

**Chemistry: A Molecular Approach, 3e (Tro)**  
**Chapter 9 Chemical Bonding I: Lewis Theory**

Multiple Choice Questions

1) Which of the following statements is TRUE?

- A) A covalent bond is formed through the transfer of electrons from one atom to another.
- B) A pair of electrons involved in a covalent bond are sometimes referred to as "lone pairs."
- C) It is not possible for two atoms to share more than two electrons.
- D) Single bonds are shorter than double bonds.
- E) A covalent bond has a lower potential energy than the two separate atoms.

Answer: E

Diff: 2 Page Ref: 9.2

2) Which of the following represent the Lewis structure for N?

- A)  $\cdot\ddot{\text{N}}:$
- B)  $:\ddot{\text{N}}:$
- C)  $\text{N}:$
- D)  $\cdot\text{N}:$
- E)  $\text{N}\cdot$

Answer: A

Diff: 1 Page Ref: 9.3

3) Which of the following represent the Lewis structure for Cl?

- A)  $:\ddot{\text{Cl}}:$
- B)  $:\ddot{\text{Cl}}:$
- C)  $\text{Cl}\cdot$
- D)  $\cdot\ddot{\text{Cl}}:$
- E)  $\cdot\ddot{\text{Cl}}:$

Answer: B

Diff: 1 Page Ref: 9.3

4) Which of the following represent the Lewis structure for Mg?

- A)  $\text{Mg}\cdot$
- B)  $\text{Mg}$
- C)  $\text{Mg}:$
- D)  $:\ddot{\text{Mg}}:$
- E)  $\text{Mg}:$

Answer: C

Diff: 1 Page Ref: 9.3

5) Which of the following represent the Lewis structure for  $\text{Br}^-$ ?

- A)  $\text{Br}^-$
- B)  $\text{Br}^-$
- C)  $\text{Br}^-$
- D)  $\text{Br}^-$
- E)  $\text{Br}^-$

Answer: D

Diff: 1 Page Ref: 9.4

6) Which of the following represent the Lewis structure for  $\text{Ca}^{2+}$ ?

- A)  $\text{Ca}^{2+}$
- B)  $\text{Ca}$
- C)  $\text{Ca}^{2+}$
- D)  $\text{Ca}^{2+}$
- E)  $\text{Ca}^{2+}$

Answer: E

Diff: 1 Page Ref: 9.4

7) Which of the following represent the Lewis structure for  $\text{S}^{2-}$ ?

- A)  $\text{S}^{2-}$
- B)  $\text{S}^{2-}$
- C)  $\text{S}^{2-}$
- D)  $\text{S}^{2-}$
- E)  $\text{S}^{2-}$

Answer: A

Diff: 1 Page Ref: 9.4

8) Give the complete electronic configuration for  $\text{Br}^-$ .

- A)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^6$
- B)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^{10} 4p^6$
- C)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$
- D)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$
- E)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$

Answer: C

Diff: 3 Page Ref: 9.4

9) Give the complete electronic configuration for  $\text{Ca}^{2+}$ .

- A)  $1s^2 2s^2 2p^6 3s^2 4p^6$
- B)  $1s^2 2s^2 2p^6 3s^2 3p^6$
- C)  $1s^2 2s^2 2p^6 3s^2 3p^5$
- D)  $1s^2 2s^2 3p^6 4s^2 5p^6$
- E)  $1s^2 2s^2 2p^6 3s^2 3p^6$

Answer: B

Diff: 3 Page Ref: 9.4

10) Give the complete electronic configuration for  $\text{S}^{2-}$ .

- A)  $1s^2 2s^2 2p^6 3s^2 4p^6$
- B)  $1s^2 2s^2 2p^6 3s^2 3p^6$
- C)  $1s^2 2s^2 2p^6 3s^2 3p^5$
- D)  $1s^2 2s^2 3p^6 4s^2 5p^6$
- E)  $1s^2 2s^2 2p^6 3s^2 2p^6$

Answer: B

Diff: 3 Page Ref: 9.4

11) Which of the following statements is TRUE?

- A) An ionic bond is much stronger than most covalent bonds.
- B) An ionic bond is formed through the sharing of electrons.
- C) Ionic compounds at room temperature typically conduct electricity.
- D) Once dissolved in water, ionic compounds rarely conduct electricity.
- E) None of the above are true.

Answer: A

Diff: 1 Page Ref: 9.4

12) Use Lewis theory to determine the chemical formula for the compound formed between Al and O.

- A)  $Al_3O_2$
- B)  $Al_2O_3$
- C)  $AlO_2$
- D)  $Al_2O$
- E)  $AlO$

Answer: B

Diff: 2 Page Ref: 9.4

13) Which of the following reactions is associated with the lattice energy of  $Li_2O$  ( $\Delta H^\circ_{latt}$ )?

- A)  $Li_2O(s) \rightarrow 2 Li^+(g) + O^{2-}(g)$
- B)  $2 Li^+(aq) + O^{2-}(aq) \rightarrow Li_2O(s)$
- C)  $2 Li^+(g) + O^{2-}(g) \rightarrow Li_2O(s)$
- D)  $Li_2O(s) \rightarrow 2 Li^+(aq) + O^{2-}(aq)$
- E)  $2 Li(s) + \frac{1}{2} O_2(g) \rightarrow Li_2O(s)$

Answer: C

Diff: 2 Page Ref: 9.4

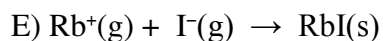
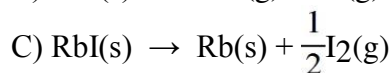
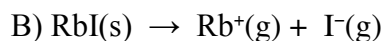
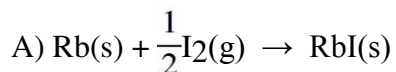
14) Which of the following reactions is associated with the lattice energy of  $CaS$  ( $\Delta H^\circ_{latt}$ )?

- A)  $Ca(s) + S(s) \rightarrow CaS(s)$
- B)  $CaS(s) \rightarrow Ca(s) + S(s)$
- C)  $Ca^{2+}(aq) + S^{2-}(aq) \rightarrow CaS(s)$
- D)  $Ca^{2+}(g) + S^{2-}(g) \rightarrow CaS(s)$
- E)  $CaS(s) \rightarrow Ca^{2+}(aq) + S^{2-}(aq)$

Answer: D

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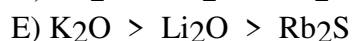
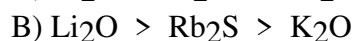
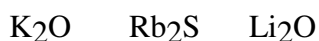
15) Which of the following reactions is associated with the lattice energy of  $RbI$  ( $\Delta H^\circ_{latt}$ )?



Answer: E

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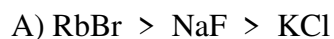
16) Place the following in order of **decreasing** magnitude of lattice energy.



