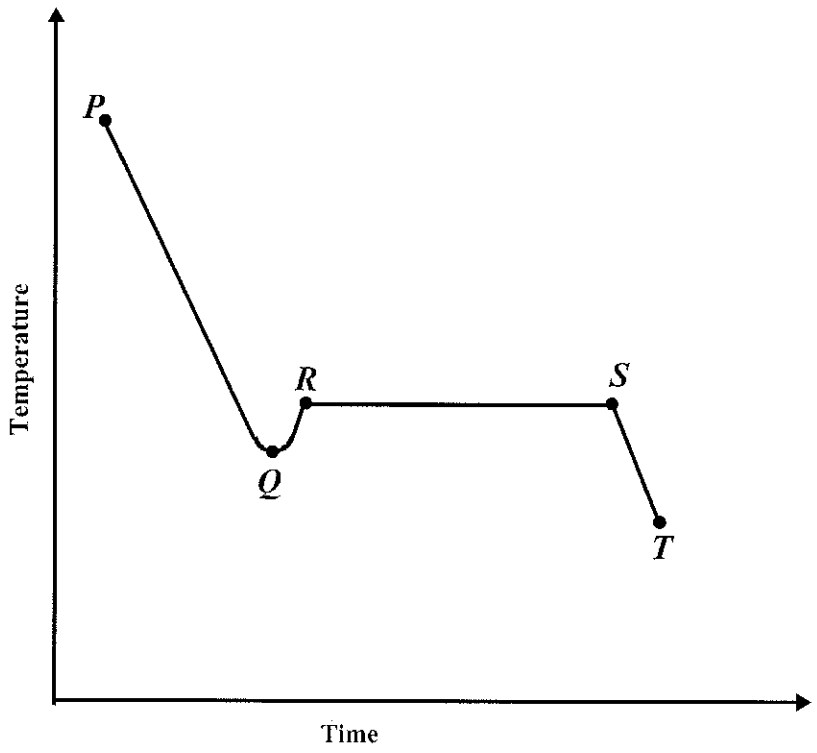
AP Chemistry - Unit 7

Wkst: Unit 7 Review

1. At 20. °C, the vapor pressure of toluene is 25 millimeters of mercury and that of benzene is 75 millimeters of mercury. An ideal solution, equimolar in toluene and benzene, is prepared. At 20. °C, what is the mole fraction of benzene in the vapor in equilibrium with this solution?

   (A) 0.25
   (B) 0.33
   (C) 0.50
   (D) 0.75

Questions 2 and 3 refer to the following cooling curve.



A student heated a sample of solid naphthalene to 95°C. The sample was then placed into a water bath and cooled to 30°C, as represented in the cooling curve above.

2. The solid and the liquid coexist at

   (A) point *Q* only
   (B) point *R* only
   (C) all points on the curve between *Q* and *S*
   (D) all points on the curve between *R* and *T*

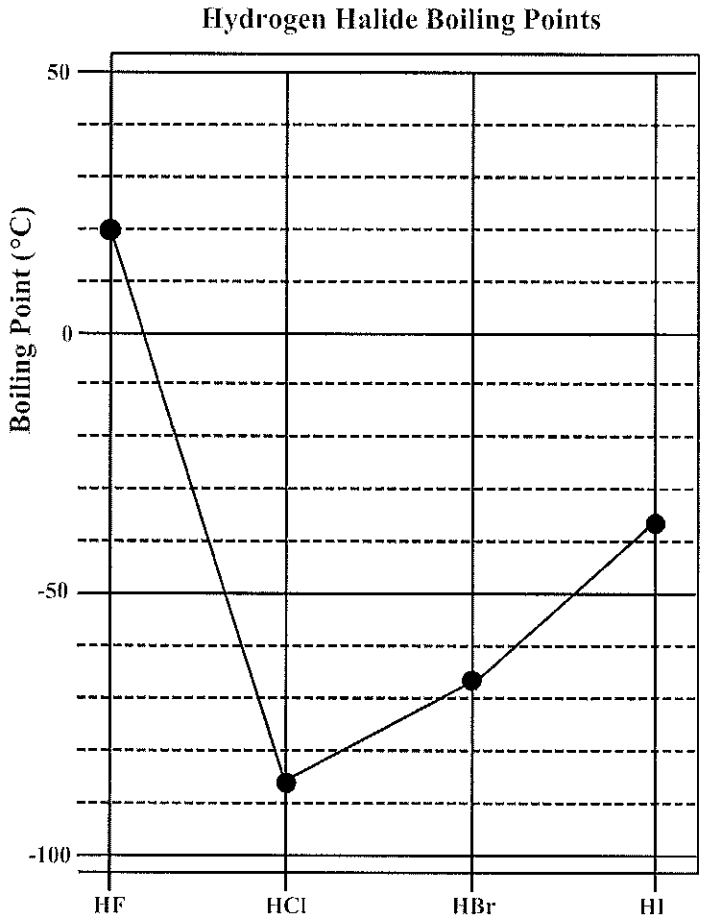
3. From which section of the curve can the melting point of naphthalene be determined?
   (A) point *R* only
   (B) point *S* only
   (C) all points on the curve between *R* and *S*
   (D) all points on the curve between *R* and *T*

