KATTAR NEET 2026

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Thermodynamics and Thermochemistry

Q1 The standard enthalpies of formation of CO_2 (g), H_2O(l) and glucose(s) at 25° C are – 400 kJ/mol, –300 kJ/mol and –1300 kJ/ mol, respectively. The standard enthalpy of combustion per gram of glucose at 25° C is;
(A) + 2900 kJ
(B) – 2900 kJ
(C) – 16.11 kJ
(D) +16.11 kJ

Q2 One mole of an ideal gas at 300 K in thermal contact with surroundings expands isothermally from 1.0 L to 2.0 L against a constant pressure of 3.0 atm. In this process, the change in entropy of surroundings (ΔS_{surr}) in JK^{-1} is (1 L atm = 101.3J)
(A) 5.763   (B) 1.013
(C) -1.013   (D) -5.763

Q3 Out of boiling point (I), entropy (II), pH (III) and e.m.f. of a cell (IV), Intensive properties are:
(A) I, II   (B) I, II, III
(C) I, III, IV   (D) All of these

Q4 What is the change in internal energy , for a system that does 70 joules of work as it absorbs 45 joules of heat?
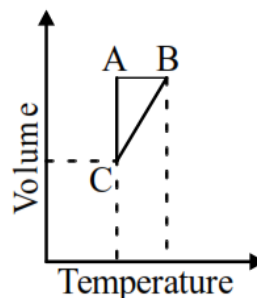(A) 115 J   (B) 25 J
(C) – 25 J   (D) – 115 J

Q5 C_2H_5OH(l) on complete combustion produce CO_2(g) and H_2O(l) at 300 K. The difference between ΔH and ΔU at this temperature is:
(A) -2.49 kJ mol^{-1}
(B) $+2.49$ kJ mol^{-1}
(C) $+4.98$ kJ mol^{-1}
(D) -4.98 kJ mol^{-1}

Q6 Five moles of a gas is put through a series of changes as shown graphically in a cyclic process

the A → B, B → C and C → A respectively are:

(A) Isochoric, Isobaric, Isothermal
(B) Isobaric, Isochoric, Isothermal
(C) Isothermal, Isobaric, Isochoric
(D) Isochoric, Isothermal, Isobaric

Q7 An isolated system comprises the liquid in equilibrium with vapours. At this stage the molar entropy of the vapour is:
(A) Less than that of liquid
(B) More than that of liquid
(C) Equal to zero
(D) Equal to that of liquid

Q8 Choose the **incorrect** statement:
(A) system and surrounding are always separated by a real or imaginary boundary.
(B) perfectly isolated system can never be created.
(C) in reversible process, energy change in each step can be reversed.
(D) irreversible process are slow process.

Q9 For two mole of an ideal gas:
(A) C_V - C_P = R   (B) C_P - C_V = 2R
(C) C_P - C_V = R   (D) C_V - C_P = 2R

Q10 The enthalpy change for the following reaction is 514 kJ mol^{-1}. Calculate the average Cl – F bond energy (in kJ mol^{-1}).
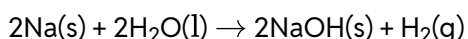ClF_3(g) → Cl(g) + 3F(g)

(A) 1542.5   (B) 88.2
(C) 171.3   (D) 514.1

Q11 The bond dissociation energy of gaseous H_2, Cl_2 and HCl are 104, 58 and 103 kcal mol^{-1} respectively. The enthalpy of formation for HCl gas will be:-
(A) – 44.0 kcal mol^{-1}
(B) – 22.0 kcal mol^{-1}
(C) 22.0 kcal mol^{-1}
(D) 44.0 kcal mol^{-1}

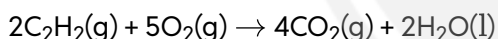**Q12** Using the following information calculate the heat of formation of NaOH.
2Na(s) + 2H$_2$O(l) → 2NaOH(s) + H$_2$(g)
$\Delta H^\circ = -281.9$ kJ mol^{-1}
$(\Delta H_f^o)_{H_2O(l)}$ = –285.8 kJ/mole
(A) –141.6 kJ mol^{-1}
(B) –712.6 kJ mol^{-1}
(C) –426.8 kJ mol^{-1}
(D) –650.4 kJ mol^{-1}

Q13 The heats of formation of CO_2(g) and H_2O(l) are –394 kJ/mole and –285.8 kJ/mole respectively. Using the data for the following combustion reaction, calculate the heat of formation of C_2H_2(g).
2C$_2$H$_2$(g) + 5O$_2$(g) → 4CO$_2$(g) + 2H$_2$O(l)
$\Delta H^\circ = -2601$ kJ mol^{-1}
(A) –238.6 kJ mol^{-1}
(B) 253.2 kJ mol^{-1}
(C) 238.7 kJ mol^{-1}
(D) 226.7 kJ mol^{-1}

Q14 For which of the following change $\Delta H \neq \Delta E$?
(A) $H_2(g) + I_2(g) \rightarrow 2HI(g)$
(B) $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$
(C) $C(s) + O_2(g) \rightarrow CO_2(g)$
(D) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Q15 Match the column-I with column II:

Column I		Column II	
(A)	$\frac{1}{8}$ S$_8$(Rhombic) + O$_2$(g) →SO$_2$(g); ΔH	(I)	Heat of solution
(B)	CH$_4$(g) + 2O$_2$(g) → CO$_2$(g) + 2H$_2$O(l); ΔH	(II)	Heat of neutralisation
(C)	NaOH(s) + aq → NaOH(aq); ΔH	(III)	Heat of formation
(D)	NaOH(aq) + HCl(aq) → NaCl(aq) + H$_2$O(l); ΔH	(IV)	Heat of combustion

