

1001_4th Exam_1010111

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

1) The three molecular shapes an sp^3 hybridized molecule can have are:

- A) octahedron, square pyramid, square planar
- B) irregular tetrahedron, T-shaped, linear
- C) tetrahedron, trigonal pyramid, bent
- D) triangular, bent, T-shaped
- E) none of these

Answer: C

2) 3.2 grams of a compound with a mole weight of 96 g/mol dissolved in 50 grams of water gave a solution which freezes at $-1.50\text{ }^{\circ}\text{C}$. K_f for water is $1.86\text{ }^{\circ}\text{C/molal}$. The van't Hoff factor for this solution is:

- A) 1.2
- B) 0.83
- C) 0.21
- D) 2.0
- E) 0.17

Answer: A

3) A handbook lists the aqueous solubility of carbon monoxide at $0\text{ }^{\circ}\text{C}$ and 1 atm CO pressure at 0.0354 mg CO per mL of solution. What would be the molarity of CO in water if the partial pressure of CO were 2.00 atm?

- A) 1.59 M
- B) 6.32×10^{-2} M
- C) 2.53×10^{-3} M
- D) 3.16×10^{-3} M
- E) 1.58×10^{-3} M

Answer: C

4) A container holds a small amount of liquid and its vapor in equilibrium. If the volume of the container is decreased, which of the following has occurred once equilibrium is reestablished?

- A) The pressure is higher.
- B) The temperature is lower.
- C) The pressure is lower.
- D) The temperature is higher.
- E) none of these

Answer: D

5) Given that the vapor pressure of pure n-hexane and pure n-heptane at $25\text{ }^{\circ}\text{C}$ are 151.4 mmHg and 45.62 mmHg respectively, calculate the total vapor pressure above a solution containing only n-hexane and n-heptane in which the mole fraction of n-hexane is 0.600.

- A) 106 mmHg
- B) 109 mmHg
- C) 170 mmHg
- D) 197 mmHg
- E) 87.9 mmHg

Answer: B

6) What would be the bond order of the N-C bonds in the benzene like molecule ($\text{C}_5\text{H}_5\text{N}$)?

- A) 2
- B) 1
- C) 0
- D) $1/2$
- E) $3/2$

Answer: E

- 7) 252 mL of 3.00 M H_2SO_4 are added to 1.50 L of 0.500 M H_2SO_4 . What is the concentration of the resulting solution?
- A) 0.860 M
 - B) 2.64 M
 - C) 1.75 M
 - D) 1.50 M
 - E) none of these

Answer: A

- 8) Which combination of hybrid orbital descriptions and electronic geometry descriptions is INCORRECT?
- A) sp^3 /tetrahedral
 - B) sp /linear
 - C) sp^3d^2 /octahedral
 - D) sp^2 /trigonal planar
 - E) sp^3d /square planar

Answer: E

- 9) Which of the following orbitals have lobes aligned along the x axis?

A) d_{yz} B) $d_{x^2-y^2}$ C) s D) d_{xz} E) d_{xy}

Answer: B

- 10) Different types of crystalline solids are not held together by:

- A) ionic attractions
- B) pi bonds only
- C) dipole-dipole interactions
- D) hydrogen bonds
- E) covalent bonds

Answer: B

- 11) Choose the INCORRECT statement about H_3O^+ .

- A) There is one lone pair on O.
- B) The OH bonds are $\text{O}(sp^3) - \text{H}(1s)$.
- C) The hybridization on O is sp^3 .
- D) There is one π bond.
- E) There are 3 σ bonds.

Answer: D

- 12) The concept of an anti-bonding orbital is unique to the:

- A) electrostatic repulsion theory
- B) concept of resonance
- C) molecular orbital theory
- D) valence bond theory
- E) theory of bond hybridization

Answer: C

13) Which probably has the highest boiling point at 1.00 atm pressure?

