

# Concept Review Questions

## Lecture 2 | Chemical Bonding

**Directions:** Choose the one alternative that best completes the statement or answers the questions.

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### Topic : Nomenclature of compounds

Students should be able to;

- Give examples of correct formulas for ionic compounds and covalent compounds.
  - Name common ionic compounds, molecular compounds, bases, and hydrates given their respective chemical formulas.
  - Predict the chemical formulas of common ionic compounds and covalent compounds.
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- 1) Which of the following compounds is ionic?  
A)  $\text{PF}_3$                       B)  $\text{CS}_2$                       C)  $\text{HCl}$                       D)  $\text{SO}_2$                       E)  $\text{MgCl}_2$   
Difficulty: M
- 2) Which of the following compounds is covalent?  
A)  $\text{CaCl}_2$                       B)  $\text{MgO}$                       C)  $\text{Al}_2\text{O}_3$                       D)  $\text{Cs}_2\text{S}$                       E)  $\text{PCl}_3$   
Difficulty: M
- 3) Which of the following contains ionic bonding?  
A)  $\text{CO}$                       B)  $\text{SrF}_2$                       C)  $\text{Al}$                       D)  $\text{OCl}_2$                       E)  $\text{HCl}$   
Difficulty: E
- 4) Which of the following is an ionic compound?  
A)  $\text{H}_2\text{S}$                       B)  $\text{NH}_3$                       C)  $\text{I}_2$                       D)  $\text{KI}$                       E)  $\text{CCl}_4$   
Difficulty: E
- 5) Which of the following is a covalent compound?  
A)  $\text{Na}_2\text{O}$                       B)  $\text{CaCl}_2$                       C)  $\text{Cl}_2\text{O}$                       D)  $\text{CsCl}$                       E)  $\text{Al}_2\text{O}_3$   
Difficulty: E
- 6) Which of the following contains covalent bonds?  
A)  $\text{BaO}$                       B)  $\text{IBr}$                       C)  $\text{Mg}$                       D)  $\text{LiBr}$                       E)  $\text{Cu}$   
Difficulty: E
- 7) Based on the octet rule, magnesium most likely forms a \_\_\_\_\_ ion.  
A)  $\text{Mg}^{2+}$                       B)  $\text{Mg}^{2-}$                       C)  $\text{Mg}^{6-}$                       D)  $\text{Mg}^{6+}$                       E)  $\text{Mg}^-$
- 8) Based on the octet rule, phosphorus most likely forms a \_\_\_\_\_ ion.  
A)  $\text{P}^{3+}$                       B)  $\text{P}^{3-}$                       C)  $\text{P}^{5+}$                       D)  $\text{P}^{5-}$                       E)  $\text{P}^+$

- 9) Based on the octet rule, iodine most likely forms an \_\_\_\_\_ ion.  
A)  $I^{2+}$       B)  $I^{4+}$       C)  $I^{4-}$       D)  $I^+$       E)  $I^-$
- 10) Sodium oxide combines violently with water. Which of the following gives the formula and the bonding for sodium oxide?  
A) NaO, ionic compound      D)  $Na_2O$ , covalent compound  
B) NaO, covalent compound      E)  $Na_2O_2$ , ionic compound  
C)  $Na_2O$ , ionic compound  
Difficulty: E
- 11) Select the correct formula for a compound formed from barium and nitrogen.  
A) BaN      B)  $BaN_2$       C)  $Ba_2N_3$       D)  $Ba_2N$       E)  $Ba_3N_2$   
Difficulty: M
- 12) Select the correct formula for a compound formed from calcium and chlorine.  
A) CaCl      B)  $CaCl_2$       C)  $Ca_2Cl$       D)  $Ca_2Cl_2$       E)  $CaCl_3$   
Difficulty: M
- 13) Barium fluoride is used in embalming and in glass manufacturing. Which of the following gives the formula and bonding for barium fluoride?  
A)  $BaF_2$ , ionic compound      D) BaF, covalent compound  
B) BaF, covalent compound      E)  $Ba_2F$ , ionic compound  
C) BaF, ionic compound  
Difficulty: E
- 14) The colorless substance,  $MgF_2$ , is used in the ceramics and glass industry. What is its name?  
A) magnesium difluoride  
B) magnesium fluoride  
C) magnesium(II) fluoride  
D) monomagnesium difluoride  
E) none of the above, since they are all misspelled  
Difficulty: M
- 15) The compound, BaO, absorbs water and carbon dioxide readily and is used to dry gases and organic solvents. What is its name?  
A) barium oxide      D) baric oxide  
B) barium(II) oxide      E) barium peroxide  
C) barium monoxide  
Difficulty: M
- 16) What is the name of  $Na_2O$ ?  
A) disodium monoxide      D) sodium(I) oxide  
B) sodium monoxide      E) sodium oxide  
C) sodium dioxide  
Difficulty: M

