Chemical Thermodynamics JEE Main PYQ - 2

Total Time: 25 Minute **Total Marks:** 40

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

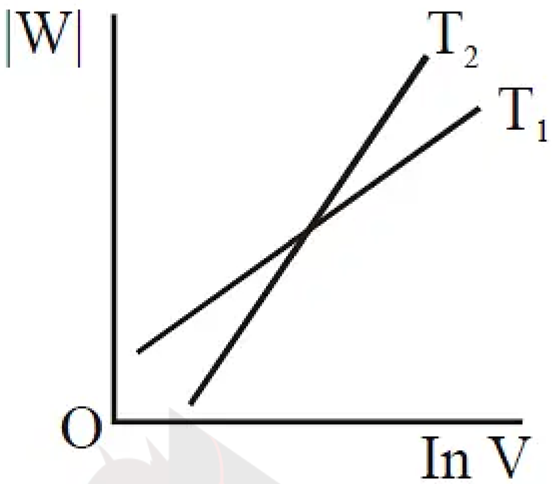
Navigating & Answering a Question

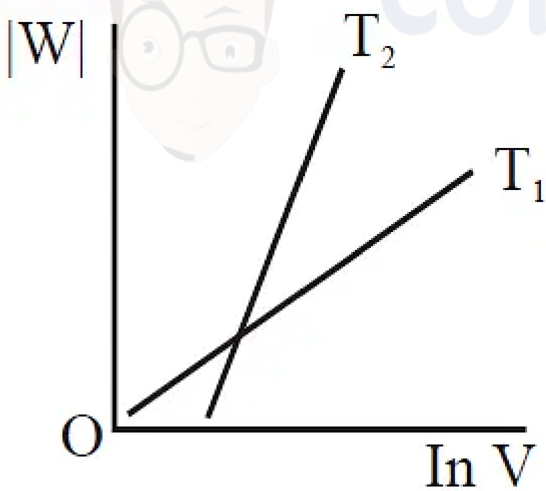
1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

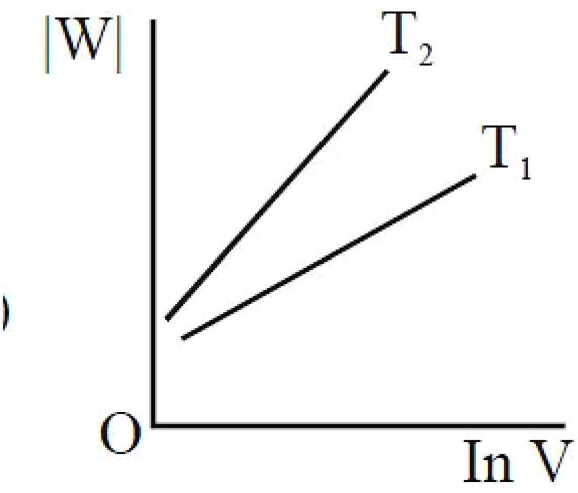
Chemical Thermodynamics

1. Consider the reversible isothermal expansion of an ideal gas in a closed system at two different temperatures T_1 and $T_2 (T_1 < T_2)$. The correct graphical depiction of the dependence of work done (w) on the final volume (V) is: **(+4, -1)**

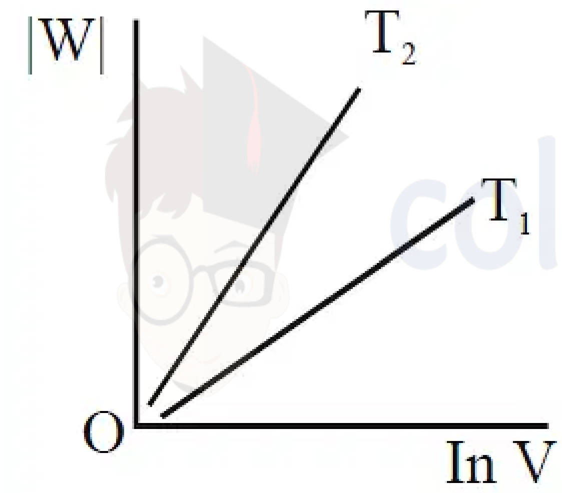
[Jan. 9, 2019 (I)]

a. 

b. 



c.



d.

