

Q1. JEE Main 2026 (21 January Shift 2)

Consider the following data:

$$\Delta_f H^\ominus (\text{methane, g}) = -X \text{ kJ mol}^{-1}$$

$$\text{Enthalpy of sublimation of graphite} = Y \text{ kJ mol}^{-1}$$

$$\text{Dissociation enthalpy of } H_2 = Z \text{ kJ mol}^{-1}$$

The bond enthalpy of C – H bond is given by :

$$(1) \frac{-X+Y+Z}{4}$$

$$(2) \frac{X+Y+4Z}{2}$$

$$(3) \frac{X+Y+2Z}{4}$$

$$(4) X + Y + Z$$

Q2. JEE Main 2026 (23 January Shift 1)

A cup of water at 5°C (system) is placed in a microwave oven and the oven is turned on for one minute during which the water begins to boil. Which of the following option is true ?

$$(1) q = +ve, w = 0, \Delta U = -ve$$

$$(2) q = +ve, w = -ve, \Delta U = -ve$$

$$(3) q = -ve, w = -ve, \Delta U = -ve$$

$$(4) q = +ve, w = -ve, \Delta U = +ve$$

Q3. JEE Main 2026 (28 January Shift 2)

The plot of $\log_{10} K$ vs $\frac{1}{T}$ gives a straight line. The intercept and slope respectively are (where K is equilibrium constant).

$$(1) \frac{\Delta S^\ominus}{2.303R}, -\frac{\Delta H^\ominus}{2.303R}$$

$$(2) -\frac{\Delta S^\ominus R}{2.303}, \frac{\Delta H^\ominus R}{2.303}$$

$$(3) \frac{2.303R}{\Delta H^\ominus}, \frac{2.303R}{\Delta S^\ominus}$$

$$(4) -\frac{\Delta H^\ominus}{2.303R}, \frac{\Delta S^\ominus}{2.303R}$$

Q4. JEE Main 2026 (24 January Shift 2)

The heat of atomisation of methane and ethane are 'x' kJ mol^{-1} and 'y' kJ mol^{-1} respectively. The longest wavelength (λ) of light capable of breaking the C – C bond can be expressed in SI unit as:

$$(1) \frac{N_A hc}{250(4y-6x)}$$

$$(2) \frac{hc}{1000} \left(\frac{y-6x}{4} \right)^{-1}$$

$$(3) \frac{N_A hc}{250(y-6x)}$$

$$(4) N_A hc \left(y - \frac{6x}{4} \right)^{-1}$$

Q5. JEE Main 2026 (22 January Shift 2)

If the enthalpy of sublimation of Li is 155 kJ mol^{-1} , enthalpy of dissociation of F_2 is 150 kJ mol^{-1} , ionization enthalpy of Li is 520 kJ mol^{-1} , electron gain enthalpy of F is -313 kJ mol^{-1} , standard enthalpy of formation of LiF is -594 kJ mol^{-1} . The magnitude of lattice enthalpy of LiF is _____ kJ mol^{-1} . (Nearest Integer)

Q6. JEE Main 2026 (22 January Shift 1)

Match the LIST-I with LIST-II

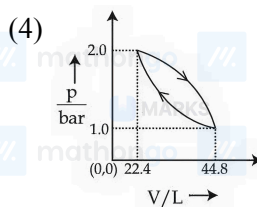
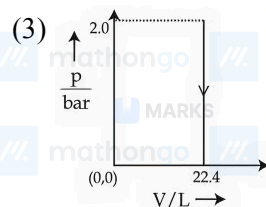
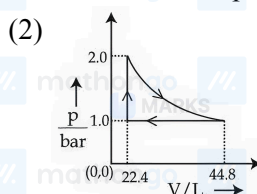
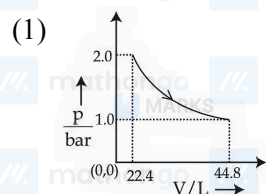
	List-I (Thermodynamic Process)		List-II (Magnitude in kJ)
A.	Work done in reversible, isothermal expansion of 2 mol ideal gas from 2 dm ³ to 20 dm ³ at 300 K	I.	4
B.	Work done in irreversible isothermal expansion of 1 mol ideal gas from 1 m ³ to 3 m ³ at 300 K against constant pressure 3 kPa	II.	11.5
C.	Change in internal energy for adiabatic expansion of 1 mol ideal gas, $\Delta T = 320$ K, $\bar{C}_V = \frac{3}{2}R$	III.	6
D.	Change in enthalpy at constant pressure of 1 mol ideal gas, $\Delta T = 337$ K, $\bar{C}_p = \frac{5}{2}R$	IV.	7

Choose the correct answer from the options given below:

- (1) A-II, B-III, C-I, D-IV
(2) A-III, B-II, C-IV, D-I
(3) A-II, B-I, C-III, D-IV
(4) A-I, B-II, C-III, D-IV

Q7. JEE Main 2026 (21 January Shift 1)

Which of the following graphs between pressure 'p' versus volume 'V' represents the maximum work done?