- 17) The substance, CaSe, is used in materials which are electron emitters. What is its name?  
A) calcium monoselenide                      D) calcium(I) selenide  
B) calcium(II) selenide                      E) calcium(II) selenium  
C) calcium selenide  
Difficulty: M
- 18) The substance, CoCl<sub>2</sub>, is useful as a humidity indicator because it changes from pale blue to pink as it gains water from moist air. What is its name?  
A) cobalt dichloride                      D) cobaltic chloride  
B) cobalt(II) chloride                      E) copper(II) chloride  
C) cobalt chloride  
Difficulty: M
- 19) In the ionic compound with the general formula M<sub>2</sub>X<sub>3</sub>, the likely charge on X is  
A) +1.              B) +3.              C) -1.              D) -2.              E) -3.  
Difficulty: M
- 20) Which one of the following combinations of names and formulas of ions is **incorrect**?  
A) O<sub>2</sub><sup>2-</sup> oxide                      D) PO<sub>4</sub><sup>3-</sup> phosphate  
B) Al<sup>3+</sup> aluminium                      E) CrO<sub>4</sub><sup>2-</sup> chromate  
C) NO<sub>3</sub><sup>-</sup> nitrate  
Difficulty: H
- 21) Which one of the following is a polyatomic cation?  
A) nitrate                      B) chromate                      C) permanganate  
D) hydronium                      E) potassium  
Difficulty: M
- 22) Which one of the following combinations of names and formulas of ions is **incorrect**?  
A) O<sup>2-</sup> oxide                      D) HCO<sub>3</sub><sup>-</sup> hydrogen carbonate  
B) Cd<sup>2+</sup> cadmium                      E) NO<sub>2</sub><sup>-</sup> nitrate  
C) ClO<sub>3</sub><sup>-</sup> chlorate  
Difficulty: H
- 23) Which one of the following combinations of names and formulas of ions is incorrect?  
A) Ba<sup>2+</sup> barium                      D) ClO<sub>4</sub><sup>-</sup> perchlorate  
B) S<sup>2-</sup> sulfate                      E) HCO<sub>3</sub><sup>-</sup> bicarbonate  
C) CN<sup>-</sup> cyanide  
Difficulty: M
- 24) Which one of the following combinations of names and formulas of ions is incorrect?  
A) NH<sub>4</sub><sup>+</sup> ammonium                      D) S<sub>2</sub>O<sub>3</sub><sup>2-</sup> thiosulfate  
B) S<sup>2-</sup> sulfide                      E) ClO<sub>3</sub><sup>-</sup> perchlorate  
C) CN<sup>-</sup> cyanide  
Difficulty: H
- 25) A red glaze on porcelain can be produced by using MnSO<sub>4</sub>. What is its name?  
A) manganese disulfate                      D) manganese sulfate  
B) manganese(II) sulfate                      E) manganese(I) sulfate

C) manganese(IV) sulfate

Difficulty: M

26) The compound,  $(\text{NH}_4)_2\text{S}$ , can be used in analysis for trace amounts of metals present in a sample. What is its name?

A) ammonium sulfide

D) ammonia(I) sulfite

B) diammonium sulfide

E) ammonium(I) sulfide

C) ammonium sulfite

Difficulty: M

27) The substance,  $\text{KClO}_3$ , is a strong oxidizer used in explosives, fireworks, and matches. What is its name?

A) potassium chlorite

D) potassium(I) chlorate

B) potassium chloride

E) potassium chlorate

C) potassium(I) chlorite

Difficulty: M

28) The compound,  $\text{NaH}_2\text{PO}_4$ , is present in many baking powders. What is its name?

A) sodium biphosphate

D) sodium hydrophosphate

B) sodium hydrogen phosphate

E) sodium dihydride phosphate

C) sodium dihydrogen phosphate

Difficulty: M

29) Zinc acetate is used in preserving wood and in manufacturing glazes for porcelain. What is its formula?

A)  $\text{ZnAc}_2$

D)  $\text{Zn}_2\text{CH}_3\text{COO}$

B)  $\text{ZnCH}_3\text{COO}$

E)  $\text{ZnCH}_3\text{COCH}_3$

C)  $\text{Zn}(\text{CH}_3\text{COO})_2$

Difficulty: M

30) Silver chloride is used in photographic emulsions. What is its formula?

A)  $\text{Ag}_2\text{Cl}_3$

B)  $\text{Ag}_2\text{Cl}$

C)  $\text{AgCl}_3$

D)  $\text{AgCl}_2$

E)  $\text{AgCl}$

Difficulty: E

31) Barium sulfate is used in manufacturing photographic paper. What is its formula?

A)  $\text{BaSO}_4$

B)  $\text{Ba}(\text{SO}_4)_2$

C)  $\text{Ba}_2\text{SO}_4$

D)  $\text{Ba}_2(\text{SO}_4)_3$

E)  $\text{BaSO}_3$

Difficulty: M

32) What is the formula for magnesium sulfide?

A)  $\text{MgS}$

B)  $\text{MgS}_2$

C)  $\text{Mg}_2\text{S}$

D)  $\text{Mg}_2\text{S}_3$

E)  $\text{MgSO}_4$

Difficulty: E

33) Ferric oxide is used as a pigment in metal polishing. Which of the following is its formula?