Choose the **correct** answer from the options given below.
(A) A-III, B-I, C-IV, D-II
(B) A-III, B-IV, C-I D-II
(C) A-IV, B-II, C-I, D-III
(D) A-II, B-III, C-IV, D-I

Q16 A gas (system) at 0.1 atm pressure is enclosed in a cylinder fitted with a weightless, frictionless piston and the cylinder is placed in the surrounding, where the pressure is 1 atm. In the spontaneous process that occurs isothermally,
(A) entropy of the system increases, that of surrounding decreases
(B) entropy of the system decreases, that of surrounding increases
(C) entropy of the system and the surrounding increases
(D) entropy of the system and the surrounding decreases

Q17 ΔH^0 for a reaction is - 30kJ and the ΔS^0 for this reaction is -75 JK^{-1}. The temperature(s) at which reaction is spontaneous is:
(A) 399°C   (B) 120°C
(C) 401°C   (D) 172°C

Q18 The process, in which no heat enters or leaves the system, is termed as
(A) Isochoric   (B) Isobaric
(C) Isothermal   (D) Adiabatic

Q19 Enthalpy for the reaction
$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ is;
(A) Positive

(B) Negative

(C) Zero

(D) Can not be predicted

Q20 Which of the following expressions represents the first law of thermodynamics

(A) $\Delta E = -q + W$

(B) $\Delta E = q - W$

(C) $\Delta E = q + W$

(D) $\Delta E = -q - W$

Q21 For a diatomic gas, which options is **incorrect**?

(A) $\gamma = 1.40$

(B) $C_p = \frac{7R}{2}$

(C) $C_v = \frac{5R}{2}$

(D) $\gamma = 1.67$

Q22 Which of the following is a state function and also an extensive property?

(A) Internal energy

(B) Pressure

(C) Molar heat capacity

(D) Temperature

Q23 Which of the following is an endothermic reaction

(A) $2H_2 + O_2 \rightarrow 2H_2O$

(B) $N_2 + O_2 \rightarrow 2NO$

(C) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(D) $3O_2 + C_2H_5OH \rightarrow 2CO_2 + 3H_2O$

Q24 For a spontaneous change, free energy change ΔG is

(A) Positive

(B) Negative

(C) Zero

(D) Can be positive or negative

Q25 For the reaction A(g) + 2B(g) →2C(g) + 3D(g), the value of ΔE at 27° is 19.0 kcal mol^{-1}. The value of ΔH for the reaction would be (R = 2.0 cal K^{-1} mol^{-1}).

(A) 28.2 kcal mol^{-1}

(B) 17.8 kcal mol^{-1}

(C) 24.8 kcal mol^{-1}

(D) 20.2 kcal mol^{-1}

Q26

Heat combustion (ΔH^o) for C(s), H_2(g) and CH_4(g) are -94, -68 and -213 kcal/mol. The value of ΔH^o for the reaction,

$C(s) + 2H_2(g) \rightarrow CH_4(g)$ is

(A) -85 kcal mol^{-1}

(B) -111 kcal mol^{-1}

(C) -17 kcal mol^{-1}

(D) -170 kcal mol^{-1}

Q27 $C + \frac{1}{2}O_2 \rightarrow CO; \Delta H = -42 \text{ kJ}$

$CO + \frac{1}{2}O_2 \rightarrow CO_2; \Delta H = -24 \text{ kJ}$

The heat of formation of CO_2 is

(A) – 16 kJ mol^{-1}

(B) + 66 kJ mol^{-1}

(C) + 16 kJ mol^{-1}

(D) – 66 kJ mol^{-1}

Q28 Enthalpy of combustion of a substance

(A) Is always positive

(B) Is always negative

(C) Is equal to heat of formation

(D) Nothing can be said without reaction

Q29 The work done by a system is 8 *joule,* when 40 *joule* heat is supplied to it. What is the increase in internal energy of system

(A) 25 J

(B) 30 J

(C) 32 J

(D) 28 J

Q30 If gas, at constant temperature and pressure expands then its

(A) Entropy increases and then decreases

(B) Internal energy increases

(C) Internal energy remains the same

(D) Internal energy decreases

Q31 The difference in heat of reaction at constant pressure and at constant volume for the combustion of one mole of liquid benzene at 27° C is;

(A) -3.74 kJ

(B) -2.51 kJ

(C) -4.28 kJ

(D) -1.62 kJ

Q32 Among the following extensive property is;

(A) Density

(B) Refractive index

(C) Temperature

(D) Heat Capacity

Q33 Standard molar enthalpy of formation at 298 K is zero for how many species among the following?

$H(g)$, $O_3(g)$, $F_2(g)$, $Br_2(l)$, C(graphite),

(A) 5   (B) 4

(C) 2   (D) 3

Q34 Which of the following reactions defines $\Delta_c H°$?

