

## Overview of Chapter 14

- Solutions
- Concentrations:
  - Molarity
  - Molality
  - Mole fraction
- Colligative Properties
  - Freezing point depression
  - Boiling point elevation
- Osmosis

## Today's questions to consider:

- How do we calculate concentrations?
- Why does a soda fizz when we open the lid?
- How do you calculate mole fraction?

## Today's Topics

- Calculating concentrations
  - Molarity
  - Molality
  - Mole fraction
- Colligative Properties
- Raoult's Law

## Concentration Units

### Molarity, M

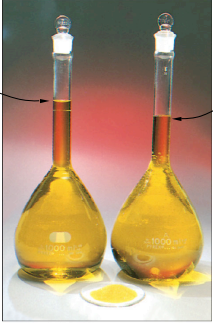
$$M \text{ of solute} = \frac{\text{mol solute}}{1 \text{ L solution (total volume)}}$$

### Molality, m

$$m \text{ of solute} = \frac{\text{mol solute}}{1 \text{ kg solvent}}$$

## Concentration Units

**Molality (m):**  
 $0.100 \text{ m K}_2\text{CrO}_4 =$   
 $\frac{19.4 \text{ g K}_2\text{CrO}_4}{1.00 \text{ kg H}_2\text{O}}$



**Molarity (M):**  
 $0.100 \text{ M K}_2\text{CrO}_4 =$   
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## Concentration Units

### Mole Fraction, X

For a mixture of A, B, and C:

$$X_A = \text{mol fraction A} = \frac{\text{mol A}}{\text{mol A} + \text{mol B} + \text{mol C}}$$

**WEIGHT %** = grams solute per 100 g solution

### Concentration Calculations

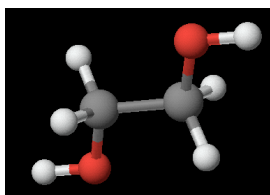
If we make dissolve 62.1 g (1.00 mol) of ethylene glycol in 250. g of H<sub>2</sub>O, calculate the

**mol fraction**

**molality**

**weight %**

of ethylene glycol.



### Concentration Calculations

Dissolve 62.1 g (1.00 mol) of ethylene glycol in 250. g of H<sub>2</sub>O. Calculate X, m, and % of glycol.

$$250. \text{ g H}_2\text{O} \times (1 \text{ mol H}_2\text{O}/18.0 \text{ g H}_2\text{O}) = 13.9 \text{ mol H}_2\text{O}$$

Calculate mole fraction X:

$$X_{\text{glycol}} = \frac{1.00 \text{ mol glycol}}{1.00 \text{ mol glycol} + 13.9 \text{ mol H}_2\text{O}}$$

$$X_{\text{glycol}} = 0.0672$$

### Concentration Calculations

Dissolve 62.1 g (1.00 mol) of ethylene glycol in 250. g of H<sub>2</sub>O. Calculate X, m, and % of glycol.

Calculate molality:

$$\text{conc (molality)} = \frac{1.00 \text{ mol glycol}}{0.250 \text{ kg H}_2\text{O}} = 4.00 \text{ molal}$$

Calculate weight %:

$$\% \text{glycol} = \frac{62.1 \text{ g}}{62.1 \text{ g} + 250. \text{ g}} \times 100\% = 19.9\%$$

### Dissolving Gases & Henry's Law



Gas solubility (in mol/L) =  $k_H \cdot P_{\text{gas}}$

$k_H$  for O<sub>2</sub> =  $1.66 \times 10^{-6} \text{ M / mmHg}$

When  $P_{\text{gas}}$  drops, solubility drops.

### Scuba Diving



TABLE 1 - ONE-OF-ONE LETTER GROUP	
DEPTH (m)	DEPTH (f)
12	40
15	50
18	60
21	70
24	80
27	90
30	100
33	110
36	120
39	130
42	140
45	150
48	160
51	170
54	180
57	190
60	200
63	210
66	220
69	230
72	240
75	250
78	260
81	270
84	280
87	290
90	300
93	310
96	320
99	330
102	340
105	350
108	360
111	370
114	380
117	390
120	400
123	410
126	420
129	430
132	440
135	450
138	460
141	470
144	480
147	490
150	500
153	510
156	520
159	530
162	540
165	550
168	560
171	570
174	580
177	590
180	600
183	610
186	620
189	630
192	640
195	650
198	660
201	670
204	680
207	690
210	700
213	710
216	720
219	730
222	740
225	750
228	760
231	770
234	780
237	790
240	800
243	810
246	820
249	830
252	840
255	850
258	860
261	870
264	880
267	890
270	900
273	910
276	920
279	930
282	940
285	950
288	960
291	970
294	980
297	990
300	1000

### Colligative Properties

On adding a solute to a solvent, the props. of the solvent are modified.

- Vapor pressure decreases
- Melting point decreases
- Boiling point increases
- Osmosis is possible (osmotic pressure)

They depend only on the **NUMBER** of solute particles relative to solvent particles, not on the **KIND** of solute particles.