

991_4th_Exam_1000112

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

1) Find a FALSE statement about X-rays.

- A) radiation of wavelength approximating 1 Angstrom
- B) visible to the naked eye
- C) produced using high-energy electrons
- D) used to determine the structure of molecules
- E) diffracted by crystals

Answer: B

2) An azeotropic mixture is a:

- A) solution of two or more substances that cannot be made to freeze.
- B) liquid mixture of two or more substances linked by azide functional groups.
- C) liquid mixture of two or more substances in which the vapor has the same composition as the liquid.
- D) mixture of two or more substances where boiling point cannot be determined.
- E) solution of two or more substances present in the same amounts in the liquid phase.

Answer: C

3) Moles of solute per liter of solution is the definition of _____.

- A) solubility
- B) molarity
- C) molality
- D) normality
- E) mole fraction

Answer: B

4) The enthalpy of fusion is:

- A) The quantity of heat when two elements are fused together to produce binary compound
- B) The quantity of heat required to fuse two atomic nuclei
- C) The quantity of heat released when a solid melts
- D) The quantity of heat required to melt a solid
- E) The quantity of heat released when an organic compound burns in an atmosphere of pure oxygen

Answer: D

5) The possible values of the magnetic quantum number, m_l , of a 3p electron are:

- A) 2, 1, 0, -1, -2
- B) 0
- C) -1, 0, +1
- D) +1, -1
- E) 0, 1, 2

Answer: C

6) Henry's Law states that:

- A) the solubility of a gas increases as the gas pressure is increased
- B) a supersaturated solution is unstable
- C) the solubility of a gas decreases as the gas pressure is increased
- D) a concentrated solution lowers the freezing point of a solution
- E) a concentrated solution increases the boiling point of a solution

Answer: A

7) The vapor pressures of pure propyl alcohol and isopropyl alcohol are 21.0 mmHg and 45.2 mmHg, respectively, at 25°C. What is the composition of the vapor in equilibrium with a propyl alcohol - isopropyl alcohol solution in which the mole fraction of propyl alcohol is 0.250?

- A) $x_{\text{iso}} = 0.317$, $x_{\text{prop}} = 0.683$ B) $x_{\text{iso}} = 0.512$, $x_{\text{prop}} = 0.488$
C) $x_{\text{iso}} = 0.750$, $x_{\text{prop}} = 0.250$ D) $x_{\text{iso}} = 0.866$, $x_{\text{prop}} = 0.134$

Answer: D

8) Which of the following compounds has the highest boiling point?

- A) H_2O B) CH_4 C) HBr D) HF E) NH_3

Answer: A

9) According to MO theory, which is the INCORRECT statement for N_2^+ ?

- A) There is one unpaired electron.
B) There are 9 electrons in the molecular orbitals.
C) The molecule is diamagnetic.
D) The σ_{2p} orbital has one electron in it.
E) The BO is 2.5.

Answer: C

10) The existence of discrete (quantized) energy levels in an atom may be inferred from:

- A) diffraction of electrons by crystals
B) visible spectrum
C) X-ray diffraction by crystals
D) experiments on the photoelectric effect
E) atomic line spectra

Answer: E

11) Which of the following ionic compounds should have the highest melting point?

- A) CaS B) NaCl C) NaI D) MgO E) LiBr

Answer: D

12) Given the tabulated data, what is the lattice energy of crystalline calcium chloride?

heat of sublimation for calcium	+178 kJ/mol
first ionization energy for calcium	+590 kJ/mol
second ionization energy for calcium	+1145 kJ/mol
heat of dissociation for chlorine	+122 kJ/mol(Cl)
electron affinity for chlorine	-349 kJ/mol
heat of formation for calcium chloride	-796 kJ/mol

- A) -2101 kJ/mol
B) -1996 kJ/mol
C) -2450 kJ/mol
D) -2345 kJ/mol
E) -2255 kJ/mol

Answer: E

13) Which statement regarding VB theory is INCORRECT?

- A) A triple bond is two sigma bonds and a pi bond.
- B) A single bond is a sigma bond.
- C) A double bond requires each atom to have an unhybridized p orbital.
- D) Both atoms in a triple bond have linear geometry.
- E) sp^3 hybridization produces tetrahedral geometry.