2. ΔU is equal to : (+4, -1)

[2017]

a. Adiabatic work

b. Isothermal work

c. Isochoric work

d. Isobaric work

3. During compression of a spring the work done is $10\,kJ$ and $2\,kJ$ escaped to the surroundings as heat. The change in internal energy, $\Delta U(in\,kJ)$ is: (+4, -1)

[April•9,•2019•(II)]

a. 8

b. 12

c. -12

d. -8

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4. Enthalpy of sublimation of iodine is $24\ cal\ g^{-1}$ at $200°C$. If specific heat of $I_2(s)$ and $I_2(vap)$ are 0.055 and $0.031\ cal\ g^{-1} K^{-1}$ respectively, then enthalpy of sublimation of iodine at $250°C$ in $cal\ g^{-1}$ is : **(+4, -1)**

[April 12, 2019(I)]

a. 2.85

b. 11.4

c. 5.7

d. 22.8

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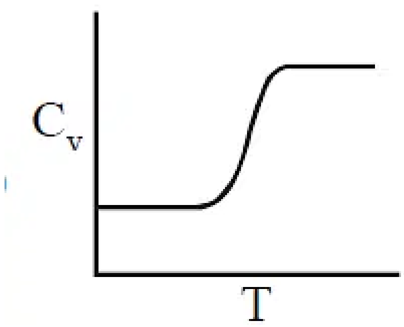
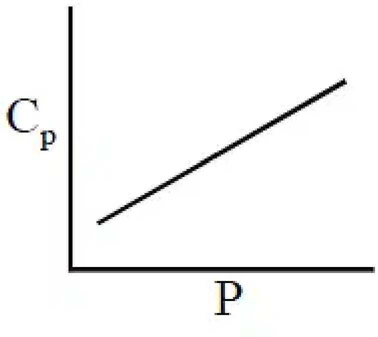
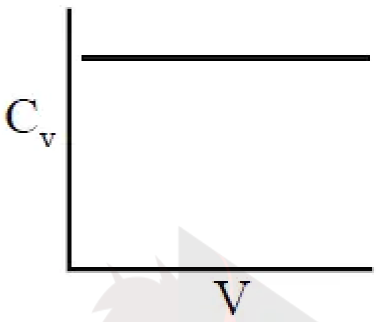
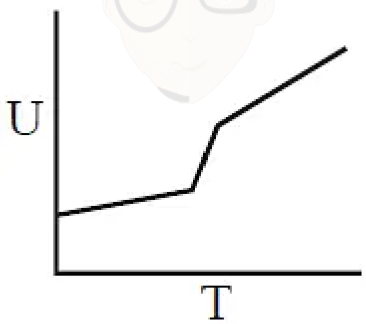
5. For diatomic ideal gas in a closed system, which of the following plots does not correctly describe the relation between various thermodynamic quantities ? **(+4, -1)**

[Jan. 12, 2019 (I)]

a. 

b. 

c. 

d. 

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6. For silver, $C_p(JK^{-1}mol^{-1}) = 23 + 0.01T$. If the temperature (T) of 3 moles of silver is raised from $300\,K$ to $1000\,K$ at $1\,atm$ pressure, the value of ΔH will be close to **(+4, -1)**

[April 8, 2019 (I)]

a. 21 kJ

b. 16 kJ

c. 13 kJ

d. 62 kJ

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7. For the complete combustion of ethanol, $C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$, the amount of heat produced as measured in bomb calorimeter, is $1364.47\, kJ\, moI^{-1}$ at $25°$C. Assuming ideality the enthalpy of combustion, $\Delta_C H$, for the reaction will be $(R = 8.314\, J\, K^{-1}\ mol^{-1})$ **(+4, -1)**

