Chemical Thermodynamics JEE Main PYQ - 1

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

Instructions

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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. For a reaction, $A_{(g)} \rightarrow A_{(l)}; \Delta H = -3RT$. The correct statement for the reaction is : **(+4, -1)**

[Online April 8,2017]

a. $\Delta H = \Delta U \neq O$

b. $\Delta H = \Delta U = O$

c. $|\Delta H| < |\Delta U|$

d. $|\Delta H| > |\Delta U|$

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2. The true statement amongst the following is : **(+4, -1)**

[Jan 09,2020 (II)]

a. S ia function of temperature but ΔS is not a function of temperature

b. Both ΔS and S are functions of temperature

c. Both S and ΔS are not functions of temperature

d. S is not a function of temperature but ΔS is a function of temperature

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3. For which of the following processes, ΔS is negative ? **(+4, -1)**

[Online April 16, 2018]

a. $H_2(g) \rightarrow 2H(g)$

b. $N_2(g, 1atm) \rightarrow N_2(g, 5atm)$

c. $C(\text{ diamond }) \rightarrow C(\text{ graphite })$

d. $N_2(g, 273K) \rightarrow N_2(g, 300K)$

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4. Which of following lines correctly show the temperature dependence of equilibrium constant K, for an exothermic reaction ? **(+4, -1)**

a. A and B

b. B and C

c. C and D

d. A and D

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5. $\Delta_r G^\circ$ at $500\,K$ for substance 'S' in liquid state and gascous state are $+100.7\,kcal\,mol^{-1}$ and $+103\,kcal\,mol^{-1}$, respectively. Vapour pressure of liquid ' S ' at $500\,K$ is approximately equal to $\left(R = 2\,cal K^{-1}\,mol^{-1}\right)$ **(+4, -1)**

[Online April 15, 2018(II)]

a. 0.1 atm

b. 1 atm

c. 10 atm

d. 100 atm

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6. Which one of the following equations does not correctly represent the first law of thermodynamics for the given processes involving an ideal gas ? (Assume non-expansion work is zero) **(+4, -1)**

[April 8, 2019 (I)]

a. Cyclic process : $q = -w$

b. Isothermal process : $q = -w$

c. Adiabatic process : $\Delta U = -w$

d. Isochoric process : $\Delta U = q$

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7. 5 moles of an ideal gas at $100\,K$ are allowed to undergo reversible compression till its temperature becomes $200\,K$. If $C_V = 28 J K^{-1} mol^{-1}, caculate \Delta U$ and ΔpV for this process. ($= 8.0$ **(+4, -1)**

a. $\Delta U = 14\,kJ : \Delta\left(pV\right) = 4\,kJ$

b. $\Delta U = 14\,kJ : \Delta\left(pV\right) = 18\,kJ$

c. $\Delta U = 2.8\,kJ : \Delta\left(pV\right) = 0.8\,kJ$

d. $\Delta U = 14\,kJ : \Delta\left(pV\right) = 0.8\,kJ$

8. An ideal gas undergoes isothermal expansion at constant pressure. During the process : **(+4, -1)**

[Online April 9, 2017]

a. enthalpy increases but entropy decreases.

b. enthalpy remains constant but entropy increases

c. enthalpy decreases but entropy increases.

d. Both enthalpy and entropy remain constant .

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9. The enthalpy of vaporisation of a substance is 8400 $^{-1}$ and its boiling point is −173.15 . The entropy change for vaporisation is: **(+4, -1)**

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10. $0.3\,g$ of ethane undergoes combustion at $27^{\circ}C$ in a bomb calorimeter The temperature of calorimeter system (including the water) is found to rise by $05^{\circ}C$ The heat evolved during combustion of ethane at constant pressure is ___ $kJ\,mol^{-1}$ (Nearest integer) [Given : The heat capacity of the calorimeter system is $20\,kJ\,K^{-1}, R = 83\,JK^{-1}\,mol^{-1}$ Assume ideal gas behaviour Atomic mass of C and H are 12 and $1\,g\,mol^{-1}$ respectively] **(+4, -1)**

[1-Feb-2023•Shift•2]

Answers

1. **Answer: d**

Explanation:

For the reaction $A(g) \rightarrow A(l)$ The change in the number of moles of gaseous species $\Delta n = 0 - 1 = -1$ The enthalpy change $\Delta H = -3RT$ $\Delta H = \Delta U + \Delta nRT$ $-3RT = \Delta U + (-1)RT$ The change in internal energy $\Delta U = -2RT$ Hence, $|\Delta H| > |\Delta U|$

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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: b**

Explanation:

$$ds = \int \frac{q_{rev.}}{T}$$

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3. **Answer: b**

Explanation:

The higher the pressure, the lower is the entropy. When pressure increase on the gases, the kinetic energy of the particles decrease along with the pressure. This causes the particles to come closer and intermolecular distance decreases thus the entropy decreases.

