

## TOPIC : CHEMICAL ENERGETICS AND THERMODYNAMICS

1. The value of  $\Delta S$  is negative for the process
  - (a) Burning of rocket fuel
  - (b) Dissolution of sugar
  - (c) Sublimation of iodine
  - (d) Freezing of water
2. In the relation ;  $H - TS = G$ ,  $TS$  refers to
  - (a) Helmholtz
  - (b) random energy
  - (c) organized energy
  - (d) Gibb's free energy
3. What is not zero for elementary substances at their standard state ?
  - (a)  $S^\circ$
  - (b)  $H^\circ$
  - (c)  $G^\circ$
  - (d) Both  $H^\circ$  and  $S^\circ$
4. All the naturally occurring processes proceed spontaneously in a direction which leads to
  - (a) increase in enthalpy of system
  - (b) decrease in entropy of system
  - (c) increase in entropy of system
  - (d) increase in entropy of universe
5. Thermodynamic parameter which is a state function and is also used to measure disorder of the system is
  - (a) Entropy
  - (b) Fugacity
  - (c) Viscosity
  - (d) Periodicity
6. If  $x$  kJ is the heat produced by the neutralization of 1 L of 1  $\text{NH}_2\text{SO}_4$  solution with 1 L of 1 N NaOH, then the amount of heat liberated by neutralizing 1 L of 1 N NaOH with HCl will be
  - (a)  $> x$
  - (b)  $= x$
  - (c)  $< x$
  - (d) unpredictable
7. For a chemical process at constant temperature and pressure,  $\Delta H$  is equal to
  - (a)  $\frac{q_{\text{rev}}}{T}$
  - (b)  $\Delta S - T\Delta G$
  - (c)  $\Delta U + P\Delta V$
  - (d)  $\Delta U - P\Delta V$
8.  $\text{CuSO}_4(\text{s}) + 5\text{H}_2\text{O}(\text{l}) \rightarrow \text{CuSO}_4 \cdot 5\text{H}_2\text{O}(\text{s})$ ;  $\Delta H = -x$  kJ  
The value of  $\Delta H$  represents
  - (a) enthalpy of solution of copper (II) sulphate
  - (b) enthalpy of hydration of copper (II) sulphate
  - (c) enthalpy of hydrolysis of copper (II) sulphate
  - (d) lattice energy of copper (II) sulphate
9. The value of  $\Delta G$  for the process  $\text{H}_2\text{O}(\text{s}) \rightarrow \text{H}_2\text{O}(\text{l})$  at 1 atm and 260 K is
  - (a)  $< 0$
  - (b)  $= 0$
  - (c)  $> 0$
  - (d) unity
10. A system X undergoes following changes
 
$$\underset{(P_1 \ V_1 \ T_1)}{X} \longrightarrow \underset{(P_2 \ V_2 \ T_1)}{W} \longrightarrow \underset{(P_3 \ V_2 \ T_2)}{Z} \longrightarrow \underset{(P_1 \ V_1 \ T_1)}{X}$$
 The overall process may be called
  - (a) Reversible process
  - (b) Cyclic process
  - (c) Cyclic as well as reversible
  - (d) Isochoric process
11. The enthalpy of formation of the compound is
  - (a) always  $> 0$
  - (b) always  $< 0$
  - (c) can be  $> 0$  or  $< 0$
  - (d)  $= 0$  at standard state
12. For a gaseous reaction ;  $\text{N}_2\text{O}_4(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$ 
  - (a)  $\Delta H$  and  $\Delta U$  are equal
  - (b)  $\Delta H > \Delta U$
  - (c)  $\Delta H < \Delta U$
  - (d)  $\Delta H - \Delta U = 0$
13. Which of the following expressions represents Kirchhoffs equation ?
  - (a)  $K = A e^{-K_a/RT}$
  - (b)  $E^\circ_{\text{cell}} = \frac{2.30RT}{nF} \log \frac{c_2}{c_1}$
  - (c)  $\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_p$
  - (d)  $\Delta H - \Delta E = \Delta nRT$ .
