The Change of Solubility with Temperature

1. 計算每種溫度下每 1000 克溶劑的溶解度摩爾數。

(sol)

由標定得平均 NaOH N→ 草酸 mole → S= mole/水 Kg

2. 繪製 log S 對 1/T 並計算草酸在水中的溶解熱。

(sol)

『平均 S→取 LogSv.sT(K)→取 1/T』 作圖

$\log S = -\Delta H / 2.303RT + constant$ ....(2)

slope$= -\Delta H / 2.303RT$ 其中 R=1.987 (cal / K×mol)

ΔH= ?cal/mol

Exp.2

T_{room}	21.7	°C
P_{room}	750.8	mmHg

	Run1	Run2
Wt. of KHP (g)	1.999	2.002
V_{NaOH}(ml)	9.75	9.80
N(NaOH)	1.004	1.000
N(NaOH) (average)	1.002	

Titration

(a)Run1

$T(℃)$	45	41	37	33
Real Temp.($℃$)	45.3	41.6	37.6	34.0
Wt. of sol'n (g)	5.486	5.277	5.301	5.178
V_{NaOH}(mL)	25.35	21.70	18.90	16.09
草酸(g)	1.1435	0.9789	0.8526	0.7258
草酸(mole)	1.2702E-02	1.0873E-02	9.4698E-03	8.0618E-03
S_1(mol/kg)	2.9250	2.5296	2.1288	1.8108

(b)Run2

T(℃)	45	41	37	33
Real Temp.(℃)	45.3	41.6	37.6	34.0
Wt. of sol'n (g)	5.112	5.279	5.299	5.138
V_{NaOH}(mL)	23.70	21.55	18.95	16.01
草酸(g)	1.0691	0.9721	0.8548	0.7222
草酸(mole)	1.1839E-02	1.0765E-02	9.4665E-03	7.9978E-03
S_2(mol/kg)	2.9372	2.5070	2.1365	1.8166

T(K)	318.45	314.75	310.75	307.15
$S_{average}$(mol/kg)	2.9311	2.5183	2.1326	1.8137
1/T	3.14E-03	3.18E-03	3.22E-03	3.26E-03
Log S	0.4670	0.4011	0.3289	0.2586
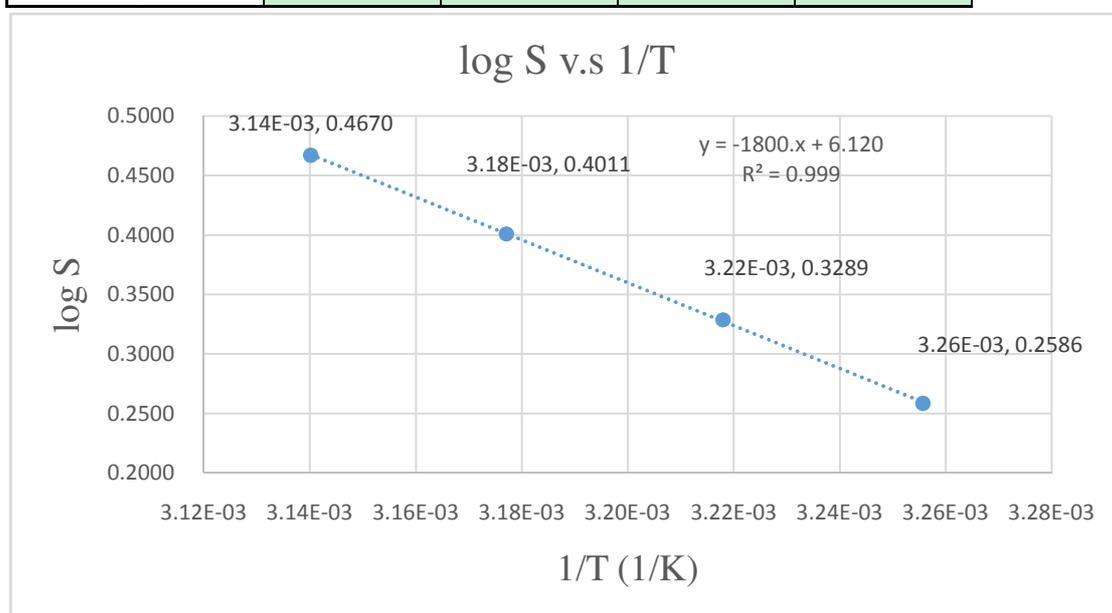
Calculation

(1) 標定 (以 Run 1 為例)

$$M_{NaOH} \times V_{NaOH} = \frac{W_{KHP}}{M_{KHP}}$$

$$M_{\text{NaOH}}(9.75 \times 10^{-3}\text{L}) = \dfrac{1.999g}{\dfrac{204.228g}{1mol}}$$

$$M_{NaOH} = 1.004(M)$$

$$M_{Avg} = \dfrac{1.004 + 1.000}{2} = 1.002(M)$$

(2) 草酸溶解度 (以 45.3°C,Run1 為例)

$$M_{\text{NaOH}} \times V_{\text{NaOH}} = n_{草酸} \times 21.002M \times (25.33 \times 10^{-3}\text{L}) = n_{草酸} \times 2$$

$$n_{草酸} = 1.27 \times 10^{-2} mol$$

$$S_{草酸} = \dfrac{n_{草酸}}{W_{水}} = \dfrac{1.27 \times 10^{-2} mol}{[5.486g - (1.27 \times 10^{-2} mol \times \frac{90.03g}{1mol}) \times \frac{1kg}{1000g})]} = 2.9250(\dfrac{\text{mol}}{\text{kg}})$$

(3) 以 T=45.3°C 為例

45.3°C=318.45K

$$\dfrac{1}{\text{T}} = \dfrac{1}{318.45\text{K}} = 3.14 \times 10^{-3}(\dfrac{1}{\text{K}})$$

$$S_{Avg} = 2.9311\,(\dfrac{mol}{kg})$$

$$\log(S_{Avg}) = 0.467$$

$$y = -1800.2\text{x} + 6.1205R^2 = 0.9999$$

$$\log(\text{S}) = -\dfrac{\Delta\text{H}}{2.303\text{RT}} + \text{constant}$$

$$\text{slope} = -1800.2\,(\text{K}) = -\dfrac{\Delta\text{H}}{2.303\text{RT}}$$

$$\Delta\text{H} = 1800.2(\text{K}) \times 2.303 \times 1.987 \left(\dfrac{\text{cal}}{\text{K} \times \text{mol}}\right) = 8237.83\,(\dfrac{\text{cal}}{\text{mol}})$$