A)  $\text{FeO}$

B)  $\text{Fe}_2\text{O}$

C)  $\text{FeO}_3$

D)  $\text{Fe}_2\text{O}_5$

E)  $\text{Fe}_2\text{O}_3$

A Difficulty: E

34) What is the formula for lead (II) oxide?

A)  $\text{PbO}$

B)  $\text{PbO}_2$

C)  $\text{Pb}_2\text{O}$

D)  $\text{PbO}_4$

E)  $\text{Pb}_2\text{O}_3$

Difficulty: E

35) Potassium permanganate is a strong oxidizer that reacts explosively with easily oxidized materials. What is its formula?

- A)  $\text{KMnO}_3$                       B)  $\text{KMnO}_4$                       C)  $\text{K}_2\text{MnO}_4$   
D)  $\text{K}(\text{MnO}_4)_2$                   E)  $\text{K}_2\text{Mn}_2\text{O}_7$

Difficulty: M

36) Calcium hydroxide is used in mortar, plaster, and cement. What is its formula?

- A)  $\text{CaOH}$                           B)  $\text{CaOH}_2$                       C)  $\text{Ca}_2\text{OH}$   
D)  $\text{Ca}(\text{OH})_2$                   E)  $\text{CaHO}_2$

Difficulty: E

37) What is the formula for lithium nitrite?

- A)  $\text{LiNO}_2$                           B)  $\text{Li}_2\text{NO}_2$                       C)  $\text{LiNO}_3$   
D)  $\text{Li}_2\text{NO}_3$                       E)  $\text{LiNO}_4$

Difficulty: E

38) Iron (III) chloride hexahydrate is used as a coagulant for sewage and industrial wastes. What is its formula?

- A)  $\text{Fe}(\text{Cl} \cdot 6\text{H}_2\text{O})_3$                   D)  $\text{Fe}_3\text{Cl}(\text{H}_2\text{O})_6$   
B)  $\text{Fe}_3\text{Cl} \cdot 6\text{H}_2\text{O}$                       E)  $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$   
C)  $\text{FeCl}_3(\text{H}_2\text{O})_6$

Difficulty: M

39) Which one of the following formulas of ionic compounds is the least likely to be correct?

- A)  $\text{NH}_4\text{Cl}$                           B)  $\text{Ba}(\text{OH})_2$                       C)  $\text{Na}_2\text{SO}_4$   
D)  $\text{Ca}_2\text{NO}_3$                       E)  $\text{Cu}(\text{CN})_2$

Difficulty: M

40) Which one of the following formulas of ionic compounds is the least likely to be correct?

- A)  $\text{CaCl}_2$                           B)  $\text{NaSO}_4$                           C)  $\text{MgCO}_3$   
D)  $\text{KF}$                               E)  $\text{Cu}(\text{NO}_3)_2$

Difficulty: M

41) What is the name of  $\text{PCl}_3$ ?

- A) phosphorus chloride                  D) trichlorophosphide  
B) phosphoric chloride                  E) phosphorus trichloride  
C) phosphorus trichlorate

Difficulty: E

42) The compound,  $\text{P}_4\text{S}_{10}$ , is used in the manufacture of safety matches. What is its name?

- A) phosphorus sulfide                      D) tetraphosphorus decasulfide  
B) phosphoric sulfide                      E) phosphorus pentasulfide  
C) phosphorus decasulfide

Difficulty: M

- 43) What is the name of  $\text{BBr}_3$ ?  
A) boron bromide  
B) boric bromide  
C) boron tribromide  
D) tribromoboride  
E) bromine triboride  
Difficulty: M
- 44) What is the name of  $\text{IF}_7$ ?  
A) iodine fluoride  
B) iodic fluoride  
C) iodine heptafluoride  
D) heptafluoroiodide  
E) heptafluorine iodide  
Difficulty: M
- 45) What is the name of  $\text{P}_4\text{Se}_3$ ?  
A) phosphorus selenide  
B) phosphorus triselenide  
C) tetraphosphorus selenide  
D) phosphoric selenide  
E) tetraphosphorus triselenide  
Difficulty: M
- 46) Diiodine pentaoxide is used as an oxidizing agent that converts carbon monoxide to carbon dioxide. What is its chemical formula?  
A)  $\text{I}_2\text{O}_5$     B)  $\text{IO}_5$     C)  $2\text{IO}_5$     D)  $\text{I}_5\text{O}_2$     E)  $(\text{IO}_5)_2$   
Difficulty: E
- 47) Tetrasulfur dinitride decomposes explosively when heated. What is its formula?  
A)  $\text{S}_2\text{N}_4$     B)  $\text{S}_4\text{N}_2$     C)  $4\text{SN}_2$     D)  $\text{S}_4\text{N}$     E)  $\text{S}_2\text{N}$   
Difficulty: E
- 48) Chlorine dioxide is a strong oxidizer that is used for bleaching flour and textiles and for purification of water. What is its formula?  
A)  $(\text{ClO})_2$     B)  $\text{Cl}_2\text{O}$     C)  $\text{Cl}_2\text{O}_2$     D)  $\text{Cl}_2\text{O}_4$     E)  $\text{ClO}_2$   
Difficulty: E
- 49) Magnesium atom have the electronic configuration  $(1s^2 2s^2 2p^6 3s^2)$ . Oxygen atoms have the electronic configuration  $(1s^2 2s^2 2p^4)$ . Which statement is true about the formation of  $\text{MgO}$ .  
A) A magnesium atom accepts a pair of electron from oxygen atom.  
B) A magnesium atom gives a pair of electron to an oxygen atom.  
C) A magnesium atom gives a pair of electron to a magnesium atom.  
D) An oxygen atom shares a pair of electrons with magnesium atom.  
E) All of these are correct.
- 50) Magnesium atom have the electronic configuration  $(1s^2 2s^2 2p^6 3s^2)$ . Oxygen atoms have the electronic configuration  $(1s^2 2s^2 2p^4)$ . Which statement is true about the formation of  $\text{MgO}$ .  
A) A magnesium atom accepts a pair of electron from oxygen atom.  
B) A magnesium atom gives a pair of electron to an oxygen atom.  
C) An oxygen atom gives a pair of electron to a magnesium atom.  
D) An oxygen atom shares a pair of electrons with magnesium atom.  
E) All of these are correct.

