



## NEET 2023 – Chemistry NCERT Based QB Thermodynamics – NCERT Exercise

- Q.1 Thermodynamics is not concerned about \_\_\_\_
- (1) energy changes involved in a chemical reaction
  - (2) the extent to which a chemical reaction proceeds.
  - (3) the rate at which a reaction proceeds.
  - (4) the feasibility of a chemical reaction.
- Q.2 Which of the following statements is correct?
- (1) The presence of reacting species in a covered beaker is an example of open system.
  - (2) There is an exchange of energy as well as matter between the system and the surroundings in a closed system.
  - (3) The presence of reactants in a closed vessel made up of copper is an example of a closed system.
  - (4) The presence of reactants in a thermos flask or any other closed insulated vessel is an example of a closed system.
- Q.3 The state of a gas can be described by quoting the relationship between \_\_\_\_.
- (1) pressure, volume, temperature
  - (2) temperature, amount, pressure
  - (3) amount, volume, temperature
  - (4) pressure, volume, temperature, amount
- Q.4 The volume of gas is reduced to half from its original volume. The specific heat will be
- (1) reduce to half
  - (2) be doubled
  - (3) remain constant
  - (4) Increase four times
- Q.5 During complete combustion of one mole of butane, 2658 kJ of heat is released. The thermochemical reaction for above change is
- (1)  $2\text{C}_4\text{H}_{10}(\text{g}) + 13\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 10\text{H}_2\text{O}(\text{l})$   $\Delta_c\text{H} = -2658.0 \text{ kJ mol}^{-1}$
  - (2)  $\text{C}_4\text{H}_{10}(\text{g}) + \frac{13}{2} \text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 5\text{H}_2\text{O}(\text{g})$   $\Delta_c\text{H} = -1329.0 \text{ kJ mol}^{-1}$
  - (3)  $\text{C}_4\text{H}_{10}(\text{g}) + \frac{13}{2} \text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 5\text{H}_2\text{O}(\text{l})$   $\Delta_c\text{H} = -2658.0 \text{ kJ mol}^{-1}$
  - (4)  $\text{C}_4\text{H}_{10}(\text{g}) + \frac{13}{2} \text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 5\text{H}_2\text{O}(\text{l})$   $\Delta_c\text{H} = +2658.0 \text{ kJ mol}^{-1}$
- Q.6  $\Delta_f\text{U}^-$  of formation of  $\text{CH}_4$  (g) at certain temperature is  $-393 \text{ kJ mol}^{-1}$ . The value of  $\Delta_f\text{H}^+$  is
- (1) zero
  - (2)  $< \Delta_f\text{U}^-$
  - (3)  $> \Delta_f\text{U}^+$
  - (4) equal to  $\Delta_f\text{U}^+$

Q.7 In an adiabatic process, no transfer of heat takes place between system and surroundings. Choose the correct option for free expansion of an ideal gas under adiabatic condition from the following.

- (1)  $q = 0, \Delta T \neq 0, w = 0$
- (2)  $q \neq 0, \Delta T = 0, w = 0$
- (3)  $q = 0, \Delta T = 0, w = 0$
- (4)  $q = 0, \Delta T < 0, w \neq 0$

Q.8 The pressure-volume work for an ideal gas can be calculated by using the expression

$$w = - \int_{V_i}^{V_f} p_{\text{ex}} dV.$$

The work can also be

calculated from the pV-plot by using the area under the curve within the specified limits. When an ideal gas is compressed (a) reversibly or (b) irreversibly from volume  $V_i$  to  $V_f$ . choose the correct option.

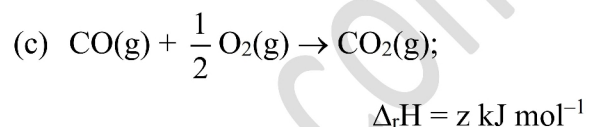
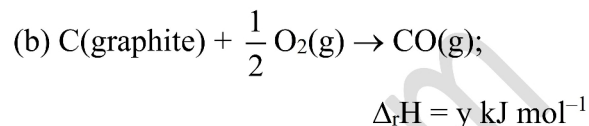
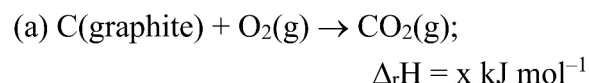
- (1)  $w$  (reversible) =  $w$  (irreversible)
- (2)  $w$  (reversible) <  $w$  (irreversible)
- (3)  $w$  (reversible) >  $w$  (irreversible)
- (4)  $w$  (reversible) =  $w$  (irreversible) +  $p_{\text{ex}} \cdot \Delta V$

Q.9 The entropy change can be calculated by using the expression  $\Delta S = \frac{q_{\text{rev}}}{T}$ .

When water freezes in a glass beaker, choose the correct statement amongst the following:

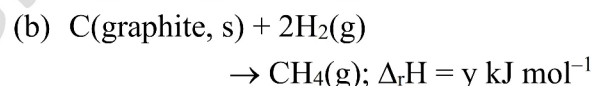
- (1)  $\Delta S$  (system) decreases but  $\Delta S$  (surroundings) remains the same.
- (2)  $\Delta S$  (system) increases but  $\Delta S$  (surroundings) decreases.
- (3)  $\Delta S$  (system) decreases but  $\Delta S$  (surroundings) increases.
- (4)  $\Delta S$  (system) decreases and  $\Delta S$  (surroundings) also decreases.

Q.10 On the basis of thermochemical equations (a), (b) and (c), find out which of the algebraic relationships given in options (i) to (iv) is correct.



- (1)  $z = x + y$
- (2)  $x = y - z$
- (3)  $x = y + z$
- (4)  $y = 2z - x$

Q.11 Consider the reactions given below. On the basis of these reactions find out which of the algebraic relations given in options (i) to (iv) is correct?



- (1)  $x = y$
- (2)  $x = 2y$
- (3)  $x > y$
- (4)  $x < y$

Q.12 The enthalpies of elements in their standard states are taken as zero. The enthalpy of formation of a compound

- (1) is always negative
- (2) is always positive
- (3) may be positive or negative
- (4) is never negative

Q.13 Enthalpy of sublimation of a substance is equal to

- (1) enthalpy of fusion + enthalpy of vapourisation
- (2) enthalpy of fusion
- (3) enthalpy of vapourisation
- (4) twice the enthalpy of vapourisation

Q.14 Which of the following is **not** correct?

