Thermodynamics and Thermochemistry

SET Self Evaluation Test -10

1. The internal energy change when a system goes from state *A* to *B* is 40 *kJ/mole*. If the system goes from *A* to *B* by a reversible path and returns to state *A* by an irreversible path what would be the net change in internal energy

[CBSE PMT 2003]

(a) 40 *kJ* (b) > 0 *kJ*

(c) < 40 *kJ* (d) Zero

2. The correct relationship is **[DPMT 2002]**

(a) $\Delta H + P\Delta V = \Delta V$ (b) $\Delta H - \Delta nRT = \Delta E$

(c) $\Delta E + \Delta nRT = \Delta P$ (d) None of these

3. For $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ at 977^oC; $\Delta H = 176$ *kJ mol*, then ΔE is **[BVP 2003]**

(a) 180 *kJ* (b) 186.4 *kJ*

(c) 165.6 *kJ* (d) 160 *kJ*

4. Values of ΔH and ΔS for five different reactions are given below.

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

On the basis of these values predict which one of these will be spontaneous at all tempeature

[Kerala PMT 2004; KCET 1988,90]

(a) Reaction I (b) Reaction II

(c) Reaction III (d) Reaction IV

(e) Reaction V

5. Molar heat capacity of water in equilibrium with ice at constant pressure is **[IIT JEE 1997]**

(a) Zero (b) Infinity (∞)

(c) $40.45\, kJ\, K^{-1} mol^{-1}$ (d) $75.48\; J\, K^{-1}$

6. Internal energy does not include

[AIIMS 1999; CPMT 2000]

(a) Nuclear energy

(b) Rotational energy

(c) Vibrational energy

(d) Energy arising by gravitational pull

7. Two moles of an ideal gas expand spontaneously into a vacuum. The work done is **[AMU 2000]**

(a) 2 *Joule* (b) 4 *Joule*

(c) Zero (d) Infinite

8. Heat exchanged in a chemical reaction at constant temperature and constant pressure is called as

[BHU 1998; Pb. PET 2000; MP PET 2002]

(a) Internal energy (b) Enthalpy

(c) Entropy (d) Free energy

9. Which of the following statements is true**[KCET 2002]**

(a) ΔE is always greater than ΔH

(b) ΔE is always less than ΔH

(c) ΔE may be lesser or greater or equal to ΔH

(d) ΔE is always proportional to ΔH

10. Mass and energy are conserved is demonstrated by

[MH CET 2002]

(a) First law of thermodynamics

(b) Law of conservation of energy

(c) Law of conservation of mass

(d) Modified form of Ist law of thermodynamics

11. The enthalpy of the reaction,

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g)$ is ΔH_1 and that of

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ is ΔH_2. Then **[KCET 2004]**

(a) $\Delta H_1 < \Delta H_2$ (b) $\Delta H_1 + \Delta H_2 = 0$

(c) $\Delta H_1 > \Delta H_2$ (d) $\Delta H_1 = \Delta H_2$

12. A reaction occurs spontaneously if

[MP PET 2002; CBSE PMT 2005]

(a) $T\Delta S < \Delta H$ and both ΔH and ΔS are +ve

(b) $T\Delta S > \Delta H$ and both ΔH and ΔS are +ve

(c) $T\Delta S = \Delta H$ and both ΔH and ΔS are +ve

(d) $T\Delta S > \Delta H$ and ΔH is +ve and ΔS is –ve

13. Which expression is correct for the work done in adiabatic reversible expansion of an ideal gas**[AMU 2002]**

(a) $W = nRT\ \ln\frac{V_2}{V_1}$ (b) $W = n_e\ \ln\frac{T_2}{T_1}$

(c) $W = P\Delta V$ (d) $W = -\int_1^2 PdV$

14. If an endothermic reaction is non-spontaneous at freezing point of water and becomes feasible at its boiling point, then

[AIEEE 2002]