## Ionic bonding

51) A type of chemical bond that is formed from the attraction of an atom that has lost an electron for an atom that has gained an electron is called a(n)\_\_\_\_\_.

- A) covalent bond.                      B) ionic bond.                      C) metallic bond  
D) hydrogen bond                      E) none of these are correct.

52) Which one of the following properties is least characteristic of typical ionic compounds?

- A) high melting point  
B) high boiling point  
C) brittleness  
D) poor electrical conductor when solid  
E) poor electrical conductor when molten

Difficulty: M

53) Some properties of four substances are tabulated below. Which substance is likely to be sodium chloride

substances	Melting point (°C)	Ability to conduct electricity	
		When molten	In aqueous solution
A	-100	none	none
B	-85	none	good
C	115	none	(insoluble)
D	808	good	good
E	1658	good	none

54) Select the element whose Lewis symbol is correct.

- (a)  $\cdot\text{Fr}\cdot$             (b)  $\cdot\text{Ra}\cdot$             (c)  $\cdot\text{Pb}\cdot$             (d)  $:\text{Te}:$             (e)  $\text{H}\cdot$

Difficulty: E

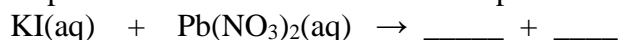
55) Select the element whose Lewis symbol is correct.

- (a)  $\cdot\text{Al}\cdot$             (b)  $\cdot\ddot{\text{B}}\cdot$             (c)  $:\ddot{\text{Br}}\cdot$             (d)  $:\text{N}:$             (e)  $:\ddot{\text{P}}\cdot$

Difficulty: E

## Aqueous Ionic Reactions

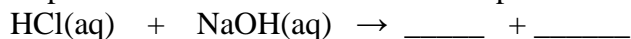
56) Select the product from the reaction between potassium iodide and lead(II) nitrate.



- A)  $\text{KNO}_3$  only  
B)  $\text{KNO}_3 + \text{I}_2$   
C)  $\text{KNO}_3(\text{aq}) + \text{PbI}_2(\text{s})$   
D)  $\text{KClO}_3 + \text{I}_2$   
E)  $\text{PbO} + \text{KNO}_3$

Difficulty: E

57) Select the product from the reaction between potassium iodide and lead(II) nitrate.



- A)  $\text{NaCl} + \text{H}_2$   
 B)  $\text{Na(s)} + \text{Cl}_2(\text{g})$   
 C)  $\text{H}_2\text{O} + \text{Cl}_2$   
 D)  $\text{NaCl} + \text{H}_2\text{O}$   
 F) None of these

Difficulty: E

58) Select the precipitate that forms when the following reactants are mixed.



- A)  $\text{Ba}_2\text{CO}_3$     B)  $\text{BaCO}_3$     C)  $\text{NaCl}$     D)  $\text{NaCl}_2$     E)  $\text{BaO}$

Difficulty: E

59) Select the precipitate that forms when aqueous ammonium sulfide reacts with aqueous copper(II) nitrate.

- A)  $\text{CuS}$     B)  $\text{Cu}_2\text{S}$     C)  $\text{NH}_4\text{NO}_3$     D)  $\text{NH}_4(\text{NO}_3)_2$     E)  $\text{CuSO}_4$

Difficulty: M

60) Select the precipitate that forms when aqueous lead(II) nitrate reacts with aqueous sodium sulfate.

- A)  $\text{NaNO}_3$     B)  $\text{Na}_2\text{NO}_3$     C)  $\text{PbSO}_4$     D)  $\text{Pb}_2\text{SO}_4$     E)  $\text{PbS}$

Difficulty: M

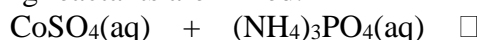
61) Select the correct name and chemical formula for the precipitate that forms when the following reactants are mixed.



