MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) As a gaseous element condenses, the atoms become _______ and they have _______.
   A) more separated, more
   B) larger, greater
   C) more separated, less
   D) closer together, less
   E) closer together, more

2) Which one of the following should have the lowest boiling point?
   A) SH₄
   B) H₂O
   C) H₂S
   D) PH₃
   E) HCl

3) In which of the following molecules is hydrogen bonding likely to be the most significant component of the total intermolecular forces?
   A) CH₄
   B) CO₂
   C) CH₃OH
   D) C₅H₁₁OH
   E) C₆H₁₃NH₂

4) Which one of the following derivatives of ethane has the highest boiling point?
   A) C₂F₆
   B) C₂H₆
   C) C₂Cl₆
   D) C₂H₄
   E) C₂Br₂

5) The heating curve shown was generated by measuring the heat flow and temperature of a solid as it was heated. The heat flow into the sample in the segment _______ will yield the value of the ΔH_fusion of this substance.
   A) AB
   B) BC
   C) CD
   D) DE
   E) EF
6) According to the phase diagram shown above, the normal boiling point of this substance is ______ °C.
   A) 10     B) 38     C) -3     D) 0     E) 29

7) Based on the figure above, the boiling point of water under an external pressure of 0.493 atm is ______ °C.
   A) 80     B) 90     C) 60     D) 70     E) 40

8) Formation of solutions where the process is endothermic can be spontaneous provided that ______.

   A) they are accompanied by an increase in order
   B) they are accompanied by an increase in disorder
   C) the solvent is a gas and the solute is a solid
   D) they are accompanied by another process that is exothermic
   E) the solvent is water and the solute is a gas
9) A solution with a concentration higher than the solubility is _________.
(A) supersaturated
(B) is supercritical
(C) is unsaturated
(D) is saturated
(E) is not possible

10) The principal reason for the extremely low solubility of NaCl in benzene (C₆H₆) is the _________.
(A) hydrogen bonding in C₆H₆
(B) strong solvent-solvent interactions
(C) strength of the covalent bond in NaCl
(D) increased disorder due to mixing of solute and solvent
(E) weak solvation of Na⁺ and Cl⁻ by C₆H₆

11) A solution contains 28% phosphoric acid by mass. This means that _________.
(A) 1 L of this solution contains 28 mL of phosphoric acid
(B) the density of this solution is 2.8 g/mL
(C) 1 mL of this solution contains 28 g of phosphoric acid
(D) 100 g of this solution contains 28 g of phosphoric acid
(E) 1 L of this solution has a mass of 28 g

12) Molality is defined as the _________.
(A) moles solute/kg solution
(B) moles solute/kg solvent
(C) moles solute/liters solution
(D) moles solute/moles solvent
(E) none (dimensionless)

13) Which one of the following solutes has a limiting van't Hoff factor (i) of 3 when dissolved in water?
(A) KNO₃  (B) sucrose  (C) Na₂SO₄  (D) CH₃OH  (E) CCl₄

14) The concentration of HCl in a solution that is prepared by dissolving 5.5 g of HCl in 200 g of C₂H₆O is ________ molal.
(A) 27.5  (B) 7.5 × 10⁻⁴  (C) 0.75  (D) 1.3  (E) 3.3 × 10⁻²

15) The molarity of urea in a solution prepared by dissolving 16 g of urea (MW = 60.0 g/mol) in 39 g of H₂O is ________ M. The density of the solution is 1.3 g/mL.
(A) 3.7  (B) 6.8  (C) 6.3  (D) 0.16  (E) 0.11
16) The Henry's law constant for helium gas in water at 30 °C is 3.70 \times 10^{-4} \text{ M/atm}. When the partial pressure of helium above a sample of water is 0.650 atm, the concentration of helium in the water is _________ M.

A) 5.69 \times 10^{-4}  
B) 3.70 \times 10^{-4}  
C) 2.41 \times 10^{-4}  
D) 1.76 \times 10^{-3}  
E) 1.30

\[ 21 \text{ g} \times \frac{\text{mol}}{60 \text{ g}} = \frac{35}{41.166 + 3.5} \times = \frac{4.166}{41.166 + 3.5} \]

\[ 75 \text{ g} \times \frac{\text{mol}}{18 \text{ g}} = \frac{4.166 (23.8)}{9.22} = \]

17) The vapor pressure of pure water at 25 °C is 23.8 torr. Determine the vapor pressure (torr) of water at 25 °C above a solution prepared by dissolving 21 g of urea (a nonvolatile, non-electrolyte, MW = 60.0 g/mol) in 75 g of water.

A) 0.92  
B) 0.35  
C) 27  
D) 2.9  
E) 22

18) Calculate the freezing point of a 0.08500 m aqueous solution of NaNO₃. The molal freezing-point-depression constant of water is 1.86 °C/m.

A) -0.158  
B) 0.0425  
C) -0.316  
D) -0.0790  
E) 0.0790

19) An aqueous solution of a soluble compound (a nonelectrolyte) is prepared by dissolving 33.2 g of the compound in sufficient water to form 250 mL of solution. The solution has an osmotic pressure of 1.2 atm at 25 °C. What is the molar mass (g/mole) of the compound?