4. On a mountaintop, it is observed that water boils at 90°C, not at 100°C as at sea level. This phenomenon occurs because on the mountaintop the

(A) equilibrium water vapor pressure is higher due to the higher atmospheric pressure
(B) equilibrium water vapor pressure is lower due to the higher atmospheric pressure
(C) equilibrium water vapor pressure equals the atmospheric pressure at a lower temperature
(D) water molecules have a higher average kinetic energy due to the lower atmospheric pressure

5. A solution is made by dissolving a nonvolatile solute in a pure solvent. Compared to the pure solvent, the solution

(A) has a higher normal boiling point
(B) has a higher vapor pressure
(C) has a higher freezing point
(D) is more nearly ideal



6. Under standard conditions, iodine is a bluish-black solid appearing to sublimate into a noxious violet-pink gas. Which of the following best accounts for the fact that iodine is a solid at room temperature?

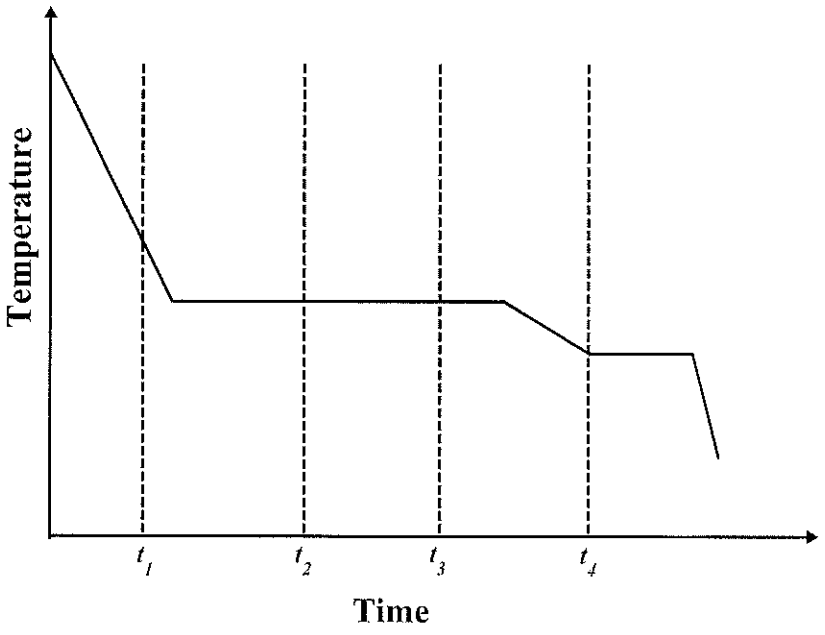
(A) hybridization
(B) ionic bonding
(C) resonance
(D) London dispersion forces

7. Which of the following best accounts for HF having the highest boiling point?

(A) Hybridization
(B) Ionic bonding
(C) Hydrogen bonding
(D) London dispersion forces

8. Which of the following best describes the energy change that occurs in the conversion of an ionic solid to widely separated gaseous ions?

(A) Activation energy
(B) Ionization energy
(C) Kinetic energy
(D) Lattice energy



9. The cooling curve above shows how the temperature of a sample varies with time as the sample goes through phase changes. The sample starts as a gas, and heat is removed at a constant rate. At which time does the sample contain the most liquid?

(A) t_2
(B) t_3
(C) t_4
(D) t_5

10. The London (dispersion) forces are weakest for which of the following gases under the same conditions of temperature and pressure?

