# Molality

1a) $\frac{199\ g\ NiBr_2}{218.498\ g/mol} = 0.910\,763\ mol$

$$\text{molality} = \frac{0.910\,736\ mol}{0.5000\ kg} = 1.82\ mol/kg$$

b) $\frac{92.3\ g\ KF}{58.096\,703\ g/mol} = 1.588\,730\ mol$

$$\text{molality} = \frac{1.588\,730\ mol}{1.0000\ kg} = 1.59\ mol/kg$$

c) $\frac{98.0\ g\ RbBr}{165.3718\ g/mol} = 0.593\ mol$

$$\text{molality} = \frac{0.593\ mol}{0.824\ kg} = 0.719\ mol/kg$$

d) $\frac{85.2\ g\ SnBr_2}{278.498\ g/mol} = 0.306\ mol$

$$\text{molality} = \frac{0.306\ mol}{0.1400\ kg} = 2.19\ mol/kg$$

f
e) $\frac{1.50\ g\ C_6H_4Cl_2}{147.003\,76\ g/mol} = 0.0102\ mol$

$$\text{molality} = \frac{0.0102\ mol}{0.0350\ kg} = 0.292\ mol/kg$$

# Molality

1e) $\frac{10.0\ g\ AgClO_3}{191.3194\ g/mol} = 0.0523\ mol$

$$\text{molality} = \frac{0.0523\ mol}{0.201\ kg} = 0.260\ mol/kg$$

2a) $\text{molality} = \frac{mol}{kg} \quad \therefore \quad mol = \text{molality} \cdot kg\ solvent$

$$mol = (0.851\ mol/kg)(1.0000\ kg) = 0.851\ mol$$

$$mol = \frac{mass}{mol\ mass} \qquad mass = mol \cdot mol\ mass$$

$Fe_2(C_2O_4)_3$

$$mass = (0.851\ mol)(375.7528\ g/mol) = 320.\ g$$

b) $VOBr_3$ mass = ?

$$mol = (0.534\ mol/kg)(1.0000\ kg) = 0.534\ mol$$
$$mass = (0.534\ mol)(306.6529\ g/mol) = 164\ g$$

c) $LiMnO_4$ mass = ?

$$mol = (0.614\ mol/kg)(0.5000\ kg) = 0.307\ mol$$
$$mass = (0.307\ mol)(125.8766\ g/mol) = 38.6\ g$$

# Molality

2d $I_2$ mass = ?

$CCl_4$ mass = vol · density
= (250.0 mL)(1.595 g/mL)
= 398.75 g

mol = (0.175 mol/kg)(0.39875 kg) = 0.0698 mol
mass = (0.0698 mol)(253.809 g/mol) = 17.7 g

3. 30.0 % HF assume 100 g solution
∴ 30.0 g HF, 70.0 g $H_2O$

$$\text{mol HF} = \frac{30.0\ \text{g}}{20.006\,343\ \text{g/mol}} = 1.499\,524\ \text{mol}$$

$$\text{molality} = \frac{1.499\,524\ \text{mol}}{0.0700\ \text{kg}} = 21.4\ \text{mol/kg}$$

4a) $$\frac{25.5\ \text{g}\ C_7H_{11}NO_7S}{253.232\,84\ \text{g/mol}} = 0.100\,697\,84\ \text{mol}$$

$$\text{molality} = \frac{0.101\ \text{mol}}{0.100\ \text{kg}} = 1.01\ \text{m}$$

$\Delta T_{FP}$ = (1.01 m)(−1.86 °C/m)
= −1.87 °C
FP = 0.00 °C − 1.87 °C
= −1.87 °C

$\Delta T_{BP}$ = (1.01 m)(0.512 °C/m)
= 0.516 °C
BP = 100.00 °C + 0.516 °C
= 100.52 °C

