EXP7: Partial molsr volume

1.Although to a great extent the weights themselves enter into the calculations, it is necessary also to have the density d of every solution to within an accuracy of at least one part per thousand:

$d = W_{sol}/V = W - W_g / V_p$

The volume of the pycnometer $V_P$is obtained by use of the density of pure water at 30.0℃，$d_o$ (with the value 0.9957 g · cm-3)，and $W_0 - W_e$.

(sol)先計算 M

(1).由 H2O 計算 Vp = W – We/ d = ? 其中: W=Wsol+We We:比重瓶重 d:查表

(2). 分別計算 4 瓶 $d = W - W_g / V_p$

| dilution | 1/8 | 1/4 | 1/2 | 1 |
|---|---|---|---|---|
| $M_{NaCl}$(M) | | | | |
| d(g/cm3) | | | | |

2.The molalities m (concentration in mole per Kg of solvent) which are needed for the calculations can he obtained from the molarities M (concentration in mole per liter of solution) obtained from the volumetric procedures by using the equation

$m = 1/ 1 - (M/d \cdot M_2/1000) \cdot M/d = 1/(d/M - M_2/1000)$

Where M2 is the solute molecular weight (58.45 g/cm) and d is the experimental density in g · cm -3 units.

(sol)$M_2$=58.45 g/mol

由 m= 1/(d/M －$M_2$/1000)計算出 4 個 m(mol/Kg)

3.Calculate Φ for each solution using Eq. (7) and plot Φ vs.$m^{1/2}$. Determine the slope $d\Phi/dm^{1/2}$and the intercept $\Phi^0$ at m equal zero from the best straight line through these data points.

(sol)

(1)計算出 4 個Φ(ml/mol)

$\Phi = 1/d\ (M_2 - (1000/m)(W-W_0)/(W_0-W_e)$ ----------(7)

或$=1/d\ (M_2 - (1000/m)(d-d_0)/(d_0)$

(2)Φ對 $m^{1/2}$ 作圖

| Φ(ml/mol) | | | | |
|---|---|---|---|---|
| m(mol/kg) | | | | |
| $m^{1/2}(mol/kg)^{1/2}$ | | | | |

4.Calculate $\bar{V}_2$and $\bar{V}_1$ for m = 0, 0.5, 1.0, 1.5, 2.0, and 2.5. Plot them against mand draw a smooth curve for each of the two quantities

(sol)

(1)

$\bar{V}_1 = V_1^0 - m/55.51(m^{1/2}/2 \cdot d\Phi/dm^{1/2})$ .....(12)

$\bar{V}_2 = \Phi^0 + 3/2m^{1/2} \cdot d\Phi/dm^{1/2}$.....(11)

再由上式Φ對 $m^{1/2}$ 作圖得Φ $= a\, m^{1/2}+b$

可得 m = 0 時$\Phi_0$ =

$d\Phi/dm^{1/2}$ =

(2)由$\Phi_0$、$d\Phi/dm^{1/2}$、及 m = 0, 0.5, 1.0, 1.5, 2.0, and 2.5.分別代入(12)、(11)求得 6 組 $\bar{V}_1\bar{V}_2$

5.In your report, present the curves (Φ vs.m, $V^{1/2}$ and $\bar{V}1$ vs. m) mentioned above. Present also in tabular form the quantities d, M, m, and Φ for each solution studied. Give the values obtained for the pycnometer volume $V_P$ and for $\Phi^0$and $d\Phi/dm^{1/2}$

| dilution | H2O | 1/8 | 1/4 | 1/2 | 1 |
|---|---|---|---|---|---|
| $M_{Nacl}$(M) | | | | | |
| d(g/ml) | | | | | |
| m(mol/kg) | | | | | |
| Φ(ml/mol) | | | | | |

$\bar{V}_1$ VS. m 作圖一張及 $\bar{V}_2$VS. m 作圖一張

| m(mol/kg) | 0 | 0.5 | 1 | 1.5 | 2 | 2.5 |
|---|---|---|---|---|---|---|
| $\bar{V}_1$(cm3/mol) | | | | | | |

| m(mol/kg) | 0 | 0.5 | 1 | 1.5 | 2 | 2.5 |
|---|---|---|---|---|---|---|
| $\bar{V}_2$(cm3/mol) | | | | | | |