- (1)  $\Delta G$  is zero for a reversible reaction  
 (2)  $\Delta G$  is positive for a spontaneous reaction  
 (3)  $\Delta G$  is negative for a spontaneous reaction  
 (4)  $\Delta G$  is positive for a non-spontaneous reaction

Q.15 Match the following processes with entropy change:

**Reaction** **Entropy change**

- (i) A liquid vapourises (a)  $\Delta S = 0$   
 (ii) Reaction is non-spontaneous at all temperatures and  $\Delta H$  is positive (b)  $\Delta S = \text{positive}$   
 (iii) Reversible expansion of an ideal gas (c)  $\Delta S = \text{negative}$

- (1) (i)  $\rightarrow$  b; (ii)  $\rightarrow$  c; (iii)  $\rightarrow$  a  
 (2) (i)  $\rightarrow$  a; (ii)  $\rightarrow$  b; (iii)  $\rightarrow$  c  
 (3) (i)  $\rightarrow$  c; (ii)  $\rightarrow$  a; (iii)  $\rightarrow$  b  
 (4) (i)  $\rightarrow$  b; (ii)  $\rightarrow$  a; (iii)  $\rightarrow$  c

Q.16 Match the following parameters with description for spontaneity

	$\Delta(\text{Parameters})$				<b>Description</b>
	$\Delta_r H^-$	$\Delta_r S^-$	$\Delta_r G^-$		
(i)	+	-	+	(a)	Non-spontaneous at high temperature
(ii)	-	-	+ at high T	(b)	Spontaneous at all temperature
(iii)	-	+	-	(c)	Non-spontaneous at all temperature

- (1) (i)  $\rightarrow$  c; (ii)  $\rightarrow$  a; (iii)  $\rightarrow$  b  
 (2) (i)  $\rightarrow$  a; (ii)  $\rightarrow$  b; (iii)  $\rightarrow$  c

(3) (i)  $\rightarrow$  b; (ii)  $\rightarrow$  c; (iii)  $\rightarrow$  a

(4) (i)  $\rightarrow$  b; (ii)  $\rightarrow$  a; (iii)  $\rightarrow$  c

Q.17 **Assertion (A):** Combustion of all organic compounds is an exothermic reaction.

**Reason (R):** The enthalpies of all elements in their standard state are zero.

- (i) Both A and R are true and R is the correct explanation of A.  
 (ii) Both A and R are true but R is not the correct explanation of A.  
 (iii) A is true but R is false.  
 (iv) A is false but R is true.

Q.18 **Assertion (A):** Spontaneous process is an irreversible process and may be reversed by some external agency.

**Reason (R):** Decrease in enthalpy is a contributory factor for spontaneity.

- (i) Both A and R are true and R is the correct explanation of A.  
 (ii) Both A and R are true but R is not the correct explanation of A.  
 (iii) A is true but R is false.  
 (iv) A is false but R is true.

Q.19 **Assertion (A):** A liquid crystallises into a solid and is accompanied by decrease in entropy.

**Reason (R):** In crystals, molecules organise in an ordered manner

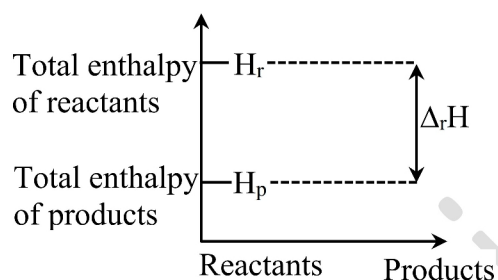
- (i) Both A and R are true and R is the correct explanation of A.

- (ii) Both A and R are true but R is not the correct explanation of A.  
 (iii) A is true but R is false.  
 (iv) A is false but R is true.

Q.20 Which of the following does not represent enthalpy change during phase transformation?

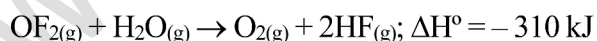
- (1) Standard enthalpy of fusion
- (2) Standard enthalpy of vaporisation
- (3) Standard enthalpy of sublimation
- (4) Standard enthalpy of formation

Q.21 The given enthalpy diagram represents which of the following reactions?



- (1) Enthalpy diagram for endothermic reaction.
- (2) Enthalpy diagram for exothermic reaction
- (3) Enthalpy diagram for reversible reaction.
- (4) Enthalpy diagram for non-spontaneous reaction.

Q.22 What will be the standard internal energy change for the reaction at 298 K?



- (1)  $-312.5 \text{ kJ}$
- (2)  $-125.03 \text{ kJ}$
- (3)  $-310 \text{ kJ}$
- (4)  $-156 \text{ kJ}$

Q.23 Which of the following relationships is not correct for the relation between  $\Delta H$  and  $\Delta U$ ?

- (1) When  $\Delta n_g = 0$  then  $\Delta H = \Delta U$
- (2) When  $\Delta n_{(g)} > 0$  then  $\Delta H > \Delta U$
- (3) When  $\Delta n_{(g)} < 0$  then  $\Delta H < \Delta U$
- (4) When  $\Delta n_g RT = 0$  then  $\Delta H > \Delta U$

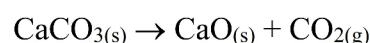
Q.24 A process is called reversible when

- (1) surrounding and system change are same
- (2) there is no boundary between system and surrounding
- (3) surrounding is always in equilibrium with system
- (4) system changes into surroundings spontaneously.

Q.25 Two litres of an ideal gas at a pressure of 10 atm expands isothermally into a vacuum until its total volume is 10 litres. How much heat is absorbed and how much work is done in the expansion?

- (1) 10 J
- (2) 8 J
- (3) 18 J
- (4) 0 J

Q.26 For a reaction,



$$\Delta_f H^\circ(\text{CaO}) = -635.1 \text{ kJ mol}^{-1},$$

$$\Delta_f H^\circ(\text{CO}_2) = -393.5 \text{ kJ mol}^{-1} \text{ and}$$

$$\Delta_f H^\circ(\text{CaCO}_3) = -1206.9 \text{ kJ mol}^{-1}$$

Which of the following is a correct statement?

- (1) A large amount of heat is evolved during the decomposition of  $\text{CaCO}_3$
- (2) Decomposition of  $\text{CaCO}_3$  is an endothermic process and heat is provided for decomposition.

