Solve the following boiling point elevation problems and the freezing point depression problems as shown in the sample problems below. [*NOTE:* At standard pressure, 1 mol of dissolved particles will elevate the boiling point of 1,000 g of water by 0.52°C and will depress the freezing point of 1,000 g of water by 1.86°C]

Sample Problem

Find the boiling point of a solution containing 1,000 g of water and 2 mol of dissolved MgF_2.

Step 1: Determine the number of moles of solute particles

$2MgF_2(s) \rightarrow 2Mg^{2+}(aq) + 4F^{-}(aq)$ *mol* =6

Step 2: Multiply the boiling point elevation per mole by the number of moles of solute to find the boiling point elevation

BPE = $0.52^{\circ C}/mol \times 3\ mol = 3.12°C$

Step 3: Add the boiling point elevation to 100°C

BP = 100°C + 3.12°C = 10 3.12°C

Sample Problem

Find the freezing point of a solution containing 1,000 g of water and 30 g of dissolved antifreeze ($C_2H_4O_2$).

Step 1: Determine the number of moles of solute particles

C = 12 × 2 = 24
H = 1 × 4 = 4
O = 16 × 2 = 32
60

$$mol = \frac{g}{GFM} = \frac{30g}{60\,{}^{g}/_{mol}} = 0.5mol$$

Step 2: Multiply the freezing point depression per mole by the number of moles of solute to find the freezing point depression

FPD = $1.86^{\circ C}/mol \times 0.5\ mol = 0.93°C$

Step 3: Subtract the freezing point depression from 0°C

FP = 0°C – 0.93°C = – 0.93°C

4. One mole of dissolved particles elevates the boiling point of 1,000 g of water by 0.52°C. At standard pressure, what will the boiling point of a solution be if it contains 1,000 g of water and:

   a. 1 mol of antifreeze ($C_2H_4O_2$)? _____
   b. 1 mol of salt (NaCl)? _____
   c. 1 mol of ethanol (C_2H_5OH)? _____
   d. 2 mol of glycerol ($C_3H_6O_3$)? _____
   e. 2 mol of $CaCl_2(aq)$? _____
   f. 5 mol of sucrose ($C_{12}H_{22}O_{11}$)? _____
   g. 1 mol of $KNO_3(aq)$? _____
   h. 3 mol of $Ba(NO_3)_2(aq)$? _____
   i. 40 g of NaOH(*aq*)? _____
   j. 270 g of glucose ($C_6H_{12}O_6$)? _____

5. One mole of dissolved particles depresses the freezing point of 1,000 g of water by1.86°C. At standard pressure, what will the freezing point of a solution be if it contains 1,000 g of water and:

   a. 1 mol of glucose ($C_6H_{12}O_6$)? _____
   b. 1 mol of $BaCl_2(aq)$? _____
   c. 2 mol of methanol (CH_3OH)? _____
   d. 3 mol of glycerol ($C_3H_6O_3$)? _____
   e. 2 mol of $CuSO_4(aq)$? _____
   f. 4 mol of sucrose ($C_{12}H_{22}O_{11}$)? _____
   g. 3 mol of $KNO_3(aq)$? _____
   h. 2 mol of salt (NaCl)? _____
   i. 150 g of $KHCO_3(aq)$? _____
   j. 180 g of glucose ($C_6H_{12}O_6$)? _____