

THERMODYNAMICS & THERMOCHEMISTRY

I -CHEMISTRY

- C_v values for monoatomic and diatomic gases respectively are

a) $\frac{1}{2}R, \frac{3}{2}R$ b) $\frac{3}{2}R, \frac{5}{2}R$ c) $\frac{5}{2}R, \frac{7}{2}R$ d) $\frac{3}{2}R, \frac{3}{2}R$
- Which of the following relationship is correct?

a) $\Delta G^\circ = -RT \ln K$ b) $K = e^{-\Delta G^\circ/RT}$ c) $K = 10^{-\Delta G^\circ/2.303 RT}$ d) All are correct
- ΔH and ΔS for the reaction
 $\text{Ag}_2\text{O}_{(s)} \rightarrow 2\text{Ag}_{(s)} + 1/2 \text{O}_{2(g)}$ are $30.56 \text{ kJ mol}^{-1}$ and $66.00 \text{ JK}^{-1} \text{ mol}^{-1}$ respectively. The temperature at which the free energy change for the reaction will be zero is

a) 463 K b) 35440 K c) 20 K d) 483 K
- The free energy and entropy change in kJ per mole when liquid water boils at 1 atmosphere are respectively (latent heat of water = 2.0723 kJ g^{-1})

a) 0, 0 b) 0.1, 0.1 c) 0.1, 0 d) 0, 0.1
- What entropy change is involved in the isothermal expansion of 5 mol of ideal gas from a volume of 10 L to 100 L at 300 K?

a) -95.7 J K^{-1} b) $+95.7 \text{ J K}^{-1}$ c) 28.72 kJ K^{-1} d) -28.72 kJ K^{-1}
- A plot of $\ln K$ against $1/T$ (abscissa) is expected to be a straight line with intercept on ordinate axis equal to

a) $\frac{\Delta S^\circ}{2.303R}$ b) $\frac{\Delta S^\circ}{R}$ c) $-\frac{\Delta S^\circ}{R}$ d) $R \times \Delta S^\circ$
- The standard Gibbs free energy change (ΔG°) at 25°C for the dissociation of $\text{N}_2\text{O}_{4(g)}$ to $\text{NO}_{2(g)}$ is (given, equilibrium cont. = 0.15, $R = 8.314 \text{ J K/mol}$)

a) 1.1 kJ b) 4.7 kJ c) 8.1 kJ d) 38.2 kJ
- Calculate the change in entropy when two gram atoms of aluminium is heated from 25°C to 600°C . The atomic heat capacity of aluminium is given by $C_p = 5.006 + 0.0026 T \text{ cal/deg}$.

a) 23.75 cal/deg b) 6.8 eu c) 13.75 eu d) 10 eu
- Which of the following is not correct for ideal gas?

a) $\left(\frac{\partial U}{\partial V}\right)_T = 0$ b) $\left(\frac{\partial H}{\partial P}\right)_T = 0$ c) $\left(\frac{\partial T}{\partial P}\right)_H = 0$ d) $\left(\frac{\partial P}{\partial T}\right)_V = 0$
- Consider the reaction $2\text{NO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{NO}_{2(g)}$
Predict whether the reaction is spontaneous at 298 K.
 $\Delta_f G^\circ(\text{NO}) = 86.69 \text{ kJ/mol}$, $\Delta_f G^\circ(\text{NO}_2) = 51.84 \text{ kJ/mol}$