Answer: A

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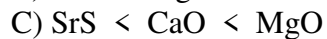
17) Place the following in order of **decreasing** magnitude of lattice energy.



Answer: B

Diff: 2 Page Ref: 9.4

18) Place the following in order of **increasing** magnitude of lattice energy.



Answer: C

Diff: 2 Page Ref: 9.4

19) Use the data given below to construct a Born-Haber cycle to determine the lattice energy of CaO.

	<u>DH°(kJ)</u>
Ca(s) → Ca(g)	193
Ca(g) → Ca <sup>+</sup> (g) + e <sup>-</sup>	590
Ca <sup>+</sup> (g) → Ca <sup>2+</sup> (g) + e <sup>-</sup>	1010
2 O(g) → O <sub>2</sub> (g)	-498
O(g) + e <sup>-</sup> → O <sup>-</sup> (g)	-141
O <sup>-</sup> (g) + e <sup>-</sup> → O <sup>2-</sup> (g)	878
Ca(s) + $\frac{1}{2}$ O <sub>2</sub> (g) → CaO(s)	-635

- A) -3414 kJ
- B) +1397 kJ
- C) -2667 kJ
- D) +3028 kJ
- E) -2144 kJ

Answer: A

Diff: 3 Page Ref: 9.4

20) Use the data given below to construct a Born-Haber cycle to determine the electron affinity of Br.

	<u>DH°(kJ)</u>
K(s) → K(g)	89
K(g) → K <sup>+</sup> (g) + e <sup>-</sup>	419
Br <sub>2</sub> (l) → 2 Br(g)	193
K(s) + $\frac{1}{2}$ Br <sub>2</sub> (g) → KBr(s)	-394
KBr(s) → K <sup>+</sup> (g) + Br <sup>-</sup> (g)	674

- A) -885 kJ
- B) -325 kJ
- C) +367 kJ
- D) -464 kJ
- E) +246 kJ

Answer: B

Diff: 3 Page Ref: 9.4

21) Use the data given below to construct a Born-Haber cycle to determine the heat of formation of KCl.

	<u>DH°(kJ)</u>
$\text{K(s)} \rightarrow \text{K(g)}$	89
$\text{K(g)} \rightarrow \text{K}^+(\text{g}) + \text{e}^-$	418
$\text{Cl}_2(\text{g}) \rightarrow 2 \text{Cl}(\text{g})$	244
$\text{Cl}(\text{g}) + \text{e}^- \rightarrow \text{Cl}^-(\text{g})$	-349
$\text{KCl(s)} \rightarrow \text{K}^+(\text{g}) + \text{Cl}^-(\text{g})$	717

A) -1119 kJ

B) -997 kJ

C) -437 kJ

D) +631 kJ

E) +158 kJ

Answer: C

Diff: 3 Page Ref: 9.4

22) Use the data given below to construct a Born-Haber cycle to determine the bond energy of O<sub>2</sub>.

	<u>DH°(kJ)</u>
$\text{Na(s)} \rightarrow \text{Na(g)}$	107
$\text{Na(g)} \rightarrow \text{Na}^+(\text{g}) + \text{e}^-$	496
$\text{O(g)} + \text{e}^- \rightarrow \text{O}^-(\text{g})$	-141
$\text{O}^-(\text{g}) + \text{e}^- \rightarrow \text{O}^{2-}(\text{g})$	878
$2 \text{Na(s)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{Na}_2\text{O(s)}$	-416
$2 \text{Na}^+(\text{g}) + \text{O}^{2-}(\text{g}) \rightarrow \text{Na}_2\text{O(s)}$	-2608

A) 426 kJ

B) 249 kJ

C) 852 kJ

D) 498 kJ

E) 356 kJ

Answer: D

Diff: 3 Page Ref: 9.4

23) Use the data given below to construct a Born-Haber cycle to determine the second ionization energy of Ca.

	<u>DH°(kJ)</u>
Ca(s) → Ca(g)	193
Ca(g) → Ca <sup>+</sup> (g) + e <sup>-</sup>	590.
2 O(g) → O <sub>2</sub> (g)	-498
O(g) + e <sup>-</sup> → O <sup>-</sup> (g)	-141
O <sup>-</sup> (g) + e <sup>-</sup> → O <sup>2-</sup> (g)	878
Ca(s) + $\frac{1}{2}$ O <sub>2</sub> (g) → CaO(s)	-635
Ca <sup>2+</sup> (g) + O <sup>2-</sup> (g) → CaO(s)	-3414

- A) 1010 kJ
- B) 1757 kJ
- C) 1508 kJ
- D) -3027 kJ
- E) -1514 kJ

Answer: A

Diff: 3 Page Ref: 9.4

24) A single covalent bond contains \_\_\_\_\_ of electrons.

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

Answer: B

Diff: 1 Page Ref: 9.5

25) A double covalent bond contains \_\_\_\_\_ of electrons.

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

Answer: C

Diff: 1 Page Ref: 9.5

26) A triple covalent bond contains \_\_\_\_\_ of electrons.

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

Answer: D

Diff: 1 Page Ref: 9.5

27) Identify the shortest bond.

- A) single covalent bond
- B) double covalent bond
- C) triple covalent bond
- D) all of the above bonds are the same length

Answer: C

Diff: 1 Page Ref: 9.5

28) Identify the weakest bond.

- A) single covalent bond
- B) double covalent bond
- C) triple covalent bond
- D) all of the above bonds are the same strength

Answer: A

Diff: 1 Page Ref: 9.5

29) Identify the strongest bond.

- A) single covalent bond
- B) double covalent bond
- C) triple covalent bond
- D) all of the above bonds are the same strength

Answer: C

Diff: 1 Page Ref: 9.5

30) Identify the number of bonding pairs and lone pairs of electrons in water.

- A) 1 bonding pair and 1 lone pair
- B) 1 bonding pair and 2 lone pairs
- C) 2 bonding pairs and 2 lone pairs
- D) 2 bonding pairs and 1 lone pair
- E) 3 bonding pairs and 2 lone pairs

Answer: C

Diff: 1 Page Ref: 9.5

31) Identify the compound with the largest dipole moment in the gas phase.

- A)  $\text{Cl}_2$
- B)  $\text{ClF}$
- C)  $\text{HF}$
- D)  $\text{LiF}$

Answer: D

Diff: 1 Page Ref: 9.6

32) Identify the compound with the smallest dipole moment in the gas phase.

- A)  $\text{Cl}_2$
- B)  $\text{ClF}$
- C)  $\text{HF}$
- D)  $\text{LiF}$

Answer: A

Diff: 1 Page Ref: 9.6



33) Identify the compound with the highest percent ionic character.

- A) HF
- B) IBr
- C) HCl
- D) LiF

Answer: D

Diff: 1 Page Ref: 9.6

34) Identify the compound with the smallest percent ionic character.