14. Which of the following changes is exothermic ?
  - (a)  $\text{NH}_4\text{Cl}(\text{s}) + \text{aq} \rightarrow \text{NH}_4\text{Cl}(\text{aq})$
  - (b)  $\text{Br}(\text{g}) + \text{e}^- \rightarrow \text{Br}^-(\text{g})$
  - (c)  $\text{Br}_2(\text{g}) \rightarrow 2\text{Br}(\text{g})$
  - (d)  $\text{Na}(\text{g}) \rightarrow \text{Na}^+ + \text{e}^-$
15. For the reaction,  $3\text{O}_2(\text{g}) \rightarrow 2\text{O}_3(\text{g})$  ; the sign of  $\Delta G$  and  $\Delta S$  respectively are
  - (a) +ve and -ve
  - (b) +ve and +ve
  - (c) -ve and -ve
  - (d) -ve and +ve
16. Identity the quantity which is state function out of the following
  - (a)  $q$
  - (b)  $q/w$
  - (c)  $q \times w$
  - (d)  $q + w$

17. Which of the following expression gives the value of heat capacity of 1 mol of ideal gas at constant pressure ?
- (a)  $\frac{dU}{dT}$  (b)  $\frac{dS}{dT}$   
 (c)  $\frac{dH}{dT}$  (d)  $\frac{dH}{dP}$
18. For the process  $2F(g) \rightarrow F_2(g)$ , the sign of  $\Delta H$  and  $\Delta S$  respectively are
- (a) +, - (b) +, +  
 (c) -, - (d) -, +.
19. For which of the following process will  $\Delta H$  be +ve?
- (a)  $H_2(g) + I_2(g) \rightarrow 2HI(g)$   
 (b)  $C + O_2 \rightarrow CO_2$   
 (c)  $CO + \frac{1}{2}O_2 \rightarrow CO_2$   
 (d)  $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$
20. Carbon forms two oxides on combustion. Carbon (IV) oxide and carbon (II) oxide having values of their standard enthalpy of formation as  $-393.5$  and  $-281.50 \text{ kJ mol}^{-1}$  respectively. The value of  $\Delta_c H^\circ$  of C will be
- (a)  $-393.5 \text{ kJ mol}^{-1}$  (b)  $112.0 \text{ kJ mol}$   
 (c)  $-678.6 \text{ kJ mol}^{-1}$  (d)  $-112.0 \text{ kJ mol}$
21. A hypothetical reaction  $X \rightarrow 2Y$  proceeds by the following sequence of steps
- $$\frac{1}{2}X \rightarrow Z; \Delta H = q_1$$
- $$Z \rightarrow 2W; \Delta H = q_2$$
- $$W \rightarrow \frac{1}{2}Y; \Delta H = q_3$$
- The values of  $\Delta H$  of reaction is
- (a)  $q_1 + q_2 + q_3$  (b)  $2q_1 + 2q_2 + 3q_3$   
 (c)  $2(q_1 + q_2 + 2q_3)$  (d)  $2(q_1 + q_2 + q_3)$
22. At 298 K, the enthalpy changes of cleavage of successive O – H bonds of water molecule are
- $$H_2O(g) \rightarrow H(g) + OH(g); \Delta H = 498 \text{ kJ mol}^{-1}$$
- $$OH(g) \rightarrow H(g) + O(g); \Delta H = 428 \text{ kJ mol}^{-1}$$
- From the above data, the value of  $\Delta H_{O-H}$  bond is
- (a)  $498 \text{ kJ mol}^{-1}$  (b)  $428 \text{ kJ mol}^{-1}$   
 (c)  $463 \text{ kJ mol}^{-1}$  (d)  $70 \text{ kJ mol}^{-1}$
23. The value of  $\Delta_{sol} H$  of  $BaCl_2(s)$  and  $BaCl_2 \cdot 2H_2O(s)$  are  $-a \text{ kJ}$  and  $b \text{ kJ}$  respectively. The value of  $\Delta H_{Hydration}$  of  $BaCl_2(s)$  is
- (a)  $b - a$  (b)  $a + b$   
 (c)  $-a - b$  (d)  $a - b$
24. If  $H^+(aq) + OH^-(aq) \rightarrow H_2O(l); \Delta H = -X \text{ kJ}$ , then heat liberated for complete neutralization of 1 gm-molecule of  $H_2SO_4$  in aqueous solution will be
- (a)  $-57.0 \text{ kJ}$  (b)  $-2X \text{ kJ}$   
 (c)  $-X \text{ kJ}$  (d)  $-X/2 \text{ kJ}$
25. For a reaction,  $2C_6H_6(l) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(l)$  the value of  $q_{(P)} - q_{(V)}$  will be (at  $25^\circ C$ )
- (a)  $-7.43 \text{ kJ}$   
 (b)  $+3.72 \text{ kJ}$   
 (c)  $+7.43 \text{ kJ}$   
 (d) unpredictable as values of  $\Delta H$  is not given
26. One mole of ideal gas expands freely at 310 K from five litre volume to 10 litre volume. Then  $\Delta U$  and  $\Delta H$  of the process are respectively.
