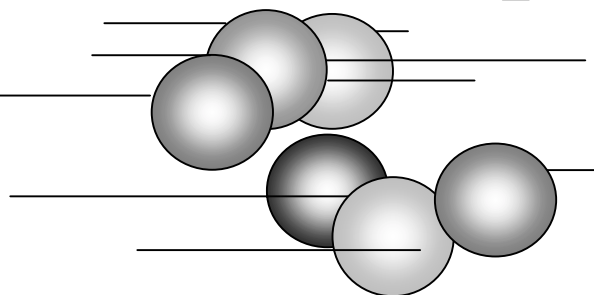


A Simple Model for Chemical Bonds



Multiple Choice

1. Modern organic chemistry
- is the study of carbon-containing compounds.
 - is the study of compounds from living organisms.
 - deals exclusively with chemicals that are obtainable from natural sources.
 - a, b, and c
 - a and c

ANS: a

2. The basic chemical building block is the
- proton.
 - ion.
 - atom.
 - electron.
 - neutron.

ANS: c

3. The nucleus of an atom consists of
- protons.
 - protons and neutrons.
 - electrons, proton, and neutrons.
 - protons and electrons.
 - neutrons and electrons.

ANS: b

4. The atomic nucleus
- is positively charged.
 - has no charge (neutral) because of the neutrons.
 - is neutral because of the electrons.
 - is negatively charged.
 - none of the above

ANS: a

2 A Simple Model for Chemical Bonds

5. The electrons are located

- a. in the nucleus.
- b. in orbitals.
- c. in perfectly circular orbits.
- d. in and around the nucleus.
- e. in nodes.

ANS: b

6. Valence electrons refer to those

- a. in the nearest shell.
- b. which are negative.
- c. of lowest energy.
- d. in the outermost shell.
- e. that are electronegative.

ANS: d

7. All atoms of a given element have the same

- a. number of electrons.
- b. number of neutrons.
- c. number of protons.
- d. mass.
- e. number of protons and electrons.

ANS: c

8. The dots in Lewis structures represent

- a. all electrons.
- b. valence electrons.
- c. the number of protons.
- d. the charge.
- e. none of the above

ANS: b

9. Which compound(s) is (are) ionic?

- a. BF_3
- b. NaNH_2
- c. Li_2CO_3
- d. a and b
- e. b and c

ANS: e

10. Which of the following is most stable?

- a. $+CH_3$
- b. CH_4
- c. $\bullet CH_3$
- d. $\bullet \overset{\bullet\bullet}{C}H_2$
- e. CH_3

ANS: b

11. Which compound contains ionic bonds?

- a. Nl_3
- b. CH_3COCl
- c. $NaHCO_3$
- d. NH_3
- e. SiO_2

ANS: c

12. Covalent bonding

- a. involves a transfer of electrons from one atom to another.
- b. occurs when atoms share all their valence electrons.
- c. occurs when unpaired valence electrons are shared between atoms.
- d. usually produces very polar compounds.
- e. none of these

ANS: c

13. Ionic bonding

- a. occurs when metals are combined with non metals.
- b. involves a sharing of electrons between metal and non metal.
- c. occurs when crystals form.
- d. occurs when the inner core electrons of the metal are transferred to the non metal.
- e. none of these

ANS: a

14. The noble gases do not readily form chemical bonds because

- a. they are gases.
- b. they have an even number of protons and electrons.
- c. they have a filled outer shell of electrons.
- d. their electrons do not allow bonding with other elements.
- e. none of these

ANS: c

4 A Simple Model for Chemical Bonds

15. An element may form an ion
- that has a noble gas electron configuration.
 - if the charge is small in relation to its volume.
 - if the element is a metal, metalloid, or nonmetal.
 - a, b, and c
 - b and c

ANS: d

16. Which structure could best illustrate the octet rule?
- He
 - H₂
 - SiH₄
 - BH₃
 - none of these

ANS: c

17. Elements from the same group
- have the same number of neutrons.
 - have the same number of valence electrons.
 - usually form the same number of bonds.
 - occur in horizontal rows.
 - b and c

ANS: e

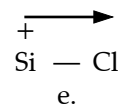
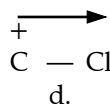
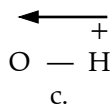
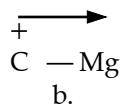
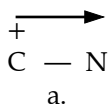
18. Which of the following does *not* exhibit a net dipole moment of zero?
- CO₂
 - CH₄
 - CCl₄
 - H₂O
 - SO₃