- A) HF
- B) IBr
- C) HCl
- D) LiF

Answer: B

Diff: 1 Page Ref: 9.6

35) Choose the bond below that is **most** polar.

- A) H-I
- B) H-Br
- C) H-F
- D) H-Cl
- E) C-H

Answer: C

Diff: 1 Page Ref: 9.6

36) Choose the bond below that is **least** polar.

- A) P-F
- B) C-Br
- C) C-F
- D) C-I
- E) C-Cl

Answer: D

Diff: 1 Page Ref: 9.6

37) Using periodic trends, place the following bonds in order of **increasing** ionic character.

Si-P    Si-Cl    Si-S

- A) Si-P < Si-Cl < Si-S
- B) Si-P < Si-S < Si-Cl
- C) Si-S < Si-Cl < Si-P
- D) Si-Cl < Si-P < Si-S
- E) Si-Cl < Si-S < Si-P

Answer: B

Diff: 1 Page Ref: 9.6

38) Choose the best Lewis structure for BeF<sub>2</sub>.

- A)  $\text{:}\ddot{\text{F}}=\text{Be}=\ddot{\text{F}}\text{:}$   
B)  $\text{:}\ddot{\text{F}}-\ddot{\text{Be}}-\ddot{\text{F}}\text{:}$   
C)  $\text{:}\ddot{\text{F}}-\ddot{\text{Be}}-\ddot{\text{F}}\text{:}$   
D)  $\text{:}\ddot{\text{F}}-\text{Be}-\ddot{\text{F}}\text{:}$   
E)  $\text{:}\ddot{\text{F}}-\text{Be}=\ddot{\text{F}}\text{:}$

Answer: D

Diff: 2 Page Ref: 9.7

39) Choose the best Lewis structure for OCl<sub>2</sub>.

- A)  $\text{:}\ddot{\text{Cl}}=\ddot{\text{O}}-\ddot{\text{Cl}}\text{:}$   
B)  $\text{:}\ddot{\text{Cl}}-\ddot{\text{O}}=\text{Cl}\text{:}$   
C)  $\text{:}\ddot{\text{Cl}}=\ddot{\text{O}}=\text{Cl}\text{:}$   
D)  $\text{:}\ddot{\text{Cl}}=\text{O}=\text{Cl}\text{:}$   
E)  $\text{:}\ddot{\text{Cl}}-\ddot{\text{O}}-\ddot{\text{Cl}}\text{:}$

Answer: E

Diff: 2 Page Ref: 9.7

40) Choose the best Lewis structure for CH<sub>2</sub>Cl<sub>2</sub>.

- A)  $\text{H}-\ddot{\text{Cl}}-\ddot{\text{C}}-\ddot{\text{Cl}}-\text{H}$   
B)  $\begin{array}{c} \text{H} \\ | \\ \text{:}\ddot{\text{Cl}}-\text{C}-\ddot{\text{Cl}}\text{:} \\ | \\ \text{H} \end{array}$   
C)  $\text{H}-\text{H}-\ddot{\text{C}}-\ddot{\text{Cl}}-\ddot{\text{Cl}}\text{:}$   
D)  $\begin{array}{c} \text{H} \\ | \\ \text{Cl}-\text{C}-\text{Cl} \\ | \\ \text{H} \end{array}$   
E)  $\begin{array}{c} \text{H} \\ | \\ \text{:}\ddot{\text{Cl}}=\text{C}=\ddot{\text{Cl}}\text{:} \\ | \\ \text{H} \end{array}$

Answer: B

Diff: 2 Page Ref: 9.7

41) Give the number of valence electrons for  $\text{CH}_2\text{Cl}_2$ .

- A) 16
- B) 18
- C) 20
- D) 22
- E) 12

Answer: C

Diff: 2 Page Ref: 9.7

42) Give the number of valence electrons for  $\text{XeI}_2$ .

- A) 22
- B) 20
- C) 18
- D) 24
- E) 16

Answer: A

Diff: 2 Page Ref: 9.7

43) Choose the best Lewis structure for  $\text{XeI}_2$ .

- A)  $\text{:}\ddot{\text{I}}\text{—Xe—}\ddot{\text{I}}\text{:}$
- B)  $\text{:}\ddot{\text{I}}\text{=}\ddot{\text{Xe}}\text{=}\ddot{\text{I}}\text{:}$
- C)  $\text{:}\ddot{\text{I}}\text{—}\ddot{\text{Xe}}\text{—}\ddot{\text{I}}\text{:}$
- D)  $\text{:}\ddot{\text{I}}\text{—}\ddot{\text{Xe}}\text{—}\ddot{\text{I}}\text{:}$
- E)  $\text{:}\ddot{\text{I}}\text{=Xe=}\ddot{\text{I}}\text{:}$

Answer: C

Diff: 2 Page Ref: 9.7

44) Give the number of valence electrons for  $\text{ICl}_5$ .

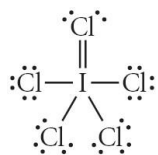
- A) 36
- B) 40
- C) 42
- D) 44
- E) 46

Answer: C

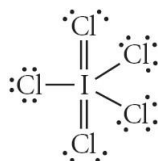
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45) Choose the best Lewis structure for  $\text{ICl}_5$ .

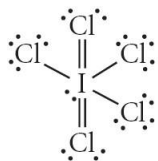
A)



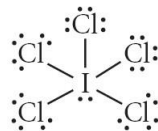
B)



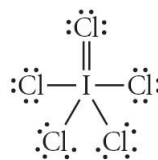
C)



D)



E)

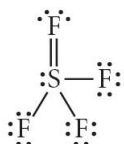


Answer: D

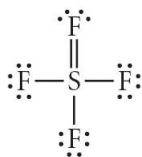
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46) Choose the best Lewis structure for SF<sub>4</sub>.

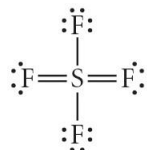
A)



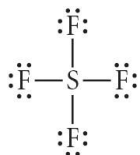
B)



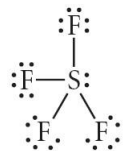
C)



D)



E)

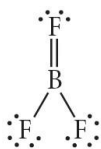


Answer: E

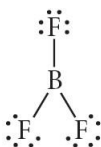
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47) Choose the best Lewis structure for BF<sub>3</sub>.

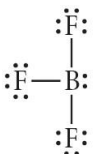
A)



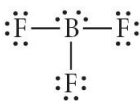
B)



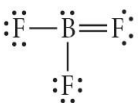
C)



D)



E)

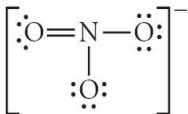


Answer: B

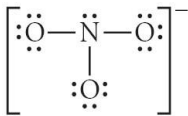
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48) Choose the best Lewis structure for  $\text{NO}_3^-$ .

