Solutions -4a Conversion of Conc. Units

* An aq. soln of ethylene glycol (CH_2OHCH_2OH, MW = 62.0 g/mol) is used as an engine coolant. It is 40.0% ethylene glycol by mass. The density of the solution is 1.05 g/mL. Calculate
(a) molarity (b) molality & (c) mol fraction of eth. glycol

molarity: mol solute / L soln.
molality: mol solute / kg solvent.
mol fraction: mol solute / total mols.

Ans $40.0\% = \frac{40\text{ g EG}}{100\text{ g soln}}$; $d_{soln} = 1.05\text{ g/mL}$ → 1 L soln

(a) Molarity = mol solute / L solution.
comes from mass of solute from mass of solution

mass of solution = $1\text{ L} \times \frac{1000\text{ mL}}{1\text{ L}} \times \frac{1.05\text{ g}}{\text{mL}} = 1050\text{ g soln}$.

$1050\text{ g} \times \frac{40\text{ g EG}}{100\text{ g soln}} = 420\text{ g EG}$. (convert to mols)

$420\text{ g} \times \frac{1\text{ mol}}{62.01\text{ g}} = 6.77\text{ mol}$,

$6.77\text{ mol} / 1\text{ L} = \boxed{6.77\text{ M}}$

(b) Molality = mol solute → already calc.: 6.77 mol.
kg solvent — from mass of soln in (a).

$1050\text{ g} - 420\text{ g EG} = 630\text{ g } H_2O \times 1\text{ kg}/1000\text{ g} = 0.630\text{ kg}$

$6.77\text{ mol} / 0.630\text{ kg} = \boxed{10.7\text{ m}}$

(c) $\chi_{EG} = \frac{\text{mol EG}}{\text{mol EG} + \text{mol } H_2O}$ → 6.77 mol
← mass of H_2O (630 g)

$630\text{ g } H_2O \times \frac{1\text{ mol}}{18\text{ g}} = 35\text{ mol } H_2O$

$\chi_{EG} = \frac{6.77}{(6.77+35)} = \boxed{0.162}$