A) 2.3 \times 10^2  
B) 1.0 \times 10^3  
C) 2.7 \times 10^3  
D) 6.8 \times 10^2  
E) 28

\[ M = \frac{1.2 \text{ atm}}{0.0821 \text{ L atm/mol K}} (298 K) \]

\[ 4.19 \times 10^{-2} \text{ mol} \times \frac{250 \text{ L}}{1} = \frac{33.28}{M} \]

\[ (0.085 \text{ m})(1.86 \frac{\circ C}{m}) \times = 2.70 \circ C/m \]

\[ F_p = -0.316 \circ C \]
30. 1-Octanol has a higher boiling point than decane because

A. 1-octanol is an ionic compound
B. 1-octanol has a higher molecular weight than decane
C. Hydrogen bonding is possible in 1-octanol but not in decane
D. 1-octanol has more covalent bonds that must be broken in order to vaporize it than decane does
E. There are more induced dipole-induced dipole forces per mole in 1-octanol than in decane

31. Which one of the following is the best conductor of electricity?

A. Diamond  B. Quartz  C. Silicon  D. Silver  E. Water

32. How much heat is required to convert 9.0 g of ice at -5 °C to water at 25 °C?

A. 4030 J  C. 4890 J  E. 5840 J
B. 4510 J  D. 5370 J

33. High surface tension is favored by:

A. Weak intermolecular forces
B. Strong intermolecular forces
C. High vapor pressure
D. Low vapor pressure
E. High osmotic pressure

\[ \begin{align*}
L_1 &= \left(9g\right)\left(2.1J/\degree\text{C} \right)\left(5\degree\text{C}\right) = 94.5J \\
L_2 &= 9g \times \frac{333J}{5\degree\text{C}} = 2997.5J \\
L_3 &= \left(9g\right)\left(4.18J/\degree\text{C} \right)\left(25\degree\text{C}\right) = 940.5J \\
\end{align*} \]
14 \[ \frac{5.5 \text{ g HCl}}{0.2 \text{ kg}} \times \frac{1 \text{ mol HCl}}{36.45 \text{ g}} = 0.75 \text{ mol/kg} \]

15 \[ \frac{16 \text{ g urea}}{(39 \text{ g} + 16 \text{ g}) \text{ solution}} \times \frac{1 \text{ mol urea}}{60 \text{ g}} \times \frac{1.33}{1 \text{ mL solution}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = \frac{6.3 \text{ mol}}{L} \]

16 \[ S = kP \]

\[ = (0.650 \text{ atm}) \left( 3.70 \times 10^{-4} \frac{\text{M}}{\text{atm}} \right) \]

\[ = 2.41 \times 10^{-4} \text{ M} \]
17. \(21 \text{ g urea} \times \frac{1 \text{ mol urea}}{60 \text{ g}} = 0.35 \text{ mol urea}\)

\(75 \text{ g H}_2\text{O} \times \frac{1 \text{ mol}}{18 \text{ g}} = 4.166 \text{ mol H}_2\text{O}\)

\[ P = X \cdot P^0 \text{ solv} \text{ solv} \]

\[ X_{\text{solv}} = \frac{4.166}{4.166 + 0.35} = 0.922 \]

\[ = (0.922)(23.8 \text{ torr}) \]

\[ = 21.9 \text{ torr} \]

18. \(\Delta T = i \cdot M \cdot K \cdot e^{-\frac{i}{	ext{NaNO}_3}} = 2\)

\[ = 2(0.085 \text{ m})(1.86 \text{ }^\circ\text{C} \text{ m}) \]

\[ = 0.316 \text{ }^\circ\text{C} \]

\(F.P. = -0.316 \text{ }^\circ\text{C}\)
\[ P = \frac{MRT}{V} \]

\[ M = \frac{P}{RT} \]

\[ \frac{1.2 \text{ atm}}{\left( \frac{0.0821 \text{ L atm}}{\text{mol k}} \right) \left( 298 \text{ K} \right)} \]

\[ = \frac{4.9 \times 10^{-2} \text{ mol}}{L} \times 0.25 \text{ L} \]

\[ = \frac{33.29}{0.01226 \text{ mol}} \]

\[ = 2700 \text{ g/mol} \]
21. \( (9.5 \times \frac{2.15 \text{ J}}{5 \text{ °C}}) \times (5 \text{ °C}) \)  
\[
= 94.5 \text{ J}
\]

22. \( 9.9 \times \frac{333.5}{9} = 2997.5 \text{ J} \)

23. \( (9.9 \times \frac{4.185 \text{ J}}{9 \text{ °C}}) \times (25 \text{ °C}) \)  
\[
= 946.5 \text{ J}
\]

\( \Delta H = 21 + 22 + 23 \)
\[
= 94.5 + 2997.5 + 946.5 \text{ J}
\]
\[
= 4032.5 \text{ J}
\]