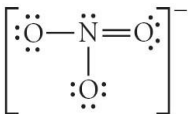
A)



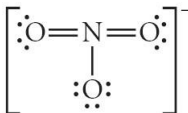
B)



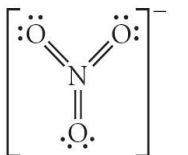
C)



D)



E)



Answer: A

Diff: 2 Page Ref: 9.7

49) Give the number of valence electrons for  $\text{SO}_4^{2-}$ .

A) 32

B) 30

C) 34

D) 28

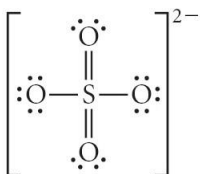
E) 36

Answer: A

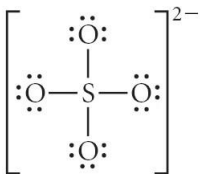
Diff: 2 Page Ref: 9.7

50) Choose the best Lewis structure for  $\text{SO}_4^{2-}$ .

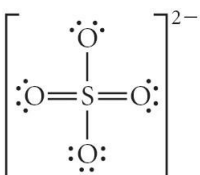
A)



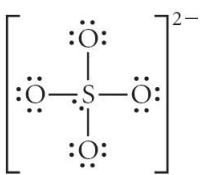
B)



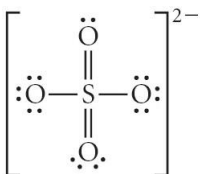
C)



D)



E)



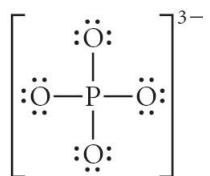
Answer: A

Diff: 2 Page Ref: 9.7

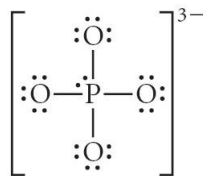


51) Choose the best Lewis structure for  $\text{PO}_4^{3-}$ .

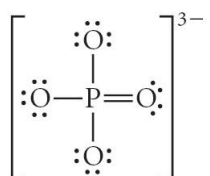
A)



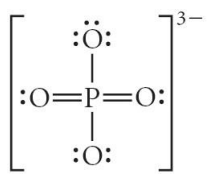
B)



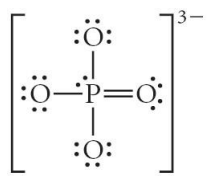
C)



D)



E)

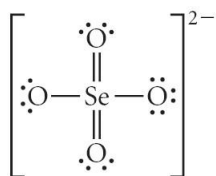


Answer: C

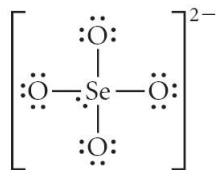
Diff: 2 Page Ref: 9.7

52) Choose the best Lewis structure for  $\text{SeO}_4^{2-}$ .

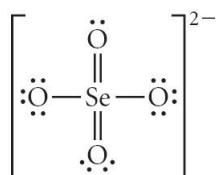
A)



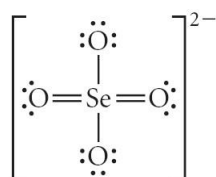
B)



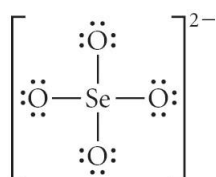
C)



D)



E)

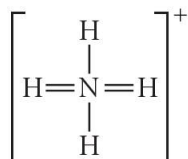


Answer: D

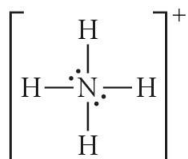
Diff: 2 Page Ref: 9.7

53) Choose the best Lewis structure for  $\text{NH}_4^+$ .

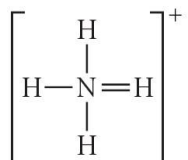
A)



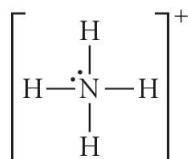
B)



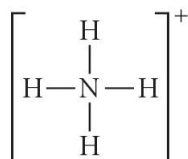
C)



D)



E)



Answer: E

Diff: 2 Page Ref: 9.7

54) Draw the Lewis structure for  $\text{NO}_2^-$  including any valid resonance structures. Which of the following statements is TRUE?

A) The nitrite ion contains one  $\text{N}-\text{O}$  single bond and one  $\text{N}=\text{O}$  double bond.

B) The nitrite ion contains two  $\text{N}-\text{O}$  bonds that are equivalent to  $1\frac{1}{2}$  bonds.

C) The nitrite ion contains two  $\text{N}=\text{O}$  double bonds.

D) The nitrite ion contains two  $\text{N}-\text{O}$  single bonds.

E) None of the above are true.

Answer: B

Diff: 2 Page Ref: 9.8

55) Draw the Lewis structure for  $\text{CO}_3^{2-}$  including any valid resonance structures. Which of the following statements is TRUE?

- A) The  $\text{CO}_3^{2-}$  ion contains one C—O single bond and two C=O double bonds.
- B) The  $\text{CO}_3^{2-}$  ion contains two C—O single bonds and one C=O double bond.
- C) The  $\text{CO}_3^{2-}$  ion contains three C—O double bonds.
- D) The  $\text{CO}_3^{2-}$  ion contains two C—O single bonds and one C $\equiv$ O triple bond.
- E) None of the above are true.

Answer: B

Diff: 2 Page Ref: 9.8

56) Which of the following resonance structures for  $\text{OCN}^-$  will contribute most to the correct structure of  $\text{OCN}^-$ ?

- A) O(2 lone pairs)=C=N (2 lone pairs)
- B) O(1 lone pair)  $\equiv$  C—N(3 lone pairs)
- C) O(1 lone pair)=C(2 lp)  $\equiv$  N(1 lone pair)
- D) O(3 lone pairs)—C $\equiv$ N(with 1 lone pair)
- E) They all contribute equally to the correct structure of  $\text{OCN}^-$ .

Answer: D

Diff: 2 Page Ref: 9.8

57) Using Lewis structures and formal charge, which of the following ions is most stable?



- A)  $\text{OCN}^-$
- B)  $\text{ONC}^-$
- C)  $\text{NOC}^-$
- D) None of these ions are stable according to Lewis theory.
- E) All of these compounds are equally stable according to Lewis theory.

Answer: A

Diff: 2 Page Ref: 9.8

58) Draw the Lewis structure for  $\text{SO}_4^{2-}$ . How many equivalent resonance structures can be drawn?

- A) 6
- B) 2
- C) 4
- D) 3
- E) 8

Answer: A

Diff: 3 Page Ref: 9.8

59) Draw the best Lewis structure for  $\text{Cl}_3^-$ . What is the formal charge on the central Cl atom?

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

Answer: A

Diff: 3 Page Ref: 9.8

60) Draw the best Lewis structure for the free radical,  $\text{NO}_2$ . What is the formal charge on the N?

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

Answer: B

Diff: 3 Page Ref: 9.8

61) Draw the best Lewis structure for  $\text{CH}_3^-$ . What is the formal charge on the C?

