Honour Chemistry Practice Test: Unit 2 (Part 2): Matter as Solutions and Gases

$$\% \text{ by Mass} = \frac{m_{solute}}{m_{solution}} \times 100\% \qquad \% \text{ (v/v)} = \frac{V_{solute}}{V_{solution}} \times 100\% \qquad \% \text{ (m/v)} = \frac{m_{solute} \text{ in g}}{V_{solution} \text{ in mL}} \times 100\%$$

$$C = \frac{n_{solute}}{V_{solution}} \qquad \text{Molality} = \frac{n_{solute}}{m_{solvent} \text{ in kg}} \qquad \text{ppm} = \frac{m_{solute} \text{ (mg)}}{V_{solution} \text{ (L)}} \qquad \text{ppb} = \frac{m_{solute} \text{ (μg)}}{V_{solution} \text{ (L)}}$$

$$C = kP \qquad i = \frac{n_{ions}}{n_{solute}} \qquad \Delta T_b = iK_b \times \text{Molality}_{solute} \qquad \Delta T_f = iK_f \times \text{Molality}_{solute}$$
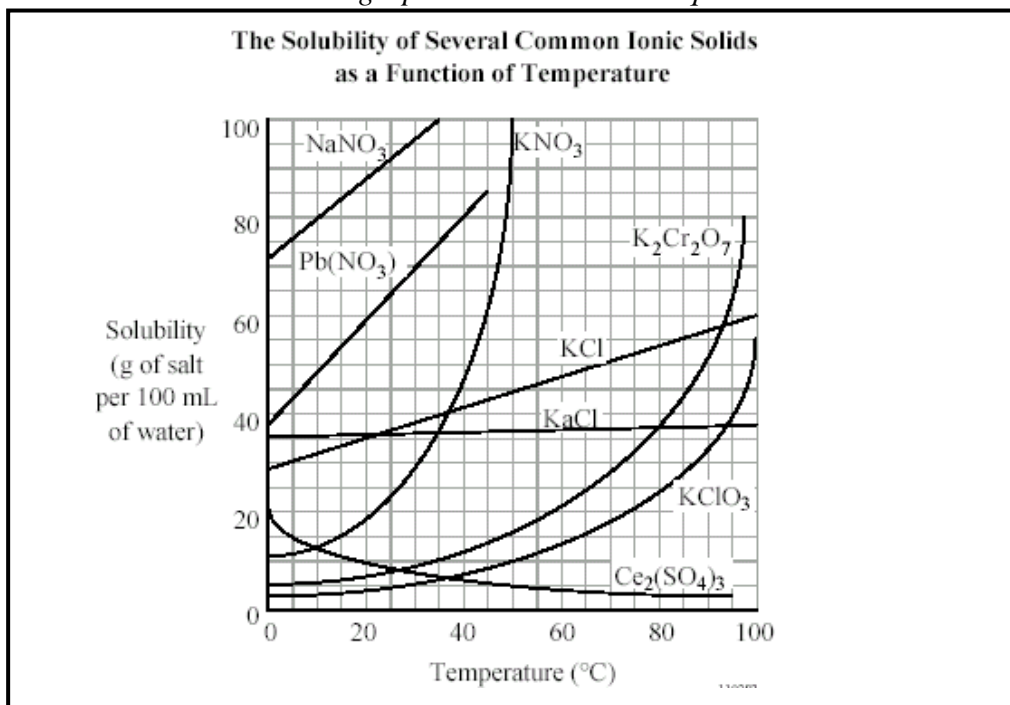
Part A: Multiple Choice (1 point each)

1. Which of the following would be expected to have the *lowest* vapour pressure at room temperature?

    A. ethanol, bp = 78°C   **B.** methanol, bp = 65°C
    C. water, bp = 100°C   **D.** acetone, bp = 56°C

2. Which property of water allows a razor blade to float on it without sinking?

    A. viscosity   **B.** surface tension   **C.** density   **D.** specific heat   **E.** triple point

3. A liquid boils when its

    A. vapour pressure is exactly 1 atmosphere.
    B. vapour pressure is equal to, or greater than, the external pressure pushing on it.
    C. temperature is equal to 273 K (standard temperature).
    D. temperature is greater than room temperature.

4. Use the graph of vapour pressure to determine the normal boiling point of trichloromethane, $CHCl_3$.

    A. 19°C
    B. 52°C
    C. 60°C
    D. 64°C
    E. 70°C

5. What is the molarity of a solution that is 26.0% by mass phosphoric acid (H_3PO_4) and that has a density of 1.155 g/mL?