[2014]

a. $-1366.95\, kJ\, moI^{-1}$

b. $-1361.95\, kJ\, moI^{-1}$

c. $-1460.50\, kJ\, moI^{-1}$

d. $-1350.50\, kJ\, moI^{-1}$

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8. For which of the following reactions, ΔH is equal to ΔU ? **(+4, -1)**

[Online April 15, 2018 (I)]

a. $N_2(g) + 3H2(g) -> 2NH_3(g)$

b. $2HI(g) -> H_2(g) + I_2(g)$

c. $2NO_2(g) -> N_2O_4(g)$

d. $2SO_2(g) + O_2(g) -> 2SO_3(g)$

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9. The enthalpy change for the conversion of $\frac{1}{2}Cl_2(g)$ to $Cl^-(aq)$ is (-)______________ $KJmol^{-1}$ (Nearest integer) **(+4, -1)**

Given : $\Delta_{\text{dis}}\, H^{\ominus}_{Cl_{2(g)}} = 240\, kJ\, mol^{-1}$, $\Delta_{eg} H^{\ominus}_{Cl} = -350\, kJ\, mol^{-1}$, $\Delta_{\text{hyd}}\, H^{\theta} Cl^-_{(g)} = -380\, kJ\, mol^{-1}$

[31-Jan-2023•Shift•1]

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10. The value of $log_{10}K$ for a reaction A ⇋ B is **(+4, -1)**

(Given, **[6-Apr-2023•shift•1]**

ΔH°_{298K} = −54.67 kJ mol^{-1}

ΔH°_{298K} = 10 kJ mol^{-1}

and R = 8.314 J $K^{-1}mol^{-1}$

$2.303 \times 8.314 \times 298 = 5705)$

Answers

1. **Answer: b**

Explanation:

$w = -nRTIn\frac{V_2}{V_1}$ $w = -nRTln\frac{V_b}{V_i}$ $|w| = nRTln\frac{V_b}{V_i}$ $|w| = nRT\left(lnV_b - lnV_i\right)$ $|w| = nRTlnV_b - nRTlnV_i$ $Y = mx - C$ So, slope of curve 2 is more than curve 1 and intercept of curve 2 is more negative then curve 1.

Concepts:

1. **Thermodynamics:**

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Laws of Thermodynamics

Zeroth Law of Thermodynamics

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The Second law of thermodynamics is a physical law of thermodynamics about heat and loss in its conversion.

Third Law of Thermodynamics

Third law of thermodynamics states, regarding the properties of closed systems in thermodynamic equilibrium: The entropy of a system approaches a constant value when its temperature approaches absolute zero.

2. **Answer: a**

Explanation:

For adiabatic process, $q=0$ $\therefore$ As per 1^{st} law of thermodynamics, $\Delta U = W$

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3. **Answer: a**

Explanation:

$\Delta U = q + w \;\; q = -2\,kJ, W = 10\,kJ \;\; \Delta U = 8\,kJ$

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4. **Answer: d**

Explanation:

$I_{2(s)} -> I_{2(g)}$: $\Delta H_1 = 24\ cal/g\ at\ 200°C$ $\Delta H_2 = \Delta H_1 + \Delta C_{P_{rxn}}(T_2 - T_1)$ = $24 + (0.031 - 0.055) \times 50$ = $24 - 1.2$ = $22.8\,Cal/g$

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5. **Answer: b**

Explanation:

At higher temperature, rotational degree of freedom becomes active. $C_P = \frac{7}{2}R$ (Independent of P) $C_V = \frac{5}{2}R$ (Independent of V) Variation of U vs T is similar as C_V vs T.