- A) 0
- B) 1
- C) -1
- D) 2

Answer: C

Diff: 3 Page Ref: 9.8

62) Draw the best Lewis structure for  $\text{CH}_3^+$ . What is the formal charge on the C?

- A) 0
- B) 1
- C) -1
- D) 2

Answer: B

Diff: 3 Page Ref: 9.8

63) Draw the best Lewis structure for  $\text{BrO}_4^-$  and determine the formal charge on bromine.

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

Answer: C

Diff: 3 Page Ref: 9.9

64) Identify the compound with atoms that have an incomplete octet.

- A)  $\text{ICl}_5$
- B)  $\text{CO}_2$
- C)  $\text{BF}_3$
- D)  $\text{Cl}_2$
- E)  $\text{CO}$

Answer: C

Diff: 3 Page Ref: 9.9

65) Which compound has the longest carbon-carbon bond length?

- A)  $\text{CH}_3\text{CH}_3$
- B)  $\text{CH}_2\text{CH}_2$
- C)  $\text{HCCH}$
- D) all bond lengths are the same

Answer: A

Diff: 1 Page Ref: 9.10

66) Which compound has the shortest carbon-carbon bond length?

- A)  $\text{CH}_3\text{CH}_3$
- B)  $\text{CH}_2\text{CH}_2$
- C)  $\text{HCCH}$
- D) all bond lengths are the same

Answer: C

Diff: 1 Page Ref: 9.10

67) Which compound has the highest carbon-carbon bond strength?

- A)  $\text{CH}_3\text{CH}_3$
- B)  $\text{CH}_2\text{CH}_2$
- C)  $\text{HCCH}$
- D) all bond strengths are the same

Answer: C

Diff: 1 Page Ref: 9.10

68) Place the following in order of **increasing** bond length.

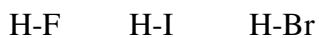
C-F    C-S    C-Cl

- A)  $\text{C-S} < \text{C-Cl} < \text{C-F}$
- B)  $\text{C-Cl} < \text{C-F} < \text{C-S}$
- C)  $\text{C-F} < \text{C-S} < \text{C-Cl}$
- D)  $\text{C-F} < \text{C-Cl} < \text{C-S}$
- E)  $\text{C-S} < \text{C-F} < \text{C-Cl}$

Answer: D

Diff: 1 Page Ref: 9.10

69) Place the following in order of **decreasing** bond length.

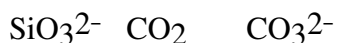


- A) H-F > H-Br > H-I
- B) H-I > H-F > H-Br
- C) H-I > H-Br > H-F
- D) H-Br > H-F > H-I
- E) H-F > H-I > H-Br

Answer: C

Diff: 1    Page Ref: 9.10

70) Place the following in order of **decreasing** XO bond length, where "X" represents the central atom in each of the following compounds or ions.



- A) CO<sub>2</sub> > SiO<sub>3</sub><sup>2-</sup> > CO<sub>3</sub><sup>2-</sup>
- B) CO<sub>2</sub> > CO<sub>3</sub><sup>2-</sup> > SiO<sub>3</sub><sup>2-</sup>
- C) CO<sub>3</sub><sup>2-</sup> > CO<sub>2</sub> > SiO<sub>3</sub><sup>2-</sup>
- D) CO<sub>3</sub><sup>2-</sup> > SiO<sub>3</sub><sup>2-</sup> > CO<sub>2</sub>
- E) SiO<sub>3</sub><sup>2-</sup> > CO<sub>3</sub><sup>2-</sup> > CO<sub>2</sub>

Answer: E

Diff: 1    Page Ref: 9.10

71) Place the following in order of **increasing** bond length.



- A) NO < NO<sub>2</sub><sup>-</sup> < NO<sub>3</sub><sup>-</sup>
- B) NO<sub>2</sub><sup>-</sup> < NO<sub>3</sub><sup>-</sup> < NO
- C) NO<sub>3</sub><sup>-</sup> < NO < NO<sub>2</sub><sup>-</sup>
- D) NO < NO<sub>3</sub><sup>-</sup> < NO<sub>2</sub><sup>-</sup>
- E) NO<sub>3</sub><sup>-</sup> < NO<sub>2</sub><sup>-</sup> < NO

Answer: D

Diff: 1    Page Ref: 9.10

72) Rank the following molecules in decreasing bond energy.

Cl<sub>2</sub>      Br<sub>2</sub>      F<sub>2</sub>      I<sub>2</sub>

- A) I<sub>2</sub> > Br<sub>2</sub> > Cl<sub>2</sub> > F<sub>2</sub>
- B) Cl<sub>2</sub> > Br<sub>2</sub> > F<sub>2</sub> > I<sub>2</sub>
- C) I<sub>2</sub> > Cl<sub>2</sub> > Br<sub>2</sub> > F<sub>2</sub>
- D) Cl<sub>2</sub> > I<sub>2</sub> > F<sub>2</sub> > Br<sub>2</sub>

Answer: B

Diff: 2    Page Ref: 9.10

73) Identify the bond with the highest bond energy.

- A) Si=O
- B) N=N
- C) C=C
- D) C=N
- E) O=O

Answer: D

Diff: 2    Page Ref: 9.10

74) Which of the following processes are exothermic?

- A) Cl<sub>2</sub>(g) → 2Cl(g)
- B) Br(g) + e<sup>-</sup> → Br<sup>-</sup>(g)
- C) Li(s) → Li(g)
- D) NaF(s) → Na<sup>+</sup>(g) + F<sup>-</sup>(g)
- E) None of the above are exothermic.

Answer: B

Diff: 2    Page Ref: 9.10

75) Which of the following processes are exothermic?

- A) the second ionization energy of Mg
- B) the sublimation of Li
- C) the breaking the bond of I<sub>2</sub>
- D) the formation of NaBr from its constituent elements in their standard state
- E) None of the above are exothermic

Answer: D

Diff: 2    Page Ref: 9.10

76) Which of the following processes are endothermic?

- A) K<sup>+</sup>(g) + I<sup>-</sup>(g) → KI(s)
- B) 2 Br(g) → Br<sub>2</sub>(g)
- C) Ca(s) → Ca(g)
- D) 2 Na(s) +  $\frac{1}{2}$  O<sub>2</sub>(g) → Na<sub>2</sub>O(s)

E) None of the above are endothermic.

Answer: C

Diff: 2    Page Ref: 9.10

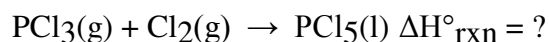


- 77) Which of the following processes are endothermic?  
A) the reaction associated with the lattice energy of LiCl.  
B) the reaction associated with the ionization energy of potassium.  
C) the reaction associated with the heat of formation of CaS.  
D) the formation of F<sub>2</sub> from its elements in their standard states.  
E) None of the above are endothermic.

