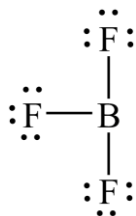


CHEM 1411 – STUDY-GUIDE-for-FINAL-EXAM

(CHAPTERS 9,10,11)

1. Write the Lewis structure of boron trifluoride.

Ans:

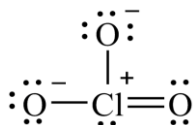


2. (TRUE/FALSE) The bond in F_2 is described as *polar covalent*.

Ans: False

3. Write a Lewis structure for the chlorate ion, ClO_3^- , that obeys the octet rule, showing all non-zero formal charges, and give the total number of resonance structures for ClO_3^- that obey the octet rule.

Ans:



Total number of resonance structures of this type (that obey the octet rule) = 3.

4. Which one of the following compounds does not follow the octet rule?

A) NF_3 B) CF_4 C) PF_5 D) AsH_3 E) HCl

Ans: C

5. Which one of the following molecules has an atom with an incomplete octet?

A) NF_3 B) H_2O C) AsCl_3 D) GeH_4 E) BF_3

Ans: E

6. BeF_4^{2-} is called the fluoberyllate ion. The formal charge on the beryllium atom in this ion is
A) -2 B) -1 C) 0 D) +1 E) +2

Ans: A

7. The formal charge on the bromine atom in BrO_3^- drawn with three single bonds is
A) -2 B) -1 C) 0 D) +1 E) +2

Ans: E

8. Assuming the octet rule is obeyed, how many covalent bonds will an oxygen atom form to give a formal charge of zero?
A) 0 B) 1 C) 2 D) 3 E) 4

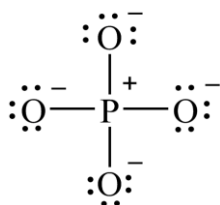
Ans: C

9. Which of the following is a useful guideline for the application of formal charges in neutral molecules?
A) A Lewis structure in which there are no formal charges is preferred.
B) Lewis structures with large formal charges (e.g., +2,+3 and/or -2,-3) are preferred.
C) The preferred Lewis structure is one in which positive formal charges are on the most electronegative atoms.

Ans: A

10. Write a Lewis structure for the phosphate ion, PO_4^{3-} , that obeys the octet rule, showing all non-zero formal charges, and give the total number of resonance structures for PO_4^{3-} that obey the octet rule.

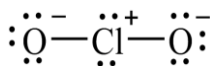
Ans:



Total number of resonance structures of this type (that obey the octet rule) = 1.

11. Write a Lewis structure for the chlorite ion, ClO_2^- , that obeys the octet rule, showing all non-zero formal charges, and give the total number of resonance structures for ClO_2^- that obey the octet rule.

Ans:



Total number of resonance structures of this type (that obey the octet rule) = 1.

12. Give the number of lone pairs around the central atom and the molecular geometry of SCl_2 .
- A) 0 lone pairs, linear
 - B) 1 lone pair, bent
 - C) 2 lone pairs, bent
 - D) 3 lone pairs, bent
 - E) 3 lone pairs, linear

Ans: C

13. Give the number of lone pairs around the central atom and the molecular geometry of SeF_4 .
- A) 0 lone pairs, tetrahedral
 - B) 1 lone pair, distorted tetrahedron (seesaw)
 - C) 1 lone pair, square pyramidal
 - D) 1 lone pair, tetrahedral
 - E) 2 lone pairs, square planar

Ans: B

14. Give the number of lone pairs around the central atom and the geometry of the ion ClO_2^- .
- A) 0 lone pairs, linear
 - B) 1 lone pair, bent
 - C) 2 lone pairs, bent
 - D) 3 lone pairs, bent
 - E) 3 lone pairs, linear

Ans: C

15. According to the VSEPR theory, the geometry of the SO_3 molecule is
- A) pyramidal.
 - B) tetrahedral.
 - C) trigonal planar.
 - D) distorted tetrahedron (seesaw).
 - E) square planar.