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6. **Answer: d**

Explanation:

$\Delta H = n \int_{T_1}^{T_2} C_{p,m} dT = 3 \times \int_{300}^{1000} (23 + 0.01T)\, dT = 3\left[23\,(1000 - 300) + \frac{0.01}{2}\left(1000^2 - 300^2\right)\right] = 61950J \approx 2kJ$

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7. **Answer: a**

Explanation:

$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$ Bomb calorimeter gives ΔU of the reaction So, as per question $\Delta U = -1364.47\, kJ\, mol^{-1}$ $\Delta g_g = -1$ $\Delta H = \Delta U + \Delta n_g RT = -1364.47 - \frac{1 \times 8.314 \times 298}{1000} = -1366.93\, kJ\, mol^{-1}$

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8. **Answer: b**

Explanation:

The correct option is(B): $2HI(g)->H_2(g)+I_2(g)$.

We know $\Delta H=\Delta U+\Delta n_g RT$ where $\Delta n_g=$ gaseous moles of products - gaseous moles of reactants For reaction $2HI(g)\rightarrow H_2(g)+I_2(g)$; $\Delta n_g=2-2=0$ Therefore, from E (1), we get $\Delta H=\Delta U$

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9. **Answer: -610 - -610**

Explanation:

$$\frac{1}{2}Cl_{2(g)} \rightarrow Cl_{(g)} \rightarrow Cl^{-}_{(g)} \rightarrow Cl^{-}_{(aq.)}$$
$$\Delta H^{\circ} = \frac{1}{2} \times 240 + (-350) + (-380)$$
$$= -610$$

The correct answer is -610

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Third law of thermodynamics states, regarding the properties of closed systems in thermodynamic equilibrium: The entropy of a system approaches a constant value when its temperature approaches absolute zero.

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10. **Answer: 10 - 10**

Explanation:

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

= −54.07 × 1000 − 298 × 10

= −57050 ΔG°

= −2.303 RTlog_{10}K

logK = 10

Concepts:

1. Thermodynamics:

Thermodynamics in physics is a branch that deals with heat, work and temperature, and their relation to energy, radiation and physical properties of matter.

Important Terms

System

A thermodynamic system is a specific portion of matter with a definite boundary on which our attention is focused. The system boundary may be real or imaginary, fixed or deformable.

There are three types of systems:

- **Isolated System –** An isolated system cannot exchange both energy and mass with its surroundings. The universe is considered an isolated system.
- **Closed System –** Across the boundary of the closed system, the transfer of energy takes place but the transfer of mass doesn't take place. Refrigerators and compression of gas in the piston-cylinder assembly are examples of closed systems.
- **Open System –** In an open system, the mass and energy both may be transferred between the system and surroundings. A steam turbine is an example of an open system.

Thermodynamic Process

A system undergoes a thermodynamic process when there is some energetic change within the system that is associated with changes in pressure, volume and internal energy.

There are four types of thermodynamic process that have their unique properties, and they are:

- **Adiabatic Process** – A process in which no heat transfer takes place.
- **Isochoric Process** – A thermodynamic process taking place at constant volume is known as the isochoric process.
- **Isobaric Process** – A process in which no change in pressure occurs.
- **Isothermal Process** – A process in which no change in temperature occurs.

Laws of Thermodynamics

Zeroth Law of Thermodynamics

The Zeroth law of thermodynamics states that if two bodies are individually in equilibrium with a separate third body, then the first two bodies are also in thermal equilibrium with each other.

First Law of Thermodynamics

The First law of thermodynamics is a version of the law of conservation of energy, adapted for thermodynamic processes, distinguishing three kinds of transfer of energy, as heat, as thermodynamic work, and as energy associated with matter transfer, and relating them to a function of a body's state, called internal energy.

Second Law of Thermodynamics

The Second law of thermodynamics is a physical law of thermodynamics about heat and loss in its conversion.

Third Law of Thermodynamics

Third law of thermodynamics states, regarding the properties of closed systems in thermodynamic equilibrium: The entropy of a system approaches a constant value when its temperature approaches absolute zero.