

## Quiz 13.2 – Colligative Properties

Name: Key

All questions on this quiz concern a solution of 12.5 ml of ethanol ( $C_2H_5OH$ ) and 36.3 ml of water. Below are some useful properties of water and ethanol

	$d_{25^\circ C}$	$T_f$	$T_b$	$K_f$	$K_b$	$P_{25^\circ C}^\circ$
H <sub>2</sub> O	$0.997 \frac{g}{cm^3}$	$0.00^\circ C$	$100.00^\circ C$	$1.86 \frac{^\circ C}{m}$	$0.512 \frac{^\circ C}{m}$	23.8 torr
EtOH	$0.7893 \frac{g}{cm^3}$	$-114.14^\circ C$	$78.24^\circ C$	$1.99 \frac{^\circ C}{m}$	$1.22 \frac{^\circ C}{m}$	44.6 torr

## Question 1

$$\text{total moles} = 2.223 \text{ moles}$$

Calculate the mole fractions of water and ethanol in both the liquid and the vapor phase

$$\chi_{H_2O}(l) = \frac{2.009 \text{ moles}}{2.223 \text{ moles}} = 0.9037 \quad \chi_{EtOH}(l) = \frac{0.2142 \text{ moles}}{2.223 \text{ moles}} = 0.09636$$

$$P_{H_2O} = 0.9037 \cdot 23.8 \text{ torr} = 21.51 \text{ torr} \quad P_{total} = 25.81 \text{ torr} \quad \chi_{H_2O}(g) = \frac{21.51 \text{ torr}}{25.81 \text{ torr}} = 0.833$$

$$P_{EtOH} = 0.09636 \cdot 44.6 \text{ torr} = 4.298 \text{ torr} \quad \chi_{EtOH}(g) = \frac{4.298 \text{ torr}}{25.81 \text{ torr}} = 0.167$$

## Question 2

Because water is the majority component, freezing and boiling points will be determined in relation to water. Find the freezing and boiling points for the solution

$$\text{Molality} = \frac{0.2142 \text{ moles}}{0.03619 \text{ kg}} = 5.919 \text{ m}$$

$$\Delta T_f = 1.86 \frac{^\circ C}{m} \cdot 5.919 \text{ m} = 11.0^\circ C \quad \Delta T_b = 0.512 \frac{^\circ C}{m} \cdot 5.919 \text{ m} = 3.03^\circ C$$

## Question 3

$$T_f = -11.0^\circ C$$

$$T_b = 103.03^\circ C$$

The mixture will have a final volume of 47.5 ml. Find the density of the mixture

$$\text{total mass} = 46.06 \text{ g} \quad d = \frac{46.06 \text{ g}}{47.5 \text{ ml}} = 0.970 \text{ g/ml}$$

## Question 4

How much osmotic pressure will this solution exhibit?

$$\pi = \frac{nRT}{V} = \frac{0.2142 \text{ moles} \cdot 0.08206 \frac{L \cdot atm}{mol \cdot K} \cdot 298 \text{ K}}{0.0475 \text{ L}} = 110 \text{ atm!}$$