CY 101 QUIZ 1
Answers

I. Objective questions (1 mark each) Total 6 marks

1. ($\Delta H - \Delta U$) for the formation of CO from elements at 298 K is,

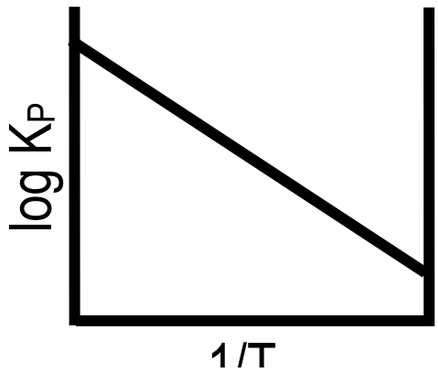
(a) -2477.57 J mol^{-1} (b) 2477.57 J mol^{-1} (c) -1238.78 J mol^{-1} (d) 1238.78 J mol^{-1}

2. Highest efficiency of a Carnot engine, working between a heat source at T_2 and heat sink at T_1, is unity which can be achieved by:
(a) setting T_2 to zero (b) setting T_1 to zero (c) setting both T_1 and T_2 to zero (d) setting $T_1 = T_2$.

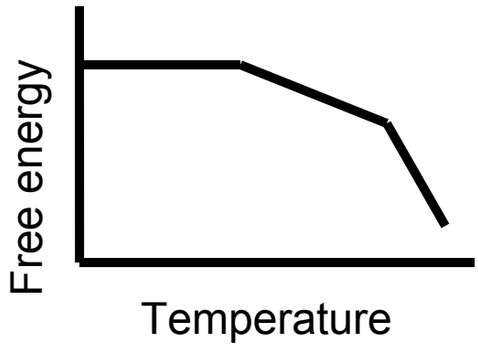
3. Molar entropy of mixing is,

(a) $-R \Sigma n_i \ln x_i$ (b) $R \Sigma n_i \ln x_i$ (c) $-R \Sigma x_i \ln x_i$ (d) $R \Sigma x_i \ln x_i$

4. For a chemical process, the diagram below is used to get the:
(a) Entropy change (b) enthalpy change (c) free energy change (d) Helmholtz potential



5. The diagram below shows the variation of free energy for a pure substance indicating.._____ phase transitions.
(a) one (b) two (c) three (d) four



6. The relation between entropy and most probable distribution is,

(a) $S = k \ln W$ (b) $S = -k \ln W$ (c) $\Delta S = k \ln W$ (d) $dS = k \ln dW$

Answers in the order: d, b, c, b, b, a

II. True or False (1 mark each) Total 10 marks

1. Entropy change of the system in a spontaneous process can be negative.
2. Entropy of the universe increases with time.
3. Direction of a process is predicted by first law.
4. An engine working between a source and sink held at the same temperature can also generate work.
5. By using nitrogen in place of steam, we can have an engine of higher efficiency if Carnot's ideas were true.
6. Only if we know Gibbs free energy change of the system and surroundings, we can predict the feasibility of a process.
7. Amorphous silica has more entropy than crystalline silica.
8. In the phase diagram of simple eutectic systems, there are three invariant points.
9. The entropy change for an adiabatic reversible expansion of ideal gas from P_1,V_1,T_1 to P_2,V_2,T_2 is zero.
10. Energy unavailable for work during a process is proportional to ΔS.

Answers in the order: T, T, F, F, F, F, T, T, T, T

III. The enthalpy of vaporization of CH_2Cl_2 is 28.06 kJ mol^{-1} at its normal boiling point (313 K). Calculate the approximate enthalpy of vaporization of CF_2Cl_2 at its normal boiling point (303 K). (4 marks)

Answer:
ΔS of CH_2Cl_2 = 28.06/313 = 89.6 J K^{-1} mol^{-1} (2 marks)

Molar entropy of vapourisation can be taken as a constant.

ΔS of CF_2Cl_2 = $\Delta H/T$, ΔH of CF_2Cl_2 = ΔS T = 27.15 kJ mol^{-1} (2 marks)

The student may use Trouton's rule directly and use 85 instead of 89.6 J K^{-1} mol^{-1} and full credit may be given.

IV. Calculate ΔG for the expansion of 10 millimoles of an ideal gas from 60 dm^3 to 100 dm^3 at 298 K. (3 marks)

Answer:
$\Delta G = nRT \ln V/V_2$
= 0.01 .8.314 . 298. ln 60/100 = -12.65 J (3 marks)

V. 100 g of water was (1) evaporated at 0.7 atm and 80 ^{0}C and (2) the pressure was brought to 0.1 atm keeping the temperature the same. Taking the enthalpy of vapourisation of water to be 40.7 kJ mol^{-1}, calculate the change in entropy and free energy for this process. (5 marks)

Answer:

Total entropy = entropy of vapourisation + entropy of expansion

$\Delta S_{vap} = n\Delta H_{vap}/T = 5.56 \times 40.7/353 = 641 \text{ J K}^{-1}$
$\Delta S_{vap} = nR \ln P_1/P_2 = 2 \times 8.314 \times \ln 0.7/.1 = 89.95 \text{ J K}^{-1}$

$\Delta S_{total} = 730.95 \text{ J K}^{-1}$ (1+1+1 marks)

$\Delta G = \Delta H - T\Delta S = 5.56 \times 40.7 - 353 \times .73095 = -31.73 \text{ kJ}$ (2 mark)

VI. Show that $\Delta G = \Delta A$ for an isothermal process involving ideal gas.(4 marks)

$(dG)_T = VdP$
$\Delta G = RT\ln P_2/P_1$ (2 marks)

$(dA)_T = -PdV$
$\Delta G = -RT\ln V_2/V_1 = RT\ln P_2/P_1$ (2 marks) There are many other ways, total 4 marks

VII. C_V of an ideal gas is expressed in the form, $C_V = a + bT$. If $a = 24 \text{ JK}^{-1}\text{mol}^{-1}$ and $b = 0.03 \text{ JK}^{-2}\text{mol}^{-1}$, calculate the q, ΔU, ΔH and ΔS involved for the compression of 1 mole of gas from 2 bar to 5 bar resulting in a temperature change of 300 K to 600 K. (8 marks)

Answer:

$\Delta U = \int C_V \, dT$
$= \int (a+bT) \, dT$
$= a (T_2-T_1) + b/2 (T_2^2-T_1^2)$
$= 11.25 \text{ kJ mol}^{-1}$ (2 marks)

$\Delta H = \int C_P \, dT$
$= \int [(a+R) + bT)] \, dT$
$= k (T_2-T_1) + b/2 (T_2^2-T_1^2)$
$= 13.744 \text{ kJ mol}^{-1}$ (2 marks)

$V_1 = 1 \times 0.082 \times 300/2 = 12.3 \text{ L}$

$V_2 = 1 \times 0.082 \times 600/5 = 9.84 \text{ L}$ (total for volume 1 mark)

$\Delta S = n[C_V dT/T + nR \, dV/V] = n [(a+bT)dT/T + R \, dV/V]$
$= n[a\ln T_2/T_1 + b(T_2-T_1) + R \ln V_2/V_1] = 23.7802 \text{ JK}^{-1}$ (2 marks)

Totak for entropy 3 marks

q is not possible to be evaluated as path is not given (1 mark)