Ans: C

16. The geometry of the CS_2 molecule is best described as
- A) linear.
 - B) trigonal planar.
 - C) tetrahedral.
 - D) bent.
 - E) trigonal pyramidal.

Ans: A

17. According to the VSEPR theory, the molecular geometry of ammonia is
- A) linear
 - B) trigonal planar
 - C) bent
 - D) tetrahedral
 - E) trigonal pyramidal

Ans: E

18. According to VSEPR theory, which one of the following molecules is *trigonal bipyramidal*?

- A) SF₄ B) XeF₄ C) NF₃ D) SF₆ E) PF₅

Ans: E

19. Predict the geometry around the central atom in PO₄³⁻.

- A) trigonal planar D) trigonal bipyramidal
B) trigonal pyramidal E) octahedral
C) tetrahedral

Ans: C

20. A molecule with 3 single bonds and 0 lone pairs of electrons is predicted to have which type of molecular geometry?

- A) Trigonal planar D) Trigonal bipyramidal
B) Trigonal pyramidal E) Linear
C) Bent

Ans: A

21. Which of the following molecules has *polar* bonds but is a *nonpolar* molecule?

- A) PCl₃ B) NCl₃ C) BF₃ D) HF E) OCl₂

Ans: C

22. Which one of the following molecules has a non-zero dipole moment?

- A) BeCl₂ B) Br₂ C) BF₃ D) IBr E) CO₂

Ans: D

23. Predict the molecular geometry and polarity of the SO₂ molecule.

- A) linear, polar D) bent, nonpolar
B) linear, nonpolar E) None of the above.
C) bent, polar

Ans: C

24. Which of the following species has the largest dipole moment (i.e., is the most polar)?

- A) H₂ B) H₂O C) H₂S D) H₂Se E) CH₄

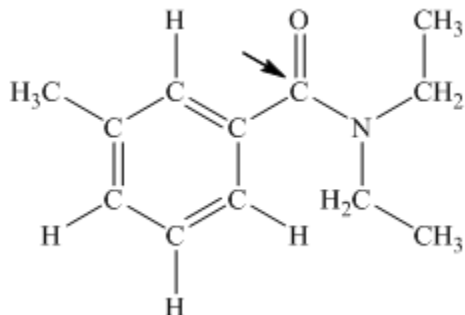
Ans: B

25. The geometry of the hybrid orbitals about a central atom with sp^3d^2 hybridization is:

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

Ans: E

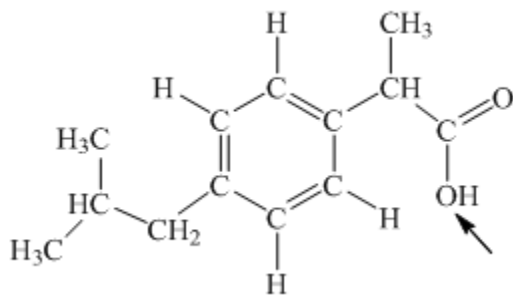
26. *N,N*-diethyl-*m*-toluimide (DEET) is the active ingredient in many mosquito repellents. What is the hybridization state of carbon indicated by the arrow in the structure of DEET shown below?



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

Ans: B

27. Ibuprofen is used as an analgesic for the relief of pain, and also to help reduce fever. What is the hybridization state of oxygen indicated by the arrow in the structure of ibuprofen shown below?



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

Ans: C

28. Which of the following correctly lists species in order of *increasing* bond order?

- A) $C_2 < Li_2 < Be_2 < N_2$
- B) $Be_2 < Li_2 < C_2 < N_2$
- C) $N_2 < Be_2 < Li_2 < C_2$
- D) $N_2 < C_2 < Li_2 < Be_2$
- E) $Be_2 < C_2 < N_2 < Li_2$