Answer: A

14) A solution prepared by dissolving 4.00 g KCl in 36.0 g H_2O is said to be:

- A) 9.00% KCl by mass
- B) 0.100% KCl by mass
- C) 0.111% KCl by mass
- D) 11.1% KCl by mass
- E) 10.0% KCl by mass

Answer: E

15) Which of the following statements concerning the carbon dioxide molecule is correct?

- A) The molecule contains two σ bonds.
- B) The molecule contains four π bonds.
- C) The molecule contains two lone pairs of valence electrons.
- D) The carbon is described by sp^2 hybridization.
- E) Each oxygen is described by sp^3 hybridization.

Answer: A

16) A crystal and its melt readily conduct electricity. The crystal also has a luster and is easily deformed. Thus, it is:

- A) a metallic crystal
- B) a covalent network crystal
- C) a molecular crystal
- D) a covalent crystal.
- E) an ionic crystal

Answer: A

17) A solution that can dissolve no more solute is called:

- A) oversaturated
- B) supersaturated
- C) concentrated
- D) saturated
- E) unsaturated

Answer: D

18) Colligative properties are similar in that they all:

- A) depend on the number of solute particles in solution
- B) are due to solvent chemical interactions
- C) depend on the solvent
- D) describe colloids
- E) have no effect on the properties of solution

Answer: A

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

Answer: B

20) A liquid will "wet" a surface if:

- A) the liquid has a lesser density than the surface
- B) the forces between the molecules and the surface are greater than the forces between the molecules of the liquid
- C) the forces between the liquid molecules are weak
- D) the liquid has a low vapor pressure
- E) The liquid has low viscosity and the surface is smooth

Answer: B

21) The geometry of sp^2 hybridized orbitals is _____.

- A) octahedral
- B) linear
- C) T-shaped
- D) trigonal planar
- E) tetrahedral

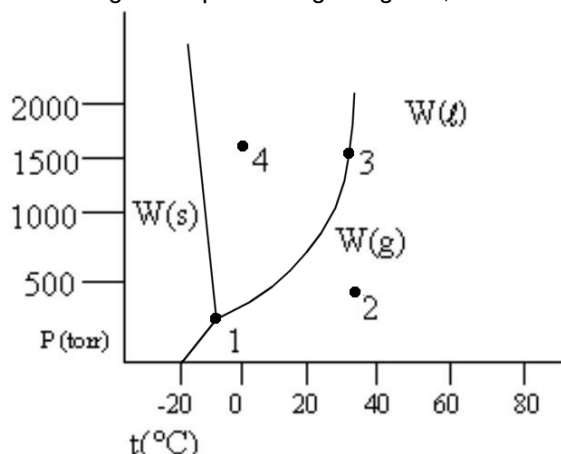
Answer: D

22) According to the principles of VSEPR applied on ICl_5 , which of the following is INCORRECT?

- A) molecular geometry = square pyramid
- B) hybridization = sp^3d
- C) VSEPR formula = AX_5E
- D) electron pair geometry = octahedral
- E) one lone pair and 5 bonding pairs

Answer: B

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



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

Answer: B

24) Solutions are made that contain 0.1 moles of each of the following compounds below in 100 g of H_2O . Choose the compound whose solution will have the lowest freezing point.

- A) $MgSO_4$
- B) $MgCl_2$
- C) $NaBr$
- D) $KClO_3$
- E) CO_2

Answer: B

25) 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 molality of the anhydrous compound in the solution? (Atomic weights: H = 1.0, O = 16.0, S = 32.1, Mg = 24.3)

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

Answer: C

26) What would be the bond order of the N-C bonds in the benzene-like molecule (C_5H_5N)?

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

Answer: C

27) Which of the following compounds is the most viscous?

CH_3CH_2OH , $CH_3CH_2CH_2CH_3$, $HOCH_2CH_2OH$, $CH_3OCH_2CH_3$

- A) CH_3CH_2OH
- B) $HOCH_2CH_2OH$
- C) $CH_3CH_2CH_2CH_3$
- D) $CH_3OCH_2CH_3$

Answer: B

28) Choose the INCORRECT statement.