- A) copper(I) carbonate,  $\text{Cu}_2\text{CO}_3$     D) copper(II) carbonate,  $\text{CuCO}_3$   
 B) copper(II) carbonate,  $\text{Cu}_2\text{CO}_3$     E) sodium chloride,  $\text{NaCl}$   
 C) copper(I) carbonate,  $\text{CuCO}_3$

Difficulty: M

62) Select the correct name and chemical formula for the precipitate that forms when the following reactants are mixed.



- A) cobalt(II) phosphate,  $\text{Co}_3(\text{PO}_4)_2$     D) cobalt(III) phosphate,  $\text{CoPO}_4$   
 B) cobalt(III) phosphate,  $\text{Co}_3(\text{PO}_4)_2$     E) ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$   
 C) cobalt(II) phosphate,  $\text{CoPO}_4$

Difficulty: M

## Covalent bonding

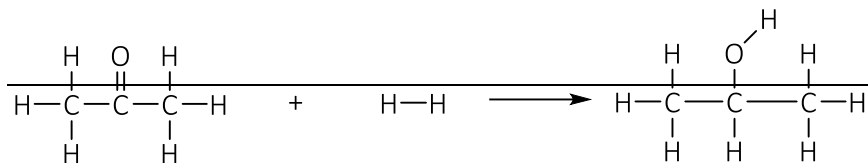
63) When two atoms form a covalently-bonded diatomic molecule, the distance between the nuclei at which the potential energy is at a minimum is called\_\_\_\_\_.

- A) the bond energy.    B) the bond length.    C) the molecular diameter.  
 D) the covalent radius.    E) the covalent diameter.

Difficulty: E



- 72) ~~Acetone can be easily converted to isopropyl alcohol by addition of hydrogen to the carbon oxygen double bond. Calculate the enthalpy of reaction using the bond energies given.~~

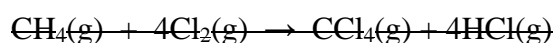


~~**Bond:**  $\text{C}=\text{O}$   $\text{H}-\text{H}$   $\text{C}-\text{H}$   $\text{O}-\text{H}$   $\text{C}-\text{C}$   $\text{C}-\text{O}$   
**Bond energy (kJ/mol):** 745 436 414 464 347 351~~

- ~~A) 484 kJ B) 366 kJ C) 48 kJ D) +48 kJ E) +366 kJ~~

~~Difficulty: H~~

- 73) Using the bond energies provided below, calculate  $\Delta H_{\text{rxn}}^{\circ}$  for the reaction



~~Bond energies:  $\text{C}-\text{H} = 413 \text{ kJ/mol}$ ,  $\text{Cl}-\text{Cl} = 243 \text{ kJ/mol}$ ,  
 $\text{C}-\text{Cl} = 339 \text{ kJ/mol}$ ,  $\text{H}-\text{Cl} = 427 \text{ kJ/mol}$~~

- ~~A) 1422 kJ B) 440 kJ C) 110 kJ D) 110 kJ E) 440 kJ~~

~~Difficulty: E~~

## Electronegativity

- 74) Electronegativity is a measure of \_\_\_\_

- A) the energy needed to remove an electron from an atom.  
 B) the energy released when an electron is added to an atom.  
 C) the magnitude of the negative charge on an electron.  
 D) the attraction by an atom for electrons in a chemical bond.  
 E) the magnitude of the negative charge on a molecule.

Difficulty: M

- 75) The ability of an atom in a molecule to attract electrons is best quantified by the \_\_\_\_.

- A) paramagnetism B) diamagnetism C) electronegativity  
 D) electron change-to-mass ratio E) first ionization potential

- 76) Electronegativity \_\_\_\_\_ from left to right within a period and \_\_\_\_\_ from top to bottom within a group.

- A) decreases, increases B) increases, increases C) increases, decreases  
 D) stays the same, increases E) increases, stays the same

- 77) Which of the following elements is the most electronegative?

- A) S B) Ru C) Si D) Te E) Cs

Difficulty: M

- 78) Which of the following elements is the least electronegative? (Difficulty: M)

- A) Si B) Se C) S D) Sc E) Sr

- 79) Which of the following elements is the most electronegative?  
A) Ne      B) Rb      C) P      D) I      E) Cl  
Difficulty: E
- 80) Arrange aluminum, nitrogen, phosphorus, and indium in order of increasing electronegativity.  
A) Al < In < N < P      D) In < P < Al < N  
B) Al < In < P < N      E) None of the above orders is correct.  
C) In < Al < P < N  
Difficulty: M
- 81) Arrange calcium, rubidium, sulfur, and arsenic in order of decreasing electronegativity.  
A) S > As > Rb > Ca      D) As > S > Ca > Rb  
B) S > As > Ca > Rb      E) None of the above orders is correct.  
C) As > S > Rb > Ca  
Difficulty: M
- 82) Arrange oxygen, sulfur, calcium, rubidium, and potassium in order of decreasing electronegativity.  
A) O > S > Ca > K > Rb      D) O > S > Rb > Ca > K  
B) O > S > Ca > Rb > K      E) None of the above orders is correct.  
C) O > S > Rb > K > Ca  
Difficulty: E