Exp.7

| | |
|---|---|
| Wt. of NaCl | 34.998 g |
| Molar conc. of NaCl | 2.9944mole/L |
| $W_e$ | 27.197g |
| $T_{exp't}$ | 23.8°C |
| $d_{water,exp't}$ | 0.9974g/ml |

| | |
|---|---|
| room temperature | 23.9°C |
| room pressure | 747.1 mmHg |

| Run | $H_2O$ | 1/8 | 1/4 | 1/2 | 1 |
|---|---|---|---|---|---|
| $M_{NaCl}$ | 0 | 0.3743 | 0.7486 | 1.4972 | 2.9944 |
| $W_{sol'n} + W_e$ | 77.123 | 77.915 | 78.674 | 80.137 | 82.888 |

Calculation (以 3 M 為例)

1. $NaCl_{(aq)}$ 取 34.998 g

$$M_{NaCl} = \frac{n_{NaCl}}{V(L)} = \frac{\frac{34.998\ (g)}{58.44\left(\frac{g}{mol}\right)}}{0.200\ (L)} = 2.99_4(\mathrm{M})$$

2. 比重瓶體積

$$V_p = \frac{W_{water}}{d_{water}} = \frac{(W_{sol'n} + W_e) - W_e}{d_{water}} = \frac{77.145 - 27.197}{0.9974} = 50.078\ (ml)$$

3. 密度(density) (以 3M 為例)

$$\mathrm{d}_1 = \frac{w_1}{V_p} = \frac{(82.888 - 27.197)g}{50.078\ ml} = 1.1121\ (\frac{\mathrm{g}}{\mathrm{ml}})$$

4. Molalities (m) (以 3M 為例)

$$\mathrm{m}_1 = \frac{1}{\frac{d}{M} - \frac{M_{NaCl}}{1000}} = \frac{1}{\left(\frac{1.1121\left(\frac{g}{ml}\right)}{2.9944\left(\frac{mol}{L}\right)}\right) - \left(\frac{58.44\left(\frac{g}{mol}\right)}{1000\left(\frac{g}{kg}\right)}\right)} = 3.195\ \left(\frac{mol}{kg}\right)$$

5. ∅(以 3M 為例)

$$\emptyset_1 = \frac{1}{\mathrm{d}_1} \times \left(M_{NaCl} - \frac{1000}{m} \times \frac{d_1 - d_0}{d_0}\right)$$

$$= \frac{1}{1.1121\left(\frac{g}{ml}\right)} \times (58.44\left(\frac{g}{mol}\right) - \frac{1000}{3.195\left(\frac{mol}{kg}\right)}$$

$$\times \left( \frac{1.1121\left(\frac{g}{ml}\right) - 0.9974\left(\frac{g}{ml}\right)}{0.9974\left(\frac{g}{ml}\right)} \right)$$

$$= 20.19_4(\frac{ml}{mol})$$

6. $\emptyset$ vs. $\sqrt{m}$ (y 為$\emptyset$ x 為$\sqrt{m}$) y=3.2448x+14.237

$\frac{d\emptyset}{d\sqrt{m}} = slope = 3.2448$ m=0 時$\emptyset^0 = 14.237$ $(\frac{\text{ml}}{\text{mol}})$

7. $V_1$ & $V_2$ 以 m=0.5 為例

$$\overline{V}_1 = \overline{V}_1^0 - \frac{m}{55.51(mole)} \times \left( \frac{\sqrt{m}}{2} \times \frac{d\emptyset}{d\sqrt{m}} \right)$$

$$= 18.063(ml) - \frac{0.5\left(\frac{\text{mole}}{\text{kg}}\right)}{55.51\left(\frac{\text{mole}}{\text{kg}}\right)}$$

$$\times \left( \frac{\sqrt{0.5}\left(\frac{mol^{0.5}}{kg^{0.5}}\right)}{2} \times 3.2448\left(\frac{kg^{0.5}}{mol^{0.5}}\right) \right)$$