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

Answer: C

29) All of the following are p-type semiconductors EXCEPT:

- A) Al in Si.
- B) As in Si.
- C) B in Ge.
- D) In in Se.

Answer: B

30) A passage of substance directly from the vapor to the solid state is known as:

- A) deposition
- B) sublimation
- C) solidification
- D) decomposition
- E) fusion

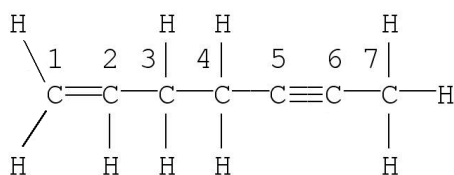
Answer: A

31) A substance has a heat of fusion of 61.5 kJ/mol and a heat of deposition of -167.4 kJ/mol. What is the heat of sublimation in kJ/mol?

- A) 167.4 kJ/mol
- B) 61.5 - 167.4 kJ/mol
- C) 167.4 - 61.5 kJ/mol
- D) 61.5 + 167.4 kJ/mol
- E) -61.5 kJ/mol

Answer: A

32) Which statement is correct for the structure shown?



- A) Carbon no. 2 is described by sp^2 hybridization.
- B) Carbon no. 7 is described by sp hybridization.
- C) Carbon no. 1 is described by sp^3 hybridization.
- D) The molecule contains a total of five π bonds.
- E) The molecule contains 19 σ bonds.

Answer: A

- 33) The relationship between the vapor pressure of a liquid and temperature can be expressed by the Clausius-Clapeyron equation:

$$\ln[P_2/P_1] = [\Delta H_{\text{vap}}/R] \times [1/T_1 - 1/T_2]$$

Ethanol ($\text{C}_2\text{H}_5\text{OH}$) has a normal boiling point of 78.3°C and, with $\Delta H_{\text{vap}} = 39.3 \text{ kJ/mol}$. What is the vapor pressure of ethanol at 50.0°C ? ($1 \text{ atm} = 760 \text{ torr}$; $R = 8.314 \text{ J / mol} \cdot \text{K}$)

- A) 485 torr B) 234 torr C) 670 torr D) 118 torr E) 354 torr

Answer: B

- 34) Choose the INCORRECT statement about NH_4^+ .

- A) The molecule is tetrahedral.
B) There are four σ bonds.
C) There are no π bonds.
D) There is one lone pair of electrons on N.
E) The hybridization of N is sp^3 .

Answer: D

- 35) The property that causes water to have a concave meniscus but mercury to have a convex meniscus is _____.

- A) critical point
B) surface tension
C) vapor pressure
D) sublimation
E) heat of vaporization

Answer: B

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

Answer: B

- 37) What is the hybridization of the S atom in SF_4 ?

- A) sp^3 B) sp^3d C) sp^3d^2 D) sp^4

Answer: B

- 38) Which combination of hybrid orbital descriptions and electronic geometry descriptions is INCORRECT?

- A) sp /linear
B) sp^2 /trigonal planar
C) sp^3d /square planar
D) sp^3 /tetrahedral
E) sp^3d^2 /octahedral

Answer: C

39) An atomic orbital represents:

- A) the shape of an atom
- B) the region of electron density for a covalent bond
- C) the region of high probability for an electron around the nucleus of an atom
- D) a fixed path that an electron follows around the nucleus of an atom
- E) the repulsion of all the electrons among themselves

Answer: C

40) Henry's Law constants for aqueous solutions at 25°C are 8.20×10^{-7} molal/mmHg for N₂ and 1.62×10^{-6} molal/mmHg for O₂. Determine the solubility of oxygen in water under an atmospheric pressure of 760 mmHg, assuming that air is 80% N₂ and 20% O₂.

- A) 1.2×10^{-3} m
- B) 1.3×10^{-4} m
- C) 2.5×10^{-4} m
- D) 6.2×10^{-3} m
- E) 5.0×10^{-4} m

Answer: C

41) Arrange the following compounds in order of increasing boiling point: HCl, HBr, HI.