- A) $(\text{CH}_3)_3\text{N}$
- B) $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$
- C) $(\text{CH}_3)_2\text{CHNH}_2$
- D) $\text{CH}_3\text{CH}_2\text{NHCH}_3$
- E) $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$

Answer: B

14) In band theory, why is a material such as diamond an insulator?

- A) All of the electrons are in the conduction band.
- B) There are no electrons in the valence band.
- C) All of the electrons are tied to nuclei.
- D) Very few electrons can make the transition over the large energy gap between the valence band and the conduction band.
- E) The bonds in diamond are too strong to allow atoms to move so no current flows.

Answer: D

15) Which probably has the lowest boiling point at 1.0 atm pressure.

- A) C_2H_6
- B) C_5H_{12}
- C) C_4H_{10}
- D) C_3H_8
- E) C_6H_{14}

Answer: A

16) Solutions are made that contain 0.10 moles of each of the following compounds in 100 g of H_2O . Choose the compound whose solution will have the highest freezing point.

- A) $\text{Mg}(\text{CH}_3\text{CO}_2)_2$
- B) $\text{Ca}_3(\text{PO}_4)_2$
- C) NaI
- D) K_2SO_4
- E) $\text{Sr}(\text{NO}_3)_2$

Answer: C

17) Which compound is most likely to be soluble in water?

- A) hexane (C_6H_{14})
- B) benzene (C_6H_{12})
- C) butyl alcohol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$)
- D) iodine (I_2)
- E) ethylene glycol ($\text{HOCH}_2\text{CH}_2\text{OH}$)

Answer: E

18) For BeCl_2 , the dipole moment of the molecule, hybridization on the central atom, and number of lone pairs on the central atom are:

- A) none, sp , none
- B) toward Be, sp , one
- C) toward Be, sp^2 , none
- D) away from Be, sp^2 , one
- E) none, sp^3 , two

Answer: A

19) Which of the following statements concerning the relative energy levels of molecular orbitals for the O₂ molecule is INCORRECT?

- A) $\sigma_{2p} < \pi_{2p}$ B) $\pi_{2p}^* < \sigma_{2p}^*$ C) $\sigma_{1s} < \sigma_{1s}^*$ D) $\sigma_{1s}^* < \sigma_{2s}$ E) $\sigma_{2s} < \sigma_{2p}$

Answer: A

20) The extra stability that a molecule gains due to electron delocalizations (the electrons being free to move throughout large parts of the molecule) is called:

- A) lattice energy
B) covalent strength
C) bond energy
D) resonance energy
E) ionization energy

Answer: D

21) Which of the following is NOT a colligative property?

- A) boiling point elevation
B) osmotic pressure
C) freezing point depression
D) solubility
E) none of these

Answer: D

22) The concentration unit used in Raoult's Law calculations is:

- A) molarity
B) mole fraction
C) percent by weight
D) molality
E) none of these

Answer: B

23) A solution in which rates of solution and crystallization are equal is called:

- A) dilute
B) saturated
C) supersaturated
D) unsaturated
E) none of these

Answer: B

24) An unknown compound is composed of 65.44% C, 29.07% O and 5.49% H. A sample weighing 5.34 g, when dissolved in 60.00 g H₂O lowers the freezing point to -0.600 °C. What is the molecular formula of the compound? (K_f for water = 1.86 °C/m; C = 12.0, O = 16.0, H = 1.0 g/mol).

- A) C₁₅H₁₅O₅
B) CHO
C) C₃H₃O
D) C₅H₅O₅
E) none of these

Answer: A

25) Which of the following statements about ideal solutions is true?

- A) The forces between like kinds of molecules are (almost) equal to the forces between unlike kinds of molecules.
- B) They mix because of entropy effects.
- C) The heat of solution is zero.
- D) The vapor pressure varies linearly with composition.
- E) All of the above answers are true.