- (a) 0 and 5 cal (b) 0 and  $5 \times 300 \text{ cal}$   
 (c) 0 and 0 (d) 5 and 0 cal
27. In certain chemical reaction  $\Delta H = 150 \text{ kJ}$  and  $\Delta S$  is  $100 \text{ JK}^{-1}$  at 300 K. The value of  $\Delta G$  would be
- (a) zero (b) 300 kJ  
 (c) 330 kJ (d) 120 kJ
28. If  $\Delta_{vap} H$  of pure water at  $100^\circ C$  is  $40.627 \text{ kJ mol}^{-1}$ . The value of  $\Delta_{vap} S$  is
- (a)  $108.91 \text{ kJ mol}^{-1}$  (b)  $108.91 \text{ JK}^{-1} \text{ mol}^{-1}$   
 (c)  $606.27 \text{ JK}^{-1} \text{ mol}^{-1}$  (d)  $808.27 \text{ JK}^{-1} \text{ mol}^{-1}$
29. A human being requires 2700 kcal of energy per day, if  $\Delta_c H$  of glucose is  $-1350 \text{ kcal mol}^{-1}$ . How many gram of glucose a person has to consume every day ?
- (a) 360 g (b) 36.0 g  
 (c) 3.6 g (d) 360 mg
30. The Gibb's energy change occurring during the reversible process
- (a) is negative  
 (b) is zero  
 (c) can be +ve or -ve  
 (d) negative only if the process is exothermic

31. Given that  $\Delta H_{\text{comb}}$  of cyclopropane as  $-4000 \text{ kJ mol}^{-1}$ . The amount of cyclopropane that needs to be burnt in oxygen for producing  $2 \times 10^5 \text{ kJ}$  of heat is  
 (a) 20 kg (b) 2.1 kg  
 (c) 21 g (d) 210 mg
32. Given that  
 (i)  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ ;  $\Delta H^\circ = -x \text{ kJ}$   
 (ii)  $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$ ;  $\Delta H^\circ = -y \text{ kJ}$   
 The enthalpy of formation of carbon monoxide will be  
 (a)  $y - 2x$  (b)  $\frac{2x - y}{2}$   
 (c)  $\frac{y - 2x}{2}$  (d)  $2y - y$
33.  $\text{S} + \frac{3}{2} \text{O}_2 \rightarrow \text{SO}_3 + 2x \text{ kcal}$   
 $\text{SO}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{SO}_3 + y \text{ kcal}$   
 Find out the heat of formation of  $\text{SO}_2$   
 (a)  $(y - 2x)$  (b)  $(2x + y)$   
 (c)  $(x + y)$  (d)  $2x/y$
34. Standard mole enthalpy of formation of  $\text{CO}_2$  is equal to  
 (a) zero  
 (b) Standard mole enthalpy of combustion of carbon (graphite)  
 (c) Standard molar enthalpy of combustion of gaseous carbon  
 (d) Sum of molar enthalpies of formation of CO and  $\text{O}_2$ .
35. The value of  $\Delta H^\circ$  for the hypothetical reaction,  
 $\text{A}_2\text{B(s)} \rightarrow 2\text{A(s)} + \frac{1}{2} \text{B}_2(\text{g})$  is  $+7.3 \text{ kJ}$   
 The value of  $\Delta U^\circ$  for the reaction is  
 (a)  $> 7.3 \text{ kJ}$   
 (b)  $< 7.3 \text{ kJ}$   
 (c)  $= 7.3 \text{ kJ}$   
 (d) unpredictable
36. An isothermal process proceeds with the absorption of heat  $q$  but does not involve any change in volume. The value of  $\Delta P$ , however, is greater than zero. Then  $q$  represents  
 (a)  $\Delta U$  (b)  $\Delta G$   
 (c)  $\Delta U + P\Delta V$  (d)  $\Delta U + V\Delta P$
37. The latent heat of vaporization of a liquid at 500 K and 1 atm pressure is  $10.0 \text{ kcal mol}^{-1}$ . The internal energy change of 3 mol of liquid at the same temperature and pressure is  
 (a) 30 kcal (b) 27 kcal  
 (c) 33 kcal (d) 13 kcal
38. The solubility product of AgCl is  $1.6 \times 10^{-10}$  and  $\log K_{\text{sp}}$  is  $-9.80$ . The value of  $\Delta G^\circ$  for the process.  
