

117 Practice Problems – Chapter 13 – Chem1C

- Which of the following statements is *incorrect*?
  - Ionic bonding results from the transfer of electrons from one atom to another.
  - Dipole moments result from the unequal distribution of electrons in a molecule.
  - The electrons in a polar bond are found nearer to the more electronegative element.
  - A molecule with very polar bonds can be nonpolar.
  - Linear molecules cannot have a net dipole moment.
- The electron pair in a C-F bond could be considered
  - closer to C because carbon has a larger radius and thus exerts greater control over the shared electron pair.
  - closer to F because fluorine has a higher electronegativity than carbon.
  - closer to C because carbon has a lower electronegativity than fluorine.
  - an inadequate model because the bond is ionic.
  - centrally located directly between the C and F.
- Which of the following shows these molecules in order from most polar to least polar?
  - $\text{CH}_4 > \text{CF}_2\text{Cl}_2 > \text{CF}_2\text{H}_2 > \text{CCl}_4 > \text{CCl}_2\text{H}_2$
  - $\text{CH}_4 > \text{CF}_2\text{H}_2 > \text{CF}_2\text{Cl}_2 > \text{CCl}_4 > \text{CCl}_2\text{H}_2$
  - $\text{CF}_2\text{Cl}_2 > \text{CF}_2\text{H}_2 > \text{CCl}_2\text{H}_2 > \text{CH}_4 = \text{CCl}_4$
  - $\text{CF}_2\text{H}_2 > \text{CCl}_2\text{H}_2 > \text{CF}_2\text{Cl}_2 > \text{CH}_4 = \text{CCl}_4$
  - $\text{CF}_2\text{Cl}_2 > \text{CF}_2\text{H}_2 > \text{CCl}_4 > \text{CCl}_2\text{H}_2 > \text{CH}_4$
- In the gaseous phase, which of the following diatomic molecules would be the most polar?
  - CsF
  - CsCl
  - NaCl
  - NaF
  - LiF
- Atoms having greatly differing electronegativities are expected to form
  - no bonds.
  - polar covalent bonds.
  - nonpolar covalent bonds.
  - ionic bonds.
  - covalent bonds.
- Which of the following bonds is the least polar?
  - H-F
  - H-N
  - H-O
  - H-C
  - All are the same.
- Which compound does *not* contain both polar covalent and ionic bonds?
  - $\text{C}_2\text{H}_5\text{OH}$
  - NaOH
  - $\text{NH}_4\text{ClO}_3$
  - $\text{RbC}_2\text{H}_3\text{O}_2$
  - $\text{Ca}(\text{CN})_2$
- In which case is the bond polarity *incorrect*?
  - $\delta^+ \text{H}-\text{F} \delta^-$
  - $\delta^+ \text{Na}-\text{O} \delta^-$
  - $\delta^+ \text{Mg}-\text{H} \delta^-$
  - $\delta^+ \text{Cl}-\text{Br} \delta^-$
  - $\delta^+ \text{C}-\text{O} \delta^-$
- What of the following shows the bonds in order of decreasing polarity?
  - N-Cl, P-Cl, As-Cl
  - P-Cl, N-Cl, As-Cl