# Molality

4b) $\frac{100.0\ g\ C_{10}H_8O_6S_2}{288.301\ 92\ g/mol} = 0.3468\ mol$

$molality = \frac{0.3468\ mol}{0.1000\ kg} = 3.469\ m$

$\Delta T_{FP} = (3.469\ m)(-1.86\ ^\circ C/m) = -6.45\ ^\circ C$

$FP = 0.00\ ^\circ C - 6.45\ ^\circ C = -6.45\ ^\circ C$

$\Delta T_{BP} = (3.469\ m)(0.512\ ^\circ C/m) = 1.78\ ^\circ C$

$BP = 100.00\ ^\circ C + 1.78\ ^\circ C = 101.78\ ^\circ C$

4c) $NiSO_4 \rightarrow Ni^{2+} + SO_4^{2-}$

$mol = \frac{21.6\ g}{154.7536\ g/mol} = 0.140\ mol$

$molality = \frac{0.140\ mol \times 2\ ions/compound}{0.1000\ kg} = 2.79\ m$

$\Delta T_{FP} = (2.79\ m)(-1.86\ ^\circ C/m) = -5.19\ ^\circ C$

$FP = -5.19\ ^\circ C + 0.00\ ^\circ C$

$FP = -5.19\ ^\circ C$

$\Delta T_{BP} = (2.79\ m)(0.512\ ^\circ C/m) = 1.43\ ^\circ C$

$BP = 100.00\ ^\circ C + 1.43\ ^\circ C$

$= 101.43\ ^\circ C$

# Molality

4d) $Mg(ClO_3)_2 \rightarrow Mg^{2+} + 2ClO_3^-$

$$mol = \frac{77.0\ g}{191.2074\ g/mol} = 0.403\ mol \quad (\times 3\ ions/compound) = 1.21\ mol$$

$$molality = \frac{1.21\ mol}{0.2000\ kg} = 6.04\ m$$

$\Delta T_{FP} = (6.04\ m)(-1.86\ ^\circ C/m) = -11.2\ ^\circ C$

$FP = 0.00^\circ C - 11.2^\circ C = -11.2^\circ C$

$\Delta T_{BP} = (6.04\ m)(0.512\ ^\circ C/m) = 3.09\ ^\circ C$

$BP = 100.00^\circ C + 3.09^\circ C = 103.09^\circ C$

e) $C_{15}H_9NO_4$ in $C_6H_5NO_2$

$$mol = \frac{41.3\ g}{267.24076\ g/mol} = 0.155\ mol$$

$$molality = \frac{0.155\ mol}{0.1000\ kg} = 1.55\ m$$

$\Delta T_{FP} = (1.55\ m)(-7.00\ ^\circ C/m) = -10.8\ ^\circ C$

$FP = 5.7^\circ C - 10.8^\circ C = -5.1^\circ C$

$\Delta T_{BP} = (1.55\ m)(5.24\ ^\circ C/m) = 8.10\ ^\circ C$

$BP = 210.8^\circ C + 8.10^\circ C = 218.9^\circ C$

# Molality

4f) 97.5 g $C_{12}H_{22}O_{11}$ in 185 g $H_2O$

$$\text{mol} = \frac{97.5\text{ g}}{342.30008\text{ g/mol}} = 0.285\text{ mol}$$

$$\text{molality} = \frac{0.285\text{ mol}}{0.185\text{ kg}} = 1.54\text{ m}$$

$\Delta T_{FP} = (1.54\text{ m})(-1.86\ ^\circ\text{C/m}) = -2.86\ ^\circ\text{C}$

$FP = 0.00^\circ\text{C} - 2.86^\circ\text{C} = -2.86^\circ$

$\Delta T_{BP} = (1.54\text{ m})(0.512\ ^\circ\text{C/m}) = 0.788\ ^\circ\text{C}$

$BP = 100.00^\circ\text{C} + 0.788^\circ\text{C} = 100.79\ ^\circ\text{C}$

4g) 14.0 g $C_{10}H_8$ in 25.0 g $C_6H_6$

$$\text{mol} = \frac{14.0\text{ g}}{128.17352\text{ g/mol}} = 0.109\text{ mol}$$

$$\text{molality} = \frac{0.109\text{ mol}}{0.0250\text{ kg}} = 4.37\text{ m}$$

$\Delta T_{FP} = (4.37\text{ m})(-4.90\ ^\circ\text{C/m}) = -21.4\ ^\circ\text{C}$