Ans: B

29. Indicate the type of hybrid orbitals used by the central atom in SF₆.

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

Ans: E

30. Indicate the type of hybrid orbitals used by the central atom in BrF₃.

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

Ans: D

31. An sp^3 hybridized central carbon atom with no lone pairs of electrons has what type of bonding?

- A) 1 π and 2 σ bonds
B) 1 π and 3 σ bonds
C) 2 π and 2 σ bonds
D) 3 π and 2 σ bonds
E) 0 π and 4 σ bonds

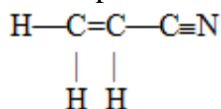
Ans: E

32. Which of the following species have the same geometries?

- A) NH₂⁻ and H₂O
B) NH₂⁻ and BeH₂
C) H₂O and BeH₂
D) NH₂⁻, H₂O, and BeH₂

Ans: A

33. The number of pi bonds in the molecule below is



- A) 1 B) 2 C) 3 D) 5 E) 9

Ans: C

34. According to Molecular Orbital Theory, two separate 1s orbitals interact to form what molecular orbital(s)?

- A) σ only B) σ and σ^* C) π only D) π and π^* E) σ and π

Ans: B

35. Consider the species Cl₂⁺, Cl₂, and Cl₂⁻. Which of these species will be paramagnetic?

- A) only Cl₂
B) Cl₂⁺ and Cl₂
C) Cl₂ and Cl₂⁻
D) Cl₂⁺ and Cl₂⁻
E) all three are paramagnetic

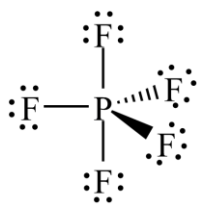
Ans: D

36. Explain why CO_2 is nonpolar, but OCS is polar.

Ans: In CO_2 the two bond moments point in opposite directions and are of equal magnitude. Therefore, they cancel. In OCS , even though the two bond moments point in opposite directions, they are not of the same magnitude and do not cancel.

37. Draw a Lewis structure for PF_5 that shows the correct atom arrangement predicted by VSEPR theory.

Ans:



38. List all of the bond angles present in a molecule with a trigonal bipyramidal geometry.

Ans: 90° and 120°

39. How does the geometrical structure of PF_5 differ from that of IF_5 ?

Ans: PF_5 is trigonal bipyramidal, whereas IF_5 is square pyramidal

40. TRUE/FALSE: More energy is required to break a bond with an order of $3/2$ than is required to break a bond of order 2.

Ans: False

41. TRUE/FALSE: Valence Bond Theory alone can be used to determine that O_2 is paramagnetic.

Ans: False

Chapter-11:

42. Which one of the following substances is expected to have the highest boiling point?

- A) HBr B) HCl C) HF D) HI

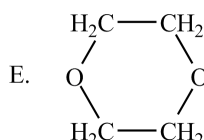
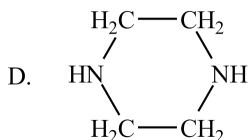
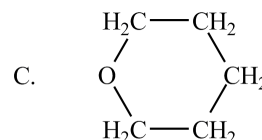
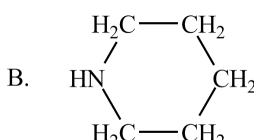
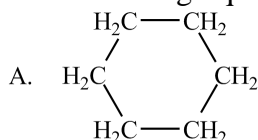
Ans: C

43. Which one of the following substances should exhibit hydrogen bonding in the liquid state?

- A) PH₃ B) H₂ C) H₂S D) CH₄ E) NH₃

Ans: E

44. Which of the following liquids would have the lowest viscosity at 25°C?



- A) A B) B C) C D) D E) E

Ans: A

45. The intermolecular forces present in CH₃NH₂ include which of the following?

- I. dipole-dipole
II. ion-dipole
III. dispersion
IV. hydrogen bonding

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

Ans: C

46. Each of the following substances is a liquid at -50°C . Place these liquids in order of *increasing* vapor pressure: dimethyl ether (CH_3OCH_3), propane (C_3H_8), and ethanol ($\text{CH}_3\text{CH}_2\text{OH}$).
- A) ethanol < propane < dimethyl ether D) dimethyl ether < ethanol < propane
B) ethanol < dimethyl ether < propane E) propane < ethanol < dimethyl ether
C) propane < dimethyl ether < ethanol

Ans: B

47. Given the following liquids and their boiling points, which has the *highest* vapor pressure at its normal boiling point?
- A) ethanol, bp = 78°C
B) methanol, bp = 65°C
C) water, bp = 100°C
D) benzene, bp = 80°C
E) The vapor pressure of each of the liquids at its normal boiling point would be the same.

