kd education academy (9582701166)

Time : 5 Hour
STD 11 Science chemistry
Total Marks : 480

kd700+ neet target ch-5 thermodynamics and thermochemistry

*** Chemistry** **[480]**

1. Match List-I with List-II.

List $-I$ (Process)	List $-II$ (Conditions)
A. Isothermal process	I. No heat exchange
B. Isochoric process	II. Carried out at constant temperature
C. Isobaric process	III. Carried out at constant volume
D. Adiabatic process	IV. Carried out at constant pressure

Choose the correct answer from the options given below:

(A) $A-IV, B-II, C-III, D-I$
(B) $A-I, B-II, C-III, D-IV$
(C) $A-II, B-III, C-IV, D-I$
(D) $A-IV, B-III, C-II, D-I$

Ans. : (A) Isothermal process $\Rightarrow$ Temperature is constant throughout the process
(B) Isochoric process $\Rightarrow$ Volume is constant throughout the process
(C) Isobaric process $\Rightarrow$ Pressure is constant throughout the process
(D) Adiabatic process $\Rightarrow$ No exchange of heat (q) between system and surrounding

2. The work done during reversible isothermal expansion of one mole of hydrogen gas at $25^{\circ}\mathrm{C}$ from pressure of $20\mathrm{atmosphereto}10\mathrm{atmosphere}$ is
(Given $R = 2.0 \mathrm{calK}^{-1}\ \mathrm{mol}^{-1}$)

(A) -413.14 calories
(B) 413.14 calories
(C) 100 calories
(D) 0 calorie

Ans. : a

$W_{\text{rev, iso}} = -2.303 nRT \log \frac{P_i}{P_f}$
$= -2.303 \times 1 \times 2 \times 298 \times \log 2$
$= -2.303 \times 1 \times 2 \times 298 \times 0.3$
$= -413.14 \text{ calories}$

3. Which amongst the following options is the correct relation between change in enthalpy and change in internal energy?

(A) $\Delta H + \Delta U = \Delta nR$
(B) $\Delta H = \Delta U - \Delta n_9 RT$
(C) $\Delta H = \Delta U + \Delta n_g RT$
(D) $\Delta H - \Delta U = -\Delta nRT$

Ans. : c
Correct relation between change in enthalpy and change in internal energy is
$\Delta H = \Delta U + \Delta n_g RT$

4. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R
Assertion A : In equation $\Delta_r G = -nFE_{\text{cell}}$ value of $\Delta_r G$ depends on n.

Reasons R : E_{cell} is an intensive property and $\Delta_r G$ is an extensive property.
In the light of the above statements, choose the correct answer from the options given below

(A) A is false but R is true

(B) Both A and R are true and R is the correct explanation of A

(C) Both A and R are true and R is NOT the correct explanation of A

(D) A is true but R is false

Ans. : b

The value of $\Delta_r G$ depends on n value as per the equation $\Delta_r G = -nFE_{\text{cell}}$ Where E is the emf of the cell and nF is the amount of charge passed.

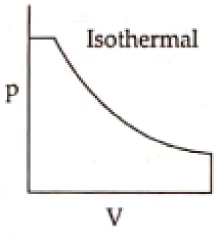
So, assertion statement is correct

Ecell is an intensive property while $\Delta_r G$ is an extensive thermodynamic property

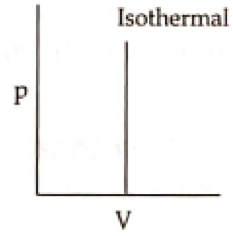
So, reason is correct but not explaining the assertion

5. Which of the following $p-V$ curve represents maximum work done?

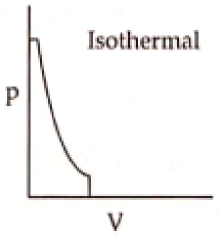
(A)



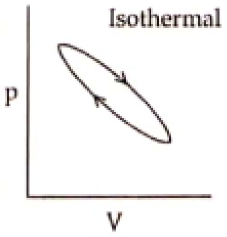
(B)



(C)



(D)



Ans. : a

In $P-V$ graph area under the curve represent magnitude of work.

As it is maximum in graph-1

6. Which one among the following is the correct option for right relationship between $\mathrm{C_P}$ and $\mathrm{C_V}$ for one mole of ideal gas?

(A) $\mathrm{C_P + C_V = R}$ (B) $\mathrm{C_P - C_V = R}$ (C) $\mathrm{C_P = RC_V}$ (D) $\mathrm{C_V = RC_P}$

Ans. : b

$\mathrm{C_P - C_V = R}$

7. If for a certain reaction $\Delta_r H$ is $30\, kJ\, mol^{-1}$ at $450\, K$, the value of $\Delta_r S($ in $JK^{-1} mol^{-1})$ for which the same reaction will be spontaneous at the same temperature is

(A) -70 (B) 70 (C) -33 (D) 33

Ans. : b

For spontaneous reaction, $\Delta_r G$ must be less than zero.

So, $\Delta_r G = \Delta_r H - T\Delta_r S < 0$

or, $\Delta_r S > \frac{\Delta_r H}{T}$

$> \frac{30,000}{450} = 66.67J$

$\therefore$ For reaction to be spontaneous, the value of $\Delta_r S$ must be greater than 66.67 J

8. In which case change in entropy is negative ?

(A) Evaporation of water

(B) Expansion of a gas at constant temperature

(C) Sublimation of solid to gas

(D) $2H(g) \rightarrow H_2(g)$

Ans. : d

$2H(g) \rightarrow H_2(g)$

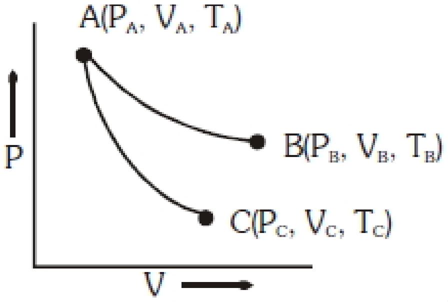
Due to bond formation, entropy decreases

9. Reversible expansion of an ideal gas under isothermal and adiabatic conditions are as shown in the figure

$AB \rightarrow$ Isothermal expansion

$AC \rightarrow$ Adiabatic expansion

Which of the following options is not correct ?



(A) $\Delta S_{\text{isothermal}} > \Delta S_{\text{adiabatic}}$	(B) $\mathrm{T_A} = \mathrm{T_B}$
(C) $W_{isothermal} > \mathrm{W_{adiabatic}}$	(D) $\mathrm{T_C} > \mathrm{T_A}$

Ans. : d

In adiabatic expansion cooling effect will take place, T_C will be less then$\mathrm{T_A}$ in adiabatic expansion

$\mathrm{q} = 0 \ \Delta \mathrm{U} = \mathrm{W}$

$W_{pv} < 0$

$\Delta \mathrm{U} < 0$

$\mathrm{nC_{vm}} \Delta \mathrm{T} < 0$

$\Delta \mathrm{T} < 0$

$\mathrm{T_C} - \mathrm{T_A} < 0$

$\mathrm{T_c} < \mathrm{T_A}$

10. The bond dissociation energies of $\mathrm{X_2, Y_2}$ and XY are in the ratio of $1:0.5:1. \Delta \mathrm{H}$ for the formation of XY is $-200\ \mathrm{kJmol^{-1}}$. The bond dissociation energy of X_2 will be......$\mathrm{kJmol^{-1}}$

(A) 200 (B) 100 (C) 800 (D) 400

Ans. : c

let B.E. of $\mathrm{x_2, y_2}$ and xy are $\mathrm{x\ kJ}$ mol^{-1}

$\mathrm{0.5\ xkJmol^{-1}}$ and $\mathrm{x\ kJmol^{-1}}$ respectively

$\frac{1}{2}\mathrm{x_2} + \frac{1}{2}\mathrm{y_2} \rightarrow \mathrm{xy}; \Delta \mathrm{H} = -200\mathrm{kJmol^{-1}}$

$\Delta \mathrm{H} = -200 = \Sigma(\mathrm{B.E})$ Reactant $-\Sigma(\mathrm{B.E})$ product

$= \left[\frac{1}{2} \times (\mathrm{x}) + \frac{1}{2} \times (0.5\mathrm{x})\right] - [1 \times (\mathrm{x})]$

B.E of $\mathrm{X_2} = \mathrm{x} = 800\mathrm{kJmol^{-1}}$

11. The correct thermodynamic conditions for the spontaneous reaction at all temperatures is

(A) $\Delta H > 0$ and $\Delta S < 0$ (B) $\Delta H < 0$ and $\Delta S < 0$

(C) $\Delta H < 0$ and $\Delta S = 0$ (D) $\Delta H < 0$ and $\Delta S > 0$

Ans. : d

$\Delta G = \Delta H - T\Delta S$

For spontaneous process

$\Delta S = +ve$

$\Delta H = -ve$

12. The heat of combustion of carbon to CO_2 is $-393.5\ kJ/mol$. The heat released upon formation of $35.2\ g$ of CO_2 from carbon and oxygen gas is