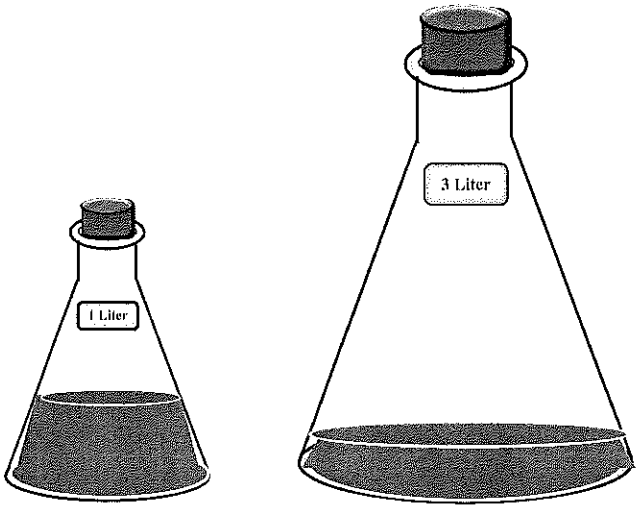
(A) H_2
(B) O_2
(C) F_2
(D) N_2

11. Which of the following substances involves the breaking of covalent bonds in order to melt?

(A) Salt, $NaCl$
(B) Sand, SiO_2
(C) Ice, H_2O
(D) Paraffin, $C_{31}H_{64}$

12. Which of the following processes best accounts for the fact that inches of snowfall from the last storm of the season decrease steadily throughout the remaining winter despite the ambient temperature staying well below the freezing point of water?

(A) evaporation
(B) sublimation
(C) condensation
(D) vaporization



Container 1 **Container 2**

13. The figure above shows two closed containers. Each contains the same volume of acetone in equilibrium with its vapor at the same temperature. The vapor pressure of the acetone is

(A) higher in container 2 because the surface area of the liquid is greater
(B) higher in container 2 because the volume of vapor is greater
(C) the same in both containers because the volume of the liquid is the same
(D) the same in both containers because the temperature is the same

14. The modality of the glucose in a 1.0-molar glucose solution can be obtained by using which of the following?
    (A) Volume of the solution
    (B) Temperature of the solution
    (C) Solubility of glucose in water
    (D) Degree of dissociation of glucose
    (E) Density of the solution

15. Two flexible containers for gases are at the same temperature and pressure. One holds 0.50 gram of hydrogen and the other holds 8.0 grams of oxygen. Which of the following statements regarding these gas samples is FALSE?
    (A) The volume of the hydrogen container is the same as the volume of the oxygen container
    (B) The number of molecules in the hydrogen container is the same as the number of molecules in the oxygen container.
    (C) The density of the hydrogen sample is less than that of the oxygen sample.
    (D) The average kinetic energy of the hydrogen molecules is the same as the average kinetic energy of the oxygen molecules.
    (E) The average speed of the hydrogen molecules is the same as the average speed of the oxygen molecules

16. Which, if any, of the following species is in the greatest concentration in a 0.100-molar solution of H_2SO_4 in water?
    (A) H_2SO_4 molecules
    (B) H_3O^+ ions
    (C) HSO_4^- ions
    (D) SO_4^{2-} ions
    (E) All species are in equilibrium and therefore have the same concentrations

17. Which of the following aqueous solutions has the highest boiling point?
    (A) 0.10 M potassium sulfate, K_2SO_4
    (B) 0.10 M hydrochloric acid, HCl
    (C) 0.10 M ammonium nitrate, NH_4NO_3
    (D) 0.10 M magnesium sulfate, $MgSO_4$
    (E) 0.20 M sucrose, $C_{12}H_{22}O_{11}$

18. The weight of H_2SO_4 (molecular weight 98.1) in 50.0 milliliters of a 6.00-molar solution is
    (A) 3.10 grams
    (B) 12.0 grams
    (C) 29.4 grams
    (D) 294 grams

19. Which of the following does NOT behave as an electrolyte when it is dissolved in water?
    (A) CH_3OH
    (B) K_2CO_3
    (C) NH_4Br
    (D) HI
    (E) Sodium acetate, CH_3COONa

20. Which of the following is lower for a 1.0-molar aqueous solution of <u>any</u> solute than it is for pure water?
    (A) pH
    (B) Vapor pressure
    (C) Freezing point
    (D) Electrical conductivity

21. Absorption of visible light Which of the following actions would be likely to change the boiling point of a sample of a pure liquid in an open container?