Answer: B

Diff: 2 Page Ref: 9.10

- 78) Use the bond energies provided to estimate  $\Delta H^\circ_{\text{rxn}}$  for the reaction below.



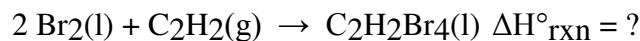
<u>Bond</u>	<u>Bond Energy (kJ/mol)</u>
Cl-Cl	243
P-Cl	331

- A) -243 kJ  
B) -419 kJ  
C) -662 kJ  
D) -67 kJ  
E) -905 kJ

Answer: B

Diff: 3 Page Ref: 9.10

- 79) Use the bond energies provided to estimate  $\Delta H^\circ_{\text{rxn}}$  for the reaction below.



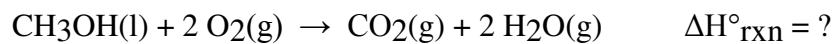
<u>Bond</u>	<u>Bond Energy (kJ/mol)</u>
Br-Br	193
C $\equiv$ C	837
C-C	347
C-Br	276
C-H	414

- A) +407 kJ  
B) -324 kJ  
C) -228 kJ  
D) +573 kJ  
E) -648 kJ

Answer: C

Diff: 3 Page Ref: 9.10

80) Use the bond energies provided to estimate  $\Delta H^\circ_{\text{rxn}}$  for the reaction below.



<u>Bond</u>	<u>Bond Energy (kJ/mol)</u>
C-H	414
C-O	360
C=O	799
O=O	498
O-H	464

- A) +473 kJ
- B) -91 kJ
- C) -486 kJ
- D) -392 kJ
- E) +206 kJ

Answer: D

Diff: 3 Page Ref: 9.10

81) Use the bond energies provided to estimate  $\Delta H^\circ_{\text{rxn}}$  for the reaction below.



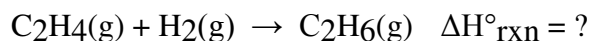
<u>Bond</u>	<u>Bond Energy (kJ/mol)</u>
Xe-F	147
F-F	159

- A) -429 kJ
- B) +159 kJ
- C) -660 kJ
- D) +176 kJ
- E) -270 kJ

Answer: E

Diff: 3 Page Ref: 9.10

82) Use the bond energies provided to estimate  $\Delta H^\circ_{\text{rxn}}$  for the reaction below.



<u>Bond</u>	<u>Bond Energy (kJ/mol)</u>
C-C	347
C-H	414
C=C	611
C≡C	837
H-H	436

- A) -128 kJ
- B) +98 kJ
- C) +700 kJ
- D) -102 kJ
- E) -166 kJ

Answer: A

Diff: 3 Page Ref: 9.10

#### Algorithmic Questions

1) Identify an ionic bond.

- A) Electrons are pooled.
- B) Electrons are shared.
- C) Electrons are transferred.
- D) Protons are gained.
- E) Electrons are lost.

Answer: C

Diff: 1 Page Ref: 9.2

2) Identify the compound with ionic bonding.

- A) NaBr
- B) Na
- C) H<sub>2</sub>O
- D) He
- E) S

Answer: A

Diff: 1 Page Ref: 9.2

3) Identify the compound with covalent bonding.

- A) NaBr
- B) Na
- C) H<sub>2</sub>O
- D) He
- E) S

Answer: C

Diff: 1 Page Ref: 9.2

4) Identify the compound with metallic bonding.

- A) NaBr
- B) Na
- C) H<sub>2</sub>O
- D) He
- E) S

Answer: B

Diff: 1 Page Ref: 9.2

5) Identify the substance that conducts electricity.

- A) NaCl dissolved in water
- B) solid NaCl
- C) ethanol
- D) solid sugar
- E) sugar dissolved in water.

Answer: A

Diff: 1 Page Ref: 9.4

6) Use Lewis theory to determine the chemical formula for the compound formed between Ba and N.

- A) BaN
- B) Ba<sub>3</sub>N<sub>2</sub>
- C) BaN<sub>2</sub>
- D) Ba<sub>2</sub>N
- E) Ba<sub>2</sub>N<sub>3</sub>

Answer: B

Diff: 2 Page Ref: 9.4

7) Use Lewis theory to determine the chemical formula for the compound formed between Na and O.

- A) NaO
- B) NaO<sub>2</sub>
- C) Na<sub>2</sub>O
- D) Na<sub>2</sub>O<sub>3</sub>
- E) Na<sub>3</sub>O<sub>2</sub>

Answer: C

Diff: 2 Page Ref: 9.4

8) Use Lewis theory to determine the chemical formula for the compound formed between Ba and I.

- A) BaI
- B) Ba<sub>2</sub>I<sub>3</sub>
- C) Ba<sub>3</sub>I<sub>2</sub>
- D) BaI<sub>2</sub>
- E) Ba<sub>2</sub>I

Answer: D

Diff: 2 Page Ref: 9.4

9) Use Lewis theory to determine the chemical formula for the compound formed between Al and Cl.

- A)  $\text{Al}_3\text{Cl}_2$
- B)  $\text{Al}_2\text{Cl}_3$
- C)  $\text{AlCl}_2$
- D)  $\text{AlCl}$
- E)  $\text{AlCl}_3$

Answer: E

Diff: 2 Page Ref: 9.4

10) Use Lewis theory to determine the chemical formula for the compound formed between Li and Br.

- A)  $\text{LiBr}_2$
- B)  $\text{Li}_2\text{Br}$
- C)  $\text{Li Br}$
- D)  $\text{Li}_2\text{Br}_2$

Answer: C

Diff: 2 Page Ref: 9.4

11) Which of the following ionic compounds would be expected to have the highest lattice energy?

- A)  $\text{LiF}$
- B)  $\text{LiCl}$
- C)  $\text{LiBr}$
- D)  $\text{LiI}$

Answer: A

Diff: 2 Page Ref: 9.4

12) Which of the following ionic compounds would be expected to have the highest lattice energy?

- A)  $\text{Li Cl}$
- B)  $\text{Na Cl}$
- C)  $\text{K Cl}$
- D)  $\text{Rb Cl}$

Answer: A

Diff: 2 Page Ref: 9.4

13) Which ionic compound would be expected to have the highest lattice energy?

- A)  $\text{Rb}_2\text{O}$
- B)  $\text{SrO}$
- C)  $\text{In}_2\text{O}_3$
- D)  $\text{CO}_2$

Answer: C

Diff: 2 Page Ref: 9.4

14) Identify the compound with the highest magnitude of lattice energy.

- A)  $\text{MgCl}_2$
- B)  $\text{BaCl}_2$
- C)  $\text{SrCl}_2$
- D)  $\text{CsCl}_2$

Answer: A

Diff: 2 Page Ref: 9.4

15) Identify the compound with the lowest magnitude of lattice energy.

