Bonus quiz Name _____

Potentially useful information for water: k_b = 0.512 °C kg/mol; k_f = 1.86°C kg/mol; k_H= 1.66×10^{-6}M/mm Hg; R = 0.0821 atm L/mol K; 1 atm = 760 mm Hg; $T_b = i\, k_b m$; $\pi = MRT$

Consider an aqueous solution of $CaCl_2$. It's boiling point is carefully measured to be 100.010°C. Answer the following questions:

_____ (1) What is the molality of ions in the solution?

a) 0.013 m b) 0.20 m c) 0.020 m d) 0.52 m e) 0.0014 m

solution: **C** $m = \Delta T_b/k_b = 0.010/0.512 = 0.0195$ m ≈ 0.020 m (2 sig. figs)

_____(2) What is its freezing point?

a) 0.010°C b) -0.010°C c) + 0.036°C d) – 0.026°C e) -0.036°C

solution: **E** $\Delta T_b = k_b m$ and $\Delta T_f = k_f m$ and so: $m = \Delta T_b/k_b = \Delta T_f/k_f \Rightarrow T_f = \Delta T_b(k_f/k_b)$

$T_f = (100.010\text{-}100.000)(1.86/0.512)°C = 0.036°C$;

Freezing point depression results in: $T_f = 0.000°C - \Delta T_f = -0.036°C$

_____ (3) What is the ppm Ca^{2+} (40.1g/mol) in this solution? (hint: assume no ion-pairing)

a) 120 ppm b) 240 ppm c) 190 ppm d) 22 ppm e) 0.065 ppm

solution: **B** first get molality: $i\, m = \Delta T_b/k_b = 0.010/0.512 = 0.0195$ m where i=3 (since no ion pairing). So $m_{CaCl2} = m_{Ca2+} = 0.0195/3 = 0.0065$ m = 0.0065 mol Ca^{2+}/kg

so ppm Ca^{2+} = 0.0065mol (40.1g)/kg x(10^3mg/g) (1kg/L)=260 mg/L = 260 ppm

(As mentioned in lecture, for dilute solutions, density of dilute aq. sol'n ≈1g/mL or kg/L)

(As announced in class, you need to choose the closest one – namely 240 pm)

_____ (4) What is the osmotic pressure associated with this solution at 27°C? (hint: for dilute solutions, magnitude of molality ≈ magnitude of molarity)

a) 370 mmHg b) 40 mmHg c) 0.25 mmHg d) 490 mmHg

solution: **A** $\pi = MRT \approx m_{ions}RT = (0.0195\text{mol/L})(0.0821\text{atm L/mol K})(300\text{K}) = 0.48$ atm

In mmHg, that would be 0.48 atm (760mmHg/atm)=365mmHg = 370 mmHg

_____ (5) What is the MW of a 0.70 % (m/V) sugar solution if its boiling point is the same as this $CaCl_2$ solution?

a) 220 g/mol b) 180 g/mol c) 540 g/mol d) 360 g/mol

e) 98 g/mol

solution: **D** Here we need to correlate the grams sugar to the moles sugar.

So, first convert this sugar solution to g/L:

0.70% sugar = 0.70 g sugar/100 mL = 0.70g sugar/0.1L = 7.0 g sugar/ L

but its molality must be the same as the ion molality = 0.0195 mol/kg≈ 0.0195mol/L

so! MW = 7.0g/0.0195mol = 359 ≈ 360 g/mol