TERMODINAMIKA ARIKETAK

1. ARIKETA

$\Delta T = 1°C$

$P = ct \rightarrow Q_p = \Delta H$

$1_g H_2O \cdot \frac{1mol}{18_g} = 0'055 mol$

$1cal = 4'184 J = Q_p$

$Q_p = n \cdot \bar{C}_p \cdot \Delta T \rightarrow 4'184 = 0'055 \cdot \bar{C}_p \cdot 1$

$\bar{C}_p = 76'07 \, J/molK$

2. ARIKETA

$C_{12}H_{22}O_{11}(s) + 12O_2(g) \longrightarrow 12CO_2(g) + 11H_2O(l)$

hitzarmenez =0

$\Delta_r H°_{298} = \sum n \Delta_f H°_{prod} - \sum n \Delta_f H°_{errea} = 12 \Delta_f H° CO_2 + 11 \Delta_f H° H_2O - \Delta_f H° C_{12}H_{22}O_{11} - \Delta_f H° O_2$

$\Delta_r H°_{298} = 12 \cdot (-393'5) + 11 \cdot (-285'8) + 2221'7 = -5644'1 \, kJ/mol$ (aerobio)

$C_{12}H_{22}O_{11}(s) + H_2O(l) \rightarrow 4 CH_3CH(OH)COOH(s)$

$\Delta H°_{298} = 4 \cdot (-694) + 285'8 + 2221'7 = -268'5 \, kJ/mol$ (anaerobio)

$\Delta H°_{298}$ (aerobio) $- \Delta H°_{298}$ (anaerobio) $= -5644'1 - (-268'5) = -5375'6 \, kJ/mol$

6. ARIKETA

$C(s) + O_2(g) \longrightarrow CO_2(g)$ (=0 / =0)

$-393'5 = \Delta_f H° CO_2 - \Delta_f H° C - \Delta_f H° O_2$

$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$

$-285'8 = \Delta_f H° H_2O$

$CH_4(s) + 2O_2(s) \longrightarrow CO_2(s) + 2H_2O(l)$

$-890'8 = \Delta_f H CO_2 + 2 \cdot \Delta_f H H_2O - \Delta_f H CH_4$

$-890'8 = -393'5 + 2 \cdot (-285'3) - \Delta_f H CH_4$

$\Delta_f H CH_4 = -74'3 \, kJ/mol$

9. ARIKETA

$C_p = 185 \, J/K$

$0'5M \, HCl, 250cm^3$ → $n = 0'25 \cdot 0'5 = 0'125 mol \cdot 36'45 = 4'55_g$ → murgatutako

$0'65M \, NaOH, 200cm^3$ → $n = 0'65 \cdot 0'2 = 0'13 mol \cdot 39'99 = 5'19_g$

$\rho = 1_g/cm^3$

$ce = 4'184 J/gK$

$\Delta T = 3'45°C$

$Q \times Urg + Q_{dis} = 0$

$Q_x = C_p \Delta T + m \cdot ce \cdot \Delta T$

$Q_x = 185 \cdot 3'45 + 0'452 \cdot \frac{1000_g}{1L} \cdot 3'45 \cdot 4'184$

$Q_x = 7133'91 J \rightarrow Q_{dis} = -7133'91 J$

$\frac{-7133'91}{0'125} = -57071 J/mol = -57'14 J/mol$

10. ARIKETA

$\Delta_{ds} H^\circ = 14'8\ kJ/mol$

$c_e = 3'55\ J/gK$ | Q_{xurg}

$1\ mol\ NH_4Cl$

$200\ mol\ H_2O$

$1\ dm^3\ H_2O \quad 1:200$ | Q_{osu}

$\Delta T = -1'1\ ^\circ C$

$$1000\ mL\ H_2O \cdot \frac{1g\ H_2O}{1mL} \cdot \frac{1\ mol}{18g} \cdot \frac{1\ mol\ NH_4Cl}{200\ mol\ H_2O} = 0'27\ mol$$

$$0'27\ mol\ NH_4Cl \cdot \frac{53'5g}{1\ mol\ NH_4Cl} = 14'4g\ NH_4Cl$$

$$Q_x = 0'27\ mol\ NH_4Cl \cdot \frac{14'8\ kJ}{1\ mol} = 4\ kJ$$

$$Q_{osu} + Q_{xurg} = 0$$

$$Q_{osu} = -4 = C_p \cdot \Delta T + (m_{H_2O} + m_{NH_4Cl}) \cdot c_e \cdot \Delta T$$

$$-4 = C_p(-1'1) + (1000 + 14'4) \cdot 3'5 \cdot 10^{-3}(+1'1)$$

$$C_p = 0'215\ kJ/^\circ C$$

$500\ cm^3\ H_2O \quad 1:400$

$\Delta T = -1'4\ ^\circ C$

$c_e = 1'9\ J/gK$

$$500\ cm^3 \cdot \frac{1g}{1cm^3} \cdot \frac{1\ mol\ H_2O}{18g} \cdot \frac{1\ mol\ Na_2CO_3}{400g\ H_2O} = 6'94 \cdot 10^{-2}\ mol\ Na_2CO_3$$

$$6'94 \cdot 10^{-2}\ mol \cdot \frac{106g\ Na_2CO_3}{1\ mol} = 7'36g$$

$$Q_{osu} = 0'215(-1'4) + (500 + 7'36) \cdot 1'9 \cdot 10^{-3}(-1'4)$$

$$Q_{osu} = -1'65\ kJ \rightarrow Q_{osu} + Q_x = 0 \rightarrow Q = \frac{1'65}{6'94 \cdot 10^{-2}} = 23'78\ kJ/mol$$