- C) As-Cl, N-Cl, P-Cl  
D) P-Cl, As-Cl, N-Cl  
E) As-Cl, P-Cl, N-Cl
10. Which of the following is nonpolar?  
A)  $\text{Cl}_2\text{O}$   
B)  $\text{CS}_2$   
C)  $\text{SF}_4$   
D)  $\text{NCl}_3$   
E)  $\text{IF}_3$
11. Which of the following is polar?  
A)  $\text{SiF}_4$   
B)  $\text{XeF}_2$   
C)  $\text{BCl}_3$   
D)  $\text{NBr}_3$   
E)  $\text{SBr}_6$
12. Which statement is correct?  
A)  $\text{H}_2\text{O}$  is linear.  
B) The molecule  $\text{ClO}_2$  cannot be accurately described by a Lewis structure consistent with the octet rule.  
C) The diatomic molecule  $\text{Cl}_2$  is an example of a polar molecule.  
D) The bonds in  $\text{LiF}$  have a more covalent character than those in  $\text{F}_2$ .  
E) none of these
13. Which of the following molecules does *not* have a dipole moment?  
A)  $\text{H}_2\text{S}$   
B)  $\text{H}_2\text{O}$   
C)  $\text{H}_2\text{Xe}$   
D) All of these have a dipole moment.  
E) None of these has a dipole moment.
14. Which of the following molecules has a nonzero dipole moment?  
A)  $\text{CCl}_4$   
B)  $\text{SiF}_4$   
C)  $\text{CS}_2$   
D)  $\text{SO}_3$   
E)  $\text{PBr}_3$
15. Which of the following molecules has a dipole moment?  
A)  $\text{CF}_4$   
B)  $\text{SF}_4$   
C)  $\text{XeF}_4$   
D) All of these have a dipole moment.  
E) None of these has a dipole moment.
16. Which of the following molecules has a dipole moment?  
A)  $\text{SCl}_6$   
B)  $\text{BH}_3$   
C)  $\text{CO}_2$   
D)  $\text{OF}_2$   
E) None of these has a dipole moment.
17. Which of the following molecules has a dipole moment?  
A)  $\text{BCl}_3$   
B)  $\text{SiCl}_4$   
C)  $\text{PCl}_3$   
D)  $\text{Cl}_2$   
E) none of these
18. Which of the following molecules has a zero dipole moment?  
A)  $\text{XeF}_2$   
B)  $\text{NCl}_3$

- C)  $\text{H}_2\text{O}$
- D)  $\text{SCl}_4$
- E)  $\text{ICl}_3$

Use the following to answer question 19:

Consider the following molecules.

- I.  $\text{BF}_3$  II.  $\text{CHBr}_3$  III.  $\text{Br}_2$  IV.  $\text{XeCl}_2$  V.  $\text{CO}$  VI.  $\text{SF}_4$

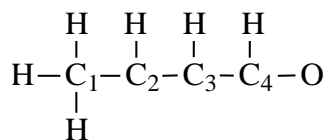
Select the molecule(s) that fit the given statement.

19. These molecules have a zero net dipole moment.
- III, V
  - I, III, IV
  - III, IV, V
  - I, III, IV, VI
  - none of them
20. Which of the following has a zero dipole moment?
- NH<sub>3</sub>
  - NO<sub>2</sub>
  - PF<sub>5</sub>
  - SO<sub>2</sub>
  - HCN
21. Choose the statement that best describes the PbCl<sub>4</sub> molecule in the gas phase.
- The bond angles are all about 109°.
  - The molecule is polar.
  - The molecule has a dipole moment.
  - The bonds are nonpolar.
  - The molecule is polar with bond angles of about 109°.
22. As the number of bonds between two carbon atoms increases, which one of the following decreases?
- the number of electrons between the carbon atoms
  - the bond energy
  - the bond length
  - all of these
  - none of these
23. Choose the molecule with the strongest bond.
- F<sub>2</sub>
  - Cl<sub>2</sub>
  - Br<sub>2</sub>
  - I<sub>2</sub>
24. Choose the molecule with the strongest bond.
- HF
  - HCl
  - HBr
  - HI
25. Choose the molecule with the strongest bond.
- CH<sub>4</sub>
  - H<sub>2</sub>O
  - NH<sub>3</sub>
  - HF
26. Which of the following molecules exhibits the greatest bond energy?
- F<sub>2</sub>
  - Cl<sub>2</sub>
  - Br<sub>2</sub>
  - I<sub>2</sub>
  - all the same
27. Which of the following molecules and ions has a lone pair of electrons on the central atom?
- CH<sub>3</sub><sup>+</sup>
  - XeO<sub>4</sub>
  - BeCl<sub>2</sub>
  - CH<sub>3</sub><sup>-</sup>
  - PCl<sub>5</sub>
28. This molecule shows the smallest number of lone pairs in its Lewis structure.
- CH<sub>3</sub>CHO
  - CO<sub>2</sub>