(A) $+315\ kJ$ (B) $-630\ kJ$

(C) $-3.15\ kJ$ (D) None of the above

Ans. : d

Formation of $\mathrm{CO_2}$ from carbon and dioxygen gas can be represented as:

$\mathrm{C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}} \quad \Delta_f H = -393.5\ \mathrm{kJ\,mol^{-1}}$

$(1\ \mathrm{mole}\ = 44\ g)$

Heat released on formation of $44\ \mathrm{g\ CO_2} = -393.5\ \mathrm{kJ\,mol^{-1}}$

Heat released on formation of $35.2\ \mathrm{g\ CO_2}$

$= \frac{-393.5\ \mathrm{kJ\ mol^{-1}}}{44\ \mathrm{g}} \times 35.2\ \mathrm{g}$

$= -314.8\ \mathrm{kJ\,mol^{-1}}$

13. Ratio of C_p and C_v of a gas X is 1.4, the number of atom of the gas 'X'' present in 11.2 litres of it at NTP will be

(A) 6.02×10^{23} (B) 1.2×10^{23} (C) 3.01×10^{23} (D) 2.01×10^{23}

Ans. : (a) $\frac{C_P}{C_V} = 1.4$ so, given gas is diatomic

$11.2\ L = 3.01 \times 10^{23}$ molecules

$\therefore$ No. of atoms $= 3.01 \times 10^{23} \times 2 \ = 6.023 \times 10^{23}$ atoms

14. Equal volumes of monoatomic and diatomic gases at same initial temperature and pressure are mixed. The ratio of specific heats of the mixture (C_p/C_v) will be

(A) 1 (B) 2 (C) 1.67 (D) 1.5

Ans. : (d)$C_v = \frac{3}{2}RT;\ C_p = \frac{5}{2}RT$ for monoatomic gas

$C_v = \frac{5}{2}\mathrm{RT}; C_p = \frac{7}{2}RT$ for diatomic gas

Thus for mixture of 1 mole each, $C_v = \frac{\frac{3}{2}RT + \frac{5}{2}RT}{2}$ and $C_p = \frac{\frac{5}{2}RT + \frac{7}{2}RT}{2}$

Therefore, $C_p/C_v = \frac{3RT}{2RT} = 1.5$.

15. When $100\,ml$ of $1\,M\,NaOH$ solution and $10\,ml$ of $10\,N\,H_2SO_4$ solution are mixed together, the resulting solution will be

(A) Alkaline (B) Acidic (C) Strongly acidic (D) Neutral

Ans. : (d) For $NaOH$, $M = N$

$N_1V_1 = 100\,ml \times 1\,N = 100\,ml(N)$ For H_2SO_4,

$N_2V_2 = 10\,ml \times 10\,N = 100\,ml(N)$

Hence, $N_1V_1 = N_2V_2$.

16. If $C + O_2 \rightarrow CO_2 + 94.2\,kcal$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O + 68.3\,kcal$ $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 210.8\,kcal$ then the possible heat of methane will be......$kcal$

(A) 47.3 (B) 20 (C) 45.9 (D) -47.3

Ans. : (b)$C + O_2 \ \rightarrow \ CO_2 + 94.2\ Kcal.$ .....(i)

$H_2 + \frac{1}{2}O_2 \ \rightarrow \ H_2O + 68.3\ Kcal.$ ....(ii)

On multiplication of eq. (ii) by 2 and than adding in eq. (i)

$C + 2H_2 + 2O_2 \rightarrow CO_2 + 2H_2O + 230.8\ Kcal$ ...(iii)

On subtracting eq. (iii) by following eq.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 210.8\ Kcal.$ we get,

$C + 2H_2 \rightarrow CH_4\ \Delta H = 20\ Kcal.$

17. The enthalpy of fusion of ice per mole......kJ

(A) 18 (B) 8 (C) 80 (D) 6

Ans. : d

The molar enthalpy of fusion for ice at $0°C$ has an accepted value of $+6.01\,kJ/mol$.

18. The mutual heat of neutralisation of $40\,gm$ of $NaOH$ and $60\,gm$ CH_3COOH will be

(A) $56.1\,kcal$ (B) Less than $56.1\,kcal$

(C) More than $56.1\,kcal$ (D) $13.7\,kcal$

Ans. : (b)Heat of neutralisation is less than $56.1\,Kcal$ when a strong base and a weak acid reacts.

19. Heat of formation of $CO_2(g)$, $H_2O(l)$ and $CH_4(g)$ are $-94.0, -68.4$ and $-17.9\,kcal$ respectively. The heat of combustion of methane is.....$kcal$

(A) -212.9
(B) -136.8
(C) -304.3
(D) -105.2

Ans. : (a)Find ΔH for $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O_{(g)}$.

20. A solution of $500\,ml$ of $0.2\,M\,KOH$ and $500\,ml$ of $0.2\,M\,HCl$ is mixed and stirred; the rise in temperature is T_1. The experiment is repeated using $250\,ml$ each of solution, the temperature raised is T_2. Which of the following is true

(A) $T_1 = T_2$
(B) $T_1 = 2T_2$
(C) $T_1 = 4T_2$
(D) $T_2 = 9T_1$

Ans. : (a)Suppose heat evolved in Ist case is Q_1 and that in the IInd case it is Q_2.
Then $Q_2 = \frac{1}{2}Q_{1.}$
But $Q_1 = 1000\,T_1$ and $Q_2 = 500\,T_2$
$\therefore 500\ T_2 = \frac{1}{2} \times 1000\ T_1\ i.e.\ T_2 = T_1$.

21. If $H^+ + OH^- \rightarrow H_2O + 13.7\,kcal$, then the heat of neutralization for complete neutralization of one mole of H_2SO_4 by base will be.......$kcal$

(A) 13.7
(B) 27.4
(C) 6.85
(D) 3.425

Ans. : (a)If acid or base or both are strong, heat of neutralization $= 13.7\ kcal.$

22. Heat of neutralisation for the given reaction $NaOH + HCl \rightarrow NaCl + H_2O$ is $57.1\,kJ\,mol^{-1}$. What will be the heat released when $0.25\,mole$ of $NaOH$ is titrated against $0.25\,mole$ of HCl ....$kJ\,mol^{-1}$

(A) 22.5
(B) 57.1
(C) 14.3
(D) 28.6

Ans. : (c)$57.1\ \times 0.25 = 14.3\ \ kJ\,mol^{-1}$.

23. In the combustion of $2.0\,gm$ of methane $25\,kcal$ heat is liberated, heat of combustion of methane would be.....$kcal$

(A) 100
(B) 200
(C) 300
(D) 400

Ans. : (b)$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
Molecular weight of $CH_4 = 12 + 4 = 16$
$\therefore$ On the combustion of $2.0\ gm$ of methane $= 25.0\,kcal$
$\therefore$ On the combustion of $16.0\,gm = \frac{25 \times 16}{2} = 200\,kcal.$

24. Enthalpy of formation of HF and HCl are $-161\,kJ$ and $-92\,kJ$ respectively. Which of the following statements is incorrect

(A) HCl is more stable than HF

(B) HF and HCl are exothermic compounds

(C) The affinity of fluorine to hydrogen is greater than the affinity of chlorine to hydrogen

(D) HF is more stable than HCl

Ans. : (a) HF is more stable than $HCl.$

25. The heat of reaction at constant pressure is given by

(A) $E_P - E_R$ (B) $E_R - E_P$ (C) $H_P - H_R$ (D) $H_R - H_P$

Ans. : c

The heat of reaction (q_p) at constant pressure is given by $H_P - H_R$.

26. Equal volumes of methanoic acid and sodium hydroxide are mixed. If x is the heat of formation of water, then heat evolved on neutralisation is

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

Ans. : (d)As methanoic acid is weak acid, heat of neutralization $< x$.

27. Heat of neutralization of the acid-base reaction is $57.32\,kJ$ for

(A) $HNO_3 + LiOH$ (B) $HCOOH + KOH$

(C) $HCl + NH_4OH$ (D) $CH_3COOH + NaOH$

Ans. : (a)Strong acid $(HNO_3)$and strong base $(LiOH)$.

28. In order to decompose $9\,g$ water $142.5\,kJ$ heat is required. Hence the enthalpy of formation of water is......kJ

(A) -142.5 (B) $+142.5$ (C) -285 (D) $+285$

Ans. : (c)For the decomposition of 9 gm of water heat required $= 142.5\,kJ$

we know $H_2O = 2 + 16 = 18$

Therefore heat required for decomposition of 18 gm water $= \frac{18}{9} \times 142.5 = 285\,KJ$

Than, enthalpy of formation of water is reverse of heat required $= -285\,kJ$.

29. Heat of neutralization of strong acid and weak base is

(A) $57.1\,kJ\,mol^{-1}$

(B) $13.7\,kJ\,mol^{-1}$

(C) Less than $13.7\,kcal\,mol^{-1}$

(D) More than $13.7\,kcal\,mol^{-1}$

Ans. : (c)Heat of neutralization of strong acid and weak base is less than $13.7\,kcal\,mol^{-1}$.