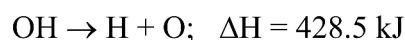
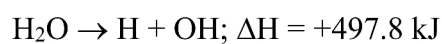
- (3) The amount of heat evolved cannot be calculated from the data provided.
- (4)  $\Delta_r H^\circ = \sum \Delta_f H^\circ (\text{reactants}) - \sum \Delta_f H^\circ (\text{products})$
- Q.27 What will be the heat of reaction for the following reaction? Will the reaction be exothermic or endothermic?
- $$\text{Fe}_2\text{O}_3(\text{s}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{Fe}(\text{s}) + 3\text{H}_2\text{O}(\text{l})$$
- $\Delta_f H^\circ(\text{H}_2\text{O}, \text{l}) = -285.83 \text{ kJ mol}^{-1}$ ,  
 $\Delta_f H^\circ(\text{Fe}_2\text{O}_3, \text{s}) = -824.2 \text{ kJ mol}^{-1}$
- (1)  $-824.2 \text{ kJ mol}^{-1}$ , exothermic  
 (2)  $+33.3 \text{ kJ mol}^{-1}$ , endothermic  
 (3)  $-33.3 \text{ kJ mol}^{-1}$ , exothermic  
 (4)  $+824.2 \text{ kJ mol}^{-1}$ , endothermic
- Q.28 The total entropy change ( $\Delta S_{\text{total}}$ ) for the system and surrounding of a spontaneous process is given by
- (1)  $\Delta S_{\text{total}} = \Delta S_{\text{system}} + \Delta S_{\text{surr}} > 0$   
 (2)  $\Delta S_{\text{total}} = \Delta S_{\text{system}} + \Delta S_{\text{surr}} < 0$   
 (3)  $\Delta S_{\text{system}} = \Delta S_{\text{total}} + \Delta S_{\text{surr}} > 0$   
 (4)  $\Delta S_{\text{surr}} = \Delta S_{\text{total}} + \Delta S_{\text{system}} < 0$
- Q.29 Which of the following statements regarding Gibb's energy change is correct?
- (1) If  $\Delta G$  is negative ( $< 0$ ), the process is non-spontaneous.  
 (2) If  $\Delta G$  is positive ( $> 0$ ), the process is spontaneous  
 (3) If  $\Delta G$  is negative ( $< 0$ ), the process is spontaneous.  
 (4) If  $\Delta G$  is positive ( $> 0$ ), the process is in equilibrium.
- Q.30 When the system does not exchange heat with the surroundings, the process is
- (1) isothermal (2) adiabatic  
 (3) thermal (4) isochoric.
- Q.31 In thermodynamics, which one of the following properties is not an intensive property?
- (1) Pressure (2) Temperature  
 (3) Volume (4) Density
- Q.32  $\Delta H$  for the reaction,  $\text{OF}_2 + \text{H}_2\text{O} \rightarrow \text{O}_2 + 2\text{HF}$  (B.E. of O—F, O—H, H—F and O=O are 44, 111, 135 and 119 kcal mol<sup>-1</sup> respectively)
- (1)  $-222 \text{ kcal}$  (2)  $-88 \text{ kcal}$   
 (3)  $-111 \text{ kcal}$  (4)  $-79 \text{ kcal}$
- Q.33 What is the enthalpy change for the given reaction, if enthalpies of formation of  $\text{Al}_2\text{O}_3$  and  $\text{Fe}_2\text{O}_3$  are  $-1670 \text{ kJ mol}^{-1}$  and  $-834 \text{ kJ mol}^{-1}$  respectively?
- $$\text{Fe}_2\text{O}_3 + 2\text{Al} \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe}$$
- (1)  $-836 \text{ kJ mol}^{-1}$  (2)  $836 \text{ kJ mol}^{-1}$   
 (3)  $-424 \text{ kJ mol}^{-1}$  (4)  $424 \text{ kJ mol}^{-1}$
- Q.34 The molar heat capacity of water at constant pressure,  $C_p$  is  $75 \text{ J K}^{-1} \text{ mol}^{-1}$ . When 10 kJ of heat is supplied to 1 kg water which is free to expand, the increase in temperature of water is
- (1) 2.4 K (2) 4.8 K  
 (3) 3.2 K (4) 10 K
- Q.35 For an isothermal reversible expansion process, the value of  $q$  can be calculated by the expression
- (1)  $q = 2.303nRT \log \frac{V_2}{V_1}$

$$(2) q = -2.303nRT \log \frac{V_2}{V_1}$$

$$(3) q = -2.303nRT \log \frac{V_1}{V_2}$$

$$(4) q = -P_{\text{exp}} nRT \log \frac{V_1}{V_2}$$

Q.36 Dissociation for water takes place in two steps:



What is the bond energy of O — H bond?

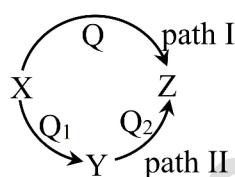
(1) 463.15 kJ mol<sup>-1</sup>

(2) 428.5 kJ mol<sup>-1</sup>

(3) 69.3 kJ mol<sup>-1</sup>

(4) 926.3 kJ mol<sup>-1</sup>

Q.37 A reaction proceeds through two paths I and II to convert X → Z.



What is the correct relationship between Q, Q<sub>1</sub> and Q<sub>2</sub>?

(1)  $Q = Q_1 \times Q_2$                       (2)  $Q = Q_1 + Q_2$

(3)  $Q = Q_2 - Q_1$                       (4)  $Q = Q_1/Q_2$

Q.38 The work done during the expansion of a gas from 4 dm<sup>3</sup> to 6 dm<sup>3</sup> against a constant external pressure of 3 atm is (1 L atm = 101.32 J)

(1) -6 J                                      (2) -608 J

(3) +304 J                                  (4) -304 J

Q.39 What will be the work done when one mole of a gas expands isothermally from 15 L to

50 L against a constant pressure of 1 atm at 25° C ?

(1) -3542 cal                              (2) -843.3 cal

(3) -718 cal                                (4) -60.23 cal

Q.40 Which of the following is not a correct statement about enthalpy of solution?