(A) $C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g)$

(B) $N_2(g) + O_2(g) \rightarrow 2NO(g)$

(C) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

(D) $C_2H_5OH(l) + \frac{1}{2}O_2(g) \rightarrow C_2H_2(g) + 2H_2O(l)$

Q35 The minimum temperature above which a process will be spontaneous for which $\Delta H = 200$ J mol^{-1} and $\Delta S = 400$ J K^{-1} mol^{-1} is;

(A) 10 K   (B) 5 K

(C) 2 K   (D) 14 K

Q36 An ideal gas undergoes isothermal compression from 5 m^3 to 2 m^3 against a constant external pressure 6 Nm^{-2}. Heat released in the process is used to increase the temperature of 1 mole of Al. The temperature of Al (Molar Heat capacity 24 J mol^{-1} K^{-1}) increases by;

(A) $\frac{2}{3}$ K   (B) $\frac{3}{4}$ K

(C) $\frac{3}{2}$ K   (D) $\frac{4}{3}$ K

Q37 Given below are two statements:

Statement-I : First Law of Thermodynamics is adequate in predicting the direction of a process.

Statement -II: Work appears at the boundary of the system.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is correct but Statement II is incorrect.

(B) Statement I is incorrect but Statement II is correct.

(C) Both Statement I and Statement II are correct.

(D) Both Statement I and Statement II are incorrect.

Q38 For the chemical reaction, $X \rightleftharpoons Y$, $\Delta_r G°$ (in kJ mol^{-1}) $= 120 - \frac{3}{8}T(K)$

The major component of the reaction mixture at temperature T(K) is;

(A) Y if T= 320 K   (B) X if T= 320 K

(C) Y if T= 400 K   (D) X if T= 328 K

Q39 The bond energy of (C = C) and (C-C) are 145 kJ mol^{-1} and 80 kJ mol^{-1} respectively. The ΔH for the polymerisation of ethylene is nearly;

(A) 225 kJ mol^{-1} (B) 125 kJ mol^{-1}

(C) 200 kJ mol^{-1} (D) 65 kJ mol^{-1}

Q40 Match List-I with List-II:

	List I		List II
(A)	$\Delta H > 0$ and $\Delta S > 0$.	(I)	Spontaneous at all temperature
(B)	$\Delta H < 0$ and $\Delta S > 0$.	(II)	Non-spontaneous at all temperature
(C)	$\Delta H > 0$ and $\Delta S < 0$.	(III)	Non-spontaneous at high temperature only
(D)	$\Delta H < 0$ and $\Delta S < 0$.	(IV)	Spontaneous at high temperature only.

Choose the **correct** answer from the options given below:

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

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

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

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

Q41 Identify the process for which $\Delta S < 0$.

(A) Sublimation of dry ice

(B) dissolution of I_2 in water.

(C) dissociation of $CaCO_3(s)$ into CaO(s) and $CO_2(g)$

(D) synthesis of ammonia from N_2 and H_2

Q42 One mole of an ideal gas at 300K in thermal contact with surrounding expands isothermally from 1L to 4L against a constant pressure of 1 atm. In this process, the change in entropy of surroundings is; (Given: 1 L atm = 101.3J)

(A) -2.05 J K^{-1} (B) -1.01 J K^{-1}

(C) -0.58 J K^{-1} (D) -4.25 J K^{-1}

Q43 The maximum work done in expanding 32g of $O_2(g)$ at 300K from 2L to 4L is;

(A) 1.73 kJ　　　　　(B) 2.31 kJ

(C) 0.65 kJ　　　　　(D) 2.92 kJ

Q44 A sample of 0.16 g methane was subjected to combustion at 27°C in a bomb calorimeter. The temperature of calorimeter system (heat capacity = 17.5 kJ K^{-1}) was found to rise by 0.5°C. The ΔU of the process is;

(A) -875 kJ mol^{-1}　　　(B) +935 kJ mol^{-1}

(C) -935 kJ mol^{-1}　　　(D) +875 kJ mol^{-1}

Q45 4.48 L of an ideal gas at STP requires 12 cal to raise its temperature by 15°C at constant volume. The C_p (in cal $mol^{-1} K^{-1}$) of the gas is;

(A) 4　　　　　　　(B) 6

(C) 8　　　　　　　(D) 3

Q46 The average bond enthalpy of N-H bond is;
[Given: $(\Delta_f H°)_{NH_3}$ = -46 kJ mol^{-1},
$BE_{H_2} = 436$ kJ mol^{-1} and
$BE_{N_2} = 712$ kJ mol^{-1}

(A) 225 kJ mol^{-1}　　　(B) 532 kJ mol^{-1}

(C) 352 kJ mol^{-1}　　　(D) 235 kJ mol^{-1}

Q47 If standard enthalpy of combustion of $C_2H_2(g)$, C(graphite) and $H_2(g)$ are -310, -94 and −68 k cal mol^{-1} respectively then the standard enthalpy of formation of $C_2H_2(g)$ will be;

(A) 32 k cal mol^{-1}

(B) 108 k cal mol^{-1}

(C) 78 k cal mol^{-1}

(D) 54 k cal mol^{-1}

Q48 Most stable compound among the following is,

(A) PQ ($\Delta_f H°$ = 142 kJ mol^{-1})

(B) R_2S ($\Delta_f H°$ = -393 kJ mol^{-1})

(C) XY_3 ($\Delta_f H°$ = -46 kJ mol^{-1})

(D) Z_2S_3 ($\Delta_f H°$ = +25 kJ mol^{-1})

Q49 The **correct** option (s) fear the expansion of 1 mole of an ideal gas into vacuum under isolated conditions is/are;

(A) q = 0　　　　　(B) w = 0

(C) $\Delta U = 0$　　　　(D) all of these

Q50 If $\Delta_{sub}H$ of $I_2(s)$ at 200°C is 24 cal g^{-1} and Specific heat of $I_2(s)$ and I_2(Vap) are 0.05 and 0.03 cal $g^{-1}k^{-1}$ respectively, then $\Delta_{sub}H$ of $I_2(s)$ at 250°C will be;

(A) 25 cal g^{-1}

(B) 23 cal g^{-1}

(C) 21 cal g^{-1}

(D) 22 cal g^{-1}

Q51 2 mole of iron is dissolved in HCl at 27°C. The Work involve in open vessel is;

$$Fe \xrightarrow{HCl} FeCl_2 + H_2$$

(A) 3.25 kJ　　　　　(B) 6.66 kJ.