a) Spontaneous b) Non-spontaneous c) Equilibrium d) Cannot predict

11. The values of ΔH and ΔS for a reaction are respectively 30 kJ mol^{-1} and $100 \text{ JK}^{-1} \text{ mol}^{-1}$. Then the temperature above which the reaction will become spontaneous is
 a) 300 K b) 30 K c) 100 K d) 300°C
12. For the reaction, $\text{CaCO}_3(\text{s}) = \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
 Partial pressure of CO_2 at 1000 K is 0.003 atm.
 $\Delta G^\circ = 27.2 \text{ kcal}$. Calculate the value of ΔG .
 a) 12.6 kcal b) 15.6 kcal c) 13.4 kcal d) 14.2 kcal
13. Given: $\text{C}_2\text{H}_6(\text{g}) \rightarrow 2\text{C}(\text{g}) + 6\text{H}(\text{g})$; $\Delta H = 712 \text{ kcal}$
 The C – C bond energy is 112 kcal, what is the C – H bond energy?
 a) 88 kcal b) 12 kcal c) 50 kcal d) 100 kcal
14. For a particular reversible reaction at temperature T, ΔH and ΔS were found to be both positive, If T_e is the temperature at equilibrium, the reaction would be spontaneous when
 a) $T = T_e$ b) $T_e > T$ c) $T > T_e$ d) $T_e = 5T$
15. One mole of an ideal gas at 300 K is expanded Isothermally from an initial volume of 1 L to 10L. The ΔE for this process is $R = 2 \text{ cal mol}^{-1} \text{ K}^{-1}$
 a) 163.7 cal b) zero c) 1381.1 cal d) 9 L atm'
16. For the reaction $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, $\Delta H = -571$. Bond energy of H – H = 435 and O = O = 498. Then the average bond energy of O-H bond will be
 a) 484 b) -484 c) 271 d) -271
17. If one mole of monoatomic ideal gas is heated at constant pressure of 1 atm from 25°C , the change in internal energy in calories will be
 a) 124.2 cal b) -49.7 cal c) 74.5 cal d) 173.9 cal
18. For the allotropic change represented by the equation $\text{C}(\text{graphite}) \rightarrow \text{C}(\text{diamond})$, the enthalpy change $\Delta H = 1.9 \text{ kJ}$. If 6 g of diamond and 6 g of graphite are separately burnt to yield CO_2 , the heat liberated in first case is
 a) less than in the second case by 1.9 kJ
 b) more than in the second case by 11.4 kJ
 c) more than in the second case by 0.95 kJ
 d) less than in the second case by 11.4 kJ
19. The decreasing order of calorific values is
 a) $\text{C}_2\text{H}_2 > \text{C}_4\text{H}_{10} > \text{C}_3\text{H}_8 > \text{C}_2\text{H}_4$ b) $\text{C}_4\text{H}_{10} > \text{C}_3\text{H}_8 > \text{C}_2\text{H}_4 > \text{C}_2\text{H}_2$
 c) $\text{C}_2\text{H}_4 > \text{C}_3\text{H}_8 > \text{C}_4\text{H}_{10} > \text{C}_2\text{H}_2$ d) $\text{C}_3\text{H}_8 > \text{C}_2\text{H}_4 > \text{C}_4\text{H}_{10} > \text{C}_2\text{H}_2$
20. Which of the following reaction is said to be enthalpy driven?
 a) Endothermic reaction with positive entropy change and high temperature
 b) Endothermic reaction with negative entropy change and low temperature
 c) Exothermic reaction with positive entropy change and high temperature
 d) Exothermic reaction with negative entropy change and low temperature

31. 12.0 g of carbon completely reacted with oxygen to form CO and CO₂ at 25°C and constant pressure. The heat liberated is 75.0 kcal. The mass of oxygen reacted is (Given $\Delta_f H^\circ$: CO₂ = -95 kcal mol⁻¹, CO = -24 kcal mol⁻¹)
- a) 13.75 g b) 27.5 g c) 33.3 g d) 41.25 g
32. The densities of graphite and diamond at 298 K are 2.25 and 3.31 g cm⁻³ respectively. If the standard free energy difference (ΔG°) is equal to 1895 J mol⁻¹, the pressure at which graphite will be transformed into diamond at 298 K is
- a) 11.09×10^8 Pa b) 11.09×10^7 Pa c) 11.09×10^6 Pa d) 11.09×10^5 Pa
33. During an event, an athlete is given 100 g of glucose which has energy equivalent to 1560 kJ. He utilizes 50% of the gained energy in the event. In order to avoid storage of energy in the body, the weight of water he needs to perspire would be nearly (given enthalpy of vaporisation of water is 44 kJ/mol)
- a) 120 g b) 220 g c) 320 g d) 420 g
34. The enthalpy change involved in the oxidation of glucose is -2880 kJ mol⁻¹. 25% of this energy is available for muscular work. If 100 kJ of muscular work is needed to walk one kilometer, the maximum distance that a person will be able to walk after eating 100 g of glucose will be
- a) 2.9 km b) 3.8 km c) 4.8 km d) 5.8n km
35. One mole of a liquid (1 bar, 100 mL) is taken in an adiabatic container and the pressure increases steadily to 100 bar. Then at constant pressure of 100 bar, volume decreases by 1 mL. Enthalpy change during the process will be
- a) 980 J b) 990 J c) 970 J d) 950 J
36. For hypothetical reversible reaction
- $$\frac{1}{2}A_2(g) + \frac{3}{2}B_2(g) \longrightarrow AB_3(g); \quad \Delta H = -20 \text{ kJ}$$
- if standard entropies of A₂, B₂ and AB₃ are 60, 40 and 50 JK⁻¹ mol⁻¹ respectively. Then above reaction will be at equilibrium at
- a) 400 K b) 500 K c) 350 K d) 600 K
37. The enthalpy change (ΔH) for the reaction N₂ (g) + 3 H₂ (g) \longrightarrow 2 NH₃ (g) is 92.38 kJ at 298 K. The internal energy change ΔU at 298 K is
- a) -92.38 kJ b) -87.42 kJ c) -97.34 kJ d) -89.9 kJ
38. Sodium chloride is soluble in water but not in benzene because
- a) $\Delta H_{\text{hydration}} < \Delta H_{\text{lattice energy in water}}$ and $\Delta H_{\text{hydration}} > \Delta H_{\text{lattice energy in benzene}}$
- b) $\Delta H_{\text{hydration}} > \Delta H_{\text{lattice energy in water}}$ and $\Delta H_{\text{hydration}} < \Delta H_{\text{lattice energy in benzene}}$
- c) $\Delta H_{\text{hydration}} = \Delta H_{\text{lattice energy in water}}$ and $\Delta H_{\text{hydration}} < \Delta H_{\text{lattice energy in benzene}}$
- d) $\Delta H_{\text{hydration}} < \Delta H_{\text{lattice energy in water}}$ and $\Delta H_{\text{hydration}} = \Delta H_{\text{lattice energy in benzene}}$