    I. Placing it in a smaller container
    II. Increasing the number of moles of the liquid in the container
    III. Moving the container and liquid to a higher altitude

    (A) I only
    (B) II only
    (C) III only
    (D) II and III only
    (E) I, II, and III

22. Given that a solution is 5 percent sucrose by mass, what additional information is necessary to calculate the molarity of the solution?

    I. The density of water
    II. The density of the solution
    III. The molar mass of sucrose

    (A) I only
    (B) II only
    (C) III only
    (D) I and III
    (E) II and III

23. $X = CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3$

$Y = CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}OH$

$Z = HO\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}OH$

Based on concepts of polarity and hydrogen bonding, which of the following sequences correctly lists the compounds above in the order of their increasing solubility in water?

(A) Z < Y < X
(B) Y < Z < X
(C) Y < X < Z
(D) X < Z < Y
(E) X < Y < Z

24. Which of the following solutions has the lowest freezing point?
(A) 0.20 *m* $C_6H_{12}O_6$, glucose
(B) 0.20 *m* NH_4Br
(C) 0.20 *m* $ZnSO_4$
(D) 0.20 *m* $KMnO_4$
(E) 0.20 *m* $MgCl_2$

25. The volume of distilled water that should be added to 10.0 mL of 6.00 M HCl(aq) in order to prepare a 0.500 M HCl(aq) solution is approximately
(A) 50.0 mL
(B) 60.0 mL
(C) 100. mL
(D) 110. mL
(E) 120. mL

26. In which of the following are the intermolecular forces listed from the weakest to the strongest?
(A) dipole-dipole> London > hydrogen bonds
(B) london< dipole-dipole<hydrogen bonds
(C) hydrogen bonds< dipole -dipole < London
(D) London < hydrogen bonds> dipole - dipole

27. Which subtance has the weakest dispersion forces?
(A) He
(B) Ne
(C) Ar
(D) Kr
(E) Xe

28. Circle all of the FALSE statements.
(A) London dispersion forces are present in all molecular substances
(B) The greater the dipole moment, the strogner the dipole-dipole forces
(C) The polarizability of elongated molecule is greater than that of compact, more spherical molecules
(D) Polar molecules always have higher boiling points than nonpolar molecules
(E) Hydrogen bonding is the strongest type of van der Waals force

29. Carbon dioxide sublimes. Which physical transformation occurs in the sublimation?
    (A) gas to liquid
    (B) gas to solid
    (C) solid to liquid to gas
    (D) solid to gas
    (E) solid to liquid

30. Which element is expected to have the greatest polarizability?
    (A) Fe
    (B) Ca
    (C) Ne
    (D) S
    (E) Al

31. A liquid substance that exhibits low intermolecular attractions is expected to have _____.
    (A) low viscosity, low boiling points, and low heat of vaporization
    (B) high viscosity, low boiling points, and low heat of vaporization
    (C) low viscosity, high boiling points, and low heat of vaporization
    (D) low viscosity, low boiling points, and high heat of vaporization
    (E) high viscosity, high boiling points, and high heat of vaporization

32. When the following compounds are kept at the same temperature, the compound expected to evaporate most quickly is:
    (A) C_8H_{18}
    (B) $C_8H_{17}OH$
    (C) $C_8H_{17}NH_2$
    (D) C_6H_{14}
    (E) $C_7H_{15}COOH$

33. Which one of the following properties does not generally increase with increasing strengths of IMF's?
    (A) boiling point
    (B) vapor pressure
    (C) surface tension
    (D) ΔH_{vap}
    (E) deviation from ideal gas law

34. A student observed that a small amount of acetone sprayed on the back of the hand felt very cool compared to a similar amount of water. Your explanation of this phenomena should be that:
    (A) All organic compounds do this
    (B) Acetone has a lower viscosity and transfers heat quanta better
    (C) Water has a higher heat capacity than acetone, therefore retaining more heat
    (D) The higher vapor pressure of acetone results in more rapid evaporation and heat loss due to liquid turning to a vapor
    (E) The observed effect is not real and is only imagined