- C)  $\text{CH}_3\text{Cl}$   
 D)  $\text{C}_2\text{H}_6$   
 E) none of these
29. Which of the following molecules contains a double bond?  
 A)  $\text{CO}_2$   
 B)  $\text{NH}_3$   
 C)  $\text{H}_2\text{O}$   
 D) all  
 E) none
30. Which of the following compounds contains only one unshared pair of valence electrons?  
 A)  $\text{NH}_3$   
 B)  $\text{H}_2\text{O}$   
 C)  $\text{CH}_4$   
 D)  $\text{NaCl}$   
 E)  $\text{BeF}_3$
31. What does X represent in the Lewis structure  $\text{X}=\text{X}$ ?  
 A) O  
 B) C  
 C) N  
 D) F  
 E) B
32. In the Lewis structure for elemental nitrogen, there is(are)  
 A) a single bond between the nitrogens.  
 B) a double bond between the nitrogens.  
 C) a triple bond between the nitrogens.  
 D) three unpaired electrons.  
 E) none of these

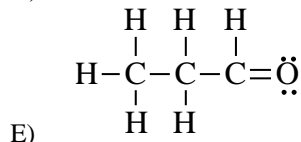
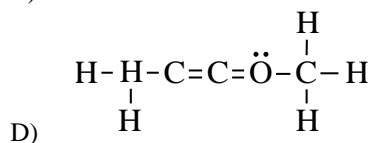
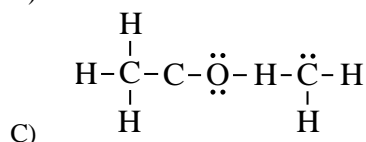
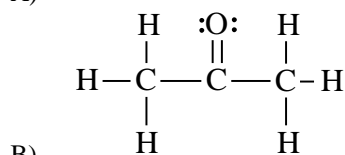
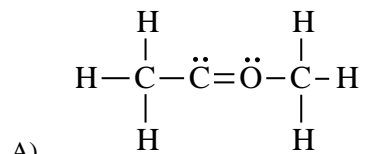
Use the following to answer questions 33-34:

Consider the compound, whose skeleton is



33. How many electrons must be shown in the Lewis structure of this molecule?  
 A) 12      B) 18      C) 24      D) 28      E) 32

34. How many nonbonding electrons appear in the Lewis structure of this molecule?
- A) 2  
B) 4  
C) 6  
D) 8  
E) 10
35. As indicated by Lewis structures, which of the following would probably *not* exist as a stable molecule?
- A) CH<sub>3</sub>OH  
B) CH<sub>2</sub>O  
C) CH<sub>3</sub>O  
D) C<sub>2</sub>H<sub>2</sub>  
E) C<sub>3</sub>H<sub>4</sub>
36. For which of the following can we *not* draw a stable Lewis structure?
- A) PCl<sub>5</sub>  
B) OCl<sub>6</sub>  
C) SCl<sub>6</sub>  
D) All of these have stable Lewis structures.  
E) None of these has a stable Lewis structure.
37. Select the best Lewis structure for acetone, CH<sub>3</sub>COCH<sub>3</sub>.



Use the following to answer question 38:

Draw the Lewis structures of the molecules below, and use them to answer the following questions.