Answer: E

26) If one compares compound A composed of nonpolar molecules with compound B composed of polar molecules, and both molecules have the same molecular formula then it is true that:

- A) both compounds have the same boiling point
- B) A boils at a lower temperature than B
- C) B boils at a lower temperature than A
- D) B will not boil
- E) none of these

Answer: B

27) Which of the pairs of molecules below have the same hybridization on the central atom in each molecule? (The central atom is underlined.)

- A) $\text{H}\underline{\text{C}}\text{N}$, $\underline{\text{C}}\text{O}_2$
- B) $\underline{\text{B}}\text{eH}_2$, $\underline{\text{N}}\text{H}_3$
- C) $\text{H}\underline{\text{O}}\text{Cl}$, $\underline{\text{C}}\text{IF}_3$
- D) $\text{H}_2\underline{\text{O}}$, $\text{H}\underline{\text{N}}\text{O}$
- E) none of these

Answer: A

28) Commercial nitric acid is 16.0 M $\text{HNO}_3(\text{aq})$ and has a density of 1.42 g/mL. What is the mole fraction of HNO_3 in this solution?

- A) 0.704
- B) 0.411
- C) 0.589
- D) 0.699

Answer: B

29) The normal boiling point of acetone is 56.2°C and the molar heat of vaporization is 32.0 kJ/mol . At what temperature will acetone boil under a pressure of 50.0 mmHg?

- A) -6.0°C
- B) 156°C
- C) 73.6°C
- D) 40.7°C
- E) 6.0°C

Answer: A

30) Liquid and vapor phases of a substance become indistinguishable at the:

- A) critical point
- B) triple point
- C) absolute point
- D) normal point
- E) permanent point

Answer: A

31) Arrange the following compounds in order of increasing boiling point: I 1-propanol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$; II 1,2-propanediol, $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{OH}$; III 1,2,3-propanetriol, (glycerol), $\text{HOCH}_2\text{CH}(\text{OH})\text{CH}_2\text{OH}$

- A) III, I, II
- B) I, III, II
- C) II, III, I
- D) I, II, III
- E) III, II, I

Answer: D

32) Choose the *INCORRECT* statement about CO₂.

- A) There are two π bonds.
- B) The molecule is linear.
- C) The hybridization on C is sp .
- D) C has one lone pair.
- E) There are two σ bonds.

Answer: D

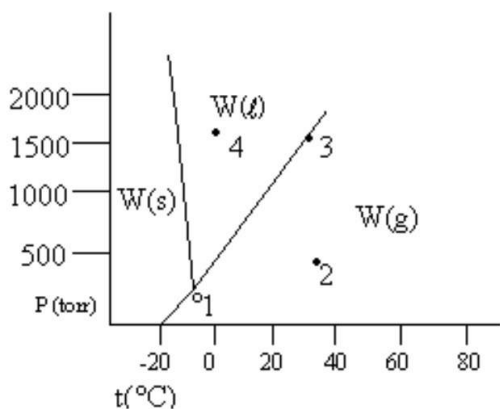
33) Given the following information, calculate ΔH° (in kcal mole⁻¹) for: $\text{Cl(g)} + \text{e}^- \rightarrow \text{Cl}^-(\text{g})$

Process	ΔH° (kcal/mole)
$\text{Li(s)} \rightarrow \text{Li(g)}$	+37
$\text{Li(g)} \rightarrow \text{Li}^+(\text{g}) + \text{e}^-$	+124
$\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl(g)}$	+58 (per mole Cl ₂)
$\text{LiCl(s)} \rightarrow \text{Li}^+(\text{g}) + \text{Cl}^-(\text{g})$	+216
$2\text{Li(s)} + \text{Cl}_2(\text{g}) \rightarrow 2\text{LiCl(s)}$	-109 (per mole LiCl)

- A) 161
- B) -83
- C) 190
- D) +83
- E) -112

Answer: B

34) According to the phase diagram given, which of the following statements is wrong?