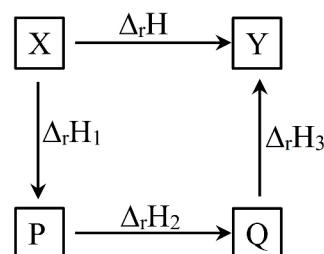
(1) For most ionic compounds,  $\Delta H^{\circ}_{\text{soln}}$  is positive and the dissociation process is endothermic.

(2) Solubility of most salts increases with increase in temperature.

(3) If the lattice enthalpy is very high, the dissolution of compound becomes very easy.

(4) Enthalpy of solution is determined by the selective values of the lattice enthalpy and hydration enthalpy.

Q.41 Which thermochemical process is shown by the following figure?



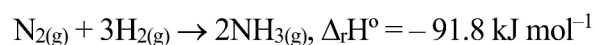
(a) Standard enthalpy of a reaction

(b) Born - Haber cycle of lattice enthalpy

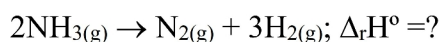
(c) Hess's law of constant heat summation

(d) Standard enthalpy of a solution.

Q.42 Formation of ammonia is shown by the reaction,



What will be the enthalpy of reaction for the decomposition of  $\text{NH}_3$  according to the reaction?



- (1)  $-91.8 \text{ kJ mol}^{-1}$
- (2)  $+91.8 \text{ kJ mol}^{-1}$
- (3)  $-45.9 \text{ kJ mol}^{-1}$
- (4)  $+45.9 \text{ kJ mol}^{-1}$

Q.43 Match the column I with column II and mark the appropriate choice.

Column I		Column II	
(A)	$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}$	(i)	$\Delta_{\text{sol}} H^\circ$
(B)	$\text{H}_2(\text{g}) \rightarrow 2\text{H}(\text{g})$	(ii)	$\Delta_{\text{lattice}} H^\circ$
(C)	$\text{NaCl}(\text{s}) \rightarrow \text{Na}^+(\text{g}) + \text{Cl}^-(\text{g})$	(iii)	$\Delta_c H^\circ$
(D)	$\text{NaCl}(\text{s}) \rightarrow \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$	(iv)	$\Delta_{\text{bond}} H^\circ$

- (1) (A)  $\rightarrow$  (iv), (B)  $\rightarrow$  (iii), (C)  $\rightarrow$  (i), (D)  $\rightarrow$  (ii)
- (2) (A)  $\rightarrow$  (ii), (B)  $\rightarrow$  (i), (C)  $\rightarrow$  (iv), (D)  $\rightarrow$  (iii)
- (3) (A)  $\rightarrow$  (i), (B)  $\rightarrow$  (ii), (C)  $\rightarrow$  (iii), (D)  $\rightarrow$  (iv)
- (4) (A)  $\rightarrow$  (iii), (B)  $\rightarrow$  (iv), (C)  $\rightarrow$  (ii), (D)  $\rightarrow$  (i)

Q.44 The enthalpy of solution of sodium chloride is  $4 \text{ kJ mol}^{-1}$  and its enthalpy of hydration of ions is  $-784 \text{ kJ mol}^{-1}$ . What will be the lattice enthalpy of sodium chloride?

- (1)  $+780 \text{ kJ mol}^{-1}$
- (2)  $+394 \text{ kJ mol}^{-1}$
- (3)  $+788 \text{ kJ mol}^{-1}$
- (4)  $+398 \text{ kJ mol}^{-1}$

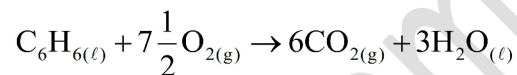
Q.45 A reaction is at equilibrium at  $100^\circ\text{C}$  and the enthalpy change for the reaction is  $42.6 \text{ kJ mol}^{-1}$ . What will be the value of  $\Delta S$  in  $\text{JK}^{-1}\text{mol}^{-1}$ ?

- (1) 120
- (2) 426.2

(3) 373.1

(4) 114.2

Q.46 For combustion of 1 mole of benzene at  $25^\circ\text{C}$ , the heat of reaction at constant pressure is  $-780.9 \text{ kcal}$ . What will be the heat of reaction at constant volume?

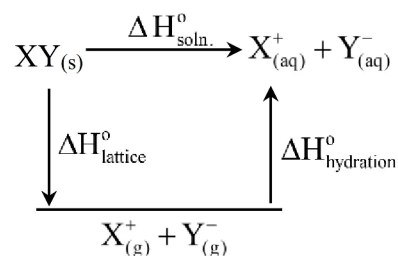


- (1)  $-781.8 \text{ kcal}$
- (2)  $-780.0 \text{ kcal}$
- (3)  $781.8 \text{ kcal}$
- (4)  $780.0 \text{ kcal}$

Q.47 System in which there is no exchange of matter, work or energy from surrounding is

- (1) closed
- (2) adiabatic
- (3) isolated
- (4) isothermal

Q.48 Study the figure given below and mark the correct expression.



The enthalpy of solution of  $\text{XY}(\text{s})$ ,  $\Delta H^\circ_{\text{soln.}}$  in water can be determined by

- (1)  $\Delta H^\circ_{\text{lattice}} = \Delta H^\circ_{\text{hyd}} + \Delta H^\circ_{\text{soln.}}$
- (2)  $\Delta H^\circ_{\text{hyd}} = \Delta H^\circ_{\text{lattice}} + \Delta H^\circ_{\text{soln.}}$
- (3)  $\Delta H^\circ_{\text{soln.}} = \Delta H^\circ_{\text{lattice}} + \Delta H^\circ_{\text{hyd}}$
- (4)  $\Delta H^\circ_{\text{soln.}} = \Delta H^\circ_{\text{lattice}} \times \Delta H^\circ_{\text{hyd}}$

Q.49 At dynamic equilibrium the reaction on both sides occur at the same rate and the mass on both sides of the equilibrium does not undergo

any change. This condition can be achieved

only when the value of  $\Delta G$  is

- (1)  $\Delta G = -1$                       (2)  $\Delta G = +1$   
 (3)  $\Delta G = +2$                       (4)  $\Delta G = 0$

Q.50 Which of the following reactions will have the value of  $\Delta S$  with a negative sign?