(C) 5.21 kJ　　　　　(D) 4.98 kJ

Q52 Path functions among the following are;

(I) q

(II) W

(III) H-TS

(IV) q+W

(A) II and IV　　　　(B) I and II

(C) I, II and III　　　(D) II, III and IV

Q53 Reversible expansion of an ideal gas under isothermal and adiabatic conditions are as show in figure:
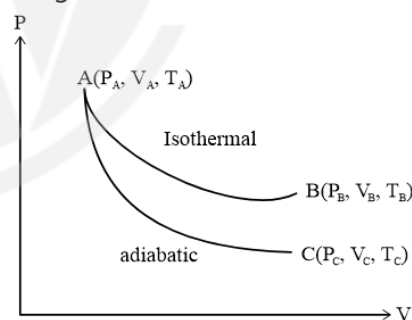
Identify the **incorrect** options?

(A) $T_A = T_B$

(B) $T_C > T_A$

(C) |W| isothermal > |W| adiabatic

(D) $\Delta S_{isothermal} > \Delta S_{adiabatic}$

Q54 For the process at 100°C and 1 atm pressure;
$H_2O(l) \rightarrow H_2O(g)$
The **correct** option is;

(A) $\Delta S_{system} < 0$ and $\Delta S_{surrounding} > 0$

(B) $\Delta S_{system} < 0$ and $\Delta S_{surrounding} < 0$

(C) $\Delta S_{system} > 0$ and $\Delta S_{surrounding} < 0$

(D) $\Delta S_{system} > 0$ and $\Delta S_{surrounding} > 0$

Q55 The bond dissociation enthalpy of X_2, Y_2 and XY are in the ratio of 1 : 0.75 : 1. if $\Delta_f H$ of XY is –100 kJ mol^{-1}, then bond dissociation energy of Y_2 will be;

(A) 800 kJ mol^{-1}

(B) 600 kJ mol^{-1}

(C) 700 kJ mol–1

(D) 750 kJ mol^{-1}

Q56 Given below are two statements:

Statement-I : ΔU does not discriminate between reversible and irreversible process.

Statement-II : The entropy of any pure Crystalline substance approaches zero as the temperature approaches to 0°C

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is correct but Statement II is incorrect.

(B) Statement I is incorrect but Statement II is correct.

(C) Both Statement I and Statement II are correct.

(D) Both Statement I and Statement II are incorrect.

Q57 Calculate $\Delta G°$ for the conversion, $2P(g) \rightleftharpoons Q(g)$ at 300K if Kp for the conversion is 10^{-10}.

(A) 65.24 kJ mol^{-1}

(B) 44.22 kJ mol^{-1}

(C) 32.38 kJ mol^{-1}

(D) 57.44 kJ mol^{-1}

Q58 Enthalpy of which process does **not** represent enthalpy of atomization?

(A) $Na(s) \rightarrow Na(g)$

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

(C) $CH_4(g) \rightarrow C(g) + 4H(g)$

(D) $NaCl(s) \rightarrow Na(s) + \frac{1}{2} Cl_2(g)$

Q59 If water vapour is assumed to be a perfect gas, molar enthalpy change for vaporisation of 1 mol of water at 1 bar and 100°C is 41 kJ mol^{-1}, then the internal energy change when 1 mol of water is vapourised at 1 bar pressure and 100°C will be:
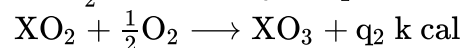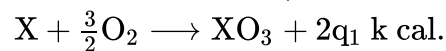
(A) 37.9 kJ mol^{-1}

(B) 31.5 kJ mol^{-1}

(C) 27.2 kJ mol^{-1}

(D) 48.2 kJ mol^{-1}

Q60 Consider the reactions;

$$X + \tfrac{3}{2}O_2 \longrightarrow XO_3 + 2q_1 \text{ k cal.}$$
$$XO_2 + \tfrac{1}{2}O_2 \longrightarrow XO_3 + q_2 \text{ k cal}$$

The enthalpy of formation of XO_2 (in k cal) is;

(A) $2q_1 - q_2$ (B) $q_1 - q_2$

(C) $2q_2 - q_1$ (D) $q_2 - 2q_1$

Answer Key

Q1	(C)		Q31	(A)
Q2	(C)		Q32	(D)
Q3	(C)		Q33	(D)
Q4	(C)		Q34	(C)
Q5	(A)		Q35	(B)
Q6	(A)		Q36	(B)
Q7	(B)		Q37	(B)
Q8	(D)		Q38	(C)
Q9	(B)		Q39	(D)
Q10	(C)		Q40	(A)
Q11	(B)		Q41	(D)
Q12	(C)		Q42	(B)
Q13	(D)		Q43	(A)
Q14	(D)		Q44	(A)
Q15	(B)		Q45	(B)
Q16	(B)		Q46	(C)
Q17	(B)		Q47	(D)
Q18	(D)		Q48	(B)
Q19	(B)		Q49	(D)
Q20	(C)		Q50	(B)
Q21	(D)		Q51	(D)
Q22	(A)		Q52	(B)
Q23	(B)		Q53	(B)
Q24	(B)		Q54	(C)
Q25	(D)		Q55	(B)
Q26	(C)		Q56	(A)
Q27	(D)		Q57	(D)
Q28	(B)		Q58	(D)
Q29	(C)		Q59	(A)
Q30	(C)		Q60	(D)