30. When the aqueous solution of $0.5\,mole\ HNO_3$ is mixed with the $0.3\,mole$ of OH^- solution, then what will be the liberated heat.......kJ (Enthalpy of neutralization is $= 57.1\,kJ$)

(A) 28.5 (B) 17.1 (C) 45.7 (D) 1.7

Ans. : (b) 0.3 mole OH^-, neutralize 0.3 mole of HNO_3

Evolved heat, $= 57.1 \times 0.3 = 17.13\,kJ$

31. What is the weight of oxygen that is required for the complete combustion of $2.8\,kg$ of ethylene? ....kg

(A) 9.6 (B) 96 (C) 6.4 (D) 2.8

Ans. : a

$$\underset{(12\times2+4)}{C_2H_4} + \underset{96\ kg}{3O_2} \rightarrow 2CO_2 + 2H_2$$

$= 28kg$

Weight of oxygen required for the Complete combustion of $28kg$ ethylene $= 96kg$

$\therefore$ Weight of oxygen required for the combustion of $2.8kg$ ethylene.

$= \frac{96\times2.8}{28} = 9.6kg$

32. The heat of combustion of carbon to CO_2 is $-393.5\,kJ/mol$. The heat released upon formation of $35.2\,g$ of CO_2 from carbon and oxygen gas is .....kJ

(A) $+315$ (B) -31.5 (C) -315 (D) $+31.5$

Ans. : (c) $C + O_2 \to CO_2\ \Delta H = -393.5\,KJ/mol$

$44\,gm$ of CO_2 form by which heat released

$= -393.5\,kJ$

$\therefore 1\,gm$ of CO_2 form by which heat released $= -\frac{393.5}{44}$

$\therefore 35.2\,gm$ (given) of CO_2 form by which heat released

$= -\frac{393.5}{44} \times 35.2\ = -315\,kJ$

33. If the heat of formation of CO_2 is$-393\,kJ$. The amount of heat evolved in the formation of $0.156\,kg$ of CO_2 is.....kJ

(A) -1357.9 (B) -1275.9 (C) -1572 (D) -1165.5

Ans. : (c)Heat of formation of a substance is the heat exchanged when one mole of that substance is formed by its constituent elements.

Heat evolved when 1 mole $(44\,g)\,CO_2$ is formed $= 393\,kJ$

$\therefore$ Heat evolved when $0.156\,Kg\,(156\,g)$ is formed $= \frac{393\times156}{44}$

$\therefore \Delta H$ for the process $= 1572\,kJ = -1572.0\,kJ$

34. The bond dissociation energies of gaseous H_2, Cl_2 and HCl are $104, 58$ and $103\,kcal$ respectively. The enthalpy of formation of HCl gas would be.....$kcal$

(A) -44 (B) 44 (C) -22 (D) 22

Ans. : (c)Aim: $\frac{1}{2}H_2 + \frac{1}{2}Cl_2 \to HCl$

$\Delta H = \sum B.E._{\text{(Products)}} - \sum B.E._{\text{(Reactants)}}$

$= B.E.(HCl) - \left[\frac{1}{2}B.E.(H_2) + \frac{1}{2}B.E.(Cl_2)\right]$

$= -103 - \left[\frac{1}{2}(-104) + \frac{1}{2}(-58)\right]$

$= -103 - (-52 - 29) = -22\ kcal$.

35. The $H-H$ bond energy is $430\,kJ\ mol$ and $Cl-Cl$ bond energy is $240\,kJ\,mol^{-1}$. ΔH for HCl is $-90\,kJ$. The $H-Cl$ bond energy is about.....$kJ\,mol^{-1}$

(A) 180 (B) 360 (C) 213 (D) 425

Ans. : (d) $\frac{1}{2}H_2 + \frac{1}{2}Cl_2 \to HCl,\ \ \Delta H = -90\,KJ$

$\therefore \Delta H = \frac{1}{2}E_{H-H} + \frac{1}{2}E_{Cl-Cl}$

or $-90 = \frac{1}{2} \times 430 + \frac{1}{2} \times 240 - E_{HCl}$

$\therefore E_{H-Cl} = 425\,kJ\,mol^{-1}$.

36. If enthalpies of methane and ethane are respectively 320 and 360 calories then the bond energy of $C-C$ bond is......$calories$

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

Ans. : (b)$CH_4 \rightarrow C + 4H,\ \Delta H = 320$
$E_{C-H} = 90\,cal$
$C_2H_6 \rightarrow 2C + 6H,\ \ \Delta H = 360$
$\therefore 360 = E_{C-C} + 6E_{C-H}$
$\therefore E_{C-C} = 360 - 320 = 40\ cal$.

37. The value of heat generated when $36.5\,gm\ \ HCl$ and $40\,gm$ of $NaOH$ reacts during neutralization.....$kcal$

(A) 76.5 (B) 13.7 (C) More than 13.7 (D) 108

Ans. : (b)When strong acid and strong base neutralize each other than the value of heat generated is about $13.7\,kcal$.

38. Enthalpy of solution of $NaOH$ (solid) in water is $-41.6\,kJ\,mol^{-1}$. When $NaOH$ is dissolved in water, the temperature of water

(A) Increase (B) Decreases

(C) Does not change (D) Fluctuates indefinitely

Ans. : (a)Since process is exothermic then heat is evolved due to this temperature of water increases.

39. Consider the reactions $C(s) + 2H_2(g) \rightarrow CH_4(g), \Delta H = -x\,kcal$
$C(g) + 4H(g) \rightarrow CH_4(g),\ \Delta H = -x_1\ k\,cal$
$CH_4(g) \rightarrow CH_3(g) + H(g),\ \Delta H = +y\,k\,cal$
The bond energy of $C - H$ bond is

(A) $y\,kcal\,mol^{-1}$ (B) $x_1\ kcal\,mol^{-1}$ (C) $x/4\,kcal\,mol^{-1}$ (D) $x_1/4\,kcal\,mol^{-1}$

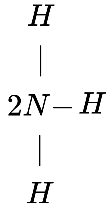
Ans. : (a)The bond energy of $C - H$ bond is $y\,kcal\ mol^{-1}$.

40. Given the bond energies $N \equiv N,\ H - H$ and $N - H$ bonds are $945, 436$ and $391\,kJ\,mole^{-1}$ respectively, the enthalpy of the following reaction $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ is......kJ

(A) -93 (B) 102 (C) 90 (D) 105

Ans. : (a).Net. energy released $= 2346 - 2253 = 93\,kJ$
i.e. $\Delta H = -93\,kJ$

$$\underbrace{\underset{945}{N \equiv N}\ \underset{+\ \ 3\times 436}{+3H\ -\ H}}_{Energy\,absorbed} \rightarrow$$



$$2\,\begin{array}{l} \ \ H \\ \ \ | \\ N - H \\ \ \ | \\ \ \ H \end{array}$$

$\underbrace{2\times(3\times391)-2346}_{Energy\,released}$

41. When $50\,cm^3$ of $0.2\,N\,H_2SO_4$ is mixed with $50\,cm^3$ of $1\,N\,KOH$, the heat liberated is

(A) $11.46\,kJ$ (B) $57.3\,kJ$ (C) $573\,kJ$ (D) $573\,J$

Ans. : (d)For complete neutralization of strong acid and strong base energy released is $57.32\,KJ/mol$

No. of mole of $H_2SO_4 = \frac{0.2\times50}{1000} = 10^{-2}$

No. of mole of $KOH = \frac{1}{1000}\times50 = 5\times10^{-2}$

So $= 57.32\times10^{-2} = 0.5732\,KJ\ = 573.2\ Joule.$

42. The heat of neutralization of HCl by $NaOH$ under certain condition is $-55.9\ kJ$ and that of HCN by $NaOH$ is $-12.1\ kJ$. the heat of ionization of HCN is .... $\mathrm{kJ\,mol^{-1}}$

(A) -68 (B) -43.8 (C) 68 (D) 43.8

Ans. : d

$HCl + NaOH \longrightarrow NaCl + H_2O \quad \Delta H = -55.9KJ/mol$

$NaCl + H_2O \longrightarrow NaOH + HCl \quad \triangle H = 55.9KJ/mol$
$--------(1)$

$HCN + NaOH \longrightarrow NaCH + H_2O \quad \triangle H = -12.1KJ/mol$
$------(2)$

Adding (1) and (2)

$HCN + NaCl \longrightarrow NaCN + HCl \longrightarrow \Delta H = 55.9 - 12.1$

$= 43.8KJ/mol$

43. The heat of neutralization of a strong acid and a strong alkali is $57.0\,kJ\,mol^{-1}$. The heat released when 0.5 mole of HNO_3 solution is mixed with $0.2\,mole$ of KOH is....kJ

(A) 57 (B) 11.4 (C) 28.5 (D) 34.9

Ans. : b

Heat released $= 57\times0.2 = 11.4\,\mathrm{kJ}$

44. The enthalpy of dissolution of $BaCl_2\ (s)$ and $BaCl_2.2H_2O\ (s)$ are -20.6 & $8.8\ kJ\ mol^{-1}$ respectively. Calculate enthalpy of hydration for given reaction $BaCl_2\,(s) + 2H_2O \rightarrow BaCl_2.2H_2O\,(s)$ ......kJ

