Worksheet: Cryoscopy and Ebullioscopy

Q1: When 6.29 g of a nonvolatile solute is dissolved in 500 g of water, the freezing point of the resultant aqueous solution is 0.646°C lower than that of pure water. The cryoscopic constant for water is $K_f = 1.856$ K·kg/mol and the solute does not dissociate. Estimate the molar mass of the solute.

A 18.1 g/mol

B 36.1 g/mol

C 36.1 kg/mol

D 72.2 g/mol

Q2: A sample of sulfur weighing 0.201 g was dissolved in 17.8 g of carbon disulfide, CS_2($K_b = 2.43$°C/m). If the boiling point of the carbon disulfide was elevated by 0.107°C, what is the formula of a sulfur molecule in this solution?

A S_4

B S

C S_5

D S_2

E S_8

Q3: Lysozyme is an enzyme that cleaves cell walls. A 0.100 L sample of a solution of lysozyme containing 0.0750 g of the enzyme exhibits an osmotic pressure of 1.32×10^{-3} atm at 25°C. What is the molar mass of lysozyme?

A 1.39×10^4 g/mol

B 1.32×10^4 g/mol

C 3.45×10^3 g/mol

D 4.50×10^4 g/mol

E 6.08×10^4 g/mol

Q4: Why are soaps useful for cleaning?

A Soaps lower the viscosity of water. This allows it to penetrate hydrophobic substances more easily, breaking them into smaller particles that can be mechanically removed.

B Soaps are amphiphilic molecules that help to emulsify hydrophobic substances, allowing them to be removed by water.

C Soaps are very reactive and decompose grease into smaller particles that can be dissolved by water.

D Soap molecules function as “molecular sandpaper”: the hydrophobic tails of the molecules are inserted between molecules of an insoluble substance, mechanically separating them into smaller particles that can be dissolved by water.

E Soaps are absorbed into grease and other hydrophobic substances. This causes the materials to swell and become less sticky, allowing them to removed by water.

Q5: A sample of an organic compound (a nonelectrolyte) weighing 1.30 g lowered the freezing point of 10.0 g of benzene ($K_f = 5.12°C/m$) by 3.66°C. What is the molar mass of the compound?

A 182 g/mol

B 210 g/mol

C 93.2 g/mol

D 145 g/mol

E 117 g/mol

Q6: A 12.0 g sample of a nonelectrolyte is dissolved in 80.0 g of water. The solution freezes at −1.94°C. What is the molar mass of this solute? The freezing point depression constant of water is 1.86°C/m.

A 120 g/mol

B 138 g/mol

C 160 g/mol

D 109 g/mol

E 144 g/mol

Q7: When 5.00 g of a nonionic compound is dissolved in 25.00 g of carbon tetrachloride (boiling point 76.8°C, $K_b = 5.02\ \text{K}\cdot\text{kg/mol}$), the boiling point of the solution at 1 atm is 81.5°C. Calculate the molar mass of the nonionic compound.

A 5.34 g/mol

B 214 g/mol

C 532 g/mol

D 112 g/mol

E 191 g/mol

Q8: A 2.43 mol/kg aqueous solution of glycerin ($C_3H_8O_3$) was prepared by mixing glycerin with 0.500 kg of water.

- What mass of glycerin was required?

A 73.0 g

B 90.2 g

C 254 g

D 112 g

E 145 g

What is the freezing point of this solution? The freezing point depression constant of water is 1.86 kg·K/mol.

A $-6.78°C$

B $-2.39°C$

C $-1.53°C$

D $-4.52°C$

E $-1.31°C$