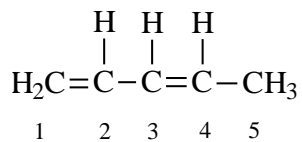
- I. BH<sub>3</sub>  
II. NO<sub>2</sub>  
III. SF<sub>6</sub>  
IV. O<sub>3</sub>  
V. PCl<sub>5</sub>

38. Which of the molecules obeys the octet rule?

- A) I
- B) II
- C) III
- D) IV
- E) V

Use the following to answer questions 39-40:

Given the following Lewis structure:



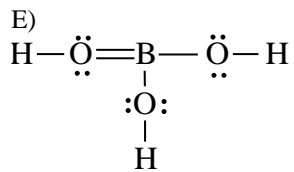
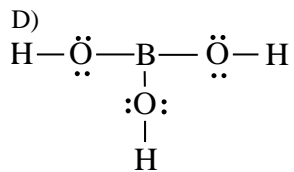
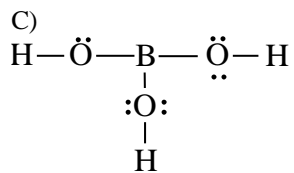
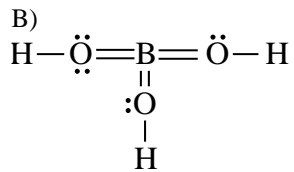
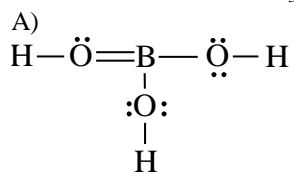
39. How many unshared pairs of electrons are present in this molecule?

- A) 0
- B) 1
- C) 2
- D) 3
- E) 4

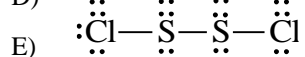
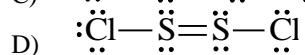
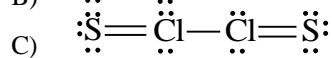
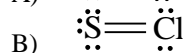
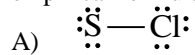
40. How many electrons are shared between carbons 1 and 2?

- A) 0
- B) 2
- C) 4
- D) 6
- E) 8

41. The Lewis structure for  $\text{H}_3\text{BO}_3$  is

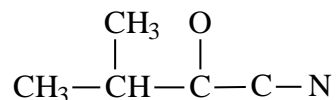


42. When molten sulfur reacts with chlorine gas, a vile-smelling orange liquid forms that is found to have the empirical formula  $\text{SCl}$ . Which of the following could be the correct Lewis structure for this compound?





43. Complete the Lewis structure for the molecule



- This molecule has \_\_\_\_\_ single bonds and \_\_\_\_\_ multiple bonds.
- A) 4, 2  
B) 6, 3  
C) 11, 5  
D) 11, 2  
E) 13, 0
44. As indicated by Lewis structures, which of the following species could probably *not* exist as a stable molecule?  
A)  $\text{NH}_3$   
B)  $\text{N}_2\text{H}_2$   
C)  $\text{N}_2\text{H}_4$   
D)  $\text{N}_2\text{H}_6$   
E)  $\text{N}_2\text{O}_4$
45. How many electrons are in the Lewis structure for  $\text{SO}_2$ ?  
A) 16  
B) 30  
C) 18  
D) 20  
E) 32
46. How many of the following molecules and ions contain double or triple bonds?  
 $\text{N}_2$      $\text{H}_2\text{CO}$      $\text{C}_2\text{H}_4$      $\text{C}_2\text{H}_6$      $\text{SCN}^-$
- A) 1  
B) 2  
C) 3  
D) 4  
E) 5
47. In the Lewis structure for  $\text{I}_3^-$ , there are \_\_\_\_\_ electrons around the central iodine atom.  
A) 4  
B) 8  
C) 10  
D) 12  
E) none of these
48. Which species has an unpaired electron?  
A)  $\text{N}_2$   
B)  $\text{CO}$   
C)  $\text{NO}$   
D)  $\text{OH}^-$   
E) none of these
49. How many of the following exhibit resonance?  
 $\text{O}_3$      $\text{OCl}_2$      $\text{NF}_3$      $\text{CCl}_4$
- A) 0  
B) 1  
C) 2  
D) 3  
E) 4

50. For which compound is resonance required to describe the structure adequately?

- A)  $\text{PCl}_3$
- B)  $\text{CO}_3^{2-}$
- C)  $\text{HCN}$
- D)  $\text{NH}_4^+$
- E) none of these