- (1)  $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}(g)$   
 (2)  $2\text{SO}_2(g) + \text{O}_2(g) \rightarrow 2\text{SO}_3(g)$   
 (3)  $\text{Cl}_2(g) \rightarrow 2\text{Cl}(g)$   
 (4)  $\text{CaCO}_3(s) \rightarrow \text{CaO}(s) + \text{CO}_2(g)$

Q.51  $\Delta E = q + W$  is mathematical expression for

- (1) first law of thermodynamics  
 (2) second law of thermodynamics  
 (3) third law of thermodynamics  
 (4) zeroth law of thermodynamics

Q.52 For a reaction to be spontaneous at any temperature, the conditions are

- (1)  $\Delta H = +ve, \Delta S = +ve$   
 (2)  $\Delta H = -ve, \Delta S = -ve$   
 (3)  $\Delta H = +ve, \Delta S = -ve$   
 (4)  $\Delta H = -ve, \Delta S = +ve$

Q.53 What will be the change in internal energy when 12 kJ of work is done on the system and 2 kJ of heat is given by the system?

- (1) + 10 kJ                      (2) - 10 kJ  
 (3) + 5 kJ                      (4) - 5 kJ

Q.54 Which of the following expressions regarding entropy is not correct?

$$(1) \Delta S_{\text{system}} = \frac{q}{T}$$

$$(2) \Delta S_{\text{system}} = \Delta S_{\text{total}} + \Delta S_{\text{surrounding}}$$

$$(3) \Delta S = S_{\text{final}} - S_{\text{initial}}$$

$$(4) \Delta S_{\text{total}} = \Delta S_{\text{system}} + \Delta S_{\text{surrounding}}$$

Q.55 What is the entropy change when 1 mole oxygen gas expands isothermally and reversibly from an initial volume of 10L to 100 L at 300K?

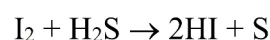
- (1) 19.12 JK<sup>-1</sup>                      (2) 109.12 J K<sup>-1</sup>  
 (3) 29.12 JK<sup>-1</sup>                      (4) 10 JK<sup>-1</sup>

Q.56 **Assertion:** An exothermic process which is non - spontaneous at high temperature may become spontaneous at low temperature.

**Reason:** Spontaneous process is an irreversible process and may be reversed by some external agency.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.  
 (b) Both assertion and reason are true but reason is not the correct explanation of assertion.  
 (c) Assertion is true but reason is false.  
 (d) Both assertion and reason are false.

Q.57 For the reaction given below the values of standard Gibbs free energy of formation at 298 K are given. What is the nature of the reaction?



$$\Delta G^\circ_f(\text{HI}) = 1.8 \text{ kJ mol}^{-1},$$

$$\Delta G^\circ_f(\text{H}_2\text{S}) = 33.8 \text{ kJ mol}^{-1}$$

(1) Non-spontaneous in forward direction.

(2) Spontaneous in forward direction.

(3) Spontaneous in backward direction.

(4) Non-spontaneous in both forward and backward directions.

Q.58 What will be the enthalpy change of conversion of graphite into diamond? Given

 $C_{\text{graphite}}, \Delta_{\text{comb}}H = -391.25 \text{ kJ};$ 
 $C_{\text{diamond}}, \Delta_{\text{comb}}H = -393.12 \text{ kJ}$ 
(1) zero (2)  $-391.25 \text{ kJ}$ (3)  $-393.12 \text{ kJ}$  (4)  $-1.87 \text{ kJ}$ 

Q.59 A system absorbs 50 kJ heat and does 20 kJ of work. What is the net change in the internal energy of the system?

(1) Increase by 30 kJ

(2) Decrease by 30 kJ

(3) Increase by 70 kJ

(4) Decrease by 70 kJ

Q.60 A system changes from state X to Y with a change in internal energy measuring to  $25 \text{ kJ mol}^{-1}$ , by a reversible path and returns from Y to X by an irreversible path. What will be the net change in internal energy?

(1) 25 kJ (2)  $> 25 \text{ kJ}$ (3)  $< 25 \text{ kJ}$  (4) zero

Q.61 For a reaction,  $P + Q \rightarrow R + S$ . The value of  $\Delta H^\circ$  is  $-30 \text{ kJ mol}^{-1}$  and  $\Delta S$  is  $-100 \text{ J K}^{-1} \text{ mol}^{-1}$ . At what temperature the reaction will be at equilibrium

(1)  $27^\circ\text{C}$  (2)  $52^\circ\text{C}$ (3)  $30^\circ\text{C}$ (4)  $45^\circ\text{C}$ 

Q.62 For a reaction:  $X \rightarrow Y + Z$

Absolute entropies are  $X = 120 \text{ J K}^{-1} \text{ mol}^{-1}$ ,  $Y = 213.8 \text{ J K}^{-1} \text{ mol}^{-1}$  and  $Z = 197.9 \text{ J K}^{-1} \text{ mol}^{-1}$ .

What will be the entropy change at 298 K and 1 atm?

(1)  $291.7 \text{ J K}^{-1}$  (2)  $255 \text{ J K}^{-1}$ (3)  $213.8 \text{ J K}^{-1}$  (4)  $257.3 \text{ J K}^{-1}$ 

Q.63 For the reaction:

 $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}; \Delta H = -44 \text{ kcal}$ 

What is the enthalpy of decomposition of HCl?

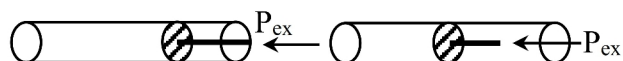
(1) 44 kcal/mol (2)  $-44 \text{ kcal/mol}$ (3)  $-22 \text{ kcal/mol}$  (4) 22 kcal/mol

Q.64 Match the column I with column II and mark the appropriate choice.

