THERMODYNAMICS

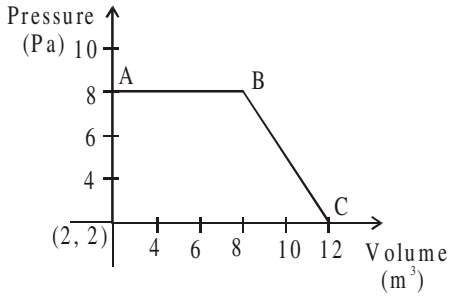
1. For the reaction ;

$A(l) \rightarrow 2B(g)$

$\Delta U = 2.1$ kcal , $\Delta S = 20$ cal K^{-1} at 300 K

Hence ΔG in kcal is_____ .

2. The magnitude of work done by a gas that undergoes a reversible expansion along the path ABC shown in the figure is _____



3. At constant volume, 4 mol of an ideal gas when heated from 300 K to 500K changes its internal energy by 5000 J. The molar heat capacity at constant volume is _____.

4. The true statement amongst the following is:

(1) Both ΔS and S are functions of temperature.

(2) S is not a function of temperature but ΔS is a function of temperature.

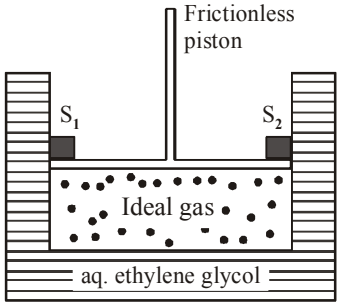
(3) Both S and ΔS are not functions of temperature.

(4) S is a function of temperature but ΔS is not a function of temperature.

5. A cylinder containing an ideal gas (0.1 mol of 1.0 dm^3) is in thermal equilibrium with a large volume of 0.5 molal aqueous solution of ethylene glycol at its freezing point. If the stoppers S_1 and S_2 (as shown in the figure) are suddenly withdrawn, the volume of the gas in litres after equilibrium is achieved will be____.

(Given, K_f (water) = 2.0 K kg mol^{-1},

$R = 0.08$ dm^3 atm K^{-1} mol^{-1})



6. Five moles of an ideal gas at 1 bar and 298 K is expanded into vacuum to double the volume. The work done is :-

(1) $C_V(T_2 - T_1)$ (2) $-RT \ln V_2/V_1$

(3) $-RT(V_2 - V_1)$ (4) zero

7. For one mole of an ideal gas, which of these statements must be true ?

(a) U and H each depends only on temperature

(b) Compressibility factor z is not equal to 1

(c) $C_{P,m} - C_{V,m} = R$

(d) $dU = C_V dT$ for any process

(1) (a), (c) and (d) (2) (b), (c) and (d)

(3) (c) and (d) (4) (a) and (c)

8. For a dimerization reaction,

$2\ A(g) \rightarrow A_2(g)$

at 298 K, $\Delta U^{\ominus}$, = – 20kJ mol^{-1}, $\Delta S^{\ominus} = -30$ J K^{-1} mol^{-1}, then the $\Delta G^{\ominus}$ will be _____J.

9. The internal energy change (in J) when 90g of water undergoes complete evaporation at 100ºC is ____ .

(Given : ΔH_{vap} for water at 373 K = 41 kJ/mol, $R = 8.314$ JK^{-1} mol^{-1})

10. The Gibbs energy change (in J) for the given reaction at $[Cu^{2+}] = [Sn^{2+}] = 1$ M and 298K is:

$Cu(s) + Sn^{2+}(aq.) \rightarrow Cu^{2+}(aq.) + Sn(s)$;

($E^0_{Sn^{2+}|Sn} = -0.16V$, $E^0_{Cu^{2+}|Cu} = 0.34V$,

Take F = 96500 C mol^{-1})

11. The variation of equilibrium constant with temperature is given below :

Temperature	**Equilibrium constant**
T_1 = 25ºC	K_1 = 100
T_2 = 100ºC	K_2 = 100

The values of ΔH°, ΔG° at T_1 and ΔG° at T_2 (in kJ mol^{-1}) respectively, are close to

[Use $R = 8.314$ $JK^{-1}mol^{-1}$]

(1) 0.64, –5.71 and –14.29

(2) 28.4, –7.14 and –5.71

(3) 28.4, –5.71 and –14.29

(4) 0.64, –7.14 and –5.71

SOLUTION

1. NTA Ans. (–2.70 to –2.71)

Sol. $A(\ell) \longrightarrow 2B(g)$

$\Delta U = 2.1$ Kcal , $\Delta S = 20$ cal K^{-1} at 300 K

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

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

$\Delta G = \Delta U + \Delta n_g RT - T\Delta S$

$$= 2.1 + \frac{2\times 2\times 300}{1000} - \frac{300\times 20}{1000}$$

($R = 2$ cal K^{-1} mol^{-1})

$= 2.1 + 1.2 - 6 = -2.70$ Kcal/mol

2. NTA Ans. (48.00)

Sol. Area enclosed under P V curve = 48 = 48 Joule

3. NTA Ans. (6.25)

Sol. For ideal gas :

$\Delta U = nC_V[T_2 - T_1]$

$\Rightarrow \quad 5000 = 4 \times C_V[500 - 300]$

$$\Rightarrow \quad C_V = \frac{5000}{800} = 6.25 \text{ J mole}^{-1} \text{ K}^{-1}$$

4. NTA Ans. (1)

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

5. NTA Ans. (2.17 to 2.23)

Sol. $0 - T_f' = 2 \times 0.5 = 1$

$T_f' = -1°C = 272$ K

$$\text{for gas } P = \frac{0.1\times 0.08\times 272}{1}$$

$P = 2.176$ atm

$P_1V_1 = P_2V_2$

$2.176 \times 1 = 1 \times V_2$

$V_2 = 2.176$ litre

6. Official Ans. by NTA (4)

Sol. As the expansion is done in vaccum that is in absence of p_{ext} so

W = zero

7. Official Ans. by NTA (1)

Sol. For ideal Gas

U = f(T), H = f(T)

Z = 1

$C_P - C_V = R$

$dU = C_V\, dT$

8. Official Ans. by NTA (–13538.00)

Official Ans. by ALLEN (–13537.57)

Sol. $\Delta G° = \Delta H° - T\Delta S°$

$= (\Delta U° + \Delta n_g RT) - T\Delta S°$

$$= \left[\left\{-20 + (-1))\frac{8.314}{1000}\times 298\right\} - \frac{298}{1000}\times(-30)\right] \text{kJ}$$

$= -13.537572$ kJ

$= -13537.57$ Joule

9. Official Ans. by NTA (189494.00)

Official Ans. by ALLEN (189494.39)

Sol. $H_2O(\ell) \rightleftharpoons H_2O(g)$ 90 gm of H_2O

$\Delta H = \Delta U + \Delta n_g RT$ $\Rightarrow$ 5 moles of H_2O

5×41000 J $= \Delta U + 1 \times 8.314 \times 373 \times 5$

$\Delta U = 189494.39$ Joule

10. Official Ans. by NTA (96500.00)

Sol. $\Delta G = \Delta G° + RT \ln \left[\frac{Sn^{+2}}{Cu^{+2}}\right]$

$$= -2 \times 96500\,[(-0.16) - 0.34] + RT \ln\left(\frac{1}{1}\right)$$

$= 96500$ J

11. Official Ans. by NTA (3)