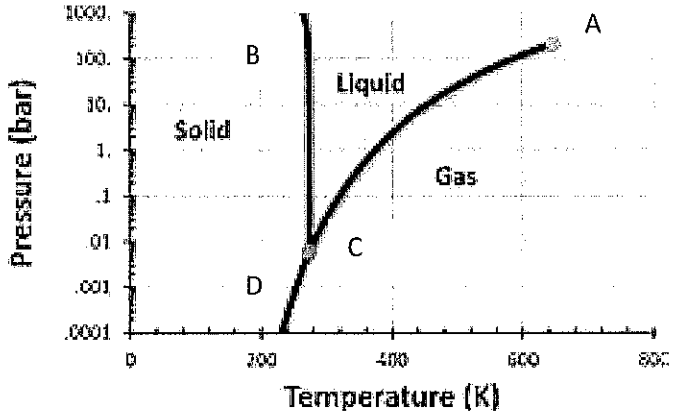
35. Substances with a higher vapor pressure tend to have
    (A) large IMF and lower boiling points
    (B) large IMF and high boiling points
    (C) small IMF and low boiling points
    (D) small IMF and high boiling points

36. Which of the following liquids has the highest vapor pressure? Assume all liquids are at the same temperature.
    (A) CH_4
    (B) NH_3
    (C) H_2O
    (D) C_5H_{12}
    (E) $NaCl_{(aq)}$

37. The greater the pressure on the surface of a liquid, the greater the _____
    (A) Mass
    (B) volume
    (C) density
    (D) molar mass
    (E) boiling point

38. How much heat, in kJ, is released when 15.8 grams of CH_3OH is condensed at 25°C? ($\Delta Hvap$ = 39.0kJ/mole)
    (A) 19.2
    (B) 600.
    (C) 77.0
    (D) 1,400
    (E) 1.00

39. When water rises in a small-diameter glass tube, it is due to _____
    (A) vaporization
    (B) viscosity
    (C) cohesive forces
    (D) capillary action



40. Assume the substance is at a temperature of 600 K and a pressure of 1.0 bar. If the pressure remains constant and the temperature is decreased, what phase change will occur?
    (A) boiling
    (B) condensing
    (C) subliming
    (D) melting
    (E) freezing

41. At 327°C and 0.1 Bar of pressure this substance will be
    (A) a liquid
    (B) a solid
    (C) a gas
    (D) a solid and liquid in equilibrium
    (E) a gas and liquid in equilibrium

42. What letter on the diagram represents all three phases in equilibrium at that temperatur and pressure?
    (A) A
    (B) B
    (C) C
    (D) D

43. Which of the following constiently have the highest melting points?
    (A) metals
    (B) salts
    (C) molecular crystals
    (D) alkanes
    (E) hydrogen-bonded compounds

44. Diamond is classified as _____
    (A) a covalent-network solid
    (B) an ionic solid
    (C) an amorphous solid
    (D) a metallic solid with covalent bonds
    (E) a molecular solid with ionic characteristics

45. The attractive forces holding the atoms together in a piece of steel are
    (A) ionic bonds
    (B) covalent bonds
    (C) metallic bonds
    (D) the attractions between oppositely charged ions
    (E) the attractions between cations and delocalized electrons

46. Which one of the following substances is most soluble in CCl_4 ?
    (A) CH_3CH_2OH
    (B) H_2O
    (C) NH_3
    (D) $C_{10}H_{22}$
    (E) NaCl

47. Which one of the following alcohols is least soluble in H_2O?
    (A) CH_3OH
    (B) CH_3CH_2OH
    (C) $CH_3CH_2CH_2OH$
    (D) $CH_3CH_2CH_2CH_2OH$
    (E) $CH_3CH_2CH_2CH_2CH_2CH_2OH$

48. Which of the following liquids would make the best solvent for iodine, I_2?
    (A) HCl
    (B) H_2O
    (C) CH_3OH
    (D) NH_3
    (E) CS_2

49. Which ONE of the following choices has the compounds arranged in the order of increasing solubility in water? (least soluble to most soluble)
    (A) $CCl_4 < CHCl_3 < NaNO_3$
    (B) $CH_3OH < CH_4 < LiF$
    (C) $CH_4 < NaNO_3 < CHCl_3$
    (D) $LiF < NaNO_3 < CHCl_3$
    (E) $CH_3OH < CH_2Cl_2 < CH_4$

50. Which one of the following concentration units varies with temperature?
    (A) molarity
    (B) mass percent
    (C) mole fraction
    (D) molality
    (E) all of these