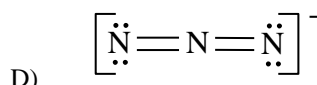
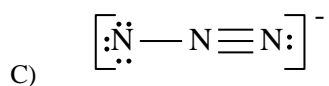
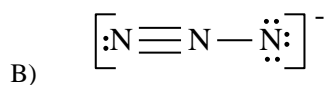
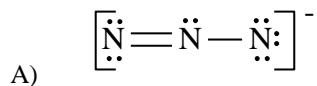
51. How many resonance structures does the molecule  $\text{SO}_2$  have?

- A) 0
- B) 1
- C) 2
- D) 3
- E) 4

52. Which molecule or ion violates the octet rule?

- A)  $\text{H}_2\text{O}$
- B)  $\text{NO}_3^-$
- C)  $\text{PF}_3$
- D)  $\text{I}_3^-$
- E) none of these

53. Which of the following is *not* a valid resonance structure for  $\text{N}_3^-$ ?



- E) All are valid.

54. How many acceptable and equivalent resonance structures can be drawn for  $\text{NO}_3^-$ ?

- A) 0
- B) 1
- C) 2
- D) 3
- E) 4

Use the following to answer question 55:

Draw the Lewis structures of the molecules below, and use them to answer the following questions.

- I.  $\text{BH}_3$
- II.  $\text{NO}_2$
- III.  $\text{SF}_6$
- IV.  $\text{O}_3$
- V.  $\text{PCl}_5$

55. Which of these molecules show resonance?
- I, II
  - II, IV
  - II, V
  - III, IV
  - III, V
56. Which of the following has an incomplete octet in its Lewis structure?
- SO<sub>2</sub>
  - ICl
  - SF<sub>2</sub>
  - F<sub>2</sub>
  - NO
57. In the Lewis structure for SF<sub>6</sub>, the central sulfur atom shares \_\_\_\_\_ electrons.
- 4
  - 8
  - 10
  - 12
  - none of the above, because SF<sub>6</sub> is an ionic compound
58. Choose the electron dot formula that most accurately describes the bonding in CS<sub>2</sub>. (*Hint: Consider formal charges.*)
- $\text{:}\ddot{\text{S}}=\text{C}=\ddot{\text{S}}\text{:}$
  - $\text{:}\ddot{\text{C}}=\text{S}=\ddot{\text{S}}\text{:}$
  - $\text{:}\ddot{\text{S}}-\text{C}-\ddot{\text{S}}\text{:}$
  - $\text{:}\ddot{\text{S}}-\ddot{\text{C}}=\ddot{\text{S}}\text{:}$
  - $\text{:}\ddot{\text{S}}-\text{C}\equiv\text{S}\text{:}$

Use the following to answer question 59:

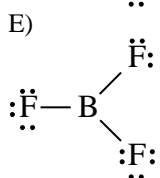
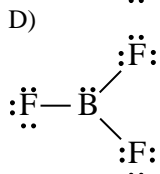
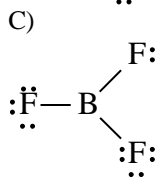
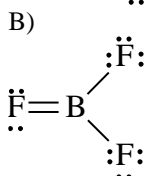
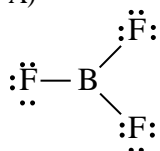
Consider the following molecules.

- BF<sub>3</sub>
- CHBr<sub>3</sub> (C is the central atom.)
- Br<sub>2</sub>
- XeCl<sub>2</sub>
- CO
- SF<sub>4</sub>

Select the molecule(s) that fit the given statement.