(A) -29.4 (B) -35.4 (C) -24.4 (D) -15.2

Ans. : a

$-20.6 = X + 8.8$

$\mathrm{X} = -20.6 - 8.8 = -29.4\,\mathrm{kJ}$

45. Calculate the $N-N$ bond energy in N_2H_4 from given bond enthalpy data.

$\varepsilon_{N-H} = 393\,kJ/mole$

$\varepsilon_{H-H} = 436\,kJ/mole$

$\Delta H_{vap}[N_2H_4(l)] = 18\,kJ/mole$

$N_2H_4(l) + H_2(g) \rightarrow 2NH_3(g) : \Delta H = -142\,kJ/mole$

.......$kJ/mole$

(A) 210 (B) 190 (C) 180 (D) 150

Ans. : (B) 190

46. The enthalpy change for the reaction, $H_2(g) + C_2H_4(g) \rightarrow C_2H_6(g)$ is ......$kcal\,mol^{-1}$ The bond energies are, $[e_{H-H} = 103, e_{C-H} = 99, e_{C-C} = 80]$ and $[e_{C=C} = 145\,kcal\,mol^{-1}]$

(A) -10 (B) $+10$ (C) -30 (D) $+30$

Ans. : c

$\Delta \mathrm{H} = -\left[1\mathrm{e}_{\mathrm{C-C}} + 6\mathrm{e}_{\mathrm{C-H}}\right] + \left[1\mathrm{e}_{\mathrm{H-H}} + 1\mathrm{e}_{\mathrm{C=C}} + 4\mathrm{e}_{\mathrm{C-H}}\right]$

47. The enthalpy change for the reaction, $C_2H_6(g) \rightarrow 2C(g) + 6H(g)$ is $X\,kJ$. The bond energy of $C-H$ bond is :-

(A) $\frac{X}{2}$ (B) $\frac{X}{3}$ (C) $\frac{X}{6}$ (D) Data insufficient

Ans. : d

$\mathrm{C_2H_6} \rightarrow 1(\mathrm{C-C}) + 6(\mathrm{C-H})$

$C-C \rightarrow$ Not given

$\mathrm{C-H} \rightarrow$ cannot be determined

48. The enthalpy of neutralization of a strong acid by a strong base is $-57.32\,kJ/mol$ the enthalpy of formation of water is $-285.84\,kJ/mol$. The enthalpy of formation of hydroxyl ion is......kJ/mol

(A) $+228.52$ (B) -114.26 (C) -228.52 (D) $+114.2$

Ans. : c

$\mathrm{H^+(aq) + OH^-(aq) \longrightarrow H_2O}(l)$

$\Delta H^\circ = -57.32\,\mathrm{kJ/mol}$

$\Delta \mathrm{H_r} = \Delta \mathrm{H}_f^\circ(\mathrm{H_2O}) - \left[\Delta \mathrm{H}_f^\circ \mathrm{H^+(aq)} + \Delta \mathrm{H}_f^\circ(\mathrm{OH})(\mathrm{aq})\right]$

49. The heat evolved in the combustion of methane is given by the following equation

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l);$

$\Delta H = -890.3\,kJ$

How many grams of methane would be required to produce $445.15\,kJ$ of heat of combustion.....g

(A) 4 (B) 8 (C) 12 (D) 16

Ans. : b

$89.03\,\mathrm{kJ}$ heat librate by $= 1\,\mathrm{mol}$

$1\,kJ$ heat librate by $= \frac{1}{890.3}\ mol$

$445.15\,\mathrm{kJ}$ heat liberate by $= \frac{445.15}{890.3}\,\mathrm{mol}$

50. The molar enthalpies of combustion of $C_2H_2(g), C(graphite)$ and $H_2(g)$ are $-1300, -394,$ and $-286\,KJ\,mol^{-1}$, respectively. The standard enthalpy of formation of $C_2H_2(g)$ is ....$kJ\,mol^{-1}$

(A) -226 (B) -626 (C) 226 (D) 626

Ans. : a

$\mathrm{C_2H_2(g)} + \frac{3}{2}\mathrm{O_2(g)} \longrightarrow \mathrm{2CO_2 + H_2O}$

$\Delta\mathrm{H} = 2 \times \Delta\mathrm{H_C} + \Delta\mathrm{H_{H_2O}} - \Delta\mathrm{H}_{\mathrm{C}_2H_2}$

$= 2 \times (-394) + (-286) - (-1300)$

$= +226\,\mathrm{kJ\,mol^{-1}}$

51. With the help of following data, find out the change in heat content for the reaction......kJ

$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$

Bond	Bond energy (kJ)
$C-H$	413
$C-C$	348
$C=C$	610
$H-H$	436

(A) -128 (B) $+128$ (C) $+256$ (D) -256

Ans.: (A) -128

52. The heat of combustion of ethylene $C_2H_4(g)$ is $-1420\,kJ/mole$. The number of litres of C_2H_4 at NTP that would evolve $355\,kJ$ on combustion is

(A) 2.8 (B) 8.4 (C) 5.6 (D) 11.2

Ans. : c

$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O \quad \Delta H = 1420\,kJ/mole$

$1420\,kJ$ energy is released by $1\,mole$ of ethylene.

Given; heat evolved $= 355\,kJ$

$\therefore$ No. of Liter $= \frac{355}{1420} \times 22.4\,lt$

$= 5.6\,liter$

53. The bond enthalpies of H_2, X_2 and HX are in the ratio of $2:1:2$. If the enthalpy for formation of HX is $-50\,kJ\,mol^{-1}$, the bond enthalpy of H_2 is .....$kJ\,mol^{-1}$

(A) 200 (B) 400 (C) 100 (D) 300

Ans.: (A) 200

54. The heat of neutralization of a strong acid and a strong alkali is $-57.0\,kJ\,mol^{-1}$. The heat released when $0.5\,mole$ of HNO_3 solution is mixed with $0.2\,mole$ of KOH is ....kJ

(A) 57 (B) 11.4 (C) 28.5 (D) 34.9

Ans. : b

Correct option

(b) $11.4kJ$

Explanation:

Heat of neutralization $(\Delta H) - 57kJ/mol$, moles of $HNO_3 = 0.5$ mole and moles of $NaOH = 0.2mole$. When HNO_3 solution is added to $NaOH$ solution, then $0.2mole$ of HNO_3 solution will combine with 0.2 mole of $NaOH$ solution.

Heat released $= \Delta H \times 0.2 = 57 \times 0.2 = 11.4kJ$

55. The enthalpy of combustion of benzene from the following data will be

$(i)\, 6C(s) + 3H_2(g) \rightarrow C_6H_6(l); \Delta H = +45.9\,kJ$

$(ii)\, H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l); \Delta H = -285.9\,kJ$

$(iii)\, C(s) + O_2(g) \rightarrow CO_2(g); \Delta H = -393.5\,kJ$

.....kJ

(A) $+3172.8$ (B) -1549.2 (C) -3172.8 (D) -3264.6

Ans. : (D) -3264.6

56. Which of the following acid will release maximum amount of heat when completely neutralised by strong base $NaOH$?

(A) $1\,M\ HCl$ (B) $1\,M\ HNO_3$ (C) $1\,M\ HClO_4$ (D) $1\,M\ H_2SO_4$

Ans. : d

Ionisation of H_2SO_4 gives double amount of $H^{\oplus}$ ions as compared to other acids.

$H_2SO_4\ \rightarrow\ 2H^{\oplus}\ +\ {SO_4}^{2-}$

57. The molar enthalpies of combustion of $C_2H_2(g), C$ (graphite) and $H_2\,(g)$ are $-1300, -394$ and $-286\,kJ\,mol^{-1}$, respectively. The standard enthalpy of formation of $C_2H_2\,(g)$ is.......$kJ\,mol^{-1}$

(A) -226 (B) -626 (C) 226 (D) 626

Ans. : c

(i) $C + O_2 \rightarrow CO_2; \Delta H = -393.5$

(ii) $H_2 + \frac{1}{2}O_2 \rightarrow H_2O; \Delta H = -282.6$

(iii) $C_2H_2 + \frac{5}{2}O_2 \rightarrow 2CO_2 + H_2O; \Delta H = -1300KJ$

Reaction: $2 \times (i) + (ii)-($ iii $)$ will result into:

$2C + H_2 \rightarrow C_2H_2$

$\Delta H = 2 \times (-393.5) + (-282.6) + 1300 = 226.8$

58. ΔH_f^o of water is $-285.5\,kJ\,mol^{-1}$. if enthalpy of neutralisation of monoacidic strong base is $-57.3\,kJ\,mol^{-1}$, of OH^- ion will be.....$kJ\,mol^{-1}$