 $\text{AgCl(s)} + \text{aq} \rightleftharpoons \text{Ag}^+ + (\text{aq}) + \text{Cl}^- (\text{aq})$  is  
 (a)  $-55.9 \text{ kJ}$  (b)  $+55.9 \text{ kJ}$   
 (c)  $+100.8 \text{ kJ}$  (d)  $-100.8 \text{ kJ}$
39. The values of  $\Delta_f H^\circ$  of  $\text{C}_2\text{H}_2(\text{g})$  and  $\text{C}_6\text{H}_6(\text{g})$  are respectively 230 and  $85 \text{ kJ mol}^{-1}$ . The standard enthalpy change for trimerisation of acetylene to benzene is  
 (a)  $205 \text{ kJ mol}^{-1}$  of benzene  
 (b)  $605 \text{ kJ mol}^{-1}$  for benzene  
 (c)  $-605 \text{ kJ mol}^{-1}$  of benzene  
 (d)  $-205 \text{ kJ mol}^{-1}$  for benzene
40. For hypothetical reversible reaction:  
 $\frac{1}{2} \text{A}_2(\text{g}) + \frac{3}{2} \text{B}_2(\text{g}) \rightleftharpoons \text{AB}_3(\text{g})$   
 the values of  $\Delta H = -20 \text{ kJ}$  while the values of standard entropies of  $\text{A}_2$ ,  $\text{B}_2$ ,  $\text{AB}_3$  are 60, 40,  $50 \text{ JK}^{-1} \text{ mol}^{-1}$  respectively. The temperature at which the above reaction attains equilibrium will approximately, be  
 (a) 400 K (b) 500 K  
 (c) 250 K (d) 200 K
41. Heat of neutralization of strong acid and strong base is  $-57.0 \text{ kJ}$ . The amount of heat released when 0.5 mol of  $\text{HNO}_3$  solution is added to 0.2 mol of NaOH solution is  
 (a) 11.40 kJ (b) 57.0 kJ  
 (c) 28.6 kJ (d) 34.9 kJ

42. The enthalpy of combustion of C(graphite) and C(diamond) are  $-393.5$  and  $-395.4 \text{ kJ mol}^{-1}$  respectively. The enthalpy of conversion of C(graphite) to C(diamond) in  $\text{kJ mol}^{-1}$  is  
 (a)  $-1.9$  (b)  $-788.9$   
 (c)  $1.9$  (d)  $788.9$
43. Given  
 $\text{NH}_3(\text{g}) + 3\text{Cl}_2(\text{g}) \rightleftharpoons \text{NCl}_3(\text{g}) + 3\text{HCl}(\text{g}); -\Delta H_1$   
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}); -\Delta H_2$   
 $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{HCl}(\text{g}); \Delta H_3$   
 The heat of formation of  $\text{NCl}_3(\text{g})$  in the terms of  $\Delta H_1$ ,  $\Delta H_2$  and  $\Delta H_3$  is  
 (a)  $\Delta_f H = -\Delta H_1 + \frac{\Delta H_2}{2} - \frac{3}{2} \Delta H_3$   
 (b)  $\Delta_f H = \Delta H_1 + \frac{\Delta H_2}{2} - \frac{3}{2} \Delta H_3$   
 (c)  $\Delta_f H = \Delta H_1 - \frac{\Delta H_2}{2} - \frac{3}{2} \Delta H_3$   
 (d) None of these
44. For the combustion of gasoline ( $\text{C}_8\text{H}_{18}$ ) in an automobile, the signs of  $\Delta H$ ,  $\Delta S$  and  $\Delta G$  will respectively be  
 (a)  $+$ ,  $-$ ,  $+$  (b)  $-$ ,  $+$ ,  $-$   