## Lewis Structure

- 83) In a Lewis dot structure the dots represent \_\_\_\_.  
A) atomic nuclei      B) valence electrons      C) protons  
D) neutron      E) atomic mass
- 84) The total number of valence electrons in a molecule of  $\text{CCl}_4$  is \_\_\_\_.  
A) 32      B) 28      C) 36      D) 28      E) 8
- 85) The total number of valence electrons in a molecule of  $\text{ICl}_4^-$  is \_\_\_\_.  
A) 34      B) 35      C) 36      D) 28      E) 8  
Answer: C
- 86) What is the central atom for  $\text{PCl}_3$ ?  
A) P      B) Cl      C) P and Cl      D) there is no central atom





- 95) In which one of the following species is the central atom (the first atom in the formula) an exception to the octet rule?  
A)  $\text{NH}_3$     B)  $\text{NH}_4^+$     C)  $\text{I}_2$     D)  $\text{BH}_4^-$     E)  $\text{SF}_6$   
Difficulty: E
- 96) In which one of the following species is the central atom (the first atom in the formula) likely to violate the octet rule?  
A)  $\text{BF}_4^-$     B)  $\text{XeO}_3$     C)  $\text{SiCl}_4$     D)  $\text{NH}_3$     E)  $\text{CH}_2\text{Cl}_2$   
Difficulty: M
- 97) Which of the following atoms can expand its valence shell when bonding?  
A) N    B) C    C) O    D) P    E) Al  
Difficulty: M
- 98) The central Xe atom in the  $\text{XeF}_4$  molecule has \_\_\_\_\_ lone electron pairs and \_\_\_\_\_ bonded electron pairs in its valence shell.  
A) 1, 4    B) 2, 4    C) 4, 0    D) 4, 1    E) 4, 2

## Molecular Shapes

- 99) According to VSEPR theory, a molecule with the general formula  $\text{AX}_3$  will have a \_\_\_\_\_ molecular shape.  
A) linear    B) bent    C) trigonal planar    D) tetrahedral    E) trigonal pyramidal  
Difficulty: E
- 100) According to VSEPR theory, a molecule with the general formula  $\text{AX}_4$  will have a \_\_\_\_\_ molecular shape.  
A) bent    D) square planar  
B) trigonal planar    E) tetrahedral  
C) trigonal pyramidal  
Difficulty: E
- 101) According to VSEPR theory, a molecule with the general formula  $\text{AX}_5$  will have a \_\_\_\_\_ molecular shape.  
A) tetrahedral    D) trigonal bipyramidal  
B) trigonal planar    E) see-saw  
C) trigonal pyramidal  
Difficulty: E
- 102) Considering all the bonds in a molecule with trigonal bipyramidal geometry, what are the bond angles present?  
A)  $120^\circ$  only    D)  $60^\circ$  and  $90^\circ$  only  
B)  $90^\circ$  only    E)  $90^\circ$ ,  $120^\circ$ , and  $180^\circ$   
C)  $180^\circ$  only  
Difficulty: M



109) The electron group arrangement and molecular geometry of  $\text{SBr}_2$  are \_\_\_\_\_ and \_\_\_\_\_, respectively.

- A) trigonal bipyramidal, trigonal planar
- B) tetrahedral, trigonal pyramidal
- C) trigonal bipyramidal, T-shaped
- D) octahedral, trigonal planar
- E) Tetrahedral, bent shape

110) The electron group arrangement and molecular geometry of  $\text{SF}_4$  are \_\_\_\_\_ and \_\_\_\_\_, respectively.

- A) trigonal bipyramidal, see saw
- B) tetrahedral, trigonal pyramidal
- C) trigonal bipyramidal, T-shaped
- D) octahedral, trigonal planar
- E) T-shaped, trigonal planar

111) What is the molecular shape of  $\text{ClO}_3\text{F}$  as predicted by the VSEPR theory?

- A) trigonal pyramidal
  - B) square planar
  - C) square pyramidal
  - D) tetrahedral
  - E) octahedral
- Difficulty: E

112) What is the molecular shape of  $\text{HOF}$  as predicted by the VSEPR theory?

- A) trigonal pyramidal
  - B) trigonal
  - C) tetrahedral
  - D) linear
  - E) bent
- Difficulty: M

113) The molecular shape of the  $\text{PHCl}_2$  molecule is \_\_\_\_\_.

- A) bent
- B) trigonal planar
- C) trigonal pyramidal
- D) tetrahedral
- E) T-shaped

114) What is the molecular shape of  $\text{NH}_2\text{Cl}$  as predicted by the VSEPR theory?

- A) trigonal pyramidal
  - B) tetrahedral
  - C) T-shaped
  - D) see-saw
  - E) trigonal planar
- Difficulty: M

115) What is the molecular shape of  $\text{ClF}_3$  as predicted by the VSEPR theory?