- A) KCl
- B) KBr
- C) SrO
- D) BaO

Answer: B

Diff: 2 Page Ref: 9.4

16) Place the following in order of **increasing** magnitude of lattice energy.

MgO Li BaS

- A) BaS < MgO < LiI
- B) LiI < BaS < MgO
- C) MgO < BaS < LiI
- D) LiI < MgO < BaS
- E) MgO < LiI < BaS

Answer: B

Diff: 2 Page Ref: 9.4

17) Place the following in order of **decreasing** magnitude of lattice energy.

KF CaS RbI

- A) RbI > KF > CaS
- B) RbI > CaS > KF
- C) CaS > RbI > KF
- D) KF > RbI > CaS
- E) CaS > KF > RbI

Answer: E

Diff: 2 Page Ref: 9.4

18) Choose the compound below that should have the **highest** melting point according to the ionic bonding model.

- A) AlN
- B) MgO
- C) NaCl
- D) CaS
- E) RbI

Answer: A

Diff: 2 Page Ref: 9.4

19) Choose the compound below that should have the **highest** melting point according to the ionic bonding model.

- A) SrI<sub>2</sub>
- B) MgF<sub>2</sub>
- C) CaCl<sub>2</sub>
- D) SrF<sub>2</sub>
- E) SrBr<sub>2</sub>

Answer: B

Diff: 2 Page Ref: 9.4

20) Choose the compound below that should have the **lowest** melting point according to the ionic bonding model.

- A) LiF
- B) LiCl
- C) CsI
- D) KBr
- E) RbI

Answer: C

Diff: 2 Page Ref: 9.4

21) Identify the number of bonding pairs and lone pairs of electrons in N<sub>2</sub>.

- A) 6 bonding pair and 1 lone pair
- B) 4 bonding pair and 2 lone pairs
- C) 3 bonding pairs and 2 lone pairs
- D) 2 bonding pairs and 1 lone pair
- E) 2 bonding pairs and 3 lone pairs

Answer: C

Diff: 1 Page Ref: 9.5

22) Of the following elements, which has the highest electronegativity?

- A) Si
- B) P
- C) Ti
- D) Ge

Answer: B

Diff: 1 Page Ref: 9.6

23) Of the following elements, which has the lowest electronegativity?

- A) Sr
- B) I
- C) Ba
- D) At

Answer: C

Diff: 1 Page Ref: 9.6

24) Place the following elements in order of **increasing** electronegativity.

Na    Rb    P

- A)  $P < Na < Rb$
- B)  $Na < P < Rb$
- C)  $Rb < P < Na$
- D)  $Rb < Na < P$
- E)  $P < Rb < Na$

Answer: D

Diff: 1    Page Ref: 9.6

25) Place the following elements in order of **decreasing** electronegativity.

S                    F                    Se

- A)  $Se > S > F$
- B)  $F > Se > S$
- C)  $Se > F > S$
- D)  $S > F > Se$
- E)  $F > S > Se$

Answer: E

Diff: 1    Page Ref: 9.6

26) Place the following elements in order of **increasing** electronegativity.

Ba    Se    Li

- A)  $Ba < Li < Se$
- B)  $Li < Se < Ba$
- C)  $Ba < Se < Li$
- D)  $Se < Ba < Li$
- E)  $Se < Li < Ba$

Answer: A

Diff: 1    Page Ref: 9.6

27) List the following compounds in decreasing electronegativity difference.

F<sub>2</sub>    HF    KF

- A)  $KF > F_2 > HF$
- B)  $F_2 > HF > KF$
- C)  $HF > KF > F_2$
- D)  $KF > HF > F_2$

Answer: D

Diff: 1    Page Ref: 9.6



28) Choose the bond below that is **most** polar.

- A) C-N
- B) C-F
- C) N-O
- D) C-C
- E) Cl-Cl

Answer: B

Diff: 1 Page Ref: 9.6

29) Using periodic trends, place the following bonds in order of **increasing** ionic character.

S-Cl Se-Cl O-Cl

- A) Se-Cl < S-Cl < O-Cl
- B) S-Cl < Se-Cl < O-Cl
- C) O-Cl < Se-Cl < S-Cl
- D) Se-Cl < O-Cl < S-Cl
- E) O-Cl < S-Cl < Se-Cl

Answer: E

Diff: 1 Page Ref: 9.6

30) Using periodic trends, place the following bonds in order of **decreasing** ionic character.

Sb-F P-F As-F

- A) Sb-F > As-F > P-F
- B) As-F > Sb-F > P-F
- C) Sb-F > P-F > As-F
- D) P-F > As-F > Sb-F
- E) Sb-F > P-F > As-F

Answer: A

Diff: 1 Page Ref: 9.6

31) Which molecule or compound below contains a **pure** covalent bond?

- A)  $\text{Li}_2\text{CO}_3$
- B)  $\text{SCl}_6$
- C)  $\text{Br}_2$
- D)  $\text{PCl}_3$
- E) NaCl

Answer: C

Diff: 1 Page Ref: 9.6

32) Which molecule or compound below contains a polar covalent bond?

- A) C<sub>2</sub>H<sub>4</sub>
- B) ZnS
- C) LiI
- D) NCl<sub>3</sub>
- E) AgI

Answer: D

Diff: 1 Page Ref: 9.6

33) Which molecule or compound below contains an ionic bond?

- A) CO<sub>2</sub>
- B) C<sub>2</sub>Br<sub>4</sub>
- C) SiF<sub>4</sub>
- D) OCl<sub>2</sub>
- E) NH<sub>4</sub>NO<sub>3</sub>

Answer: E

Diff: 1 Page Ref: 9.6

34) The electronegativity is 2.1 for H and 1.9 for Pb. Based on these electronegativities PbH<sub>4</sub> would be expected to

- A) be ionic and contain H<sup>-</sup> ions.
- B) be ionic and contain H<sup>+</sup> ions.
- C) have polar covalent bonds with a partial negative charges on the H atoms.
- D) have polar covalent bonds with a partial positive charges on the H atoms.

Answer: C

Diff: 1 Page Ref: 9.6

35) The compound ClF contains

- A) ionic bonds.
- B) nonpolar covalent bonds.
- C) polar covalent bonds with partial negative charges on the F atoms.
- D) polar covalent bonds with partial negative charges on the Cl atoms.

Answer: C

Diff: 1 Page Ref: 9.6

36) The phosphorus atom in PCl<sub>3</sub> would be expected to have a

- A) partial positive ( $\delta^+$ ) charge.
- B) partial negative ( $\delta^-$ ) charge.
- C) 3+ charge.
- D) 3- charge.

Answer: A

Diff: 1 Page Ref: 9.6

37) The iodine atom in  $I_2$  would be expected to have a

- A) charge of 1-
- B) partial charge  $\delta^-$ .
- C) partial charge  $\delta^+$ .
- D) charge of 0.