$$= 18.053\ (\frac{\text{ml}}{\text{mol}})$$

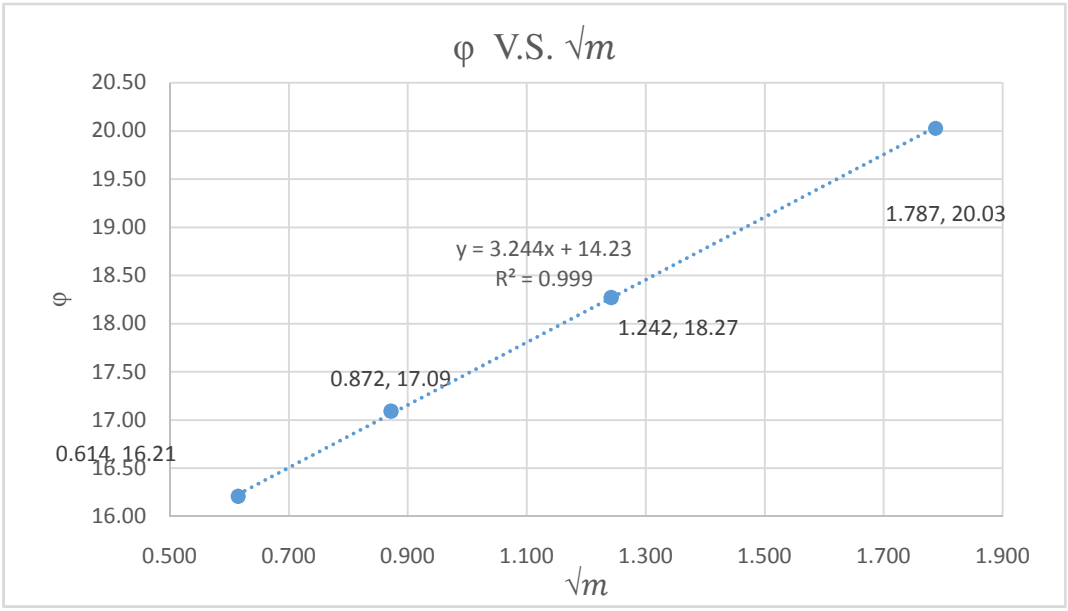
$$\overline{V}_2 = \emptyset^0 + \left( \frac{3\sqrt{m}}{2} \times \frac{d\emptyset}{d\sqrt{m}} \right)$$

$$= 14.237(ml) + \frac{3 \times \sqrt{0.5}\left(\frac{\text{mole}^{0.5}}{\text{kg}^{0.5}}\right)}{2} \times 3.2448\left(\frac{kg^{0.5}}{mol^{0.5}}\right)$$

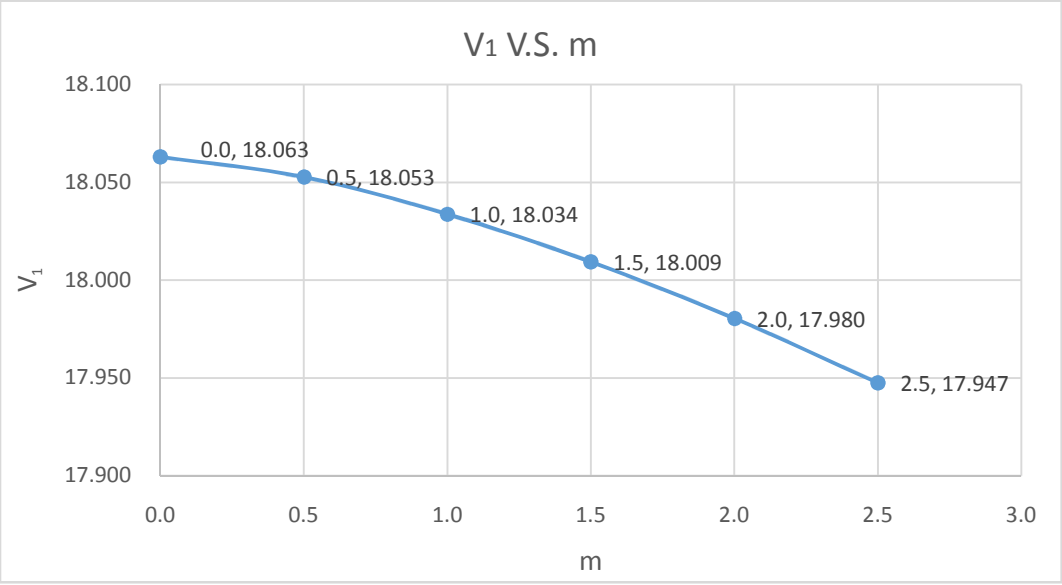
$$= 17.679\ (\frac{\text{ml}}{\text{mol}})$$