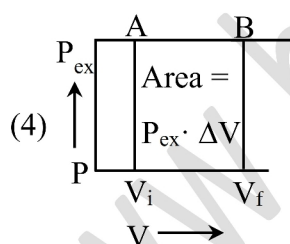
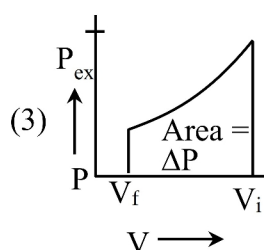
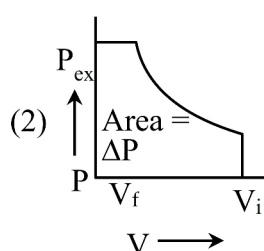
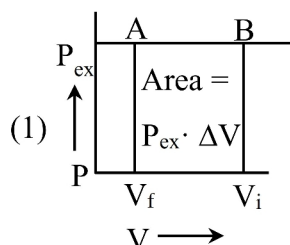
Column I		Column II	
(A)	State function	(i)	At constant pressure
(B)	$\Delta H = q$	(ii)	Specific heat
(C)	$\Delta U = q$	(iii)	Entropy
(D)	Intensive property	(iv)	At constant volume

(1) (A)  $\rightarrow$  (iii), (B)  $\rightarrow$  (i), (C)  $\rightarrow$  (iv), (D)  $\rightarrow$  (ii)(2) (A)  $\rightarrow$  (ii), (B)  $\rightarrow$  (iv), (C)  $\rightarrow$  (i), (D)  $\rightarrow$  (iii)(3) (A)  $\rightarrow$  (ii), (B)  $\rightarrow$  (iv), (C)  $\rightarrow$  (iii), (D)  $\rightarrow$  (i)(4) (A)  $\rightarrow$  (iii), (B)  $\rightarrow$  (ii), (C)  $\rightarrow$  (i), (D)  $\rightarrow$  (iv)

Q.65 Work done on an ideal gas in a cylinder when it is compressed by an external pressure in a single step is shown below.



Which of the following graphs will show the work done on the gas?



Q.66 Which of the following reactions will have the value of enthalpy of neutralisation as  $-57.1 \text{ kJ mol}^{-1}$ ?

- (1)  $\text{CH}_3\text{COO} + \text{NaOH} \rightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}$
- (2)  $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- (3)  $\text{HCl} + \text{NH}_4\text{OH} \rightarrow \text{NH}_4\text{Cl} + \text{H}_2\text{O}$
- (4)  $\text{HCOOH} + \text{NaOH} \rightarrow \text{HCOONa} + \text{H}_2\text{O}$

Q.67 Read the following statements regarding spontaneity of a process and mark the appropriate choice.

- (i) When enthalpy factor is absent then randomness factor decides spontaneity of a process.
  - (ii) When randomness factor is absent then enthalpy factor decides spontaneity of a process.
  - (iii) When both the factors take place simultaneously, the magnitude of both of factors decide spontaneity of a process.
- (a) Statements (i) and (ii) are correct and (iii) is incorrect.
  - (b) Statement (iii) is correct, (i) and (ii) are incorrect.
  - (c) Statements (i), (ii) and (iii) are correct.
  - (d) Statements (i), (ii) and (iii) are incorrect.

Q.68 At what temperature liquid water will be in equilibrium with water vapour?

$$\Delta H_{\text{vap}} = 40.73 \text{ kJ mol}^{-1}, \Delta S_{\text{vap}} = 0.109 \text{ K}^{-1} \text{ mol}^{-1}$$

- (1) 282.4 K
- (2) 373.6 K
- (3) 100 K
- (4) 400 K

Q.69 **Assertion:** Heat of neutralisation of  $\text{HNO}_3$  and  $\text{NaOH}$  is same as that of  $\text{HCl}$  and  $\text{KOH}$ .

**Reason:** Both  $\text{HNO}_3$  and  $\text{HCl}$  are strong acids and  $\text{NaOH}$  and  $\text{KOH}$  are strong bases.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Both assertion and reason are false.

Q.70 What will be the melting point of  $\text{KCl}$  if enthalpy change for the reaction is  $7.25 \text{ mol}^{-1}$  and entropy change is  $0.007 \text{ J K}^{-1} \text{ mol}^{-1}$ ?

- (1) 1835.2K
- (2) 173K

(3) 1035.7 K

(4) 1285.2K

(4) (A) → (iv), (B) → (ii), (C) → (i), (D) →

(iii)

Q.71 In endothermic reactions,

- (1) reactants have more energy than products
- (2) reactants have less energy than products
- (3) reactants and products have same energy
- (4) reactants have lower temperature than products.

Q.72  $\Delta G$  is the net energy available to do useful work and is a measure of free energy. If a reaction has positive enthalpy change and positive entropy change, under what conditions will the reaction be spontaneous?

- (a)  $\Delta G$  will be positive at low temperature hence reaction is spontaneous at low temperature.
- (b)  $\Delta G$  is negative at high temperature hence reaction is spontaneous at high temperature.
- (c)  $\Delta G$  is negative at low temperature hence reaction is spontaneous at low temperature.
- (d)  $\Delta G$  is negative at all temperatures hence reaction is spontaneous at all temperatures

Q.73 Match the column I with column II and mark the appropriate choice.

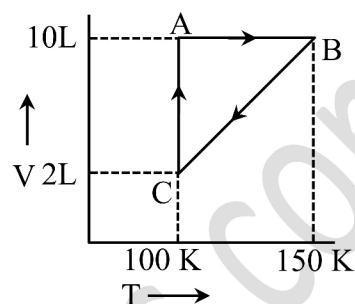
Column I		Column II	
(A)	$\text{H}_{2(\text{g})} + \text{Br}_{2(\text{g})} \rightarrow 2\text{HBr}_{(\text{g})}$	(i)	$\Delta H = \Delta U - 2RT$
(B)	$\text{PCl}_{5(\text{g})} \rightarrow \text{PCl}_{3(\text{g})} + \text{Cl}_{2(\text{g})}$	(ii)	$\Delta H = \Delta U + 3RT$
(C)	$\text{N}_{2(\text{g})} + 3\text{H}_{2(\text{g})} \rightarrow 2\text{NH}_{3(\text{g})}$	(iii)	$\Delta H = \Delta U$
(D)	$2\text{N}_2\text{O}_{5(\text{g})} \rightarrow 4\text{NO}_{2(\text{g})} + \text{O}_{2(\text{g})}$	(iv)	$\Delta H = \Delta U + RT$

(1) (A) → (iii), (B) → (i), (C) → (ii), (D) → (iv)

(2) (A) → (iii), (B) → (iv), (C) → (i), (D) → (ii)

(3) (A) → (ii), (B) → (i), (C) → (iv), (D) → (iii)

Q.74 Consider the given diagram for 1 mole of a gas X and answer the following question.



The process A → B represents

- (1) isobaric change
- (2) isothermal change
- (3) adiabatic change
- (4) isochoric change

Q.75 According to the first law of thermodynamics,  $\Delta U = q + W$ . In special cases the statement can be expressed in different ways. Which of the following is not a correct expression?