Q8. JEE Main 2026 (21 January Shift 1)

Use the following data :

Substance	$\Delta_f H^\ominus(500\text{ K})$ kJ mol^{-1}	$S^\ominus(500\text{ K})$ $\text{JK}^{-1}\text{ mol}^{-1}$
AB(g)	32	222
A ₂ (g)	6	146
B ₂ (g)	x	280

One mole each of A₂(g) and B₂(g) are taken in a 1 L closed flask and allowed to establish the equilibrium at 500 K. A₂(g) + B₂(g) $\rightleftharpoons$ 2AB(g) The value of x (in kJ mol^{-1}) is _____. (Nearest integer)
(Given : $\log K = 2.2$ $R = 8.3\text{ J K}^{-1}\text{ mol}^{-1}$)

Q9. JEE Main 2026 (28 January Shift 1)

20.0 dm³ of an ideal gas 'X' at 600 K and 0.5 MPa undergoes isothermal reversible expansion until pressure of the gas is 0.2 MPa. Which of the following option is correct?

(Given: $\log 2 = 0.3010$ and $\log 5 = 0.6989$)

- (1) $w = -9.1\text{ kJ}$, $\Delta U = 0$, $\Delta H = 0$, $q = 9.1\text{ kJ}$
- (2) $w = +4.1\text{ kJ}$, $\Delta U = 0$, $\Delta H = 0$; $q = -4.1\text{ kJ}$
- (3) $w = 9.1\text{ J}$, $\Delta U = 9.1\text{ J}$, $\Delta H = 0$; $q = 0$
- (4) $w = -3.9\text{ kJ}$, $\Delta U = 0$, $\Delta H = 0$; $q = 3.9\text{ kJ}$

Q10. JEE Main 2026 (24 January Shift 1)

Match the LIST-I with LIST-II

List-I	Isothermal process for ideal gas system	List-II	Work done ($V_f > V_i$)
A.	Reversible expansion	I.	$w = 0$
B.	Free expansion	II.	$w = -nRT \ln \frac{V_f}{V_i}$
C.	Irreversible expansion	III.	$w = -p_{\text{ex}}(V_f - V_i)$
D.	Irreversible compression	IV.	$w = -p_{\text{ex}}(V_i - V_f)$

Choose the correct answer from the options given below:

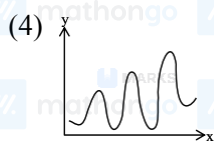
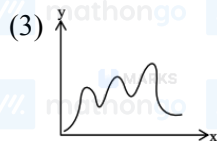
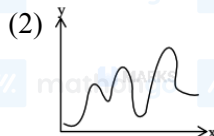
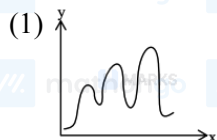
- (1) A-I, B-III, C-II, D-IV
- (2) A-II, B-I, C-III, D-IV
- (3) A-IV, B-I, C-III, D-II
- (4) A-IV, B-II, C-III, D-I

Q11. JEE Main 2026 (24 January Shift 1)

A $\rightarrow$ D is an endothermic reaction occurring in three steps (elementary).



Which of the following graphs between potential energy (y -axis) vs reaction coordinate (x -axis) correctly represents the reaction profile of $A \rightarrow D$?



ANSWERS AND SOLUTIONS

1. (3) 2. (4) 3. (1) 4. (1) 5. 1031 6. (1) 7. (1) 8. 70
9. (1) 10. (2) 11. (1)

1. (3) For methane formation: $C(g) + 2H_2(g) \rightarrow CH_4(g)$.

Using enthalpy balance: $\Delta_f H^\circ = \text{Bonds broken} - \text{Bonds formed}$.

Breaking: sublimation of C (Y) and 2 H-H bonds (2Z); Forming: 4 C-H bonds.