(a) ΔH is $-ve$, ΔS is $+ve$

(b) ΔH and ΔS both are $+ve$

(c) ΔH and ΔS both are $-ve$

(d) ΔH is $+ve$, ΔS is $-ve$

15. What is the entropy change (in $JK^{-1}mol^{-1}$) when one mole of ice is converted into water at 0^oC (The enthalpy change for the conversion of ice to liquid water is 6.0 kJ mol^{-1} at 0^oC)**[CBSE PMT 2003]**

(a) 21.98 (b) 20.13

(c) 2.013 (d) 2.198

16. One mole of $NaCl$ (s) on melting absorbed $30.5\,kJ$ of heat and its entropy is increased by $28.8\ JK^{-1}$. The melting point of $NaCl$ is **[DPMT 2004]**

(a) 1059 K (b) 30.5 K

(c) 28.8 K (d) 28800 K

17. The enthalpy change (ΔH) for the process $N_2H_4(g) \rightarrow 2N(g) + 4H(g)$ in $1724\ KJ\ mol^{-1}$. If the bond energy of $N-H$ bond in ammonia is $391\ KJ\ mol^{-1}$. What is the bond energy of $N-N$ bond is N_2H_4

[MP PMT 2004]

(a) $160\ KJ\ mol^{-1}$ (b) $391\ KJ\ mol^{-1}$

(c) $1173\ KJ\ mol^{-1}$ (d) $320\ KJ\ mol^{-1}$

18. Liquid ammonia is used in refrigeration because of its

[DCE 2003]

(a) High dipole moment

(b) High heat of vaporisation

(c) High basicity

(d) All of these

19. A cylinder of gas supplied by Bharat Petroleum is assumed to contain $14\,kg$ of butane. It a normal family requires $20{,}000\,kJ$ of energy per day for cooking, butane gas in the cylinder last for .... Days **[Kerala PMT 2004]**

(ΔH_c of $C_4H_{10} = -2658\ KJ\ per\ mole$)

(a) 15 days (b) 20 days

(c) 50 days (d) 40 days

(e) 32 days

20. 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 **[MP PET 2001]**

(a) $-68.0\,kJ\,mol^{-1}$ (b) $-43.8\,kJ\,mol^{-1}$

(c) $68.0\,kJ\,mol^{-1}$ (d) $43.8\,kJ\,mol^{-1}$

21. Equilibrium constant of a reaction is related to

[AIIMS 1991]

(a) Standard free energy change ΔG^o

(b) Free energy change ΔG

(c) Temperature T

(d) None

22. The standard Gibbs free energy change ΔG^o is related to equilibrium constant K_p as **[MP PET/PMT 1998]**

(a) $K_p = -RT\ln\Delta G^o$ (b) $K_p = \left(\frac{e}{RT}\right)^{\Delta G^o}$

(c) $K_p = -\frac{\Delta G^o}{RT}$ (d) $K_p = e^{-\frac{\Delta G^o}{RT}}$

23. The standard enthalpy or the decomposition of N_2O_5 to NO_2 is 58.04 kJ and standard entropy of this reaction is $176.7\,J/K$. The standard free energy change for this reaction at 25^oC is **[DCE 2004]**

(a) –5.38 kJ (b) 5.38 kJ

(c) 5.38 kJ (d) –538 kJ

24. For the equilibrium $H_2O(l) \rightleftharpoons H_2O(g)$ at 1 atm and 298 K

[AIIMS 2004]

(a) Standard free energy change is equal to zero $(G\Delta^o = 0)$

(b) Free energy change is less than zero $(\Delta G < 0)$

(c) Standard free energy change is less than zero $(\Delta G^o < 0)$

(d) Standard free energy change is greater than zero $(\Delta G^o > 0)$

25. 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 **[MH CET 1999]**

(a) 373 K (b) 413 K

(c) 463 K (d) 493 K

Answers and Solutions

(SET -10)

1. (d) $A \xrightarrow{40} B$

$A \xleftarrow{-40} B$

$\Delta H = 40 - 40 = 0$.