Answer: D

Diff: 1 Page Ref: 9.6

38) Give the number of valence electrons for  $SBr_4$ .

- A) 28
- B) 30
- C) 32
- D) 34

Answer: D

Diff: 2 Page Ref: 9.7

39) Give the number of pairs of valence electrons for  $BF_3$ .

- A) 16
- B) 8
- C) 14
- D) 10
- E) 12

Answer: E

Diff: 2 Page Ref: 9.7

40) In the best Lewis structure for  $NO^+$ , what is the formal charge on the N atom?

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

Answer: B

Diff: 2 Page Ref: 9.8

41) Which of the following elements can form compounds with an expanded octet?

- A) Se
- B) C
- C) Li
- D) F
- E) All of the above elements can form compounds with an expanded octet.

Answer: A

Diff: 1 Page Ref: 9.9

42) Which of the following elements can form compounds with an expanded octet?

A) O

B) Br

C) F

D) Be

E) None of the above can form compounds with an expanded octet.

Answer: B

Diff: 1 Page Ref: 9.9

43) How many of the following elements can form compounds with an expanded octet?

I O Br Xe

A) 2

B) 0

C) 3

D) 1

E) 4

Answer: C

Diff: 2 Page Ref: 9.9

44) How many of the following elements can form compounds with an expanded octet?

P Kr Xe B

A) 0

B) 1

C) 2

D) 3

E) 4

Answer: D

Diff: 2 Page Ref: 9.9

45) How many lone pairs of electrons are on the As atom in  $\text{AsCl}_3$ ?

A) 0

B) 1

C) 2

D) 3

Answer: B

Diff: 2 Page Ref: 9.9

46) Which element can expand its valence shell to accommodate more than eight electrons?

A) N

B) O

C) Br

D) He

Answer: C

Diff: 2 Page Ref: 9.9

47) Which of the following contains an atom that does **not** obey the octet rule?

- A) CsI
- B) SnO<sub>2</sub>
- C) ClF<sub>5</sub>
- D) ClF

Answer: C

Diff: 2 Page Ref: 9.9

48) How many lone pairs of electrons are on the S atom in SF<sub>4</sub> ?

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

Answer: B

Diff: 2 Page Ref: 9.9

49) How many lone pairs are on the Br atom in BrCl<sub>2</sub><sup>-</sup>?

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

Answer: D

Diff: 2 Page Ref: 9.9

50) Choose the bond below that is the **strongest**.

- A) C-F
- B) C=O
- C) C-I
- D) I-I
- E) C≡N

Answer: E

Diff: 1 Page Ref: 9.10

51) Choose the bond below that is the **strongest**.

- A) N=O
- B) N-F
- C) C-O
- D) N-C
- E) N=N

Answer: A

Diff: 1 Page Ref: 9.10

52) Choose the bond below that is the **weakest**.

- A) Na-Br
- B) Br-Br
- C) C=N
- D) Li-I
- E) C=N

Answer: B

Diff: 1 Page Ref: 9.10

53) Choose the bond below that is the **weakest**.

- A) C≡O
- B) N≡N
- C) C-I
- D) C=O
- E) K-Br

Answer: C

Diff: 1 Page Ref: 9.10

### Matching Questions

*Match the following.*

- A) metallic bond
- B) weakest ionic bond
- C) strongest covalent bond
- D) highest melting point
- E) longest covalent bond

1) Sr-Sr

Diff: 1 Page Ref: 9.2

2) Cs-I

Diff: 1 Page Ref: 9.4

3) Ca-O

Diff: 1 Page Ref: 9.4

4) Se-I

Diff: 1 Page Ref: 9.5

5) C=N

Diff: 1 Page Ref: 9.5

Answers: 1) A 2) B 3) D 4) E 5) C

## Short Answer Questions

1) Describe a covalent bond.

Answer: A bond formed from the sharing of electrons.

Diff: 1 Page Ref: 9.2

2) Draw the Lewis Dot structure for  $\text{Al}^{3+}$ .

Answer: The Al should have no electrons around it, with a 3+ charge.

Diff: 1 Page Ref: 9.4

3) Explain why the lattice energy of  $\text{MgS}$  is approximately 4 times as large as that of  $\text{NaCl}$ .

Answer: The  $\text{Mg}^{2+}$  and  $\text{Na}^+$  ion are similar in size as are the  $\text{S}^{2-}$  and  $\text{Cl}^-$  ions. Therefore, the major difference in the lattice energies for these two compounds is due to the difference in the magnitude of the ionic charge on each ion. According to Coulomb's law, Mg and S ions have 4 $\times$  the attractive force ( $2+ \times 2-$ ) than the Na and Cl ions ( $1+ \times 1-$ ).

Diff: 2 Page Ref: 9.4

4) List the most electronegative atom.

Answer: F

Diff: 1 Page Ref: 9.6

5) List the least electronegative atom.

Answer: Fr

Diff: 1 Page Ref: 9.6

6) Define dipole moment.

Answer: Dipole moment is the measured quantitative value associated with the separation of the partial positive and negative charges found within a molecule.

Diff: 1 Page Ref: 9.6

7) How are electron affinity and electronegativity different?

Answer: Electron affinity is the process of a single atom gaining an electron. Electronegativity is the strength of the attraction of a nucleus to a pair of shared (bonding) electrons within a covalent bond. Electronegativity is only important when looking at covalent bonds and electron affinity is only important when considering single atoms gaining electrons to form anions.

Diff: 2 Page Ref: 9.6

8) Describe the difference between a pure covalent bond and a polar covalent bond.

Answer: A pure covalent bond occurs when bonding electrons are shared equally (or very close to it) as in the N-N bond. A polar covalent bond is formed between 2 atoms of differing electronegativities. The bonding electrons are unequally shared between the two atoms as in the CO molecule.

Diff: 2 Page Ref: 9.6

9) Draw the Lewis structure for the acetate ion,  $\text{CH}_3\text{CO}_2^-$ , including any important resonance structures. Label each atom with its formal charge.

Answer: There should be two equivalent resonance structures drawn. All atoms should have a formal charge of "0" except the singly bonded O will have a formal charge of -1.

Diff: 2 Page Ref: 9.8

10) Draw the Lewis structure for  $\text{BrO}_3^-$ . Make sure to include any important resonance structures.

Answer: Three equivalent resonance structures should be drawn, each containing 1 single Br-O bond and 2 double Br-O bonds. Bromine has a lone pair, each double-bonded oxygen has two lone pairs, and the single-bonded oxygen has three lone pairs.

Diff: 2 Page Ref: 9.8

11) Define formal charge.

Answer: Formal charge is the charge of an atom that it would have if all bonding electrons were shared equally between the bonded atoms.

Diff: 2 Page Ref: 9.8

12) Define bond energy.

Answer: Bond energy is the energy required to break 1 mole of the bond in the gas phase.

Diff: 1 Page Ref: 9.10