- (1) At constant temperature:  $q = -W$
- (2) When no work is done:  $\Delta U = q$
- (3) In gaseous system:  $\Delta U = q + P\Delta V$
- (d) When work is done by the system:  $\Delta U = q + W$

Q.73 Match the following columns and mark the appropriate choice.

Column I		Column II	
(A)	Exothermic	(i)	$\Delta H = 0, \Delta E = 0$
(B)	Spontaneous	(ii)	$\Delta G = 0$
(C)	Cyclic process	(iii)	$\Delta H$ is negative

(D)	Equilibrium	(iv)	$\Delta G$ is negative
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- (1) (A)  $\rightarrow$  (ii), (B)  $\rightarrow$  (iii), (C)  $\rightarrow$  (i), (D)  $\rightarrow$  (iv)  
 (2) (A)  $\rightarrow$  (iv), (B)  $\rightarrow$  (i), (C)  $\rightarrow$  (iii), (D)  $\rightarrow$  (ii)  
 (3) (A)  $\rightarrow$  (i), (B)  $\rightarrow$  (ii), (C)  $\rightarrow$  (iv), (D)  $\rightarrow$  (iii)  
 (4) (A)  $\rightarrow$  (iii), (B)  $\rightarrow$  (iv), (C)  $\rightarrow$  (i), (D)  $\rightarrow$  (ii)

Q.77 The heat of combustion of C, S and CS<sub>2</sub> are -393.3 kJ, -293.7 kJ and -1108.76 kJ. What will be the heat of formation of CS<sub>2</sub>?

- (1) -128.02 kJ                      (2) + 970 kJ  
 (3) + 1108.7                        (4) + 12 kJ

Q.78 Bond energy of few bonds are given below:

- Cl — Cl = 242.8 kJ mol<sup>-1</sup>,  
 H — Cl = 431.8 kJ mol<sup>-1</sup>,  
 O — H = 464 kJ mol<sup>-1</sup>,  
 O = O = 442 kJ mol<sup>-1</sup>

Using the B.E., calculate  $\Delta H$  for the following reaction,  $2\text{Cl}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{HCl} + \text{O}_2$

- (1) 906 kJ mol<sup>-1</sup>  
 (2) 172.4 kJ mol<sup>-1</sup>  
 (3) 198.8 kJ mol<sup>-1</sup>  
 (4) 442 kJ mol<sup>-1</sup>

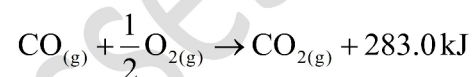
Q.79 At absolute zero. the entropy of a pure crystal is zero. This is

- (1) first law of thermodynamics  
 (2) second law of thermodynamics  
 (3) third law of thermodynamics  
 (4) zeroth law of thermodynamics.

Q.80 Which of the following relationship is not correct?

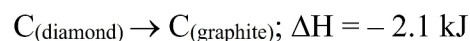
- (1)  $\Delta H = \Delta E + \Delta n_g RT$   
 (2)  $\Delta H_{\text{sub}} = \Delta H_{\text{fusion}} + \Delta H_{\text{vap}}$   
 (3)  $\Delta H_r^\circ = \sum H_{f(\text{reactants})}^\circ - \sum H_{f(\text{products})}^\circ$   
 (4)  $\Delta H_r^\circ = \sum \text{B.E. reactants} - \sum \text{B.E. of products}$

Q.81 What will be the enthalpy of combustion of carbon to produce carbon monoxide on the basis of data given below:



- (1) 676.4 kJ                              (2) -676.4 kJ  
 (3) -110.4 kJ                            (4) 110.4 kJ

Q.82 Two reactions are given below:



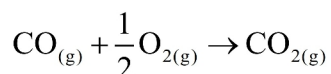
What quantity of diamond will give 800 kJ of heat on burning?

- (1) 24.25 g                                (2) 15.24 g  
 (3) 2 g                                      (4) 12.12 g

Q.83 The statement "The change of enthalpy of a chemical reaction is same whether the reaction takes place in one or several steps" is

- (1) Le Chatelier's law  
 (2) Van't Hoff's law  
 (3) First law of thermodynamics  
 (4) Hess's law

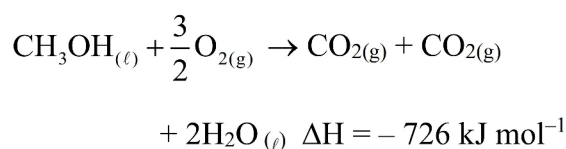
Q.84 Consider the following reaction:



How are  $\Delta E$  and  $\Delta H$  related for the reaction?

- (1)  $\Delta H = \Delta E - 0.5 RT$
- (2)  $\Delta H = \Delta E - RT$
- (3)  $\Delta H = \Delta E + 0.5 RT$
- (4)  $\Delta H = \Delta E - 1.5RT$

Q.85 Reaction of methanol with dioxygen was carried out and  $\Delta U$  was found to be  $-726 \text{ kJ mol}^{-1}$  at 298 K. The enthalpy change for the reaction will be



- (1)  $-741.5 \text{ kJ mol}^{-1}$
- (2)  $-724.7 \text{ kJ mol}^{-1}$
- (3)  $+741.5 \text{ kJ mol}^{-1}$
- (4)  $+727.2 \text{ kJ mol}^{-1}$

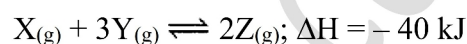
Q.86 Which of the following statements is not correct?

- (a) For a spontaneous process,  $\Delta G$  must be negative.
- (b) Enthalpy, entropy, free energy etc. are state variables.
- (c) A spontaneous process is reversible in nature.
- (d) Total of all possible kinds of energy of a system is called its internal energy.

Q.87 200 Joules of heat was supplied to a system at constant volume. It resulted in the increase in temperature of the system from 298 to 323 K. What is the change in internal energy of the system?

- (1)  $\Delta E = 400 \text{ J}$
- (2)  $\Delta E = 200 \text{ J}$
- (3)  $\Delta E = 50 \text{ J}$
- (4)  $\Delta E = 150 \text{ J}$

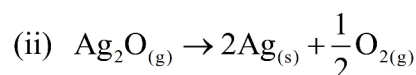
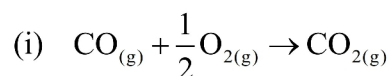
Q.88 For reversible reaction:



Standard entropies of X, Y and Z are 60, 40 and  $50 \text{ J K}^{-1} \text{ mol}^{-1}$  respectively. The temperature at which the above reaction is in equilibrium is

- (1) 273 K
- (2) 600 K
- (3) 500 K
- (4) 400 K

Q.89 Two reactions are given below:



Which of the following statements is true?