(A) -228.2 (B) 228.5 (C) 114.5 (D) -114.5

Ans. : $H^+(aq)OH^-(aq) + OH^-(aq) \rightarrow H_2o(l)$

so $\Delta H^\circ = -57.3 = -285.5 - \Delta_f^\circ(H + aq) - \Delta H_f^\circ(OH^-)$

so, $\Delta H_f^o(OH^- aq) = -228.2\, kJ/mol$

59. If combustion of $4g$ of CH_4 liberates $2.5\, kcal$ of heat, the heat of combustion of CH_4 is .....$kcal$

(A) -20 (B) -10 (C) 2.5 (D) -5

Ans. : a

$\Delta; H = 2.5 \times 164 = -10 kcalmol$

60. Heat of neutralisation of $NaOH$ and HCl is $-57.46\, kJ/eq$. Then heat of ionisation of water in kJ/mol is

(A) -57.46 (B) $+57.46$ (C) -114.92 (D) $+114.92$

Ans. : b

$\Delta H_{heat} = -\Delta H_{ionisation} = H_2O = +57.46\, KJ/eq.$

61. What is the activation energy for the reverse of this reaction?

$N_2O_4(g) \rightarrow 2NO_2(g)$

Data for the given reaction is

$\Delta H = +54\, kJ$ and $E_a = +57.2\, kJ$

.......kJ

(A) -54 (B) $+3.2$ (C) $+60.2$ (D) $+111.2$

Ans. : b

For endothermic reactions:

$E_b = E_f - \Delta H$

$= 57.2 - 54kL$

$= 3.2kL$

62. With the help of following data, find out the change in heat content for the reaction

$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$

.......kJ

Bond	Bond energy (kJ)
$C-H$	413
$C-C$	348
$C=C$	610
$H-H$	436

(A) -128 (B) $+128$ (C) $+256$ (D) -256

Ans.: (A) -128

63. Based on Hess's law calculations, what is the average $S-O$ bond energy in SO_3 if ΔH_f^o of SO_3 is $-270\,kJ\,mol^{-1}$. Bond energy of $O=O$ is $130\,kJ\,mol^{-1}$ and heat of sublimation for $S(s)$ is $100\,kJ\,mol^{-1}$? ....$kJ\,mol^{-1}$

(A) 188.5 (B) 120 (C) 12 (D) 100

Ans.: (A) 188.5

64. Given that the bond energy of hydrogen-hydrogen bonds is $436\,kJ/mol$, that of hydrogen-oxygen bonds is $464\,kJ/mol$, and those in oxygen molecules $496\,kJ/mol$, what is the approximate heat of reaction for $2H_2+O_2 \longrightarrow 2H_2O$? ... kJ/mol

(A) -488 (B) -440 (C) 440 (D) 488

Ans.: (A) -488

65. For the reaction $OF_{2(g)} \rightarrow O_{(g)} + 2F_{(g)}$, $\Delta_{rxn}H$ is $368\,kJ$. What is the average $O—F$ bond energy ? ....kJ

(A) 184 (B) 368 (C) 536 (D) 736

Ans. : a

$F-O-F \rightarrow O+2F \qquad \Delta H = 368\,kJ$

$\therefore$ Av. $O-F$ Bond energy $= \frac{368}{2} = 184$

66. Enthalpy of neutralization of HCl by $NaOH$ is $-55.84\,kJ/mol$ and by NH_4OH is $-51.34\,kJ/mol$. The enthalpy of ionization of NH_4OH is .....kJ

(A) -107.18 (B) 107.18 (C) 4.5 (D) -4.5

Ans. : c

We are given:

Enthalpy of neutralization of NaOH by HCl = -55.84 kJ

Enthalpy of neutralization of by HCl = -51.34 kJ

To calculate the enthalpy of ionization of , we use the equation:

Putting values in above equation, we get:

Hence, the enthalpy of ionization of is 4.5 kJ

67. The enthalpies of formation of N_2O and NO are 28 and $90\,kJ\,mol^{-1}$ respectively. The enthalpy of the reaction, $2N_2O(g)+O_2(g) \rightarrow 4NO(g)$ is equal to.....kJ

(A) 8 (B) 88 (C) -16 (D) 304

Ans. : d

First write the balanced chemical; equations for he formation of dinitrogen oxide and nitric
oxide.

$N_2 + \frac{1}{2}O_2 \longrightarrow N_2O; \Delta H = 28kJ \ (i)$

$\frac{1}{2}N_2 + \frac{1}{2}O_2 \longrightarrow NO; \Delta H = 90kJ_{\ldots}$ (ii)

Then multiply second equation with 4 and first equation with 2 .

$2N_2 + O_2 \longrightarrow 2N_2O; \Delta H = 2 \times 28kJ \ldots (iii)$

$2N_2 + 2O_2 \longrightarrow 4NO; \Delta H = 4 \times 90kJ_{\ldots}(iv)$

Now substract third equation from fourth equation.

$2N_2O + O_2 \longrightarrow 4NO; \Delta H = 304kJ$

Thus, the enthalpy of the reaction $2N_2O(g) + O_2(g) \longrightarrow 4NO(g)$ is $304kJ$.

68. If the enthalpy of formation and enthalpy of solution of $HCl\,(g)$ are $-92.3\,kJ/mol$ and $-75.14\,kJ/mol$ respectively then find enthalpy of formation of $Cl^-(aq)$ [Assume $\Delta H_{f(H^+)} = 0$] .....kJ/mol

(A) -17.16 (B) -167.44 (C) 17.16 (D) None of these

Ans. : b

$\frac{1}{2}\mathrm{H}_{2(g)} + \frac{1}{2}\mathrm{Cl}_{2(g)} \rightarrow \mathrm{HCl}_{(g)}$

$\mathrm{HCl}_{(g)} + \mathrm{aq} \rightarrow \mathrm{H}^+_{(\mathrm{aq})} + \mathrm{Cl}^-_{(\mathrm{aq})}$

$\frac{1}{2}\mathrm{H}_2(\mathrm{g}) + \frac{1}{2}\mathrm{Cl}_2(\mathrm{g}) \rightarrow \mathrm{H}^+_{(q)} + \mathrm{Cl}(\mathrm{g})$

69. ΔH_f^o of water is $-285.5\,kJ\,mol^{-1}$. if enthalpy of neutralisation of monoacidic strong base is $-57.3\,kJ\,mol^{-1}$, ΔH_f^o of OH^- ion will be.....$kJ\,mol^{-1}$

(A) -228.2 (B) 228.5 (C) 114.5 (D) -114.5

Ans. : a

$\mathrm{H}_2 + \frac{1}{2}\mathrm{O}_2 \rightarrow \mathrm{H}_2\mathrm{O} \quad \Delta\mathrm{H}_1 = -285.5$

$\mathrm{H}_2\mathrm{O} \rightarrow \mathrm{H}^+ + \mathrm{OH}^- \quad \Delta\mathrm{H}_2 = +57.3$

$\mathrm{H}_2(\mathrm{g}) + \frac{1}{2}\mathrm{O}_2(\mathrm{g}) \rightarrow \mathrm{H}^+(\mathrm{aq}) + \mathrm{OH}(\mathrm{aq}) \cdot \Delta\mathrm{H} = \Delta\mathrm{H}_1 + \Delta\mathrm{H}_2$

70. $1\,mole$ of H_2SO_4 is mixed with $2\,moles$ of $NaOH$. The heat evolved will be

(A) $57.3\,kJ$ (B) $2 \times 57.3\,kJ$

(C) $57.3/2\,kJ$ (D) cannot be predicted

Ans. : b

According to reaction, 1 mole H_2SO_4 completely neutralised by 2 mole of $NaOH$

As we know, Gram equivalent = no. of moles $\times$ Valency factor

Valency factor of $H_2SO_4 = 2$

Therefore, Gram equivalent of $H_2SO_4 = 1 \times 2 = 2$

As we know, Heat evolved in the neutralisation of $1gm$ eq. of strong acid = $57.3kJ$

Heat evolved in neutralisation of $2gm$ eq. of strong $\mathrm{acid} = (57.3 \times 2)kJ$

Hence the heat evolved will be $2 \times 57.3kJ$.

71. If the bond energies of $H—H$, $Br—Br$ and $H—Br$ are $433, 192$ and $364\,kJ\,mol^{-1}$ respectively, ΔH^o for the reaction $H_{2(g)} + Br_{2(g)} \rightarrow 2HBr_{(g)}$ is.....kJ

(A) -261 (B) $+103$ (C) $+261$ (D) -103

Ans. : d

$\Delta H = \sum(\Delta_{B.E.}H)_{Reactants} - \sum(\Delta_{B.E.}H)Prod$

72. Calculate the enthalpy change for the reaction

$H_2 + F_2 \longrightarrow 2HF$

given that

Bond energy of $H-H$ bond $= 434\,kJ/mol$

Bond energy of $F-F$ bond $= 158\,kJ/mol$

Bond energy of $H-F$ bond $= 565\,kJ/mol$

.....kJ

(A) 538 (B) -538 (C) 27 (D) -27

Ans. : b

$\Delta H = \sum(\Delta_{B.E}H)_{\mathrm{React}} - \sum(\Delta_{B.E}H)_{\mathrm{Product}}$

73. Mixing of non-reacting gases is generally accompanied by

(A) Decrease in entropy (B) Increase in entropy

(C) Change in enthalpy (D) Change in free energy

Ans. : (b)Mixing of non-reacting gases increases randomness and so increase entropy .