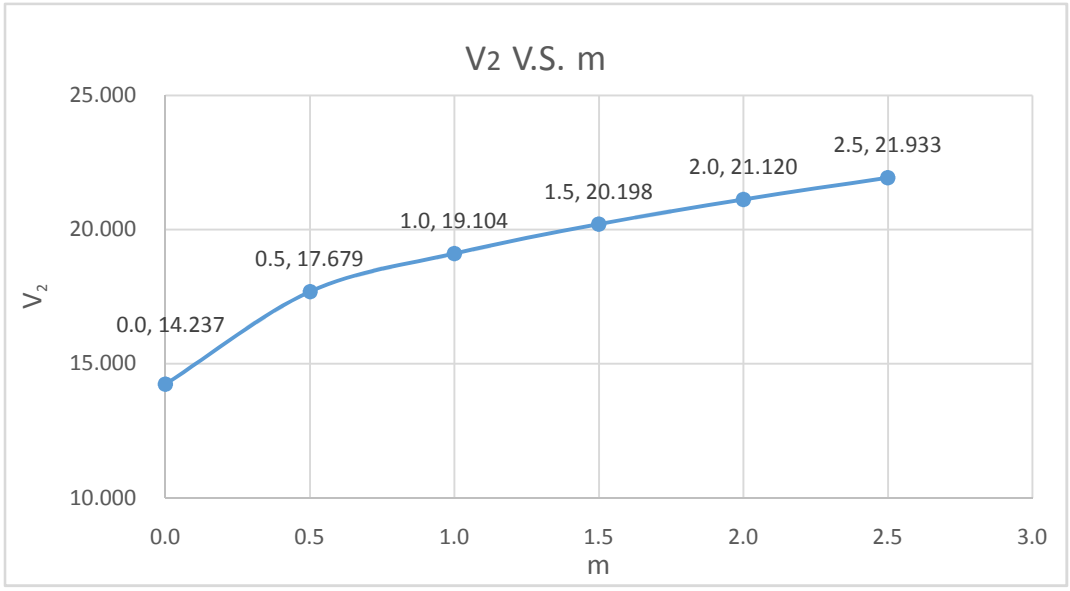
$(\overline{V}_1^0 = \frac{18.016}{d_{water}} = \frac{18.016}{0.9974} = 18.063\ (\frac{cm^3}{mol})\ )$

| Run | $H_2O$ | 1/8 | 1/4 | 1/2 | 1 |
|---|---|---|---|---|---|
| $M_{NaCl}$ | 0 | 0.3743 | 0.7486 | 1.4972 | 2.9944 |
| $W_{sol'n} + W_e$ | 77.123 | 77.915 | 78.674 | 80.137 | 82.888 |
| $W_e$ | 27.197 | | | | |
| $W_{sol'n}$ | 49.926 | 50.718 | 51.477 | 52.94 | 55.691 |
| $d_{water}$ (g/ml) | 0.9974 | | | | |
| $V_p$ (ml) | 50.056 | | | | |
| $d_{sol'n}$ | 0.9974 | 1.0132 | 1.0284 | 1.0576 | 1.1126 |
| m(mol/kg) | 0 | 0.378 | 0.760 | 1.543 | 3.194 |
| φ | 0 | 16.21 | 17.09 | 18.27 | 20.03 |
| $\sqrt{m}$ | 0.000 | 0.614 | 0.872 | 1.242 | 1.787 |



| dψ/dm= | 3.2448 | | |
|---|---|---|---|
| ψ°= | 14.237 | ml/mol | |
| m | $V_1$ | $V_2$ | $\sqrt{m}$ |
| 0.0 | 18.063 | 14.237 | 0.000 |
| 0.5 | 18.053 | 17.679 | 0.707 |
| 1.0 | 18.034 | 19.104 | 1.000 |
| 1.5 | 18.009 | 20.198 | 1.225 |
| 2.0 | 17.980 | 21.120 | 1.414 |
| 2.5 | 17.947 | 21.933 | 1.581 |




V2 V.S. m
25.000
20.000
15.000
10.000
V2
0.0, 14.237
0.5, 17.679
1.0, 19.104
1.5, 20.198
2.0, 21.120
2.5, 21.933
0.0
0.5
1.0
1.5
2.0
2.5
3.0
m