Hints & Solutions

Q1 Text Solution:

Standard enthalpy of formation:

- $\Delta H_f^\circ(CO_2) = -400 \text{ kJ/mol}$
- $\Delta H_f^\circ(H_2O) = -300 \text{ kJ/mol}$
- $\Delta H_f^\circ(C_6H_{12}O_6) = -1300 \text{ kJ/mol}$

Combustion Reaction of Glucose:
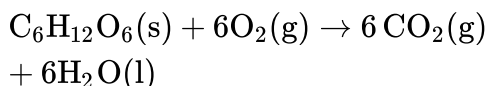
$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6\,CO_2(g)$
$+ 6H_2O(l)$

Standard Enthalpy of Combustion ΔH_{comb}^o

Using

$$\Delta H_{comb}^o = \sum \Delta H_f^o(\text{products}) -$$
$$\sum \Delta H_f^o(\text{reactants})$$

$$= [6 \times (-400) + 6 \times (-300)] - [-1300]$$

$$= [-2400 - 1800] - (-1300)$$

$$= -4200 + 1300 = -2900 \text{ kJ/mol}$$

Molar Mass of Glucose:

$$C_6H_{12}O_6 = 6(12) + 12(1) + 6(16)$$

$$= 72 + 12 + 96 = 180 \text{ g/mol}$$

Combustion per gram:

$$\frac{-2900 \text{ kJ/mol}}{180 \text{ g/mol}} \approx -16.11 \text{ kJ/g}$$

Q2 Text Solution:

To find the **change in entropy of the surroundings** (ΔS_{surr}), we can use the following relationship:

$$\Delta S_{surr} = \frac{q_{surr}}{T}$$

In an isothermal process, the heat exchanged with the surroundings is equal to the negative of the work done by the gas, since internal energy change is zero for an ideal gas:

$$\Delta U = 0 \Rightarrow q = -w$$

Calculate Work Done by the Gas

The gas expands against a constant external pressure:

$$e = -P_{ext}\Delta V$$

Given,

P=3.0 atm

ΔV=2.0–1.0=1.0 L

1 L atm=101.3 J

w=–3.0 L atm= –3.0 × 101.3 = –303.9 J

So, heat absorbed by gas $q_{gas} = -w = 303.9 \text{ J}$

Thus, heat **released** by the surroundings:

$$q_{surr} = -q_{gas} = -303.9 \text{ J}$$

$$\Delta S_{surr} = \frac{q_{surr}}{T} = \frac{-303.9}{300} = -1.013 \text{ JK}^{-1}$$

–1.013 JK⁻¹

Q3 Text Solution:

A property that **does not depend** on the amount of substance present (e.g., temperature, pressure, density, boiling point, pH).
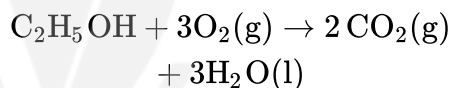
Q4 Text Solution:

ΔU = q + w

w = –70 J

q = 45 J

ΔU = –70 + 45 = – 25 J

Q5 Text Solution:

$$\Delta H = \Delta U + \Delta_{ng} RT$$
$$\Delta H - \Delta U = \Delta_{ng} RT$$
$$C_2H_5OH + 3O_2(g) \rightarrow 2\,CO_2(g)$$
$$+ 3H_2O(l)$$
$$= \frac{-1 \times 8.314 \times 300}{1000} \text{ kJ mol} - 1$$
$$= -2.49 \text{ kJ mol} - 1$$

Q6 Text Solution:

A → B   Volume Constant

B → C   Pressure is constant

C → A   Temperature is constant

Q7 Text Solution:

In an isolated system where **liquid is in equilibrium with its vapour**, both phases are at the same temperature and pressure, but their **molar entropies** differ due to differences in molecular disorder.

Q8 Text Solution:

Irreversible process are fast process

Q9 Text Solution:

For ideal gases, the relation is:

C_P — C_V = nR

Where:

- C_P: Molar heat capacity at constant pressure
- C_V: Molar heat capacity at constant volume
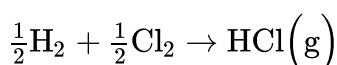- n: Number of moles
- R: Universal gas constant

Q10 Text Solution:

$$\Delta H_r = 3E_{Cl-F}$$

$$E_{Cl-F} = \frac{\Delta H_r}{3}$$

$$= \frac{514}{3} = 171.3 \, kJ$$

Q11 Text Solution:

$$\frac{1}{2}H_2 + \frac{1}{2}Cl_2 \rightarrow HCl\left(g\right)$$

$$(\Delta H_f)_{HCl} = \frac{BDE \, of \, H_2}{2} + \frac{BDE \, of \, Cl_2}{2}$$

– BDE of HCl

$$= \frac{104}{2} + \frac{58}{2} - 103$$

$$\Rightarrow 52 + 29 - 103$$

$$\Rightarrow -22 \, kcal \, mol^{-1}$$

Q12 Text Solution:

$$\Delta H_r^o = 2(\Delta H_f^o)_{NaOH} - 2(\Delta^o H_f)_{H_2O}$$

$$(\Delta H_f^o)_{NaOH} = \frac{\Delta H_r^o + 2(\Delta H_f^o)_{H_2O}}{2}$$

$$\Rightarrow -426.8 \, kJ \, mol^{-1}$$

Q13 Text Solution:

$$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(l)$$
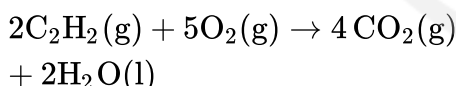
Enthalpy of combustion: ΔH^o = -2601 kJ