74. The entropy values $(in\,JK^{-1}\,mol^{-1})$ of $H_2(g) = 130.6, Cl_2(g) = 223.0$ and $HCl(g) = 186.7$ at $298\,K$ and 1 atm pressure. Then entropy change for the reaction $H_{2(g)} + Cl_{2(g)} \to 2HCl_{(g)}$ is

(A) 540.3 (B) 727.3 (C) -166.9 (D) 19.8

Ans. : (d) $\Delta S^o = 2S^o_{HCl} - (S^o_{H_2} + S^o_{Cl_2})$

$= 2 \times 186.7 - (130.6 + 223.0) = 19.8\,JK^{-1}\,mol^{-1}$

75. The enthalpy of water is $386\,kJ$. What is entropy of water.......kJ

(A) 0.5 (B) 1.03 (C) 1.5 (D) 22.05

Ans. : (b)$\Delta S_{vap} = \frac{\Delta H_{vap}}{T} = \frac{386}{298} = 1.2\,kJ$.

76. The standard entropies of $CO_2(g), C(s)$ and $O_2(g)$ are $213.5, 5.740$ and 205 JK^{-1} respectively. The standard entropy of formation of CO_2 is.......JK^{-1}

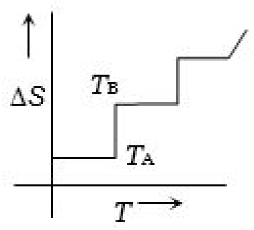
(A) 2.76 (B) 2.12 (C) 1.12 (D) 1.40

Ans. : (a)Standard entropy of formation of $CO_2(g)$= standard entropy of $CO_2(g)-$[Standard entropy of $C(s)-$standard entropy of $O_2(g)$]

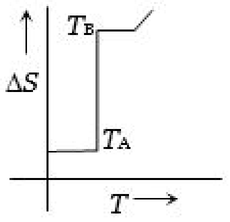
$= 213.5\ - [5.740 + 205] = 2.76\,J/K$.

77. If for a given substance melting point is T_B and freezing point is T_A, then correct variation shown by graph between entropy change and temperature is

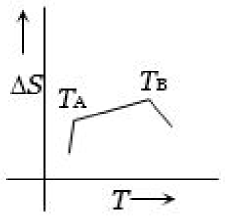
(A)



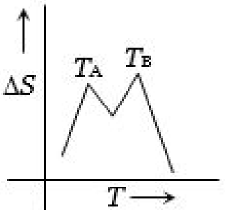
(B)



(C)



(D)



Ans. : (a)For a pure substance T_A and T_B represent the same temperature. Hence A is a correct choice.

78. The entropy values (in $JK^{-1}\ mol^{-1}$) of $H_{2(g)} = 130.6, Cl_{2(g)} = 223.0$ and $HCl_{(g)} = 186.7$ at $298\,K$ and $1\ atm$ pressure. Then entropy change for the reaction $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$ is :-

(A) $+540.3$ (B) $+727.3$ (C) -166.9 (D) $+19.8$

Ans. : d

$\Delta S^\circ = 2S^\circ_{HCl} - \left(S^\circ_{H_2} + S^\circ_{Cl_2}\right)$

$= 2 \times 186.7 - (130.6 + 223.0) = 19.8\ JK^{-1}\,mol^{-1}$

79. The heat of vaporisation and heat of fusion of H_2O are $540\,cal/g$ and $80\,cal/g$. The ratio of $\frac{\Delta_S vap}{\Delta_S fusion}$ for water is :-

(A) 6.75 (B) 9.23 (C) 4.94 (D) 0.2

Ans. : c

$\Delta S_v = \frac{\Delta H_v}{B{\cdot}pt} = \frac{540}{373}; \Delta S_f = \frac{\Delta H_f}{F{\cdot}pt} = \frac{80}{273}$

$\therefore \quad \frac{\Delta S_v}{\Delta S_f} = \frac{540}{373} \times \frac{273}{80} = 4.94$

80. For a cell,

$4B(s) + 3O_2\,(g) \rightarrow 2B_2O_3\,(g)$; $E^o_{cell} = 1.433\ volt$ What is molar entropy (in J/K) of oxygen gas

Given $\left(\Delta_f H^o\right)_{B_2O_3}(g) = -840\,\frac{KJ}{mol}$

$\left(S^o_m\right)_{B_2O_3}(g) = 280 J/K - mol$

$\left(S^o_m\right)_B\ (s) = 10\,J/K - mol$

(A) 0.1963 (B) 1.963 (C) 15.03 (D) 150.3

Ans. : (D) 150.3

81. Which of the following reaction has positive entropy change ?

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

(B) $H_2O(s) \rightarrow H_2O(l)$

(C) $C_{graphite} \rightarrow C_{diamond}$

(D) $CO_2(g) + H_2O(l) \rightarrow H_2CO_3(aq)$

Ans. : b

$S_{solid} < S_{liquid}$
$\Delta S = +ve$

82. The enthalpy change for transition of liquid water to steam is $3.73\,KJ\,mol^{-1}$ at $373\,K$. Find ΔS in $J/mol\,K$ .....$J/mol\,K$

(A) 100
(B) 10
(C) 1000
(D) None of the above

Ans. : b

$\Delta S = \frac{\Delta H_{vap}}{T}$

83. Melting point of a solid is $x\,K$ and its latent heat of fusion is $600\,cal\,mol^{-1}$. The entropy change for fusion of $1\,mol$ solid is $2\,cal\,mol^{-1}\,K^{-1}$. The value of x will be......K

(A) 100
(B) 200
(C) 300
(D) 400

Ans. : c

$\frac{\Delta_{\text{frusea}}\,\text{H}^{\text{e}}}{\text{T}_{\text{mp}}} = \Delta_{\text{fivison}}\,\text{S}^{\ominus}$
$\frac{600}{\text{T}} = 2$
$\text{T} = 300\,\text{K}$

84. The ΔH and ΔS for a reaction at one atmospheric pressure are $+30.558\,kJ$ and $0.066\,kJ\,k^{-1}$ respectively. The temperature at which the free energy change will be zero and below of this temperature the nature of reaction would be

(A) $483\,K$, spontaneous
(B) $443\,K$, non-spontaneous
(C) $443\,K$, spontaneous
(D) $463\,K$, non-spontaneous

Ans. : (d)$\Delta G = \Delta H - T\Delta S$
$0 = +30.558 - T \times 0.066$
or $T = \frac{30.558}{0.066} = 463\,K$
If $(dG)_{T,P} = 0$ sign $' = '$ mean. If is reversible process

85. For a reaction $\Delta H = 9.08\,kJ\,mol^{-1}$ and$\Delta S = 35.7\,JK^{-1}mol^{-1}$Which of the following statements is correct for the reaction

(A) Reversible and Isothermal

(B) Reversible and Exothermic

(C) Spontaneous and Endothermic

(D) Spontaneous and Exothermic

Ans. : (c)ΔH and ΔS both are $+ve$ for spontaneous change, and $\Delta H = +ve$ for endothermic reaction.

86. Which of the following is not a correct statement?

(A) When ΔG is negative, the process is spontaneous

(B) When ΔG is zero, the process is in a state of equilibrium

(C) When ΔG is positive, the process is non-spontaneous

(D) None of these

Ans. : (d)All are the correct statements.

87. Values of ΔH and ΔS for five different reactions are given below. On the basis of these values predict which one of these will be spontaneous at all tempeature

Reaction	$\Delta H(KJ\ mol^{-1})$	$\Delta S(JK^{-1}\ mol^{-1})$
I	$+98.0$	$+14.8$
II	-55.5	-84.6
III	$+28.3$	-17.0
IV	-40.5	$+24.6$
V	$+34.7$	0.0

(A) Reaction I
(B) Reaction II
(C) Reaction III
(D) Reaction IV

Ans. : (d) A spontaneous process is accompanied by decrease in enthalpy and increase in entropy means ΔH is negative and ΔS is positive.

88. For reaction $Ag_2O(s) \rightarrow 2Ag(s) + (1/2)O_2(g)$ the value of $\Delta H = 30.56\ kJ\ mol^{-1}$ and $\Delta S = 0.066\ kJK^{-1}\ mol^{-1}$. Temperature at which free energy change for reaction will be zero, is .... K

(A) 373
(B) 413
(C) 463
(D) 493

Ans. : (c) $\Delta G = \Delta H - T\Delta S$
$\Delta G = 0$ at equilibrium
$\therefore \Delta H = T\Delta S$ or $30.56 = T \times 0.066$
$T = 463\,K$.

89. The enthalpies of combustion of $S(s)$ and $H_2(g)$ are -300 and $-290\ kcal\ mol^{-1.}$
Given $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$
$\Delta H = -130\ kcal\,mol^{-1}$
$SO_2(g) + 1/2O_2(g) \rightarrow SO_3(g)$
$\Delta H = -100\ kcal\ mol^{-1}$
the enthalpy of formation of $H_2SO_4(l)$ would be ......$kcal\,mol^{-1}$

(A) -300
(B) -130
(C) -820
(D) -560

Ans. : (C) -820

90. For the reaction

$X_2O_4(g) \rightarrow 2XO_2(g)$

$\Delta U = 2.1\,kcal, \Delta S = 20\,cal\,K^{-1}$ at $300\,K$.