59. These molecules violate the octet rule.
- I, II, IV
  - I, III, IV, VI
  - III, V, VI
  - I, IV, VI
  - I, II, IV, VI

60. Which molecule or ion violates the octet rule?
- A)  $\text{CH}_4$   
 B)  $\text{I}_3^-$   
 C)  $\text{NO}_3^-$   
 D)  $\text{CO}_2$   
 E)  $\text{SO}_3$
61. The molecule  $\text{XCl}_5^-$  has a square pyramidal shape. Which of the following atoms could be X?
- A) O  
 B) P  
 C) Xe  
 D) S  
 E) At least two of these atoms could be X.
62. How many Lewis structures does  $\text{CO}_3^{2-}$  have?
- A) 1  
 B) 2  
 C) 3  
 D) 4  
 E) 5
63. Which of the following has the Lewis structure most like that of  $\text{CO}_3^{2-}$ ?
- A)  $\text{CO}_2$   
 B)  $\text{SO}_3^{2-}$   
 C)  $\text{NO}_3^-$   
 D)  $\text{O}_3$   
 E)  $\text{NO}_2$
64. Which of the following Lewis structures best describes  $\text{BF}_3$ ?



65. The Cl–Kr–Cl bond angle in KrCl<sub>4</sub> is closest to  
 A) 90°.  
 B) 109°.  
 C) 120°.  
 D) 150°.  
 E) 360°
66. Of the following, which molecule has the largest bond angle?  
 A) SO<sub>3</sub>  
 B) SF<sub>2</sub>  
 C) HCN  
 D) H<sub>2</sub>S  
 E) PF<sub>3</sub>
67. Which of the following statements about the species N<sub>2</sub>, CO, CN<sup>-</sup> and NO<sup>+</sup> is *false*?  
 A) All are isoelectronic.  
 B) Each contains a triple bond.  
 C) All are linear.  
 D) The bond in each species is polar.
68. This molecule contains a carbon atom with trigonal planar geometry.  
 A) CH<sub>3</sub>CHO  
 B) CO<sub>2</sub>  
 C) CH<sub>3</sub>Cl  
 D) C<sub>2</sub>H<sub>6</sub>  
 E) none of these

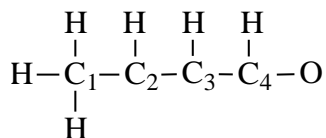
Use the following to answer question 69:

Draw the Lewis structures of the molecules below, and use them to answer the following questions.

- I. BH<sub>3</sub>  
 II. NO<sub>2</sub>  
 III. SF<sub>6</sub>  
 IV. O<sub>3</sub>  
 V. PCl<sub>5</sub>

69. How many of the molecules have no dipole moment?  
 A) 1  
 B) 2  
 C) 3  
 D) 4  
 E) They are all polar.

70. Consider the compound, whose skeleton is



Which carbon in this molecule has tetrahedral bonding?

- A) 1
- B) 2
- C) 3
- D) 4
- E) All have tetrahedral bonding.

71. Select the correct molecular structure for SF<sub>4</sub>.

- A) linear
- B) bent
- C) square pyramid
- D) tetrahedral
- E) none of these

72. Select the correct molecular structure for I<sub>3</sub><sup>-</sup>.

- A) linear
- B) bent
- C) trigonal pyramidal
- D) tetrahedral
- E) none of these

73. Select the correct molecular structure for NH<sub>3</sub>.

- A) linear
- B) bent
- C) trigonal pyramidal
- D) tetrahedral
- E) none of these

74. Select the correct molecular structure for XeF<sub>4</sub>.

- A) linear
- B) bent
- C) square pyramid
- D) tetrahedral
- E) none of these

75. Select the correct molecular structure for SO<sub>2</sub>.

- A) linear
- B) bent
- C) trigonal pyramidal
- D) tetrahedral
- E) none of these

76. How many of the following molecules and ions are linear?

NCl<sub>3</sub>    NH<sub>4</sub><sup>+</sup>    SCN<sup>-</sup>    CO<sub>2</sub>    NO<sub>2</sub><sup>-</sup>