Ans: E

48. Butter melts over a range of temperatures, rather than with a sharp melting point. Butter is classified as a/an
- A) metallic crystal. D) amorphous solid.
B) covalent solid. E) ionic crystal.
C) molecular crystal.

Ans: D

49. The structural form of the element Ge closely resembles the structure of
- A) C (diamond). D) S (S_8 ring).
B) N (diatomic). E) Kr (monatomic).
C) As (tetrahedral).

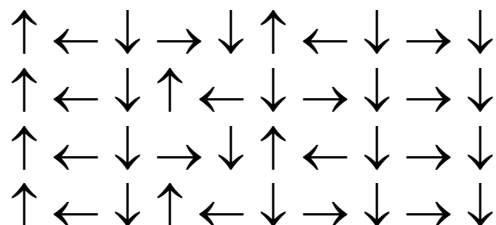
Ans: A

50. The most space efficient arrangement of spheres is found in which type(s) of atom arrangement?
- I. hexagonal close-packed
II. cubic close-packed
III. simple cubic
IV. body-centered cubic

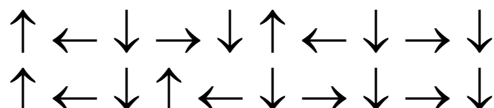
A) I only B) II only C) I and II D) IV only E) I, II, and IV

Ans: A

51. In the following picture, each arrow represents a molecule or atom. Based on the arrangement in the solid state as shown, which of the following best represents the unit cell?



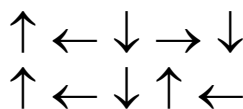
A)



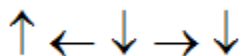
B)



C)



D)



E)



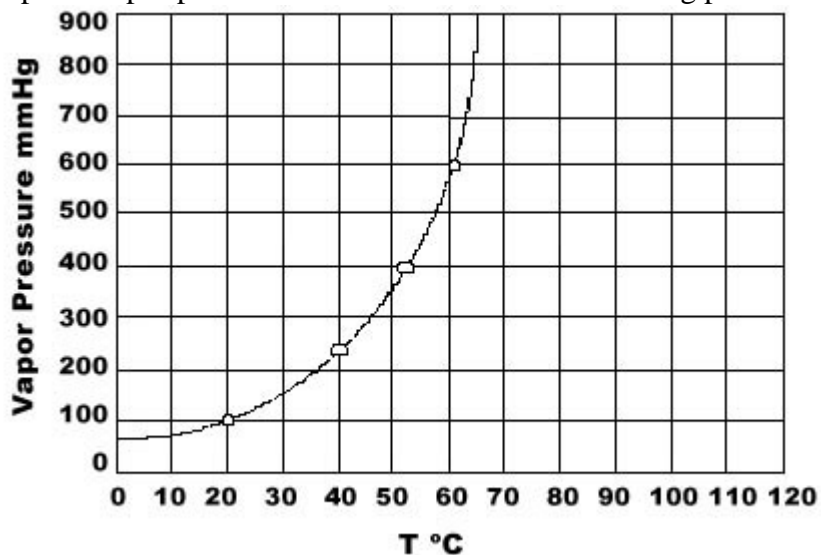
Ans: A

52. The heat capacity of liquid water is $4.18 \text{ J/g}\cdot^\circ\text{C}$ and the heat of vaporization is 40.7 kJ/mol . How many kilojoules of heat must be provided to convert 1.00 g of liquid water at 67°C into 1.00 g of steam at 100°C ?