39. Assuming that water vapour is an ideal gas, the internal energy change (ΔU) when 1 mole of water is vapourised at 1 bar pressure and 100°C (Given: molar enthalpy of vapourisation of water at bar and $373\text{ K} = 41\text{ kJ mol}^{-1}$ and $R = 8.3\text{ J mol}^{-1}$ will be
- a) 41.00 kJ mol^{-1} b) 4.100 kJ mol^{-1} c) $3.7908\text{ kJ mol}^{-1}$ d) $37.904\text{ kJ mol}^{-1}$
40. For the reaction $A \rightarrow B$, $\Delta H = +24\text{ kJ/mole}$
 For the reaction $B \rightarrow C$, $\Delta H = -18\text{ kJ/mole}$
 The decreasing order of enthalpy of A, B, C follows the order :
- a) A, B, C b) B, C, A c) C, B, A d) C, A, B
41. 1.0 g sample of substance A at 100°C is added to 100 mL of H_2O at 25°C . Using separate 100 mL portions of H_2O , the procedure is repeated with substance B and then with substance C. How will the final temperatures of the water compare?

Substance	Specific heat
A	$0.60\text{ J g}^{-1}\text{ }^\circ\text{C}^{-1}$
B	$0.40\text{ J g}^{-1}\text{ }^\circ\text{C}^{-1}$
C	$0.20\text{ J g}^{-1}\text{ }^\circ\text{C}^{-1}$

- a) $T_C > T_B > T_A$ b) $T_B > T_A > T_C$ c) $T_A > T_B > T_C$ d) $T_A = T_B = T_C$
42. A cylinder of a gas contains 11.6 kg of butane. If a normal family needs $2.0 \times 10^4\text{ kJ}$ of energy per day for cooking, how long will the cylinder last? (Given : $\Delta H_{\text{combustion}}$ of butane = -2600 kJ mol^{-1})
- a) 26 days b) 39 days c) 52 days d) 65 days
43. When 20 mL of a strong acid is added to 20 mL of an alkali, the temperature rises by 5°C . If 200 mL of each liquid are mixed, the temperature rise would be
- a) 5°C b) 50°C c) 20°C d) 0.5°C
44. One gram sample of NH_4NO_3 is decomposed in a bomb calorimeter. The temperature of the calorimeter increases by 6.12 K . The heat capacity of the system is 1.23 kJ/g/deg . What is the molar heat of decomposition for NH_4NO_3 ?
- a) -7.53 kJ/mol b) -398.1 kJ/mol c) -16.1 kJ/mol d) -602 kJ/mol
45. When 0.2 g of butanol -1 was burnt in a suitable apparatus, the heat evolved was sufficient to raise the temperature of 200 g of water by 5°C . The heat of combustion of butanol -1 in kcal/mole will be (mol mass of butanol -1 = 74)
- a) 14.8 b) 74 c) 37 d) 370
46. What amount of ice will remain when 52 g ice is added to 100 g of water at 313 K . Specific heat of water is 1 cal/g and latent heat of fusion of ice is 80 cal/g .
- a) 2 g b) 4 g c) 6 g d) 52 g