- A) square planar
  - B) tetrahedral
  - C) square pyramidal
  - D) T-shaped
  - E) octahedral
- Difficulty: M

116) The central Xe atom in the  $\text{XeF}_4$  molecule has \_\_\_\_\_ lone electron pairs and \_\_\_\_\_ bonded electron pairs in its valence shell.

- A) 1, 4
- B) 2, 4
- C) 4, 0
- D) 4, 1
- E) 4, 2

117) Which one of the following molecules and ions will have a planar geometry?

- A)  $\text{PCl}_3$     B)  $\text{BF}_4^-$     C)  $\text{XeF}_4$     D)  $\text{BrF}_5$     E)  $\text{H}_3\text{O}^+$

Difficulty: H

118) Use VSEPR theory to decide which one of the following ions and molecules is likely to be planar. (The central atom is always first in the formula.)

- A)  $\text{BrF}_3$     B)  $\text{H}_3\text{O}^+$     C)  $\text{PCl}_3$     D)  $\text{SO}_4^{2-}$     E)  $\text{SF}_4$

Difficulty: H

119) Use VSEPR theory to decide which one of the following molecules and ions will have a trigonal pyramidal geometry. (The central atom is always first in the formula.)

- A)  $\text{PCl}_3$     B)  $\text{BF}_3$     C)  $\text{SO}_3$     D)  $\text{BrF}_3$     E)  $\text{CO}_3^{2-}$

Difficulty: M

120) Predict the ideal bond angles in  $\text{GeCl}_4$  using the molecular shape given by the VSEPR theory.

- A)  $90^\circ$     B)  $109.5^\circ$     C)  $120^\circ$     D)  $180^\circ$     E)  $< 90^\circ$

Difficulty: M

121) Predict the ideal bond angles in  $\text{AsCl}_3$  using the molecular shape given by the VSEPR theory.

- A)  $90^\circ$     B)  $109.5^\circ$     C)  $120^\circ$     D)  $180^\circ$     E) between  $110$  and  $120^\circ$

Difficulty: M

122) Predict the ideal bond angles in  $\text{FNO}$  using the molecular shape given by the VSEPR theory.

- A)  $90^\circ$     B)  $109.5^\circ$     C)  $120^\circ$     D)  $180^\circ$     E) between  $120$  and  $180^\circ$

Difficulty: M

## Molecular polarity

123) Which of the following molecules has a net dipole moment?

- A)  $\text{BeCl}_2$     B)  $\text{SF}_2$     C)  $\text{KrF}_2$     D)  $\text{CO}_2$     E)  $\text{CCl}_4$

Difficulty: M

124) Which one of the following molecules **does not** have a dipole moment?

- A)  $\text{CS}_2$     B)  $\text{H}_2\text{S}$     C)  $\text{CH}_2\text{Cl}_2$     D)  $\text{PH}_3$     E)  $\text{H}_2\text{O}$

Difficulty: M

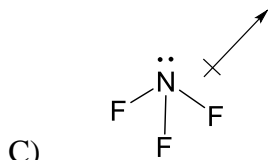
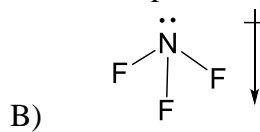
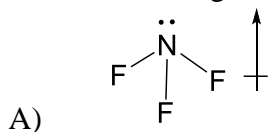
125) The molecular geometry of the  $\text{PF}_3$  molecule is \_\_\_\_\_, and this molecule is \_\_\_\_\_.

- A) trigonal planar, polar  
B) trigonal planar, nonpolar  
C) trigonal pyramidal, polar  
D) trigonal pyramidal, nonpolar  
E) tetrahedral, unipolar

126) Of the following molecules, only \_\_\_\_\_ is polar.

- A)  $\text{CCl}_4$     B)  $\text{BCl}_3$     C)  $\text{NCl}_3$     D)  $\text{BeCl}_2$     E)  $\text{Cl}_2$

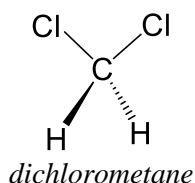
127) Which of the following shows the orientation of the net dipole for  $\text{NF}_3$ ?



D) none of these pictures is correct.

Difficulty: M

128) The structure of dichloromethane is showed below.



Which of the following shows the orientation of the net dipole for dichloromethane?



## Intermolecular force

129) Neon atoms are attracted to each other by

- |                              |                           |
|------------------------------|---------------------------|
| A) dipole-dipole forces.     | D) covalent bonding.      |
| B) London dispersion forces. | E) intramolecular forces. |
| C) hydrogen bonding.         |                           |

Difficulty: E

130) Ammonia's unusually high melting point is the result of

- |                              |                      |
|------------------------------|----------------------|
| A) dipole-dipole forces.     | D) covalent bonding. |
| B) London dispersion forces. | E) ionic bonding.    |
| C) hydrogen bonding.         |                      |

Difficulty: E

131) Methan ( $\text{CH}_4$ ) is a component of fuel used in internal combustion engines. The dominant intermolecular forces in octane are \_\_\_\_

- |                              |                           |
|------------------------------|---------------------------|
| A) dipole-dipole forces.     | D) covalent bonds.        |
| B) London dispersion forces. | E) carbon-hydrogen bonds. |
| C) hydrogen bonding.         |                           |

Difficulty: E

132) In hydrogen iodide \_\_\_\_\_ are the most important intermolecular forces.