Hence ΔG is ....$kcal$

(A) 2.7
(B) -3.3
(C) 9.3
(D) None

Ans. : b

$\mathrm{\Delta H = \Delta U + \Delta n_g RT}$

$= (2.1\,\mathrm{Kcal}) + 1 \times \frac{2}{1000} \times 300$

$= 2.7\,\mathrm{Kcal}$

$\mathrm{\Delta G = \Delta H - T\Delta S}$

$= 2.7\,\mathrm{Kcal} - 300 \times \left(\frac{20}{1000}\right)$

$= -3.3\,\mathrm{Kcal}$

91. $\Delta S_{\text{Total}} = -40\ kJ/mol - K$

$\Delta H_{\text{System}} = 2000\ kJ/mol$

$T = 400\ K$

Find out value of ΔS_{System} ....$kJ/mol - K$

(A) -35
(B) -10
(C) -40
(D) -5

Ans. : a

$\mathrm{\Delta G = \Delta H - T\Delta S}$

$\mathrm{-T\Delta S_{Total} = \Delta H - T\Delta S_{sys.}}$

$\Delta S_{\mathrm{sys.}} = -35\,\mathrm{kJ/mol - K}$

92. For the reaction $PCl_5 \rightarrow PCl_3 + Cl_2, \Delta H = 75\,KJ\,mol^{-1}$ and $\Delta S = 120\,JK^{-1}\,mol^{-1}$. At which temperature reaction is spontaneous.....K

(A) 625
(B) 610
(C) 630
(D) 600

Ans. : c

$\mathrm{T} = \frac{\mathrm{\Delta H}}{\mathrm{\Delta S}}$

$= \frac{75000}{120}$

$\mathrm{T} = 625\,\mathrm{K}$

$\mathrm{\Delta G = \Delta H - TDS}$

$\mathrm{T} > 625\,\mathrm{K}$

93. Standard entropies for H_2, Cl_2 and HCl is $60, 40$ and $60\,Jk^{-1}$ respectively. For reaction $H_2 + Cl_2 \rightleftharpoons 2HCl$, $\Delta H = +30\,kJ$ to be at equilibrium, the temperature will be .....K

(A) 2500
(B) 100
(C) 1500
(D) 1.5

Ans. : c

The expression for entropy change is,

$\Delta S = \sum\left[n \times S_{(\text{product})}\right] - \sum\left[n \times S_{(\text{reactant})}\right]$

$H_2 + Cl_2 \rightarrow 2HCl$

$\Delta S = [(n_{HCl} \times S_{HCl}) - [(n_{H_2} \times S_{H_2}) + (n_{Cl_2} \times S_{Cl_2})]$

$\Delta S = \left[2 \times 60 + -[1 \times 60 + (1 \times 40)\right] = 20JK^{-1}$

$\Delta G = \Delta H - T\Delta S$

$\Delta G =$ Gibbs free energy $=$ zero at equilibrium

$\Delta H =$ enthalpy change $= +30\ kJ = 30000\ J$

$\Delta S =$ entropy change $= 20\ J/K$

$\Delta H = T\Delta S$ at eqm

$30000J = T \times 20\ J/K$

$T = 1500\ K$

94. For the reaction at $300\,K$

$A(g) + B(g) \rightarrow C(g) \quad \Delta U = -3\,Kcal$

$\Delta S = -10\,cal/K$

value of ΔG will be ......cal

(A) -600 (B) -6600 (C) -6000 (D) -60

Ans. : a

Correct optlon (A) 600 cal

Explanatlon:

$A(g) + B(g) \rightarrow C$

$\Delta E = -3kCal$

$\Delta H = \Delta E + \Delta_{ng}R$

$= -3 - \frac{1 \times 1.987 \times 300}{1000}$

$\Delta H = -3.60$

$\Delta H = \Delta H - T\Delta S$

$= -3.5 + \frac{300 \times -10}{1000} 0.6kcal$

$\Rightarrow 600cal$

95. The maximum work done in expnading $16\,g\,O_2$ isothermally at $300\,K$ and occupying a volume $5\,dm^3$ until the volume becomes $25\,dm^3$ is

(A) $-2.01 \times 10^3\ J$ (B) $2.01 \times 10^{-3}\ J$ (C) $+2.81 \times 10^3\ J$ (D) $+2.01 \times 10^{-6}\ J$

Ans. : a

$K = \frac{10^{-14}}{55.5}$

$\Delta G^o = -RT \ln K = -8.314 \times 298\ \ell n\ \frac{10^{-14}}{55.5}$

96. Consider the following reaction

$C_6H_6(l) + \frac{15}{2} O_2(g) \rightarrow 6\,CO_2(g) + 3H_2O\,(g)$

Signs of ΔH, ΔS and ΔG for the above reaction will be

(A) $+, -, +$ (B) $-, +, -$ (C) $-, +, +$ (D) $+, +, -$

Ans. : b

$C_6H_6(l) + \frac{15}{2}O_2(g) \longrightarrow 6CO_2(g) + 3H_2O(g)$

Gaseous moles in reactant 7.5

Gareous moles in product $= 9$.

$\therefore \quad \Delta ng = 9 - 7.5 = +1.5$

$\therefore$ As Δng is tive $\therefore \Delta s$ its positive.

It is a combustion reaction (exothermic reaction)

$\therefore \Delta H$ is $-$ive.

$$\Delta G_G = \underbrace{\Delta H}_{(-)} - T\underbrace{\Delta S}_{(+)}$$

As T (temperature is positine)

$\therefore \quad \Delta G$ becomes negative.

97. Which of the following relation is incorrect

(A) $Kp = \left(\frac{e}{RT}\right)^{\Delta G^o}$

(B) $Kp = e^{-\frac{\Delta G^o}{RT}}$

(C) $\Delta G^o = -2.303\, RT \log Kp$

(D) $\log K_{eq} = \frac{-\Delta G^o}{2.303\, RT}$

Ans.: (A) $Kp = \left(\frac{e}{RT}\right)^{\Delta G^o}$

98. For the fuel cell reaction

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l) \quad ; \qquad \Delta_f H^o_{298}(H_2O(l)) = -285.5\, kJ/mol$

What is ΔS^o_{298} for the given fuel cell reaction ?

Given : $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l) \qquad E^o = 1.23\, V$

(A) $-0.322\, J/K$ (B) $-0.635\, kJ/K$ (C) $3.51\, kJ/K$ (D) $-0.322\, kJ/K$

Ans. : d

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

$\Delta H \text{ forthisreaction } = 285.5 \times 2 \frac{kj}{mol}$

$\Delta G = \Delta H - T\Delta S$

$\Delta G^o = -2.303 RT \ln K (i)$

$E^o = \frac{.06}{n} \ln K \text{ (ii)}$

using these 2 equations we will get the ΔG^o value.

so $\Delta G^o = 2.303RT \times 82$

$\Delta G = \Delta H - T\Delta S$

$2.303RT \times 82 = 2.85 \times 2 - 298\Delta S$

$\Delta S = -0.322\, \frac{kj}{mol}$

99. Three moles of an ideal gas expanded spontaneously into vacuum. The work done will be .... Joules

(A) infinite (B) 3 (C) 9 (D) 0

Ans. : d

since the ideal gas expands spontaneously into vacuum, $P_{ext} = 0$, hence work done is also zero.

100. During an isothermal expansion of an ideal gas its

(A) Internal energy increases

(B) Enthalpy decreases

(C) Enthalpy remains unaffected

(D) Enthalpy reduces to zero

Ans. : (c)During isothermal expansion of ideal gas, $\Delta T = 0$
$\Delta H = \Delta E + P\Delta V = \Delta E + nR\Delta T = 0 + 0 = 0$.