    A. 2.30×10^{-3} M   **B.** 0.30 M   **C.** 2.30 M   **D.** 3.06 M   **E.** 300 M

6. Calculate the percent by mass of potassium nitrate in a solution made from 45.0 g KNO_3 and 295 mL of water. The density of water is 0.997 g/mL.

    A. 1.51 %   **B.** 7.57 %   **C.** 13.3 %   **D.** 15.2 %   **E.** none of these

7. Calculate the molality of a solution containing 14.3 g of NaCl in 42.2 g of water.

    A. 2.45×10^{-4} *m*   **B.** 5.80×10^{-4} *m*   **C.** 2.45×10^{-1} *m*   **D.** 103 *m*   **E.** 5.80 *m*

8. Which of the following aqueous solutions has the highest boiling point? (K_b for water is 0.52°C/*m*)

    A. 0.2 *m* KCl   **B.** 0.2 *m* Na_2SO_4 **C.** 0.2 *m* $Ca(NO_3)_2$
    D. 0.2 *m* KCl and 0.2 *m* Na_2SO_4 **E.** 0.2 *m* Na_2SO_4 and 0.2 *m* $Ca(NO_3)_2$
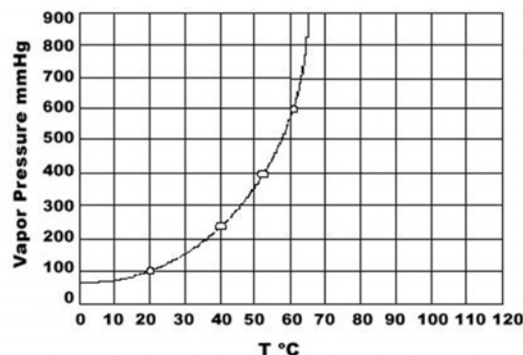
9. Calculate the freezing point of a solution made from 21.0 g NaCl and 100. g of H_2O. (K_f H_2O = 1.86°C/m)

    A. 3.59°C   **B.** 6.68°C   **C.** −13.4°C   **D.** −6.68°C   **E.** −3.59°C

Use the graph to answer the next question.

The Solubility of Several Common Ionic Solids as a Function of Temperature

10. The substance shown on the graph that is most soluble at 0°C is

    A. KNO_3 **B.** NaCl   **C.** $NaNO_3$ **D.** $KClO_3$

11. A student prepared a list of solutes.

    I. $CaCl_{2\,(s)}$ **II.** $Al_2(SO_4)_{3\,(s)}$ **III.** $H_2SO_{4\,(l)}$ **IV.** $NaNO_{3\,(s)}$

If the student prepared equal volumes of 0.10 mol/L solutions of each substance, which solute would produce the highest concentration of dissolved ions?

    A. III   **B.** IV   **C.** I   **D.** II

12. The label on a 750. mL bottle of wine indicated that the alcohol content was 82.5 mL. The concentration, expressed in percent by volume, is

    A. 8.25%   **B.** 11.0%   **C.** 12.0%   **D.** 11.5%

13. The concentration of glucose in blood plasma is 0.090%. This means that the mass of glucose in 100. mL of blood is

    A. 0.90 mg   **B.** 0.090 mg   **C.** 90. mg   **D.** 9.0 mg

14. Which factor does not affect the solubility of a solid electrolyte in a liquid solvent?

    A. temperature   **B.** nature of the solvent   **C.** pressure   **D.** nature of the solute

15. Which of the following factors is important **_only_** for the solubility of gases in solvents?

    A. the nature of the solute.   **B.** the nature of the solvent.   **C.** the pressure of the gas.
    D. the temperature.   **E.** the atmospheric pressure.

16. If the amount of solute present in a solution at a given temperature is less than the maximum amount that can dissolve at that temperature, the solution is said to be

    A. saturated   **B.** unsaturated   **C.** supersaturated   **D.** concentrated

17. What is the molality of a solution that contains 516 g KNO_3 in 4.47 L water?

  A. 0.315 m **B.** 0.779 m **C.** 1.02 m **D.** 1.14 m

18. A solution of sugar in water has a density of 1.05 g/cm^3. If you have 75.0 mL of the solution, and if the solution is 8.10% sugar by mass, how many grams of sugar are there in the solution?