2. (b) $\Delta H = \Delta E + \Delta nRT$.

3. (c) $\Delta n = 1 - 0 = 1$

$\Delta E = \Delta H + \Delta nRT$

$\Delta E = +176 - 1 \times \dfrac{8.314}{1000} \times 1240 = 165.6\, kJ$.

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

5. (b) $C_P = \left(\dfrac{\delta H}{\delta T}\right)_P$, At equilibrium T is constant *i.e.* $\delta T = 0$, thus $C_P = \infty$.

6. (d) $E = E_{\text{ele.}} + E_{\text{nucl.}} + E_{\text{chemical}} + E_{\text{potential}}$

$+ E_{\text{kinetic}}(E_t + E_v + E_r)$.

7. (c) An ideal gas under going expansion in vacuum shows, $\Delta E = 0, W = 0$ and $q = 0$.

8. (b) $\Delta H = q_p$.

9. (c) ΔE may be greater or lesser or equal to ΔH.

$\because \Delta H = \Delta E + P\Delta V = \Delta E + \Delta nRT$.

10. (d) It is a modified form of Ist law of thermodynamics. It is a conservation law of mass and energy.

11. (a) for reaction (i) $\Delta n_1 = 0.5$

for reaction (ii) $\Delta n_2 = 1.5$

So, $\Delta H_1 < \Delta H_2$

12. (b) *For spontaneous reaction* ΔG *should be negative* $\Delta G = \Delta H - T\Delta S = (+ve) - T(+ve)$

If $T\Delta S > \Delta H$ *then* ΔG *will be negative and reaction will be spontaneous.*

13. (b) $W = P\Delta V$.

14. (b) ΔH and ΔS both are $+ve$ than reaction is spontaneous.

15. (a) $\Delta S = \dfrac{q_{rev}}{T} = \dfrac{6000}{273} = 21.98\ JK^{-1}mol^{-1}$

16. (a) $NaCl(s) \rightleftharpoons NaCl(l)$

Given that : $\Delta H = 30.5\, KJ\, mol^{-1}$

$\Delta S = 28.8\ JK^{-1} = 28.8 \times 10^{-3}\ KJ\, K^{-1}$

By using $\Delta S = \dfrac{\Delta H}{T}$

$= \dfrac{30.5}{28.8 \times 10^{-3}} = 1059\ K$

17. (a) $H - \overset{\overset{H}{|}}{N} - \overset{\overset{H}{|}}{N} - H$ (So, $4\, N - H$ bond present)

means their energy $= 391 \times 4 = 1564$

so the bond energy of $N - N$ in N_2H_4

$= 1724 - 1564 = 160\, KJ/mol$

18. (b) Ammonia has high heat of vaporisation hence is used in refrigeration.

19. (e) Calorific value of butane

$= \dfrac{\Delta H_c}{\text{mol. wt.}} = \dfrac{2658}{58} = 45.8\, KJ/gm$

Cylinder consist $14\, Kg$ of butane means $14000\ gm$ of butane

$\because 1gm$ gives $45.8\, KJ$

$\therefore 14000\ gm$ gives $\quad 14000 \times 45.8$

$= 641200\ KJ$

Family need $20{,}000\ KJ/day$

So gas full fill the requirement for

$\dfrac{641200}{20{,}000} = 32.06\ days$

20. (d)

21. (a) $\Delta G^o = -2.303 \log k$.

22. (d) $K_p = e^{-\Delta G^o/RT}$.

23. (d)

24. (b) For reaction $H_2O(l) \rightleftharpoons H_2O(g)$

$\Delta n = 1$ means positive

so when Δn is positive then $\Delta G < 0$.

25. (c) $\Delta G = \Delta H - T\Delta S$

$\Delta G = 0$ at equilibrium

$\therefore \Delta H = T\Delta S$ or $30.56 = T \times 0.066$

$T = 463\ K$.

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