Name: Shelar Shreetosh Madhukar

भारतीय प्रौद्योगिकी संस्थान मुंबई
INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

उत्तर पुस्तिका/ Answer Book-12

210110101
रोल नं./**Roll No.**

MM202
पाठ्यक्रम नाम/**Course Name**

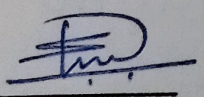
MEMS
शाखा/प्रभाग/**Branch/Div.**शैक्षणिक बैच /**Tutorial Batch**

S2
अनुभाग/**Section**

प्र.सं/Q. No.	1	2	3	4	5	6	7	8	9	10	11	12	योग/Total
आरंभिक पृष्ठ Starting Page No.													
अंक/Marks													

प्र.सं/Q. No.	13	14	15	16	17	18	19	20	21	22	23	24	योग/Total
आरंभिक पृष्ठ Starting Page No.													
अंक/Marks													

परीक्षा में उपस्थित होने वाले अभ्यर्थियों से घोषणा पत्र	**Declaration from the Candidate appearing in the Examination**
1. मैं, इस परीक्षा के आयोजन संबंधी पाठ्यक्रम अनुदेशक द्वारा दिए गए सभी अनुदेशों का पालन करूँगा / करूँगी।	**1. I will abide by all instructions given by the course instructor regarding the conduct of this examination.**
2. मैं, संस्थान के नियम तथा विनियमों में दिए गए शैक्षिक कदाचार संबंधी नियम तथा विनियमों से अवगत हूँ।	**2. I am aware of the rules and regulations regarding academic misconduct as given in rules and regulations of the institute.**
3. मैं, इस परीक्षा के दौरान शैक्षिक सत्यनिष्ठा के सिद्धांतों पर दृढ़ रहूँगा / रहूँगी।	**3. I will adhere to the principles of academic integrity during this examination.**

हस्ताक्षर/ Signature :- 

दिनांक/ Date :- 16/9/22

Q.J

(i) For 1200K :-

$$ZnO(s) + C(s) = Zn(g) + CO(g)$$

$$\Delta S^{1200}_{1200} = (189.9 + 240.7) - (28.5 + 110.3)$$

$$= 291.8 \text{ J/mol K}$$

$$\Delta G_{1200} = \Delta H - T\Delta S$$

$$= (149165 - 82101) - (-306091 + 16241) - 1200(291.8)$$

$$= 67554 \text{ J/mol}$$

∴ At 1200K the reaction is not spontaneous as ~~$\Delta G < 0$~~ $\Delta G > 0$.

(ii) For 1500K

$$\Delta S_{1500} = (194.6 + 248.4) - (122.6 + 33.7)$$

$$= 286.7 \text{ J/mol.K}$$

$$\Delta G_{1500} = \Delta H - T\Delta S$$

$$= (155401 - 71677) - (23257 - 289629) - 1500(286.7)$$

$$= -79954 \text{ J/mol}$$

∴ A 1500 K the reaction is spontaneous as $\Delta G < 0$ & $\Delta S > 0$.

Q.2] a) $F = KT\left(\frac{L}{L_0} - \frac{L_0^2}{L^2}\right)$

$$Y = \frac{L}{A}\left(\frac{dF}{dL}\right)$$

$$= \frac{L}{A}\left(KT\left(\frac{1}{L_0} + \frac{2L_0^2}{L^3}\right)\right)$$

$$= \frac{KT}{A}\left(\frac{L}{L_0} + \frac{2L_0^2}{L^2}\right)$$

$$= \frac{1}{A}\left[KT\left(\frac{L}{L_0} - \frac{L_0^2}{L^2}\right) + KT\left(\frac{3L_0^2}{L^2}\right)\right]$$

$$= \frac{1}{A}\left[F + \frac{3KTL_0^2}{L^2}\right]$$

$$\therefore \boxed{Y = \frac{F}{A} + \frac{3KTL_0^2}{AL^2}}$$

b) At zero tension $F = 0$ & $L_0 = L$

Putting this in above Y eqn we get :-

$$Y = 0 + \frac{3KTL_0^2}{AL_0^2}$$

$$\therefore \boxed{Y = \frac{3KT}{A}}$$

c) Using the given values we get :-

$$F = KT\left(\frac{L}{L_0} - \frac{L_0^2}{L^2}\right)$$

$$= 1.333 \times 10^{-2} \times 300\left(\frac{2L_0}{L_0} - \frac{L_0^2}{4L_0^2}\right)$$

$$= 1.333 \times 3 \times \frac{7}{4} = \boxed{6.998\,N \approx 7\,N}$$

$$Y = \frac{F}{A} + \frac{3KT\ell_0^2}{AL^2}$$

$$= \frac{6.998}{10^{-6}} + \frac{3\times1.333\times10^{-2}\times300\times\ell_0^2}{10^{-6}\times4\ell_0^2}$$

$$= 10^6\,(6.998 + 3\times1.333\times3)$$

$$\boxed{Y = 18.995\times10^6\ N/m^2}$$

$$\therefore \boxed{\begin{aligned} F &= 6.998 \approx 7N \\ Y &= 18.995\times10^6 \approx 19\times10^6\ N/m^2 \end{aligned}}$$

