285.8$

ΔH^{o} for C(s) (graphite) → C(g) = 716.68 ; Bond energy of H–H = 435.94

Bond energy of O = O is 498.94

	1	2	3	4	5		1	2	3	4	5
(A)	q	s	r	p	t	**(B)**	r	p	t	q	s
(C)	q	p	s	r	t	**(D)**	p	s	q	r	t

87. Heat of reaction for $C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(g)$ at constant pressure is –651 kcal at 17°C. Calculate the heat of reaction at constant volume at 17°C.

(A) –654.48 Kcal **(B)** 654.48 Kcal

(C) 336 Kcal **(D)** 290 Kcal

88. What amount of energy (kJ) is released in the combustion of 5.8 g of $C_4H_{10}(g)$?

$$2C_4H_{10}(g) + 13O_2(g) \longrightarrow 8CO_2(g) + 10H_2O(\ell) : \Delta H^{\circ} = -5756\,\text{kJ}$$

(A) 575.6 **(B)** 287.8 **(C)** 182 **(D)** 57.56

89. From the given heat of reaction,

(i) $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -97$ kcal

(ii) $CO_2(g) + C(s) \rightarrow 2CO(g)$ $\Delta H = 39$ kcal

Find the heat of combustion of CO(g) is :

(A) 68 kcal **(B)** – 68 kcal **(C)** +48 kcal **(D)** none of the above

90. What is the amount of heat to be supplied to prepare 128 g of CaC_2 by heating $CaCO_3$ followed by reduction with carbon? Reactions are :

$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ $\Delta H^o = 42.8$ kcal

$CaO(s) + 3C(s) \rightarrow CaC_2 + CO(g)$ $\Delta H^o = 111$ kcal

(A) 102.6 kcal **(B)** 221.78 kcal

(C) 307.6 kcal **(D)** 453.46 kcal

91. Ionization energy of Al = 5137 kJ $mole^{-1}$; $\Delta H_{(hydration)}$ of $Al^{3+} = -4665$ kJ $mole^{-1}$ and $\Delta H_{hydration}$ for $Cl^- = -381$ kJ $mole^{-1}$. Which of the following statements is correct?

(A) $AlCl_3$ would remain covalent in aqueous solution

(B) Only at infinite dilution $AlCl_3$ undergoes ionization

(C) In aqueous solution $AlCl_3$ becomes ionic

(D) None of the above

92. 0.16 g of methane was subjected to combustion at 27°C in a bomb calorimeter. The temperature of calorimeter system (including water) was found to rise by 0.5°C. Calculate the heat of combustion of methane at (i) constant volume and (ii) constant pressure. The thermal capacity of the calorimeter system is 17.7 kJ K^{-1}.

(A) –885, – 889.95 kJ/mol **(B)** –885, – 921.9 kJ/mol

(C) –790, – 2260 kJ/mol **(D)** –800, – 900 kJ/mol

93. Calculate the resonance energy of C_6H_6 using Kekule formula for C_6H_6 from the following data.

(i) ΔH_f^0 for $C_6H_6(g) = -358.5$ kJ / mol

(ii) Bond energy C – H, C – C, C = C and H – H are 490, 340, 620, 436.9 kJmol^{-1} respectively

(iii) $C_{(s)} \longrightarrow C_{(g)}$ $\Delta H = 716.8\,kJ/mol$

(A) –186 kJ mol^{-1} **(B)** –280 kJ mol^{-1}

(C) –150 kJ mol^{-1} **(D)** –289 kJ mol^{-1}

94. In Haber's process of manufacturing of ammonia :

$$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g);\ H^0_{25°C} = -92.2\ kJ$$

Molecule	$N_2(g)$	$H_2(g)$	$NH_3(g)$
$C_P JK^{-} mol^{-1}$	29.1	28.8	35.1

If C_P is independent of temperature, then reaction at 100°C as compared to that of 25°C will be :

(A) More endothermic

(B) Less endothermic

(C) More exothermic

(D) Less exothermic

95. From the following data of ΔH, of the following reactions,

$$C(s)+\frac{1}{2}O_2(g)\longrightarrow CO(g) \qquad \Delta H=-110\ \text{kJ}$$

$$C(s)+H_2O(g)\longrightarrow CO(g)+H_2(g) \qquad \Delta H=132\ \text{kJ}$$

What is the mole composition of the mixture of steam and oxygen on being passed over coke at 1273 K, to maintain constant temperature :

(A) 0.5 : 1 **(B)** 1 : 0.6 **(C)** 0.8 : 1 **(D)** 1 : 1

96. The reaction of nitrogen with hydrogen to make ammonia has $\Delta H = -92$ kJ.

$$N_2(g)+3H_2(g)\rightarrow 2NH_3(g)$$

What is the value of ΔU (in kJ) if the reaction is carried out at a constant pressure of 40 bar and the volume change is 1.25 litre.

97. An athlete is given 50g glucose of energy equivalent to 780 kJ. He utilizes 20% of this gained energy in an event. In order to avoid storage of energy in body. Calculate weight of water he needed to perspire. Enthalpy of H_2O for evaporation is $44\,\text{kJ mole}^{-1}$.

(A) 127.5 g
(B) 63.81 g
(C) 255.27 g
(D) Information is incomplete

98. The difference between heats of reaction at constant pressure and at constant volume for the reaction: $2C_6H_6(\ell)+15O_2(g)\longrightarrow 12CO_2(g)+6H_2O(\ell)$ at 25°C in kJ is:

99. One litre sample of a mixture of CH_4 and O_2 measured at 32°C and 760 torr, was allowed to react at constant pressure in a calorimeter. The complete combustion of CH_4 to CO_2 and water caused a temperature rise in calorimeter of 1 K. Calculate mole % of CH_4 in original mixture.

[Given : Heat of combustion of CH_4 is –210.8 Kcal/mol. Total heat capacity of the calorimeter = 2108 cal/K]

100. $2C+O_2(g)\rightarrow 2CO;\ \Delta H=-220\,\text{kJ}$

Which of the following statement is correct for this reaction ?

(A) Heat of combustion of carbon is 110 kJ
(B) Reaction is exothermic
(C) Reaction needs no initiation
(D) All of these are correct