- A) HBr, HI, HCl
- B) HI, HCl, HBr
- C) HCl, HI, HBr
- D) HI, HBr, HCl
- E) HCl, HBr, HI

Answer: E

42) Given the following information, calculate ΔH° (in kcal mol⁻¹) for: $\text{NaI(s)} \rightarrow \text{Na}^+(\text{g}) + \text{I}^-(\text{g})$

Process	ΔH° (kcal mol ⁻¹)
$\text{Na(s)} \rightarrow \text{Na(g)}$	+26
$\text{I}_2(\text{g}) \rightarrow 2\text{I(g)}$	+36 (per mole I ₂)
$\text{I}_2(\text{s}) \rightarrow \text{I}_2(\text{g})$	+15
$\text{Na(g)} \rightarrow \text{Na}^+(\text{g}) + \text{e}^-$	+118
$\text{I(g)} + \text{e}^- \rightarrow \text{I}^-(\text{g})$	-71
$2\text{Na(s)} + \text{I}_2(\text{s}) \rightarrow 2\text{NaI(s)}$	-699 (per mole NaI)

- A) 798 kcal mol⁻¹
- B) 823 kcal mol⁻¹
- C) 816 kcal mol⁻¹
- D) 562 kcal mol⁻¹
- E) 746 kcal mol⁻¹

Answer: A

43) Three of the molecular shapes which a sp^3d hybridized molecule can have are:

- A) T-shaped, linear, trigonal bipyramid
- B) irregular tetrahedron, T-shaped, bent
- C) triangular, trigonal bipyramid, linear
- D) linear, tetragonal pyramid, octahedral
- E) linear, square planar, T-shaped

Answer: A

44) How much heat would be released by the condensation of 5.40 g of steam at 100°C and the subsequent cooling of the water to 25°C ? [$\Delta H_{\text{vap}} = 40.7 \text{ kJ/mol}$ at 100°C ; C_p for $\text{H}_2\text{O}(\text{l})$ is $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$]

- A) 13.9 kJ
- B) 12.8 kJ
- C) 12.2 kJ
- D) 23.7 kJ
- E) 18.3 kJ

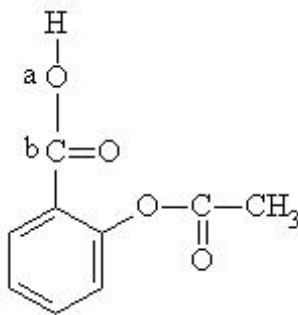
Answer: A

45) Choose the INCORRECT statement about SnCl_2 .

- A) There are no π bonds.
- B) The hybridization of Sn is sp^2 .
- C) The molecule is linear.
- D) There are two σ bonds.
- E) There is one lone pair of electrons on Sn.

Answer: C

46) The structure of aspirin is given below.



Which set of hybrid orbitals best describes the O - C bond, labeled "a", "b", in aspirin?

- A) sp^3-sp^3
- B) sp^3-sp^2
- C) sp^2-sp^2
- D) $sp-sp^2$

Answer: B

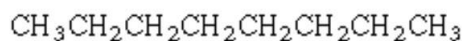
47) Which of the following organic substances is most readily soluble in water?



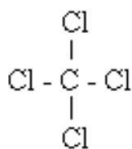
benzene



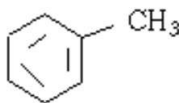
pyridine



octane



carbon tetrachloride



toluene

- A) octane
- B) benzene
- C) carbon tetrachloride
- D) toluene
- E) pyridine

Answer: E

48) The enthalpy of vaporization at 298 K for diethylether ($\text{C}_4\text{H}_{10}\text{O}$) is 26.0 kJ/mol. How much heat would be required to vaporize 1.00 L of the ether at 298 K if its density is 0.714 g/L?

- A) 186 J
- B) 440 J
- C) 130 J
- D) 250 J
- E) 74.1 J

Answer: D

49) A saline solution begins to freeze at -1.13°C . Express the concentration of NaCl in this solution in mass %. K_f for water is $1.86^\circ\text{C m}^{-1}$. (atomic weight Na : 23 ; Cl : 35.5)

- A) 8.90%
- B) 0.870%
- C) 17.8%
- D) 3.57%
- E) 1.78%

Answer: E

50) 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) 2.64 M
- B) 1.75 M
- C) 1.50 M
- D) 1.25 M
- E) 0.860 M

Answer: E