  A. 63.8 g   **B.** 6.38 g   **C.** 60.8 g   **D.** 6.08 g

19. What is the boiling point change for a solution containing 0.328 moles of naphthalene (a nonvolatile, non-ionizing compound) in 250. g of liquid benzene? ($K_b = 2.53°C/m$ for benzene)

  A. 3.32°C   **B.** 1.93°C   **C.** 7.41°C   **D.** 4.31°C

20. Which of the following aqueous solutions has the highest boiling point?

  A. 1.0 m $C_6H_{12}O_6$ **B.** 1.0 m $Al(NO_3)_3$ **C.** 1.0 m Na_2SO_4 **D.** 1.0 m KCH_3COO

21. Compared with a 0.01 m sugar solution, a 0.01 m $MgCl_2$ solution has

  A. the same boiling-point elevation.   **B.** about twice the boiling-point elevation.
  C. about three times the boiling-point elevation.   **D.** about four times the boiling-point elevation.

22. When a 20.0 g sample of an unknown compound is dissolved in 500. g of benzene (a non-electrolytic, non-ionizing compound), the freezing point of the resulting solution of 3.77°C. The freezing point of pure benzene is 5.48°C and K_f for benzene is 5.12°C/m. Calculate the molar mass of the unknown compound

  A. 120. g/mol   **B.** 140. g/mol   **C.** 100. g/mol   **D.** 80.0 g/mol

23. The attractive forces in a liquid are

  A. strong enough to prevent the particles from changing positions.
  B. too weak to hold the particles in fixed positions.
  C. more effective than those in a solid.
  D. nonexistence so particles will always repel each other.

Part B: Numerical Response   **(1 point each)**

1. A hydrogen peroxide solution is made from adding 56.0 mL of pure $H_2O_{2\,(l)}$ into 422 mL of water. It's % (v/v) solution is _____ %.

2. 35.0 mL of 0.255 M nitric acid is added to 45.0 mL of 0.328 M $Mg(NO_3)_2$. The concentration of nitrate ion in the final solution is _____ M.

Part C: Extended Response

1. Determine the mass of glucose needed to raise the boiling point of 3.00 L water to 102.0°C assuming water has a density of 1.00 g/mL. (K_b of water = 0.510°C • kg/mol)   **(3 points)**

2. A substance that has a triple point at −15°C and 0.30 atm, melts at −10.0°C at 1.0 atm, and has a normal boiling point of 90°C.   **(4 points)**

  a. Sketch the phase diagram for this substance.

  b. Based on the phase diagram in part a., below what pressure and temperature would the substance undergo sublimation? Explain your reasoning.

Part A: Multiple Choice

1. C	**2.** B	**3.** B	**4.** D	**5.** D	**6.** C	**7.** E	**8.** E	**9.** C	**10.** C
11. D	**12.** B	**13.** C	**14.** C	**15.** C	**16.** B	**17.** D	**18.** B	**19.** A	**20.** B
21. C	**22.** A	**23.** B							

Part B: Numerical Response

1. ___11.7___   **2.** ___0.481___

Part C: Extended Response

1.   2.12 kg of glucose

2a.
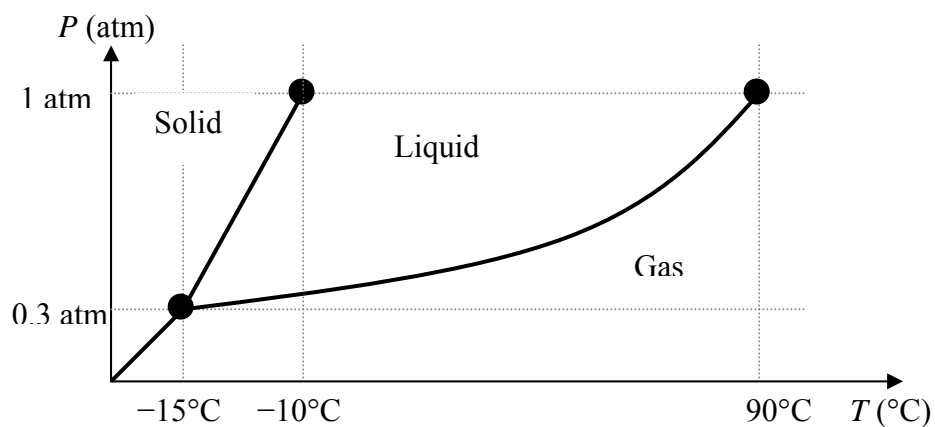
2b.   Base on the diagram, the solid-gas line is below the triple point. Hence, sublimation would only happen below −15°C and below 0.30 atm.