$\Delta H_f^o[CO_2(g)]$ = -394 kJ/mol

$\Delta H_f^o[H_2O(l)]$ = -285.8 kJ/mol

Formation enthalpy of products

$4 \times (-394) + 2 \times (-285.8)$ = -1576 + (-571.6) = -2147.6 kJ/mole

Use formula

$$\Delta H_{comb}^o = \Delta H_{products}^o - \Delta H_{reactants}^o$$

Let heat of formation of $C_2H_2(g)$ = x, then:

-2601 = -2147.6 - 2x $\Rightarrow$ 2x = -2147.6 + 2601 = 453.4

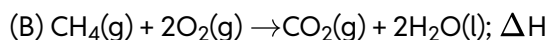$$\Rightarrow x = \frac{453.4}{2} = 226.7 \, kJ/mol$$

Q14 Text Solution:

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$
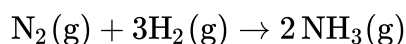
Gas moles: Reactants = 1 + 3 = 4, Products = 2

$$\Delta n_g = 2 - 4 = 2 \Rightarrow \Delta H \neq \Delta E$$

Q15 Text Solution:

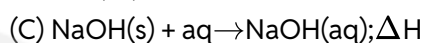(A) $\frac{1}{8}S_8$(Rhombic) + $O_2(g) \rightarrow SO_2(g)$; ΔH
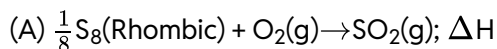
Definition: Standard enthalpy change when 1 mole of a compound is formed from its elements in their standard states. Match: (III) Heat of formation
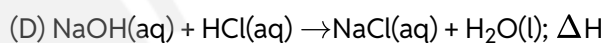
(B) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$; ΔH

Definition: Combustion of one mole of a substance in excess oxygen.

Match: (IV) Heat of combustion.

(C) NaOH(s) + aq $\rightarrow$ NaOH(aq); ΔH

Definition: Dissolution of 1 mole of solute in solvent.

Match: (I) Heat of solution

(D) NaOH(aq) + HCl(aq) $\rightarrow$ NaCl(aq) + $H_2O(l)$; ΔH

Definition: Reaction of acid and base forming salt and water.

Match: (II) Heat of neutralisation

Q16 Text Solution:

The gas (at 0.1 atm) is compressed isothermally by the surroundings (at 1 atm).

- System entropy decreases (due to compression).
- Surrounding entropy increases (heat is released to it).
- Total entropy increases $\Rightarrow$ spontaneous process.

Answer: (B) Entropy of the system decreases, that of surrounding increases.

Q17 Text Solution:

We are given:

- ΔH° = −30 kJ = −30000 J
- ΔS° = −75 J·K^{-1}
- Reaction is spontaneous when $\Delta G^\circ < 0$
- $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

Find temperature when reaction becomes spontaneous

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ < 0$$

$-30000 - T(-75) < 0$
$\Rightarrow -30000 + 75T < 0$
$\Rightarrow 75T < 30000$
$\Rightarrow T < 400 \text{ K}$

Convert 400 K to Celsius

$$T = 400 \text{ K} - 273 = 127^\circ\text{C}$$

So, the reaction is spontaneous at temperatures below 127°C.

Correct Answer: **(B) 120°C**

Q18 Text Solution:
For adiabatic process q = 0.

Q19 Text Solution:
It is a combustion reaction, $\Delta H = -$ ve.

Q20 Text Solution:
$\Delta E = q + w$

Q21 Text Solution:
f = 5
$C_P = \frac{f+2}{2}R$
$C_V = \frac{f}{2}R$
$\gamma = \frac{C_p}{C_v} = \frac{f+2}{f}$
$\gamma = 1.67$
So, correct answer is (D)

Q22 Text Solution:
State function: Depends only on the state, not the path (e.g., internal energy, pressure, temperature).
Extensive property: Depends on the amount of substance (e.g., mass, volume, internal energy).
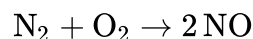
Q23 Text Solution:
$N_2 + O_2 \rightarrow 2NO$
This is an endothermic reaction. Formation of nitric oxide (NO) from nitrogen and oxygen requires a high temperature (energy input) to break the strong triple bond in N_2.

Q24 Text Solution:
For spontaneous change $\Delta G = -$ ve.