- (1) For (i)  $\Delta H < \Delta E$  and for (ii)  $\Delta H > \Delta E$
- (2) For (i)  $\Delta H > \Delta E$  and for (ii)  $\Delta H < \Delta E$
- (3) For both (i) and (ii)  $\Delta H > \Delta E$
- (4) For both (i) and (ii)  $\Delta H < \Delta E$

Q.90 Bond energies of H — H and Cl — Cl are  $430 \text{ kJ mol}^{-1}$  and  $242 \text{ kJ mol}^{-1}$  respectively.  $\Delta H_f$  for HCl is  $91 \text{ kJ mol}^{-1}$ . What will be the bond energy of HCl?

- (1) 672 kJ
- (2) 182 kJ
- (3) 245 kJ
- (4) 88 kJ

Q.91 At 373 K steam and water are in equilibrium and  $\Delta H = 40.98 \text{ kJ mol}^{-1}$ . What will be  $\Delta S$  for conversion of water into steam?

- (1)  $109.8 \text{ J K}^{-1} \text{ mol}^{-1}$
- (2)  $31 \text{ J K}^{-1} \text{ mol}^{-1}$
- (3)  $21.98 \text{ J K}^{-1} \text{ mol}^{-1}$
- (4)  $326 \text{ J K}^{-1} \text{ mol}^{-1}$

Q.92 What will be the amount of heat evolved by burning 10L of methane under standard conditions? (Given heats of formation of  $\text{CH}_4$ ,  $\text{CO}_2$  and  $\text{H}_2\text{O}$  are  $-76.2$ ,  $-398.8$  and  $-241.6 \text{ kJ mol}^{-1}$  respectively)

- (1) 805.8 kJ
- (2) 398.8 kJ
- (3) 359.7 kJ
- (4) 640.4 kJ

Q.93 The equilibrium constant for a reaction is 10. What will be the value of  $\Delta G^\circ$  at 300 K?

- (1)  $-5.74 \text{ kJ}$
- (2)  $-574 \text{ kJ}$
- (3)  $11.48 \text{ kJ}$
- (4)  $5.74 \text{ kJ}$

Q.94 The heat of combustion of ethane and benzene is  $-1560$  and  $-3268 \text{ kJ mol}^{-1}$  respectively. Which of two has higher efficiency as fuel per gram and the amount of heat produced per gram?

- (1) Benzene,  $41.9 \text{ kJ g}^{-1}$
- (2) Ethane,  $52 \text{ kJ g}^{-1}$
- (3) Benzene,  $78 \text{ kJ g}^{-1}$
- (4) Ethane,  $30 \text{ kJ g}^{-1}$

Q.95 The amount of heat evolved when 0.50 mole of HCl is mixed with 0.30 mole of NaOH solution is

- (1) 57.1 kJ
- (2) 28.55 kJ
- (3) 11.42 kJ
- (4) 17.13 kJ

Q.96 Which of the following expressions is correct to calculate enthalpy of a reaction?

- (1)  $\Delta H_{\text{reaction}} = \sum \Delta_f H_{\text{reactants}} - \sum \Delta_f H_{\text{products}}$
- (2)  $\Delta H_{\text{reaction}} = \sum \text{B.E.}_{\text{products}} - \sum \text{B.E.}_{\text{reactants}}$
- (3)  $\Delta H_{\text{reaction}} = \sum \text{B.E.}_{\text{reactants}} - \sum \text{B.E.}_{\text{products}}$
- (4)  $\Delta H_{\text{reaction}} = \Delta H_1 \times \Delta H_2 \times \Delta H_3 \dots$

Q.97 The enthalpy of formation of ammonia when calculated from the following bond energy data is (B.E. of N-H, H-H,  $\text{N} \equiv \text{N}$  is  $389 \text{ kJ mol}^{-1}$ ,  $435 \text{ kJ mol}^{-1}$ ,  $945.36 \text{ kJ mol}^{-1}$  respectively)

- (1)  $-41.82 \text{ kJ mol}^{-1}$
- (2)  $83.64 \text{ kJ mol}^{-1}$
- (3)  $-945.36 \text{ kJ mol}^{-1}$
- (4)  $-833 \text{ kJ mol}^{-1}$

**Thermodynamics****Answer Key NCERT Exercise**

Q.1	3	Q.2	3	Q.3	4	Q.4	3	Q.5	3
Q.6	2	Q.7	3	Q.8	2	Q.9	3	Q.10	3
Q.11	3	Q.12	3	Q.13	1	Q.14	2	Q.15	1
Q.16	3	Q.17	2	Q.18	2	Q.19	1	Q.20	4
Q.21	2	Q.22	2	Q.23	4	Q.24	4	Q.25	1
Q.26	2	Q.27	3	Q.28	1	Q.29	3	Q.30	2
Q.31	3	Q.32	4	Q.33	1	Q.34	1	Q.35	1
Q.36	1	Q.37	2	Q.38	2	Q.39	3	Q.40	3
Q.41	3	Q.42	2	Q.43	4	Q.44	3	Q.45	4
Q.46	2	Q.47	3	Q.48	3	Q.49	4	Q.50	2
Q.51	1	Q.52	4	Q.53	1	Q.54	2	Q.55	1
Q.56	2	Q.57	2	Q.58	4	Q.59	1	Q.60	4
Q.61	1	Q.62	1	Q.63	4	Q.64	1	Q.65	1
Q.66	2	Q.67	3	Q.68	2	Q.69	1	Q.70	3
Q.71	2	Q.72	2	Q.73	2	Q.74	4	Q.75	4
Q.76	4	Q.77	1	Q.78	2	Q.79	3	Q.80	3
Q.81	3	Q.82	1	Q.83	4	Q.84	1	Q.85	2
Q.86	3	Q.87	2	Q.88	3	Q.89	1	Q.90	3
Q.91	1	Q.92	3	Q.93	1	Q.94	2	Q.95	4
Q.96	3	Q.97	1						