11. ARIKETA

Ponpa $\rightarrow Q_v = \Delta U$

$C_p = 3612\ J/^\circ C$

$5\ kg\ H_2O$

$0'75g\ C_6H_{12}O_6$

$\Delta T = +0'48\ ^\circ C$

$\hookrightarrow Q_{xurg}$ (tresna + H_2O)

a) $C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) \quad \Delta n = 0 \rightarrow \Delta U = \Delta H$

$$Q_x = C_p \cdot \Delta T + n \cdot C_p \cdot \Delta T$$

$$Q_x = 3612 \cdot 0'45 + \frac{5000}{18} \cdot \frac{75'35}{1\ mol} \cdot 0'48 = 11'78\ kJ$$

$$Q_{osu} = -11'78\ kJ$$

$$1\ mol = 180g \cdot \frac{(-11'78\ kJ)}{0'75g} = -2824\ kJ/mol$$

b) $\Delta H_{310K} = \Delta H_{298} + \int_{298}^{310} (6C_p\,CO_2 + 6C_p\,H_2O - 6C_p\,O_2 - C_p\,glu)\,dt$

$$\Delta H_{310K} = -2825'8 + [0'247]_{298}^{310} = -2822'8\ kJ/mol$$

$$1g \cdot \frac{1\ mol}{180g} \cdot \frac{-2822'8\ kJ}{1\ mol} \cdot \frac{40}{100} = -6'27\ kJ$$

12. ANULADA

$\Delta_c H_{sudr} = -1350 \text{ kcal/mol}$

$\Delta_c H_{ganad} = -7086 \text{ kcal/mol}$

$\Delta_f H_{cal.} = -560'5 \text{ kJ}$

$\Delta_f H_{CO_2} = -393'5 \text{ kJ/mol}$

$\Delta_f H_{H_2O} = -285'8 \text{ kJ/mol}$

$2 C_3H_7NO_2 + \frac{15}{2} O_2 \longrightarrow 6 CO_2 + 7 H_2O + N_2$

$\Delta_c H_{cal} = 6(-393'5) + 7(-285'8) - 2 \cdot (-560'5)$

$\Delta_c H_{cal} = -3210'6 \text{ kJ/mol}$

$-3240'6 \frac{\text{kJ}}{\text{mol}} \cdot \frac{1 \text{ kcal}}{4'184 \text{ kJ}} = -774'52 \text{ kcal/mol}$

$6'8_5 \cdot \frac{1 \text{ mol}}{89'09_3} = 0'076 \text{ mol} \cdot 774'52 \frac{\text{kcal}}{\text{mol}} = 58'8 \text{ kcal}$

$75_3 \cdot \frac{1 \text{ mol}}{342'3_5} = 0'21 \text{ mol} \cdot 1350 = 297 \text{ kcal}$

$15'5_3 \cdot \frac{1 \text{ mol}}{887'44_7} = 0'017 \text{ mol} \cdot 7086 = 120'46 \text{ kcal}$

} 476 kcal

15. ANULADA

$CH_3COOH + 2O_2 \longrightarrow 2CO_2 + 2H_2O$

$\Delta_c H^\circ_{298} = 2(-393'5) + 2(-285'85) - 482'41 = -1841'11 \text{ kJ/mol} \cdot \frac{1 \text{ kcal}}{4'184 \text{ kJ}} = -440'03 \text{ kcal/mol}$

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$

$-94'05 = \Delta_f H_{CO_2}$

$-94'05 \frac{\text{kcal}}{\text{mol}} \cdot 4'184 = 393'5 \text{ kJ/mol}$

$2H_2 + O_2 \longrightarrow 2H_2O$

$2(-68'32) = 2\Delta H_f H_2O \rightarrow \Delta H_f H_2O = -68'32$

$-68'32 \cdot 4'184 = 285'85 \text{ kJ/mol}$

$-115'3 \text{ kcal/mol} \cdot 4'184 = 482'4 \text{ kJ/mol}$

$\Delta H_{328} = -440'035 + \int_{298}^{328} [2 \cdot (7 + 7'1 \cdot 10^{-3} \cdot 328) + 2'18 - 2 \cdot (6'5 + 0'001 \cdot 328) - 30] \, dt$