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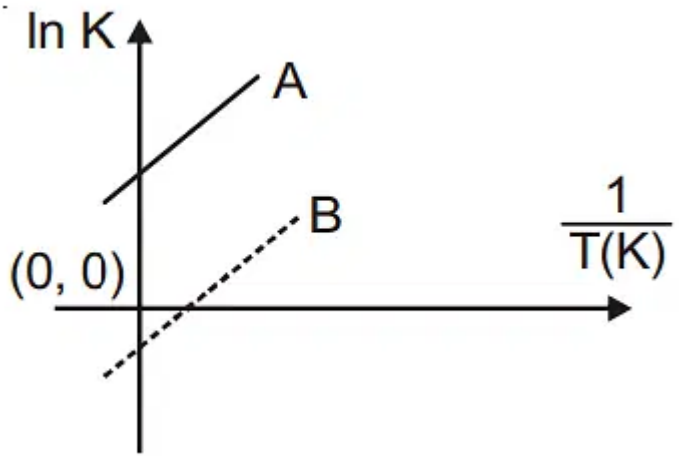
4. Answer: a

Explanation:

Equilibrium constant $K = \left(\frac{A_f}{A_b}\right) e^{-\frac{\Delta H^\circ}{RT}}$ ln $K =$ ln $\left(\frac{A_f}{A_b}\right) - \frac{\Delta H^\circ}{R}\left(\frac{1}{T}\right)$ $y = C + mx$ Comparing with equation of straight line, Slope $= \frac{-\Delta H^\circ}{R}$ Since, reaction is exothermic, $\Delta H^\circ = -ve$,

therefore, slope $= +ve$



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5. **Answer: a**

Explanation:

We have $S(\text{liquid}) \rightleftharpoons S\ (\text{gas})\ \ \Delta G^{\circ}_{\text{reaction}} = \Delta_r G^{\circ}(\text{ vapor }) - \Delta_f G^{\circ}\ (\text{liquid})\ = 103 - 100.7 = 2.3\, kcal\, mol^{-1}$ We know $\Delta G^{\circ}_{\text{Extion}} = -RT \ln K\ 2.3 \times 10^3 = -2 \times 500 \times \ln K_p\ ln\, K_p = -2.3 \Rightarrow K_p = 0.1 \Rightarrow$ vapour pressure $= 0.1\, atm$

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6. **Answer: c**

Explanation:

For cyclic process : $\Delta U = 0 \Rightarrow q = -w$ For isothermal process : $\Delta U = 0 \Rightarrow q = -w$ For adiabatic process : $q = 0 \Rightarrow \Delta U = W$ For isochoric process : $w = 0 \Rightarrow \Delta U = q$

So, the correct option is (C): Adiabatic process : $\Delta U = -w$

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7. **Answer: a**

Explanation:

$\Delta U = nC_V m \times \Delta T = 5 \times 28 \times 100 = 14\,kJ$ $\Delta PV = nR\Delta T = 5 \times 8 \times 100 = 4\,kJ$

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8. **Answer: d**

Explanation:

$$\Delta H = nC_p\Delta T = 0 \ \Delta S = nR\ln\left(V_f/V_i\right) \geq 0$$

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9. **Answer: 84 - 84**

Explanation:

Explanation:
Given: Enthalpy of vaporisation of a substance is: 8400 $^{-1}$ Temperature or boiling point of substance is: −173.15 We have temperature in Kelvin, = Celsius temperature + 273.15 = − 173.15 + 273.15 = 100 Now, we know,Change in entropy, Δ = —— = $(\frac{8400}{100})$ = 84 $^{-1}$ $^{-1}$ Hence, the correct answer is '84'.

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10. **Answer: 1006 - 1006**

Explanation:

The correct answer is 1006.
(Bomb calorimeter $\rightarrow$ const volume
Heat released
By combustion of 1 mole
$C_2H_6(\Delta U) = -\frac{20\times0.5}{0.3} \times 30 = -1000\,kJ$
$C_2H_6(g) + 7/2O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$
$\Delta ng = 2 - (2 + 7/2) = -(7/2)$
$\Delta H = \Delta U + \Delta nRT$
$= -1000 - 7/2 \times 8.3 \times 300\,kJ$
$= -1000 - 6.225$
$= -1006\,kJ$
So heat released $= 1006\,kJ\,mol^{-1}$

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