- A) If liquid W is maintained at the pressure of point 4 while the temperature is increased to 80 °C, the liquid will vaporize.
- B) The existence of liquid W at -40 °C and 500 torr represents the metastable condition of "supercooling."
- C) At the temperature and pressure of point 1, substance W exists as a three-phase equilibrium system.
- D) At the temperature of point 2, a pressure of 500 torr is sufficient to liquify gaseous W.
- E) If the $W(l) = W(g)$ system is maintained at the temperature of point 3 while pressure is decreased, more W will vaporize.

Answer: D

35) Which combination of "type of solid" and specific example is *INCORRECT*?

- A) ionic/"table salt"
- B) network covalent/silicon carbide
- C) molecular/"dry ice"
- D) metallic/copper wire
- E) network covalent/iodine

Answer: E

36) Choose the *INCORRECT* statement.

- A) Colloidal suspensions can be prepared in which the particles do not settle.
- B) Since colloidal particles are large aggregates of atoms they are electrically neutral.
- C) Colloidal particles reflect light from a beam.
- D) The addition of electrolytes to a colloidal suspension will sometimes cause the particles to coalesce and precipitate.
- E) Colloidal suspensions exhibit the Tyndall Effect.

Answer: B

37) A double bond that results from the sharing of four electrons consists of:

- A) 2 sigma bonds
- B) one sigma and one pi bond
- C) one sigma bond
- D) two pi bonds
- E) none of these

Answer: B

38) Which statement is *INCORRECT* about M.O. theory?

- A) The B.O. is $\frac{\#e^- \text{ in bonding} - \#e^- \text{ in antibonding}}{2}$.
- B) The number of molecular orbitals produced is equal to the number of atomic orbitals combined.
- C) Each pair of sigma molecular orbitals is a bonding orbital and an antibonding orbital.
- D) Hund's rule says that each orbital of identical energy has one electron before pairs are formed.
- E) The antibonding orbital is at a lower energy than the bonding orbital.

Answer: E

39) Nitrogen gas has a Henry's law constant $k = 6.3 \times 10^{-4} \text{ M/atm}$ at 25°C . The "bends" in divers results from bubbles of $\text{N}_2(\text{g})$ being rapidly released from body fluids when a diver ascends to the surface too quickly. Which of the following would be a good substitute for $\text{N}_2(\text{g})$ in order to make the "bends" less severe?

- | | |
|---|--|
| A) $\text{CO}_2(\text{g})$, $k = 3.4 \times 10^{-2} \text{ M/atm}$ | B) $\text{H}_2(\text{g})$, $k = 8.1 \times 10^{-4} \text{ M/atm}$ |
| C) $\text{Ar}(\text{g})$, $k = 1.5 \times 10^{-3} \text{ M/atm}$ | D) $\text{He}(\text{g})$, $k = 3.7 \times 10^{-4} \text{ M/atm}$ |

Answer: D

40) Choose the *INCORRECT* statement.

- A) Highly reactive molecular fragments with unpaired electrons are free radicals.
- B) VSEPR stands for *valence-shell electron pair repulsion*.
- C) Molecules with all paired electrons are diamagnetic.
- D) An expanded octet has larger electron clouds.
- E) Electron pairs repel each other.

Answer: D

41) Choose the *INCORRECT* statement about PCl_5 .

- A) There are no π bonds.
- B) P has one lone pair.
- C) There are 5 σ bonds.
- D) Each Cl has 3 lone pairs.
- E) P has sp^3d hybridization.

Answer: B

42) A magnesium sulfate heptahydrate solution, which is 18.00% by weight in the anhydrous compound, has a density at 20 °C of 1.20 g/mL. What is the molarity of the anhydrous compound in the solution? (Atomic weights: H = 1.0, O = 16.0, S = 32.1, Mg = 24.3)

- A) 1.49 M B) 1.82 M C) 1.25 M D) 5.54 M E) 1.79 M

Answer: E

43) Which of the following species is best represented by a resonance hybrid having two contributing structures?