Q25 Text Solution:

Use $\Delta H = \Delta E + \Delta n \, RT$
$\Delta H = 19 + 2 \times 2 \times 10^{-3} \times 300$
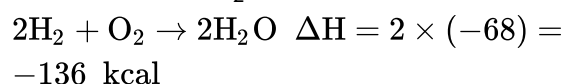$= 20.2 \text{ kcal mol}^{-1}$
$\Delta n = 2$

Q26 Text Solution:
Reverse combustion of CH_4
$CO_2 + 2H_2O \rightarrow CH_4 \quad \Delta H = +213 \text{ kcal}$
Combustion of C(s):
$C + O_2 \rightarrow CO_2 \quad \Delta H = -94 \text{ kcal}$
Combustion of $2H_2$:
$2H_2 + O_2 \rightarrow 2H_2O \quad \Delta H = 2 \times (-68) = -136 \text{ kcal}$
add all reactions:
Total ΔH = (+213) + (-94) + (-136)
ΔH = -17 kcal mol^{-1}
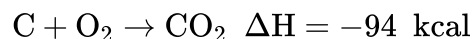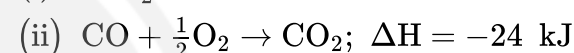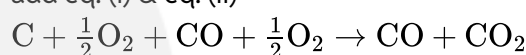
Q27 Text Solution:
(i) $C + \frac{1}{2}O_2 \rightarrow CO; \Delta H = -42 \text{ kJ}$
(ii) $CO + \frac{1}{2}O_2 \rightarrow CO_2; \; \Delta H = -24 \text{ kJ}$
add eq. (i) & eq. (ii)
$C + \frac{1}{2}O_2 + CO + \frac{1}{2}O_2 \rightarrow CO + CO_2$
Cancel CO from both sides:
$C + O_2 \rightarrow CO_2$
This is the formation reaction of CO_2, and the total enthalpy change is:
$\Delta H = -42 + (-24) = -66 \text{ kJ mol}^{-1}$
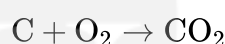
Q28 Text Solution:
Heat of combustion refers to the amount of heat released when one mole of a substance is completely burned in oxygen under standard conditions.

- Since combustion reactions release energy (heat), the enthalpy change (ΔH) is negative.
- This is because the products (usually CO_2 and H_2O) are more stable (lower in energy) than the reactants.
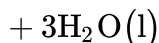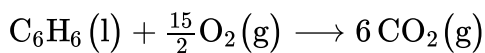
Q29 Text Solution:
$q = 40 \text{ J}$
$w = -8 \text{ J (work done by the system)}$
$\Delta E = q + w = 40 - 8 = 32 \text{ J}$

Q30 Text Solution:

We know that internal energy of a gas depends upon its pressure and temperature. Thus if a gas expands at constant temperature and pressure, then its internal energy remains same.

Q31 Text Solution:

$$C_6H_6\left(l\right) + \frac{15}{2}O_2\left(g\right) \longrightarrow 6\,CO_2\left(g\right)$$
$$+ 3H_2O\left(l\right)$$
$$\Delta n_g = 6 - \frac{15}{2} = -\frac{3}{2}$$
$$\Delta H - \Delta U = \Delta n_g RT$$
$$= -\frac{3}{2} \times 8.314 \times 300$$
= − 3741.3 J
=− 3.743 kJ

Q32 Text Solution:

Heat capacity of a system depends on mass of system so it is an extensive property.

Q33 Text Solution:

- $\Delta_f H°$ is zero in reference state.
- Reference state of H is $H_2(g)$ and O is $O_2(g)$.

Q34 Text Solution:

$\Delta_c H°$ is defined when one mole of compound is completely oxidised.
$$CO(g) + \frac{1}{2}O_2(g)$$
$$\to 4CO_2(g),\ \Delta_r H^° = (\Delta_c H^°)_{CO(g)}$$
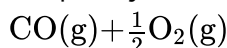
Q35 Text Solution:

$$\Delta G = \Delta H - T\Delta S < 0$$
$$T > \frac{\Delta H}{\Delta S} = \frac{200}{40} = 5\ K$$

Q36 Text Solution:

Q + W = ΔU
Q = -W = -P_{ext} (V_2 - V_1)
= -6 (2-5) = 18 J
For Al, Q = nC ΔT
18 = 1 × 24 × ΔT
$$\Delta T = \frac{18}{24} = \frac{3}{4}\ K$$

Q37 Text Solution:

First Law of Thermodynamics is not adequate in predicting the direction of a process as it is only law of Conservation of Energy.
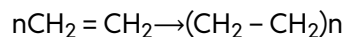
Q38 Text Solution:

at T= 400 K,

$$\Delta_r G^° = 120 - \frac{3}{8} \times 400$$
= −30 kJ mol^{-1}
Since $\Delta_r G°$ is negative so reaction is spontaneous and product (Y) will be major component of Mixture.

Q39 Text Solution:

nCH$_2$ = CH$_2$→(CH$_2$ – CH$_2$)n
ΔH = (BE)$_R$ – (BE)$_P$
= 145 – 80 = 65 kJ mol^{-1}

Q40 Text Solution:

ΔG = ΔH–TΔS
- if ΔH < 0 and ΔS > 0:
ΔG<0 at all temperature.
- if ΔH > 0 and ΔS < 0:
ΔG>0 at all temperature
- if ΔH > 0 and ΔS > 0:
ΔG<0 at High temperature only
- if ΔH < 0 and ΔS < 0:
ΔG > 0 at High temperature only.