Energy equation: $-X = Y + 2Z - 4B$ where B is C-H bond enthalpy.

Solving: $4B = X + Y + 2Z$, so $B = \frac{X+Y+2Z}{4}$.

2. (4) For water heating in a microwave:

Heat (q): The microwave radiates electromagnetic energy that is absorbed by water molecules, so $q = +ve$

Work (w): As water heats and boils, it expands against atmospheric pressure. The system does work on the surroundings, so $w = -ve$

Internal Energy (ΔU): From the first law, $\Delta U = q + w$. Since heat absorbed (+ve) is much larger in magnitude than work done against atmosphere (-ve), the net change is $\Delta U = +ve$ (confirmed by temperature increase from $5^\circ C$ to boiling)

Therefore: $q = +ve$, $w = -ve$, $\Delta U = +ve$

3. (1) The relationship between the standard Gibbs free energy change and the equilibrium constant is given by $\Delta G^\circ = -RT \ln K$.

We also know that $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$.

Equating the two expressions: $-RT \ln K = \Delta H^\circ - T\Delta S^\circ$.

Dividing by $-RT$, we get: $\ln K = -\frac{\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R}$.

To convert natural log to base 10, use $\ln K = 2.303 \log_{10} K$:

$2.303 \log_{10} K = -\frac{\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R}$.

Dividing by 2.303: $\log_{10} K = -\frac{\Delta H^\circ}{2.303RT} + \frac{\Delta S^\circ}{2.303R}$.

Rearranging in the form of a straight line equation $y = mx + c$ where $y = \log_{10} K$ and $x = \frac{1}{T}$:

$\log_{10} K = \left(-\frac{\Delta H^\circ}{2.303R}\right) \frac{1}{T} + \frac{\Delta S^\circ}{2.303R}$.

Comparing the terms:

Intercept (c) = $\frac{\Delta S^\circ}{2.303R}$

Slope (m) = $-\frac{\Delta H^\circ}{2.303R}$.

4. (1) Heat of atomization: CH_4 has x kJ/mol (4 C-H bonds), C_2H_6 has y kJ/mol (1 C-C + 6 C-H bonds)

Let C-H bond energy = a, C-C bond energy = b

Then: $x = 4a$ and $y = b + 6a$

Solving: $a = x/4$, so $b = y - 6x/4 = (4y - 6x)/4$ kJ/mol

Converting to J/mol: $b = (4y - 6x) \times 250$ J/mol

Using $E = \frac{hc}{\lambda}$ and $\lambda = \frac{hc}{E}$:

$$\lambda = \frac{N_A hc}{250(4y-6x)} \text{ (in SI units)}$$

5. (1031) Using Born-Haber cycle:

$$\Delta H_f(LiF) = \Delta H_{sub}(Li) + \frac{1}{2}\Delta H_{diss}(F_2) + \Delta H_{ie}(Li) + \Delta H_{eg}(F) - U_{lattice}$$

$$\text{Substituting values: } -594 = 155 + \frac{1}{2}(150) + 520 + (-313) - U_{lattice}$$

$$-594 = 155 + 75 + 520 - 313 - U_{lattice}$$

$$-594 = 437 - U_{lattice}$$

$$U_{lattice} = 437 + 594 = 1031 \text{ kJ/mol}$$

6. (1) Calculate each thermodynamic quantity:

A. Reversible isothermal expansion (2 mol, 2→20 dm³, 300 K):

$$W = nRT \ln(V_2/V_1) = 2 \times 8.314 \times 300 \times \ln(10) = 2 \times 8.314 \times 300 \times 2.303 = 11,481 \text{ J} \approx 11.5 \text{ kJ} \rightarrow \text{II}$$

B. Irreversible isothermal expansion (1 mol, 1→3 m³, 3 kPa constant pressure):

$$W = P_{ext} \Delta V = 3000 \times (3 - 1) = 6000 \text{ J} = 6 \text{ kJ} \rightarrow \text{III}$$

C. Adiabatic expansion (1 mol, $\Delta T = -320 \text{ K}$, $C_V = \frac{3}{2}R$):

$$\Delta U = nC_V |\Delta T| = 1 \times \frac{3}{2} \times 8.314 \times 320 = 3,991 \text{ J} \approx 4 \text{ kJ} \rightarrow \text{I}$$

D. Enthalpy change (1 mol, $\Delta T = 337 \text{ K}$, $C_p = \frac{5}{2}R$):

$$\Delta H = nC_p \Delta T = 1 \times \frac{5}{2} \times 8.314 \times 337 = 7,016 \text{ J} \approx 7 \text{ kJ} \rightarrow \text{IV}$$

Matching: A-II, B-III, C-I, D-IV

7. (1) In a pressure-volume ($P - V$) graph, the magnitude of work done is represented by the area under the curve bounded by the volume axis.