$FP = 5.5^\circ\text{C} - 21.4^\circ\text{C} = -15.9\ ^\circ\text{C}$

$\Delta T_{BP} = (4.37\text{ m})(2.53\ ^\circ\text{C/m}) = 11.1\ ^\circ\text{C}$

$BP = 80.1^\circ\text{C} + 11.1^\circ\text{C} = 91.2\ ^\circ\text{C}$

# Molality

4h) 250.0 g $C_7H_4BrNO_4$ in 500.0 g $C_6H_6$

$$\text{mol} = \frac{250.0\text{ g}}{246.01706\text{ g/mol}} = 1.02\text{ mol}$$

$$\text{molality} = \frac{1.02\text{ mol}}{0.5000\text{ kg}} = 2.03\text{ m}$$

$\Delta T_{FP} = (2.03\text{ m})(-4.90\,^\circ\text{C/m}) = -9.96\,^\circ\text{C}$

$FP = 5.5\,^\circ\text{C} - 9.96\,^\circ\text{C} = -4.5\,^\circ\text{C}$

$\Delta T_{BP} = (2.03\text{ m})(2.53\,^\circ\text{C/m}) = 5.14\,^\circ\text{C}$

$BP = 80.1\,^\circ\text{C} + 5.14\,^\circ\text{C} = 85.2\,^\circ\text{C}$

4i) 60.0 g $C_4H_{18}$ in 100.0 g $CH_3COOH$

$$\text{mol} = \frac{60.0\text{ g}}{126.24192\text{ g/mol}} = 0.475\text{ mol}$$

$$\text{molality} = \frac{0.475\text{ mol}}{0.1000\text{ kg}} = 4.75\text{ m}$$

$\Delta T_{FP} = (4.75\text{ m})(-3.90\,^\circ\text{C/m}) = -18.5\,^\circ\text{C}$

$FP = 16.604\,^\circ\text{C} - 18.5\,^\circ\text{C} = -1.9\,^\circ\text{C}$

$\Delta T_{BP} = (4.75\text{ m})(3.07\,^\circ\text{C/m}) = 14.6\,^\circ\text{C}$

$BP = 117.9\,^\circ\text{C} + 14.6\,^\circ\text{C} = 132.5\,^\circ\text{C}$

# Molality

5a) $\Delta T_{FP} = -0.430 - 0.00 = -0.430\ ^\circ C$

$m = \frac{\Delta T_{FP}}{K_{FP}} = \frac{-0.430\ ^\circ C}{-1.86\ ^\circ C/m} = 0.231\ m$

$mol = (m)(kg) = (0.231\ mol/kg)(0.861\ kg) = 0.199\ mol$

$mol\ mass = \frac{mass}{mol} = \frac{8.02\ g}{0.199\ mol} = 40.3\ g/mol$

b) $\Delta T_{BP} = 100.680 - 100 = 0.680\ ^\circ C$

$m = \frac{0.680\ ^\circ C}{0.512\ ^\circ C/m} = 1.33\ m$ $\quad mol = (1.33\ mol/kg)(0.3900\ kg) = 0.518\ mol$

$mol\ mass = \frac{64.3\ g}{0.518\ mol} = 124\ g/mol$

c) $\Delta T_{FP} = 13.5 - 16.604 = -3.104\ ^\circ C$

$m = \frac{-3.104\ ^\circ C}{-3.90\ ^\circ C} = 0.796\ m$ $\quad mol = (0.796\ m)(0.128\ kg) = 0.102\ mol$

$mol\ mass = \frac{20.8\ g}{0.102\ mol} = 204\ g/mol$

# Molality

5d) $\Delta T_{FP} = 36.3° - 43° = -6.7°C$

$m = \frac{-6.7°C}{-7.40°C/m} = 0.905\ m$ $\quad mol = (0.905\ m)(0.164\ kg) = 0.148\ mol$

$mol\ mass = \frac{10.4\ g}{0.148\ mol} = 70.\ g/mol$

e) $\Delta T_{FP} = 3.40°C - 5.7°C = -2.3°C$

$m = \frac{-2.3°C}{-7.00°C/m} = 0.329 m$ $\quad mol = (0.329\ m)(0.0635\ kg) = 0.0209\ mol$

$mol\ mass = \frac{2.53\ g}{0.0209\ mol} = 121\ g/mol$

f) $\Delta T_{FP} = -0.603°C - 0.00°C = -0.603°C$

$m = \frac{-0.603°C}{-1.86°C/m} = 0.324\ m$ $\quad mol = (0.324\ m)(0.104\ kg) = 0.0337\ mol$

$mol\ mass = \frac{5.60\ g}{0.0337\ mol} = 166\ g/mol$