- A) dipole-dipole forces  
B) London dispersion forces  
C) hydrogen bonding  
D) covalent bonds  
E) polar covalent bonds

Difficulty: E

133) The strongest intermolecular interactions between chloroform ( $\text{CHCl}_3$ ) molecules arise from \_\_\_\_\_

- A) dipole-dipole forces.  
B) London dispersion forces.  
C) hydrogen bonding.  
D) ion-dipole interactions.  
E) carbon-carbon bonds.

Difficulty: E

134) What types of forces exist between molecules of  $\text{CO}_2$ ?

- A) hydrogen bonding only.  
B) hydrogen bonding and dispersion forces.  
C) dipole-dipole forces only.  
D) dipole-dipole and dispersion forces.  
E) dispersion forces only.

Difficulty: E

135) The strongest intermolecular interactions between ethyl alcohol ( $\text{CH}_3\text{CH}_2\text{OH}$ ) molecules arise from

- A) dipole-dipole forces.  
B) London dispersion forces.  
C) hydrogen bonding.  
D) ion-dipole interactions.  
E) carbon-oxygen bonds.

Difficulty: E

136) The strongest intermolecular interactions between hydrogen sulfide ( $\text{H}_2\text{S}$ ) molecules arise from

- A) dipole-dipole forces.  
B) London dispersion forces.  
C) hydrogen bonding.  
D) ion-dipole interactions.  
E) disulfide linkages.

Difficulty: M

137) The strongest intermolecular interactions between hydrogen fluoride ( $\text{HF}$ ) molecules arise from

- A) dipole-dipole forces.  
B) London dispersion forces.  
C) hydrogen bonding.  
D) ion-dipole interactions.  
E) ionic bonds.

Difficulty: E

138) Which one of the following substances will have hydrogen bonds between molecules?

- A)  $(\text{CH}_3)_3\text{N}$   
B)  $\text{CH}_3\text{-O-CH}_3$   
C)  $\text{CH}_3\text{CH}_2\text{-OH}$   
D)  $\text{CH}_3\text{CH}_2\text{-F}$   
E)  $\text{HI}$

Difficulty: E

139) Arrange the following types of intermolecular forces in order of decreasing strength;

**Dipole-Dipole forces, Hydrogen Bonding, London forces, Ionic bond**

- a. Ionic bond > Hydrogen bond > Dipole-Dipole forces > London forces
- b. Ionic bond > Hydrogen bond > London forces > Dipole-Dipole forces
- c. Hydrogen bond > Ionic bond > Dipole-Dipole forces > London forces
- d. Ionic bond > Dipole-Dipole forces > Hydrogen bond > London forces

140) Which of the following should have the highest boiling point?

- A)  $\text{CF}_4$       B)  $\text{CCl}_4$       C)  $\text{CBr}_4$       D)  $\text{Cl}_4$       E)  $\text{CH}_4$

Difficulty: E

141) Which of the following should have the lowest boiling point?

- A)  $\text{C}_5\text{H}_{12}$       B)  $\text{C}_6\text{H}_{14}$       C)  $\text{C}_8\text{H}_{18}$       D)  $\text{C}_{10}\text{H}_{22}$       E)  $\text{C}_{12}\text{H}_{26}$

Difficulty: E

142) Which of the following has a boiling point which does not fit the general trend?

- A)  $\text{NH}_3$       B)  $\text{PH}_3$       C)  $\text{AsH}_3$       D)  $\text{SbH}_3$       E)  $\text{BiH}_3$

Difficulty: M

143) Arrange the following in order of decreasing boiling point;  $\text{F}_2$ ,  $\text{HF}$ ,  $\text{CaF}_2$

- A)  $\text{F}_2 > \text{HF} > \text{CaF}_2$       B)  $\text{F}_2 > \text{CaF}_2 > \text{HF}$       C)  $\text{CaF}_2 > \text{HF} > \text{F}_2$   
D)  $\text{HF} > \text{CaF}_2 > \text{F}_2$       E)  $\text{CaF}_2 > \text{F}_2 > \text{HF}$

144) Arrange the following in order of decreasing boiling point;

$\text{SiO}_2$ ,  $\text{CO}_2$ , Ar,  $\text{SCl}_2$

- A)  $\text{SiO}_2 > \text{CO}_2 > \text{SCl}_2 > \text{Ar}$
- B)  $\text{Ar} > \text{SCl}_2 > \text{CO}_2 > \text{SiO}_2$
- C)  $\text{SiO}_2 > \text{CO}_2 > \text{Ar} > \text{SCl}_2$
- D)  $\text{SiO}_2 > \text{SCl}_2 > \text{CO}_2 > \text{Ar}$
- E) None of these