A) 40.8 J B) 2.2 kJ C) $2,400 \text{ J}$ D) 22.7 kJ E) 40.8 kJ

Ans: C

53. Use the graph of vapor pressure to determine the normal boiling point of CHCl_3 .



- A) 19°C B) 52°C C) 60°C D) 64°C E) 70°C

Ans: D

54. Which of the following phase changes is exothermic?

- A) Sublimation B) Condensation C) Melting D) Vaporization

Ans: B

55. Calculate the amount of heat needed to melt 2.00 kg of iron at its melting point (1,809 K), given that $\Delta H_{\text{fus}} = 13.80 \text{ kJ/mol}$.

- A) 27,600 J B) 27.6 kJ C) 494 kJ D) 25,000 kJ E) 27,600 kJ

Ans: C

56. How much energy (heat) is required to convert 25.5 g of $\text{H}_2\text{O}(\text{l})$ at 35.0°C to $\text{H}_2\text{O}(\text{g})$ at 115.0°C?

specific heat of ice: 2.09 J/g·°C $\Delta H_{\text{fus}} = 6.02 \text{ kJ/mol}$

specific heat of water: 4.18 J/g·°C $\Delta H_{\text{vap}} = 40.7 \text{ kJ/mol}$

specific heat of steam: 1.84 J/g·°C

- A) 207 J B) 7,630 J C) 8,530 J D) 9,130 J E) 65,200 J

Ans: E

57. Octane is a liquid component of gasoline. Given the following vapor pressures of octane at various temperatures, estimate the boiling point of octane in Leadville, Colorado, where the atmospheric pressure is 496 mmHg.
400 mmHg @ 104°C, 500 mmHg @ 111°C, 600 mmHg @ 117°C, 700 mmHg @ 122°C, 760 mmHg @ 125°C
A) 125°C B) 120°C C) 115°C D) 110°C E) 105°C

Ans: D

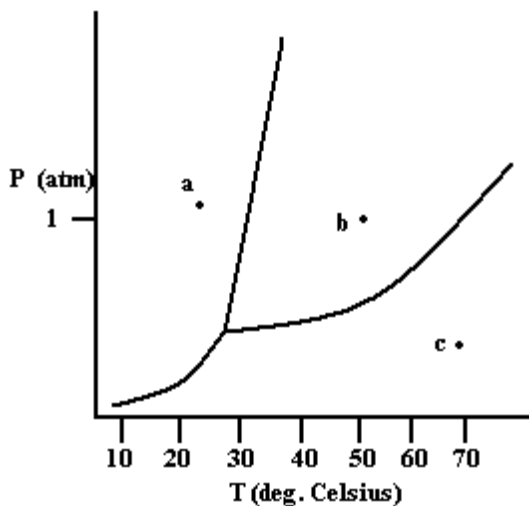
58. Which type of intermolecular force is the strongest? (*ionic, ion-dipole, dipole-dipole, hydrogen bonding, dispersion*)

Ans: Ionic

59. Which would be expected to have the higher boiling point CH₄ or CH₃OH?

Ans: CH₃OH

60. What phase exists at the point labeled *a*?



Ans: solid

61. Octane, C_8H_{18} , boils at $125^\circ C$ as compared to water, which boils at $100^\circ C$. This information suggests that the dispersion forces in nonpolar octane molecules are stronger than dispersion forces and hydrogen bonding in water.

Ans: True

62. How much enthalpy is necessary to heat 10.0 g of solid benzene (C_6H_6) at $0.0^\circ C$ to benzene vapor at $100^\circ C$?

Data for Benzene	
melting point	$5.5^\circ C$
boiling point	$80.1^\circ C$
specific heat of solid benzene	$1.52 J/g \cdot ^\circ C$
specific heat of liquid benzene	$1.73 J/g \cdot ^\circ C$
specific heat of benzene vapor	$1.06 J/g \cdot ^\circ C$
ΔH_{fus}	$9.9 kJ/mol$
ΔH_{vap}	$30.8 kJ/mol$

Ans: 6.8 kJ