51. The concentration of KBr in a solution prepared by dissolving 2.21 g of KBr in 897 g of water is _____ molal.
    (A) 2.46
    (B) 0.0167
    (C) 0.0207
    (D) 2.07×10^{-5}
    (E) 0.0186

52. The concentration (M) of nitrate ion in a solution that contains 0.900 M aluminum nitrate is
    (A) 0.900
    (B) 0.450
    (C) 0.300
    (D) 2.70
    (E) 1.80

53. A solution contains 28% phosphoric acid by mass. This means that _____
    (A) 1 mL of this solution contains 28 g of phosphoric acid
    (B) 1 L of this solution has a mass of 28 g
    (C) 100 g of this solution contains 28 g of phosphoric acid
    (D) 1 L of this solution contains 28 mL of phosphoric acid

54. As the concentration of a solute in a solution increases, the freezing point of the solution _____ and the vapor pressure of the solution _____
    (A) increases, increases
    (B) increase, decreases
    (C) decreases, increases
    (D) decreases, decreases

55. Which liquid will have the lowest freezing point? ($\Delta T = i K_f m$)
    (A) pure H_2O
    (B) solution of 0.60 m glucose
    (C) solution of 0.60 m sucrose
    (D) solution of 0.24 m FeI_3
    (E) solution of 0.50 m KF

Free Response Questions

1. Account for each of the following observations about pairs of substances. In your answers, use appropriate principles of chemical bonding and/or intermolecular forces. In each part, your answer must include references to **both** substances. (2001 AP exam)

    (A) Even though NH3 and CH4 have similar molecular masses, NH3 has a much higher normal boiling point (-33 °C) than CH4 (-164°C).

    (B) At 25°C and 1.0 atm, ethane (C_2H_6) is a gas and hexane (C_6H_{14}) is a liquid

    (C) Si melts at a much higher temperature (1,410 °C) than Cl_2 (-101 °C)

    (D) MgO melts at a much higher temperature (2,852 °C) than NaF (993 °C)

2. Answer the following questions using principles of molecular structure and intermolecular forces (2004 AP Exam)

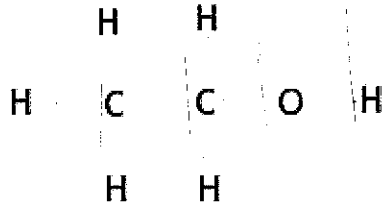
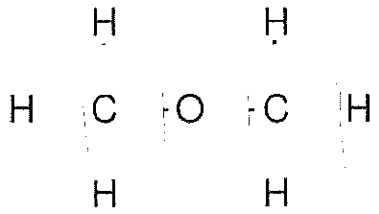
Compound	Empirical Formula	Solubility In water	Boiling Point (°C)
1	C_2H_6O	Slightly soluble	-24
2	C_2H_6O	Soluble	78

Compounds 1 and 2 in the date table above have the same empirical formula, but htey have different physical properties

(A) The skeletal structure for one of the two compounds is shown below in Box X.

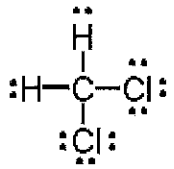
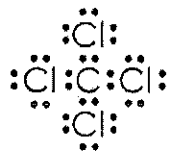
i. Complete the Lewis electron-dot diagram of the molecule in Box X. Include any lone (nonbonding) pairs of electrons

ii. In Box Y Below, draw the complete Lewis electron-dot diagram for the other compound, which is a structural isomer of the compound represented in Box X. Include any lone (nonbonding) pairs of electrons.

Box X	Box Y
	

(B) On the basis of the complete Lewis electron-dot diagrams you drew in part (A) and the information in the date table above, identify which compound, 1 or 2, has the structure represented in Box X. Justify your answer in the terms of the intermolecular forces present in each compound.

Use the information in the following table to answers parts (C) and (D)

Name	Lewis Electron -Dot Diagram	Vapor Pressure at 20° (mm Hg)	Boiling Point (°C)
Dichloromethane		353	39.6
Carbon tetrachloride		89	76.7

(C) Dichloromethane has a greater solubility in water than carbon tetrachloride has. Account for this observation in terms of the intermolecular forces between <u>each</u> of the solutes and water.

(D) In terms of intermolecular forces, explain why dichloromethane has a higher vapor pressure than carbon tetrachloride.