Let's analyze the area under the curve for each graph:

Graph (1) represents an expansion from $V = 22.4 \text{ L}$ to $V = 44.8 \text{ L}$. The area is the integral $\int_{22.4}^{44.8} P dV$, which covers a significant region under the curve.

Graph (2) represents a cyclic process. The net work done is the area enclosed by the loop. This area is much smaller than the total area under the expansion curve in graph (1).

Graph (3) represents an isochoric process (constant volume $V = 22.4 \text{ L}$). Since $dV = 0$, the work done

$$W = \int P dV = 0.$$

Graph (4) also represents a cyclic process. Similar to graph (2), the net work done is the area enclosed by the loop, which is smaller than the area under the expansion curve in graph (1).

Comparing all cases, the expansion process in graph (1) covers the maximum area under the $P - V$ curve, thus representing the maximum work done.

8. (70) Reaction: $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$

$$\Delta G^\circ = -2.303RT \log K = -2.303 \times 8.3 \times 500 \times 2.2 = -21026 \text{ J/mol} = -21.03 \text{ kJ/mol}$$

$$\Delta S^\circ = 2(222) - [146 + 280] = 444 - 426 = 18 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta H^\circ = 2(32) - [6 + x] = (58 - x) \text{ kJ/mol}$$

$$\text{Using } \Delta G^\circ = \Delta H^\circ - T\Delta S^\circ:$$

$$-21.03 = (58 - x) - (500 \times 0.018)$$

$$-21.03 = 58 - x - 9 = 49 - x$$

$$x = 49 + 21.03 = 70.03 \approx 70 \text{ kJ/mol}$$

9. (1) For isothermal reversible process $\Delta U = \Delta H = 0$

$$w_{iso} = -p_1 v_1 \ln \frac{P_1}{P_2}$$

$$w_{iso} = -0.5 \times 10^6 \times 20 \times 10^{-3} \ln \frac{0.5}{0.2}$$

$$w_{iso} = -0.5 \times 10^6 \times 20 \times 10^{-3} \times 2.303 \times (.6989 - .3010)$$

$$w \simeq -9.1 \text{ kJ}$$

$$q = -w = 9.1 \text{ kJ}$$

10. (2) Matching isothermal processes with work expressions:

A. Reversible expansion: In a reversible isothermal expansion from V_i to V_f (where $V_f > V_i$), the gas does work against external pressure equal to the surroundings. The work is $w = nRT \ln \frac{V_f}{V_i}$, matching II.

B. Free expansion: The gas expands into a vacuum with no external pressure opposition. No work is done: $w = 0$, matching I.

C. Irreversible expansion: Isothermal expansion from V_i to V_f against constant external pressure p_{ex} . Work done is $w = -p_{ex}(V_f - V_i)$, matching III.

D. Irreversible compression: Isothermal compression from V_i to V_f (where $V_f < V_i$) against constant external pressure. Work is $w = -p_{ex}(V_i - V_f)$, matching IV.

The correct pairings are A-II, B-I, C-III, D-IV.

11. (1) The reaction $A \rightarrow D$ occurs through three elementary steps with energy changes:

Step (i): $A \rightarrow B$ is endothermic ($\Delta H_I = +ve$), so B has higher energy than A, creating the first peak.

Step (ii): $B \rightarrow C$ is exothermic ($\Delta H_{II} = -ve$), so C has lower energy than B, creating a lower second peak.

Step (iii): $C \rightarrow D$ is exothermic ($\Delta H_{III} = -ve$), so D has lower energy than C, creating an even lower third feature.

Overall reaction: Since step (i) is endothermic and steps (ii) and (iii) are exothermic, the reaction can be endothermic overall depending on the magnitudes. The overall energy change is positive ($A \rightarrow D$ is endothermic), meaning D must be at higher energy than A.

The reaction profile must show three distinct peaks/steps with the final product D positioned higher than the initial reactant A.

(1) correctly depicts this three-step mechanism with proper energy relationships and overall endothermic character.