101. 1 mole of a diatomic is heated through isochoric process from $300\,K$ to $500\,K$. The entropy is :

(A) 10.61 (B) 38.26 (C) 20.05 (D) 30

Ans. : a
The entropy for a system can be calculated as :
$\Delta S = nC_v \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1} \cdots\cdots (I)$
The volume remains zero for isochoric process.
For diatomic gas;
$C_v = \frac{5R}{2}$
Substitute all the values in the expression (I).
$\Delta S = 1 \times \frac{5R}{2} \ln \frac{500}{300}$
$= \frac{5}{2} \times 8.314 \times 0.5108$
$= 10.61\,J$

102. Enthalpy of combustion of CH_4, C_2H_6 and C_3H_8 are $-210.8, -368.4$ and $-526.2\,k\,cal\,mol^{-1}$ respectively. Enthalpy of combustion of hexane can be predicted as........$k\,cal\,mol^{-1}$

(A) -840 (B) -684 (C) -1000 (D) none of these

Ans. : c
$\Delta H_c(C_2H_6) - \Delta H_c(CH_4)$
$= -368.2 - (-210.8) = -157.4$
$\Delta H_c(C_3H_8) - \Delta H_c(C_2H_6)$
$= -526.2 - (-368.4) = -157.8$
Thus, average
$\Delta H_c(-CH_2) = \frac{157.4 + 157.8}{2}$
$= -157.6\,k\,cal\,mol^{-1}$
Then,
$\Delta H_c(C_6H_{14}) = \Delta H_c(C_3H_8) + 3\Delta H_c(-CH_2)$
$= -526.2 + 3(-157.6) = -999\,k\,cal\,mol^{-1}$

103. ΔS_{surr} for an exothermic reaction is

(A) always positive

(B) always negative

(C) zero

(D) may be positive or negative

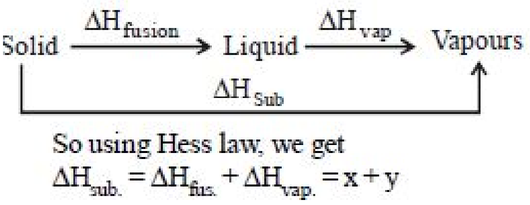
Ans. : d
Heat is released in an exothermic process which increases the entropy of

surroundings. When entropy of the system is positive, overall entropy change is also positive. In some exothermic reactions, entropy of system may decrease.

104. ΔH_{fusion} of a substance is $'x'$ and ΔH_{vap} is $'y'$, then $\Delta H_{sublimation}$ will be

(A) $x+y$ (B) $x-y$ (C) x/y (D) y/x

Ans. : a



So using Hess law, we get
$\Delta H_{sub.} = \Delta H_{fus.} + \Delta H_{vap.} = x + y$

105. The heat of neutralisation of a strong acid and a strong alkali is $57.0\,kJ\,mol^{-1}$. The heat released when $0.5\,mole$ of HNO_3 solution is mixed with $0.2\,mole$ of KOH is......kJ

(A) 57 (B) 11.4 (C) 28.5 (D) 34.9

Ans. : (b) 0.2 mole will neutralize 0.2 mole of HNO_3, heat evolved $= 57 \times 0.2 = 11.4\,kJ.$

106. Assertion : During an adiabatic process, heat energy is not exchanged between system and its surroundings.
Reason : The temperature of a gas increases when it undergoes an adiabatic expansion.

(A) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(B) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(C) If the Assertion is correct but Reason is incorrect.

(D) If both the Assertion and Reason are incorrect.

Ans. : c
The temperature of a gas decreases when it undergoes adiabatic expansion.

107. Assertion : Mass and volume are extensive properties.
Reason : Mass / volume is also an extensive parameter.

(A) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(B) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(C) If the Assertion is correct but Reason is incorrect.

(D) If both the Assertion and Reason are incorrect.

Ans. : c
The properties of a system which depend upon quantity of matter contained in it are called extensive properties, e.g., mass, volume, heat capacity etc. But mass /

volume = density is an intensive property as density does not depend upon quantity of matter in a system.

108. The internal energy of a substance

(A) Increases with increase in temperature

(B) Decreases with increase in temperature

(C) Can be calculated by the relation $E = mc^2$

(D) Remains unaffected with change in temperature

Ans. : (a)ΔE increases with temperature.

109. Which of the following is not a state function

(A) Internal energy (B) Enthalpy (C) Work (D) Entropy

Ans. : (c)Work is not a state function as during a process its value depends on the path followed. The value of enthalpy, internal energy and entropy depends on the state and not on the path followed to get that state, hence these are state functions.

110. In thermodynamics, a process is called reversible when

(A) Surroundings and system change into each other

(B) There is no boundary between system and surroundings

(C) The surroundings are always in equilibrium with the system

(D) The system changes into the surroundings spontaneously

Ans. : (c)Thermodynamics is a reversible process in which surroundings are always equilibrium with system.

111. Work done during isothermal expansion of one mole of 1 mole of an ideal gas from $10\ atm$ to 1 atm at $300\,K$ is.......cal (Gas constant $= 2$)

(A) 938.8 (B) 1138.8 (C) 1381.8 (D) 1581.8

Ans. : (c) $-W = +2.303\,nRT\ \ log\,\frac{p_1}{p_2}$

$-W = 2.303 \times 1 \times 2 \times 300\ \ log\,\frac{10}{1} = 1381.8\,cal.$

112. Assertion : Entropy of ice is less than water.
Reason : Ice has cage like structure.

(A) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.

(B) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.

(C) If the Assertion is correct but Reason is incorrect.

(D) If both the Assertion and Reason are incorrect.

Ans. : b

Entropy is defined as the extent of randomness in a system. When a substance is heated, its randomness and hence entropy increases. Thus entropy of ice is less than water because of lesser molecular motion in ice. It is also true that ice has an open cage like structure.

113. Hess law is applicable for the determination of heat of

(A) Reaction (B) Formation (C) Transition (D) All of these

Ans. : b

It’s obvious.

114. In an endothermic reaction, the value of ΔH is

(A) Zero (B) Positive (C) Negative (D) Constant

Ans. : (b)$\Delta H = +ve$ for endothermic reaction.

115. The enthalpy change of a reaction does not depend on

(A) The state of reactants and products

(B) Nature of reactants and products

(C) Different intermediate reaction

(D) Initial and final enthalpy change of a reaction

Ans. : c

Enthalpy change is a state function so it does not depend on the path taken by the reaction. it depends only on the difference of final and initial values of enthalpy change.

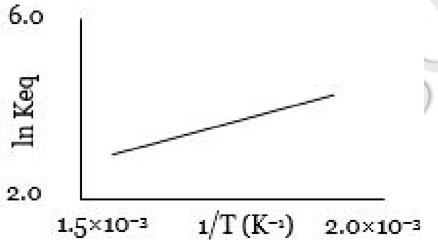
116. A well stoppered thermos flask contains some ice cubes. This is an example of a

(A) Closed system (B) Open system

(C) Isolated system (D) Non-thermodynamic system

Ans. : (c)In isolated system neither exchange of matter nor exchange of energy is possible with surroundings.

117. A schematic plot of versus inverse of temperature for a reaction is shown below The reaction must be



(A) Exothermic

(B) Endothermic

(C) One with negligible enthalpy change

(D) Highly spontaneous at ordinary temperature

Ans. : a

It’s obvious.

118. If the bond dissociation energies of XY, X_2 and Y_2 (all diatomic molecules) are in the ratio of $1:1:0.5$ and $\Delta_f H$ for the formation of XY is $-200\, kJ\, mole^{-1}$. The bond dissociation energy of X_2 will be.....$kJ\, mol^{-1}$

(A) 100 (B) 800 (C) 300 (D) 400

Ans. : (b)$XY \rightarrow X_{(g)} + Y_{(g)} \quad \Delta H = +a\ kJ/mole$ ....(i)

$X_2 \rightarrow 2X$; $\Delta H = +a\ kJ/mole$ .... (ii)

$Y_2 \rightarrow 2Y$; $\Delta H = +0.5\, a\ kJ/mole$ ....(iii)

$\frac{1}{2} \times$ (ii) $+ \frac{1}{2} \times$ (iii) - (i), gives

$\Delta H = \left(+\frac{a}{2} + \frac{0.5}{2}a - a\right)\ kJ/mole$

$+\frac{a}{2} + \frac{0.5a}{2} - a = -200$

$a = 800$

119. If at $298\, K$ the bond energies of $C-H, C-C,\ C=C$ and $H-H$ bonds are respectively $414, 347, 615$ and $435\, kJ\ mol^{-1}$, the value of enthalpy change for the reaction

$H_2C = CH_2(g) + H_2(g) \rightarrow H_3C - CH_3(g)$ at $298\, K$ will be ....kJ

(A) $+250$ (B) -250 (C) $+125$ (D) -125

Ans. : (d) $CH_2 = CH_{2(g)} + H_{2(g)} \rightarrow H_3C - CH_{3(g)}$

$414 \times 4 = 1656 \quad 414 \times 6 = 2484$

$615 \times 1 = 615 \quad 347 \times 1 \quad = \underline{347}$

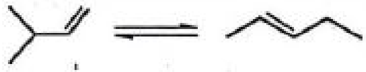
$\underline{2831}$

$435 \times 1 \quad = \underline{435}$

$\underline{2706}$

$\Delta H = 2706 - 2831 = -125\, kJ$

120. The heat of hydrogenation for 3 -methylbutene and 2 -pentene are $-30\, kcal/mol$ and $-28\, kcal/mol$ respectively. The heats of combustion of 2 -methylbutane and pentane are - $784\, kcal/mol$ and $-782\, kcal/mol$ respectively. All the values are given under standard conditions. Taking into account that combustion of both alkanes give the same products, what is ΔH (in $kcal/mol$) for the following reaction under same conditions ?



(A) 0 (B) -4 (C) -2 (D) 2

Ans. : b

$\Delta H_1 = -30\, kcal/mol$, $\Delta H_2 = (-784 + 782)\, kcal/mol$, $\Delta H_3 = 28\, kcal/mol$

$\Rightarrow \Delta H_1 + \Delta H_2 + \Delta H_3 = -4\, kcal/mol$