

## Colligative Properties

### Aim

- to explain boiling point elevation and freezing point depression

### Notes

- ★ Colligative properties - effect of solute on solvent due to the number of particles
  - ★ Nature of colligative properties
    - ★ Not affected by the properties of the solute, but only by the number of particles
    - ★ Electrolytes dissociate producing more particles per mole than nonelectrolytes
      - ★ therefore electrolytes produce larger colligative effects than nonelectrolytes
  - ★ Examples
    - ★ Boiling point elevation - nonvolatile solute reduces the vapor pressure of water, raising the boiling point
      - ★ molal boiling point elevation =  $0.512^{\circ}\text{C}/\text{m}$
    - ★ Freezing point depression - the presence of solute interferes with crystallization, lowering the freezing point
      - ★ molal freezing point depression =  $1.86^{\circ}\text{C}/\text{m}$

### Answer the questions below by circling the number of the correct response

- A pupil dissolved 180.00 grams of  $\text{C}_6\text{H}_{12}\text{O}_6$  in 1,000.0 grams of water and then heated the solution until it boiled. What was the boiling point of the  $\text{C}_6\text{H}_{12}\text{O}_6$  solution? (air pressure is 1 atmosphere) (1)  $98.96^{\circ}\text{C}$  (2)  $100.52^{\circ}\text{C}$  (3)  $99.48^{\circ}\text{C}$  (4)  $101.04^{\circ}\text{C}$
- One mole of an ionic salt will usually depress the freezing point of water to a greater extent than one mole of a soluble organic substance because the ionic salt
  - will produce more particles in solution
  - is more easily hydrated
  - has a higher melting point
  - has a higher molecular mass
- Which solution will have the highest boiling point?
 

(1) $\text{KNO}_3$	(3) $\text{Mg}(\text{NO}_3)_2$
(2) $\text{Al}(\text{NO}_3)_3$	(4) $\text{NH}_4\text{NO}_3$
- Which solution has the lowest freezing point?
 

(1) acetic acid	(3) nitrous acid
(2) potassium hydroxide	(4) ammonium hydroxide
- Which water solution will have the highest freezing point?
 

(1) $\text{CaCl}_2$	(3) $\text{C}_{12}\text{H}_{22}\text{O}_{11}$
(2) $\text{NaCl}$	(4) $\text{CH}_3\text{COOH}$

### The solutions described in questions 3 - 9 have the same concentration of dissolved solute.

- Which solution would have the lowest freezing point? (1)  $\text{NaCl}(\text{aq})$  (2)  $\text{HCl}(\text{aq})$  (3)  $\text{KCl}(\text{aq})$  (4)  $\text{CaCl}_2(\text{aq})$
- Which solution will have the lowest freezing point? (1)  $\text{CH}_3\text{COOH}$  (2)  $\text{C}_6\text{H}_{12}\text{O}_6$  (3)  $\text{C}_2\text{H}_5\text{OH}$  (4)  $\text{H}_2\text{SO}_4$
- Which water solution will have the lowest freezing point? (1)  $\text{BaCl}_2$  (2)  $\text{NaCl}$  (3)  $\text{C}_3\text{H}_5(\text{OH})_3$  (4)  $\text{CH}_3\text{COOH}$
- Which water solution will have the lowest freezing point? (1)  $\text{CaCl}_2$  (2)  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$  (3)  $\text{NaCl}$  (4)  $\text{CH}_3\text{COOH}$
- If 46.0 grams of ethanol  $\text{C}_2\text{H}_5\text{OH}$  are completely dissolved in 1,000. g of water, the freezing point of the solution in Celsius is most nearly (1) 3.72 (2) -1.86 (3) 1.86 (4) -3.72
- The solution with the lowest freezing point would be produced when 1.0 gram of  $\text{C}_6\text{H}_{12}\text{O}_6$  is dissolved in
 

(1) 18 grams of $\text{H}_2\text{O}$	(3) 180 grams of $\text{H}_2\text{O}$
(2) 100 grams of $\text{H}_2\text{O}$	(4) 1,000 grams of $\text{H}_2\text{O}$
- What is the total number of grams of  $\text{C}_6\text{H}_{12}\text{O}_6$  that must be dissolved in 1,000 grams of water to raise the boiling point  $0.52^{\circ}\text{C}$ ? (boiling point elevation constant of  $\text{H}_2\text{O} = 0.52^{\circ}\text{C}$ )
 

(1) 9	(3) 18
(2) 90	(4) 180