- A) 0
- B) 1
- C) 2
- D) 3
- E) 4

77. The bond angles about the carbon atom in the formaldehyde molecule,  $\text{H}_2\text{C} = \text{O}$ , are about
- A)  $120^\circ$ .
  - B)  $60^\circ$ .
  - C)  $109^\circ$ .
  - D)  $180^\circ$ .
  - E)  $90^\circ$ .
78. What type of structure does the  $\text{XeOF}_2$  molecule have?
- A) trigonal pyramidal
  - B) tetrahedral
  - C) T-shaped
  - D) trigonal planar
  - E) octahedral
79. Which ion is planar?
- A)  $\text{PF}_4^+$
  - B)  $\text{CO}_3^{2-}$
  - C)  $\text{SO}_3^{2-}$
  - D)  $\text{ClO}_4^-$
  - E)  $\text{SCl}_5^-$
80. Select the correct molecular structure for  $\text{NO}_3^-$ .
- A) trigonal pyramidal
  - B) tetrahedral
  - C) square planar
  - D) octahedral
  - E) none of these
81. Select the correct molecular structure for  $\text{IF}_6^+$ .
- A) square pyramid
  - B) tetrahedral
  - C) square planar
  - D) octahedral
  - E) none of these
82. Select the correct molecular structure for  $\text{SF}_5^+$ .
- A) square pyramid
  - B) tetrahedral
  - C) square planar
  - D) octahedral
  - E) none of these
83. Select the correct molecular structure for  $\text{IF}_5$ .
- A) square pyramid
  - B) tetrahedral
  - C) square planar
  - D) octahedral
  - E) none of these
84. Select the correct molecular structure for  $\text{XeCl}_4$ .
- A) square pyramid
  - B) tetrahedral
  - C) square planar
  - D) octahedral
  - E) none of these
85. Select the correct molecular structure for  $\text{PF}_3$ .
- A) trigonal pyramidal
  - B) tetrahedral
  - C) square planar
  - D) octahedral
  - E) none of these

86. Select the correct molecular structure for  $\text{PO}_4^{3-}$ .
- trigonal pyramidal
  - tetrahedral
  - square planar
  - octahedral
  - none of these
87. Select the correct molecular structure for  $\text{PO}_3^{3-}$ .
- trigonal pyramidal
  - tetrahedral
  - square planar
  - octahedral
  - none of these
88. What is the shape of the  $\text{ICl}_5$  molecule?
- square pyramid
  - trigonal bi-pyramid
  - octahedral
  - see-saw
  - none of these
89. How many of the following molecules have all of their atoms in the same plane?  
 $\text{H}_2\text{C} = \text{CH}_2$   $\text{F}_2\text{O}$   $\text{H}_2\text{CO}$   $\text{NH}_3$   $\text{CO}_2$   $\text{BeCl}_2$   $\text{H}_2\text{O}_2$
- 3
  - 4
  - 5
  - 6
  - 7

1.	E	11.	D	21.	A	31.	A	41.	C	51.	C	61.	D	71.	E	81.	D
2.	B	12.	B	22.	C	32.	C	42.	E	52.	D	62.	C	72.	A	82.	E
3.	D	13.	C	23.	A	33.	D	43.	D	53.	A	63.	C	73.	C	83.	A
4.	A	14.	E	24.	A	34.	B	44.	D	54.	D	64.	A	74.	E	84.	C
5.	D	15.	B	25.	D	35.	C	45.	C	55.	B	65.	A	75.	B	85.	A
6.	D	16.	D	26.	A	36.	B	46.	D	56.	E	66.	C	76.	C	86.	B
7.	A	17.	C	27.	D	37.	B	47.	C	57.	D	67.	D	77.	A	87.	A
8.	D	18.	A	28.	D	38.	D	48.	C	58.	A	68.	A	78.	C	88.	A
9.	E	19.	B	29.	A	39.	A	49.	B	59.	D	69.	C	79.	B	89.	C
10.	B	20.	C	30.	A	40.	C	50.	B	60.	B	70.	A	80.	E		