 (c)  $-$ ,  $+$ ,  $+$  (d)  $+$ ,  $+$ ,  $-$
45. When 100 ml of 0.2 M HCl is mixed with 100 ml of 0.2 M NaOH solution, the amount of heat produced will be  
 (a) 1.142 kJ (b) 57.1 kJ  
 (c)  $-1.142 \text{ kJ}$  (d) 5.71 kJ
46. The heat produced by the neutralization of 100 ml of  $\text{HNO}_3$  with KOH solution is 1.713 kJ. The molarity of  $\text{HNO}_3$  solution will be  
 (a) 0.1 (b) 1  
 (c) 0.3 (d) 0.5
47. Enthalpy of vaporization of water is  $40800 \text{ J mol}^{-1}$  at 1 atm pressure. The mountain where, the pressure is 380 mm of Hg, water will boil at  
 (a)  $100^\circ\text{C}$  (b)  $81.6^\circ\text{C}$   
 (c)  $104^\circ\text{C}$  (d)  $50^\circ\text{C}$
48. The value of  $\Delta_f H^\circ$  of  $\text{H}_2\text{O}(\text{g})$  is  $-242 \text{ kJ mol}^{-1}$ . The reaction of 0.5 mol of  $\text{H}_2(\text{g})$  and 0.25 mol of  $\text{O}_2(\text{g})$  at 1 atm pressure involves contraction by volume by 5.6 L. The value of  $W_{\text{pv}}$  for the process is  
 (a)  $-567.4 \text{ J}$  (b)  $567.4 \text{ J}$   
 (c) 5.6 J (d) 5.6 J
49. Enthalpy of combustion of C(s),  $\text{H}_2(\text{g})$  and methane gas are respectively  $-x_1$ ,  $-x_2$  and  $-x_3 \text{ kJ mol}^{-1}$ . The value of  $\Delta_f H^\circ$  of  $\text{CH}_4(\text{g})$  in  $\text{kJ mol}^{-1}$  is  
 (a)  $x_3 - (x_1 + x_2)$  (b)  $-(x_1 + 2x_2 + x_3)$   
 (c)  $2x_3 - (x_1 + x_2)$  (d)  $x_3 - (x_1 + 2x_2)$
50. Enthalpy change in the formation of an imaginary lattice  $\text{Cl}^+ \text{Cl}^-$  from  $\text{Cl}_2(\text{g})$  is represented as  $\Delta_f H$ . Given that  $\Delta H_{\text{Cl-Cl}} = x_1$ ; ionization enthalpy of chlorine is  $x_2$ ; electron gain enthalpy of chlorine is  $-x_3$  and lattice enthalpy of  $\text{Cl}^+ \text{Cl}^-$  is  $-x_4$ . The value of  $\Delta_f H$  is  
 (a)  $x_1 + x_2 + x_3 + x_4$  (b)  $x_1 + x_2 - (x_3 + x_4)$   
 (c)  $x_3 + x_4 - (x_1 + x_2)$  (d)  $-(x_1 + x_2 + x_3 + x_4)$

### ANSWERS KEY

<b>1</b>	D	<b>11</b>	C	<b>21</b>	C	<b>31</b>	B	<b>41</b>	A
<b>2</b>	B	<b>12</b>	B	<b>22</b>	C	<b>32</b>	C	<b>42</b>	C
<b>3</b>	A	<b>13</b>	C	<b>23</b>	C	<b>33</b>	A	<b>43</b>	A
<b>4</b>	D	<b>14</b>	B	<b>24</b>	B	<b>34</b>	B	<b>44</b>	B
<b>5</b>	A	<b>15</b>	A	<b>25</b>	A	<b>35</b>	B	<b>45</b>	C
<b>6</b>	B	<b>16</b>	D	<b>26</b>	C	<b>36</b>	A	<b>46</b>	C
<b>7</b>	C	<b>17</b>	C	<b>27</b>	D	<b>37</b>	B	<b>47</b>	B
<b>8</b>	B	<b>18</b>	C	<b>28</b>	B	<b>38</b>	B	<b>48</b>	A
<b>9</b>	C	<b>19</b>	D	<b>29</b>	A	<b>39</b>	C	<b>49</b>	D
<b>10</b>	B	<b>20</b>	A	<b>30</b>	B	<b>40</b>	B	<b>50</b>	B