$\Delta H_{328} = -440'035 + \int_{298}^{328} 11'0016 \, dt \rightarrow -440'035 + (328 - 298) \cdot 11'0016 = -209 \text{ kcal/mol}$

16. ANULADA

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

$\Delta G = -285'83 - 298 \cdot 69'91 \cdot 10^{-3} = 306'66 \text{ kJ/mol}$

$\Delta G = 0 - 298 \cdot 205'138 \cdot 10^{-3} = -61'13 \text{ kJ/mol}$

17. Apunte

$$C_{(s)} + \frac{1}{2} O_{2(g)} + N_{2(g)} + 2H_{2(g)} \longrightarrow CO(NH_2)_{2(s)}$$

$$\Delta S^\circ = S^\circ CO(NH_2)_2 - \left(S^\circ_{(s)} + \frac{1}{2} S^\circ O_2 + S^\circ N_2 + 2 S^\circ H_2\right)$$

$$\Delta S^\circ = 104'6 - \left(5'740 + \frac{1}{2} 205'138 + 191'61 + 2 \cdot 130'684\right) = -456'3875 \text{ J/mol K}$$

$$\Delta G = -333'51 + 298 \cdot 456'387 \cdot 10^{-3} = -197'5 \text{ kJ/mol}$$

21. Apunte

$P = 1 \text{ atm} = 101325 \text{ Pa}$

$0^\circ C$

$\bar{C}_p = 75'4 \text{ J/mol K}$

$H_2O_{(s)}$ $0^\circ C$, 2 mol, $\rho = 0'917 \text{ g/cm}^3$ —[1] $\Delta H = 6'01$ kJ/mol→ $H_2O_{(l)}$ $0^\circ C$, 2 mol, $\rho = 1 \text{ g/cm}^3$ —[2] Δ→ $H_2O_{(l)}$ $100^\circ C$, 2 mol, $\rho = 0'958 \text{ g/cm}^3$ —[3] $\Delta H = 40'66$ kJ/mol→ $H_2O_{(g)}$ $100^\circ C$, 2 mol, $\rho = 0'958 \text{ g/cm}^3$

$P = ct$, $Q_p = \Delta H$ $\quad \Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$

$$\Delta H_1 = 6'01 \frac{\text{kJ}}{\text{mol}} \cdot 2 \text{ mol} = 12'02 \text{ kJ}$$

$$\Delta H_2 = 75'64 \cdot 10^{-3} \cdot 2 \cdot 100 = 15'08 \text{ kJ}$$

$$\Delta H_3 = 40'66 \frac{\text{kJ}}{\text{mol}} \cdot 2 \text{ mol} = 81'32 \text{ kJ}$$

$\Big\} \; Q = \Delta H = 108'42 \text{ kJ}$

$W = -p\Delta V$, $W = W_1 + W_2 + W_3$

$$W_1 = -1'013 \cdot 10^5 \left(V_{l,0^\circ C} - V_{s,0^\circ C}\right) = 1'013 \cdot 10^5 \left(-3'25 \cdot 10^{-6}\right) = 0'335$$

$$V_1 = 2 \text{ mol} \cdot \frac{18 \text{ g}}{\text{mol}} \cdot \frac{1 \text{ L}}{1 \text{ g}} = 36 \text{ L}$$

$$V_2 = 2 \text{ mol} \cdot \frac{18 \text{ g}}{\text{mol}} \cdot \frac{1 \text{ L}}{0'917 \text{ g}} = 39'25 \text{ L}$$

$$W_2 = -1'013 \cdot 10^5 \left(V_{l,100^\circ C} - V_{l,0^\circ C}\right) = -1'013 \cdot 10^5 \left(1'58 \cdot 10^{-6}\right) = 0'0165$$

$$V_1 = 2 \text{ mol} \cdot \frac{18 \text{ g}}{\text{mol}} \cdot \frac{1 \text{ L}}{0'958} = 37'58 \text{ L}$$

$$W_3 = -p \cdot \frac{nRT}{p} = 2 \cdot 8'314 \cdot 373 = -6202'25$$

$\Big\} \; W = -6201'85 \text{ J} = -6'2 \text{ kJ}$

$$\Delta U = Q + W = -6'2 + 108'42 = 102'23 \text{ kJ}$$

$$\Delta S = \Delta S_1 + \Delta S_2 + \Delta S_3$$

$$\Delta S_1 = \frac{\Delta H}{T} = \frac{6'01 \cdot 10^3 \cdot 2}{273} = 44'025$$

$$\Delta S_2 = n \cdot C_p \cdot \ln \frac{T_2}{T_1} = 2 \cdot 75'4 \cdot 10^3 \cdot \ln \frac{373}{273} = 47'063$$

$$\Delta S_3 = \frac{\Delta H}{T} = \frac{40'66 \cdot 10^3 \cdot 2}{373} = 218'02$$

$\Big\} \; \Delta S = 309'09 \text{ J/K}$