Q41 Text Solution:

$CO_2(s) \longrightarrow CO_2(g)$, ΔS>0
$I_2(s) \longrightarrow I_2(aq)$, ΔS>0
$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$, ΔS>0
$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$, ΔS<0
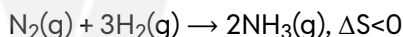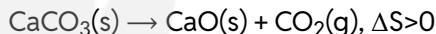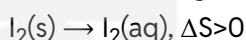
Q42 Text Solution:

Q_{ir-rev} = -W = -P_{ext} (V_2 -V_1)
= -1(4-1) = -3 Latm
$$\Delta S_{surr} = \frac{Q_{ir-rev}}{T} = \frac{-3 \times 101.3}{300}$$
= − 1.013 J K^{-1}

Q43 Text Solution:

$$W = -2.303nRT\log\left(\frac{V_2}{V_1}\right)$$
$$= -2.303 \times 1 \times 8.314 \times 300 \log\left(\frac{4}{2}\right)$$
= −2.303×8.314×300×0.3010 J
|W| = 1.728 kJ

Q44 Text Solution:

$$q = -C\Delta T \times \frac{M}{W}$$
$$= -17.5 \times 0.5 \times \frac{16}{0.16}\ kJ\ mol^{-1}$$
= − 875 kJ mol^{-1}
$$n = -875\ kJ\ mol^{-1}$$
$$\Delta U = q = -875\ kJ\ mol^{-1}$$

Q45 Text Solution:

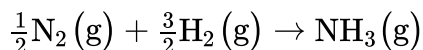$\Delta U = nC_v \Delta T$

$12 = \frac{4 \cdot 48}{22 \cdot 4} \times C_V \times 15$

$C_V = 4 \quad \text{cal mol}^{-1} \text{ K}^{-1}$

$C_P = C_V + R = 4 + 2 = 6 \text{ cal mol}^{-1} \text{ K}^{-1}$

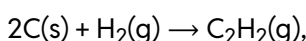**Q46 Text Solution:**

$\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightarrow NH_3(g)$

$\Delta_r H = \sum (BE)_R - \sum (BE)_D$

$-46 = \left[\frac{1}{2} \times 712 + \frac{3}{2} \times 436\right]$

$- [3 \times BE_{N-H}]$

$BE_{N-H} = 352 \text{ kJ mol}^{-1}$

Q47 Text Solution:

$2C(s) + H_2(g) \longrightarrow C_2H_2(g),$

$\left(\Delta_f H^0\right)_{C_2H_2} = \Delta_r H^0$

$= \sum (\Delta_c H)^0_R - \sum (\Delta_c H)^0_r$

$= [2 \times (-94) + (-68)] - [-310]$

= 54 k cal mol⁻¹

Q48 Text Solution:

More the negative $\Delta_f H°$, more will be the stability of compound.

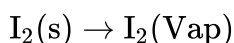**Q49 Text Solution:**

for isolated system, q = 0

In vacuum, $P_{ext} = 0$

$\therefore W = \int P_{ext} \, dV = 0$

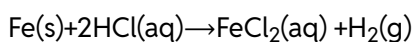$\therefore \Delta U = q + w = 0$

Q50 Text Solution:

$I_2(s) \rightarrow I_2(Vap)$

$\Delta H_2 = \Delta H_1 + \Delta Cp(T_2 - T_1)$

= 24 + (0.03 − 0.05) × (250−200)

=24 cal g⁻¹

Q51 Text Solution:

$Fe(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2(g)$

in open vessel, pressure remains Constant.

$W = -P(V_2 - V_1)$

but $V_{gas} \gg V_{liq.} > V_{solid}.$

$\therefore W = -PV_2 = -(nRT)H_2$

=−2×8.314×300 J

= − 4.98 kJ

Q52 Text Solution:

G = H-TS	:	State function
ΔU=q+W	:	State function
W	:	Path function
q	:	Path function

Q53 Text Solution:

• In adiabatic expansion, Work is done due to loss of internal energy so temperature decreases

Hence

$T_C < T_A$

• In isothermal process temperature remains same so $T_A = T_B$.

• Work is area under P-V curve

so |W| AB>|W|AC

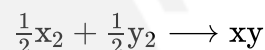**Q54 Text Solution:**

During phase change liquid to gas, randomness increases,

so $\Delta S_{system} > 0$

but at equilibrium, $\Delta S_{Total} = 0$

$\therefore \Delta S_{surrounding} < 0.$

Q55 Text Solution:

$\frac{1}{2}x_2 + \frac{1}{2}y_2 \longrightarrow xy$

$\Delta H = (BE)_R - (BE)_P$

$-100 = \left[\frac{1}{2}(a) + \frac{1}{2}(0.75a) - [a]\right]$

a = 800 kJ mol⁻¹

$\therefore$ Bond energy of $Y_2 = 0.75a$

= 0.75 × 800

= 600 kJ mol⁻¹

Q56 Text Solution:

The entropy of any pure crystalline substance approaches zero as the temperature approaches to − 273°C (absolute zero).

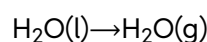**Q57 Text Solution:**

$\Delta G° = -2.303 \, RT \log K_p$

=−2.303×8.314×300 log 10⁻¹⁰

= +2.303×8.314×300×10 J mol⁻¹

= 57.44 kJ mol⁻¹

Q58 Text Solution:

Enthalpy of atomization is the enthalpy change on breaking one mole of bonds completely to obtain atoms in the gas phase.
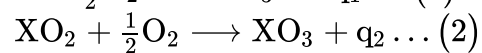
Q59 Text Solution:

$H_2O(l) \rightarrow H_2O(g)$

$\Delta U = \Delta H - \Delta n_g RT$

= 41–1×8.31×10^{-3} × 373

= 37.9 kJ mol^{-1}

Q60 **Text Solution:**

$X + \frac{3}{2}O_2 \longrightarrow XO_3 + 2q_1 \ldots (1)$

$XO_2 + \frac{1}{2}O_2 \longrightarrow XO_3 + q_2 \ldots (2)$

applying eq(1) - eq(2),

$X + O_2 \longrightarrow XO_2 + 2q_1 - q_2$

$\therefore \Delta H = -(2q_1 - q_2)$

$= q_2 - 2q_1 \text{ k cal}$