Q.3] $\Delta H_f = n C_{p(l)} \Delta T$

$$\therefore x\times11240 = 1\times30.5\times61$$

$$\therefore x = \frac{30.5\times61}{11240}$$

$$= 0.165\ \text{mol.}$$

$\therefore$ 0.165 moles of silver solidifies

Heat released $= 1\times30.5\times61 = 1860.5\ J$

$$\therefore \Delta S = \frac{\delta Q}{T} = \frac{1860.5}{(900+273)} = \frac{1860.5}{1173}$$

$$= 1.586\ J/K$$

$\therefore$ The entropy change is 1.586 J/K

Q.4] Two aluminas : A & B

$n_A = 1$, $T_A = 273\ K$ $\quad n_B = 1$, $T_B = 473\ K$

$$C_{p,Al_2O_3(s)} = 106.6 + 17.78 \times 10^{-3} T$$

$$\int_{273}^{T} n_A C_p\, dT = -\int_{473}^{T} n_B C_p\, dT$$

$$\therefore \int_{273}^{T} 1 \times (106.6 + 17.78 \times 10^{-3} T)\, dT = \int_{T}^{473} 1 \times (106.6 + 17.78 \times 10^{-3} T)\, dT$$

$$\therefore 106.6(T - 273) + \frac{17.78 \times 10^{-3}}{2}(T^2 - 273^2)$$

$$= 106.6(473 - T) + \frac{17.78 \times 10^{-3}}{2}(473^2 - T^2)$$

$$\therefore 106.6T + \frac{17.78 \times 10^{-3}}{2} T^2 - \left(106.6 \times 273 + \frac{17.78 \times 10^{-3}}{2} \times 273^2\right)$$

$$= -106.6 \times T - \frac{17.78 \times 10^{-3}}{2} T^2 + \left(106.6 \times 473 + \frac{17.78 \times 10^{-3}}{2} \times 473^2\right)$$

$$\therefore 213.2T + 17.78 \times 10^{-3} T^2 = 79523.6 + 6.632$$

$$\therefore 213.2T + 17.78 \times 10^{-3} T^2 = 86,155.54$$

$$\therefore T^2 +$$

P.T.O.

$\therefore 213.2T + 17.78 \times 10^{-3} T^2 = 79523.6 + 2651.5$

$\therefore 213.2T + 17.78 \times 10^{-3} T^2 = 82175.11$

$\therefore T^2 + 11991T - 4621772.21 = 0$

$$\therefore T = \frac{-11991 + \sqrt{(11991)^2 + 4 \times (4621772.21)}}{2}$$

$$\boxed{T = 373.785\ K}$$

$$\approx 100.785\ ^\circ C$$

The common uniform temperature is not exactly 100°C because some heat is lost in the surroundings.

Q.5]

Bonus Question :

$$\underset{1\,mole}{CaO_{(s)}} + \underset{1\,mole}{CO_{2(g)}} = \underset{1\,mole}{CaCO_{3(s)}}$$

~~$\Delta H_{rxn} = \Delta H^{o} + \Delta($~~

1 mole of CaO reacts with 1 mole of CO_2 to form 1 mole $CaCO_3$

$\therefore$ ~~n CaO~~

$$\Delta H = -168000 + (-123 \times (1183 - 298) + 52.8(1183 - 298) + 51.6(1183 - 298))$$

$$= -184,461\ J$$

$$\Delta G = \Delta G^{o} + \Delta n_g R T$$

$$= 0 - 1 \times 8.314 \times 298$$

$$= -2477.572\ J$$

P.T.O.

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

$\therefore$ ~~$-9835.462 = -124989$~~

$\therefore -2477.5720 = -184461 - 298\,\Delta S$

$\therefore \Delta S = \dfrac{-181983.428}{298}$

$\Delta S_{syst.} = -610.682\ J/K$

$\Delta S_{surr} = 610.682\ J/K$ $\quad \Delta S_{Total} = 0$