- A) nitrous acid B) nitric acid C) nitrogen D) nitride ion E) nitrate ion

Answer: B

44) Which of the following compounds is the most viscous: $\text{CH}_3\text{CH}_2\text{OH}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$, $\text{HOCH}_2\text{CH}_2\text{OH}$, $\text{CH}_3\text{OCH}_2\text{CH}_3$?

- A) $\text{CH}_3\text{CH}_2\text{OH}$
B) $\text{HOCH}_2\text{CH}_2\text{OH}$
C) There is not enough information.
D) $\text{CH}_3\text{OCH}_2\text{CH}_3$
E) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$

Answer: B

45) All of the following are true about the bonding of methane, CH_4 , EXCEPT:

- A) the compound has tetrahedral geometry
B) the carbon s and p orbitals combine to form four equivalent sp^3 orbitals
C) some of the C - H bonds are stronger than others
D) these sp^3 orbitals combine with the s orbitals of the hydrogens to form molecular orbitals
E) all of the C - H bonds are equivalent

Answer: C

46) A mixture of benzene and toluene has a total vapor pressure at 25 °C of 45.06 mmHg. What is the partial pressure of benzene in this solution? The vapor pressure of pure benzene and pure toluene at 25 °C are 95.03 mmHg and 28.40 mmHg respectively.

- A) 0.3217 mmHg
B) 16.66 mmHg
C) 21.30 mmHg
D) 0.7500 mmHg
E) 23.76 mmHg

Answer: E

47) Which is the correct molecular orbital diagram for carbon monoxide?

- A) $\sigma_{1s} \uparrow \downarrow \sigma_{1s}^* \uparrow \downarrow \sigma_{2s} \uparrow \downarrow \sigma_{2s}^* \uparrow \downarrow \pi_{2p} \uparrow \downarrow, \sigma_{2p} \uparrow \downarrow \pi_{2p}^* \uparrow \downarrow$
B) $\sigma_{1s} \uparrow \downarrow \sigma_{1s}^* \uparrow \downarrow \sigma_{2s} \uparrow \downarrow \sigma_{2s}^* \uparrow \downarrow \pi_{2p} \uparrow \downarrow, \uparrow \downarrow \sigma_{2p} \uparrow \downarrow$
C) $\sigma_{1s} \uparrow \downarrow \sigma_{1s}^* \uparrow \downarrow \sigma_{2s} \uparrow \downarrow \sigma_{2s}^* \uparrow \downarrow \pi_{2p} \uparrow \downarrow, \uparrow \downarrow \sigma_{2p} \uparrow \downarrow \pi_{2p}^* \uparrow$
D) $\sigma_{1s} \uparrow \downarrow \sigma_{1s}^* \uparrow \downarrow \sigma_{2s} \uparrow \downarrow \sigma_{2s}^* \uparrow \downarrow \pi_{2p} \uparrow, \uparrow, \sigma_{2p} \uparrow \downarrow \pi_{2p}^* \uparrow \downarrow$
E) $\sigma_{1s} \uparrow \downarrow \sigma_{1s}^* \uparrow \downarrow \sigma_{2s} \uparrow \downarrow \sigma_{2s}^* \uparrow \downarrow \pi_{2p} \uparrow \downarrow, \uparrow \downarrow \pi_{2p}^* \uparrow \downarrow$

Answer: B

48) Which of the following does NOT involve any delocalized π bonds?

- A) nitrous acid
- B) ozone
- C) acetate ion
- D) carbonate ion
- E) nitric acid

Answer: A

49) A crystal does not conduct electricity, even after melting. It is hard and brittle and melts at a very high temperature. What type of crystal is it?

- A) an ionic crystal
- B) not enough data is given
- C) a molecular crystal
- D) a covalent network crystal
- E) a metallic crystal

Answer: D

50) According to M.O. theory, which is an INCORRECT statement for H_2^- .

- A) There are no unpaired electrons.
- B) The σ_{1s}^* orbital has one electron.
- C) The B.O. is $1/2$.
- D) The molecule is paramagnetic.
- E) There are 3 electrons in the molecular orbitals.

Answer: A