ANS: d

19. Which of the following exhibits a net dipole moment?
- SO₂
 - CO₂
 - O₂
 - a and b
 - a, b, and c

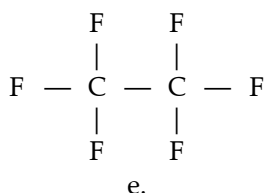
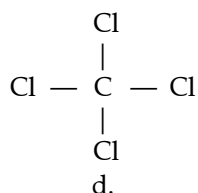
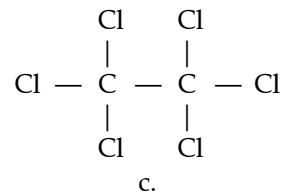
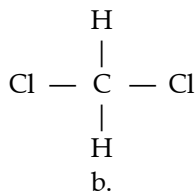
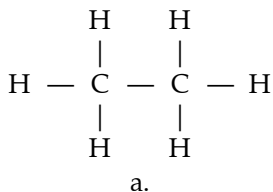
ANS: a

20. Which dipole is incorrect?



ANS: b

21. Which compound is polar (has a non zero dipole moment)?



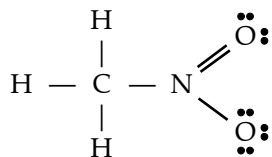
ANS: b

22. Which molecule is nonpolar?

- CH_2F_2
- CHF_3
- BF_3
- NH_3
- CO

ANS: c

23. What is the formal charge of nitrogen in nitromethane?

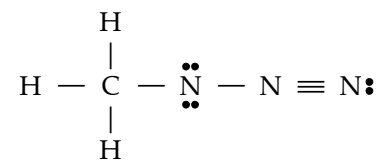


- 1
- 0
- +1
- +3
- +5

ANS: c

6 A Simple Model for Chemical Bonds

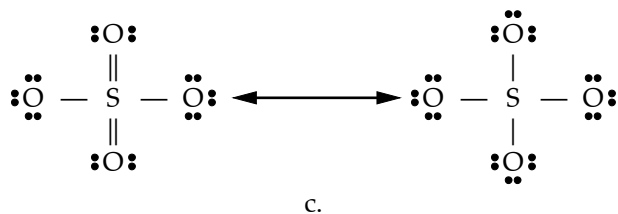
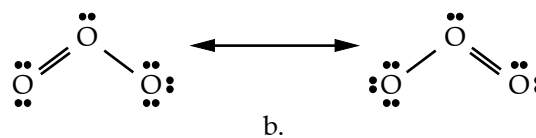
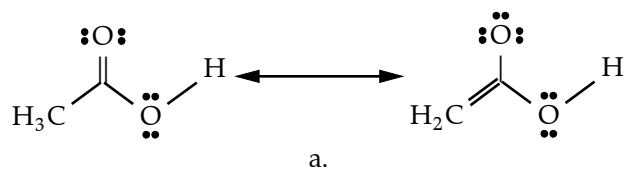
24. What are the formal charges of each nitrogen (from left to right)?



- a. -1, +1, 0
- b. +1, -1, 0
- c. 0, +1, -1
- d. -1, 0, +1
- e. +1, +1, 0

ANS: a

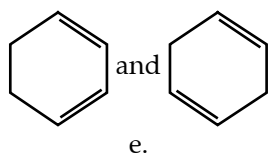
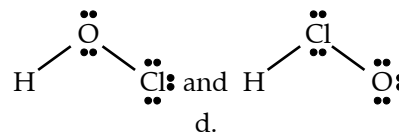
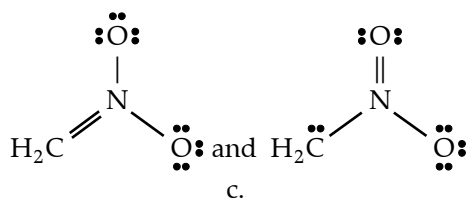
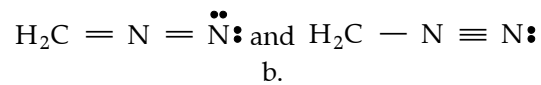
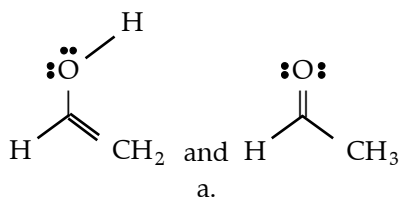
25. Which of the following is *not* an example of resonance?



- d. a and b
- e. a and c

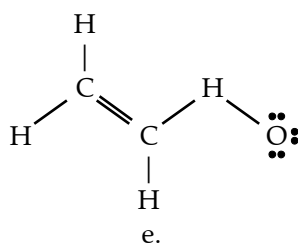
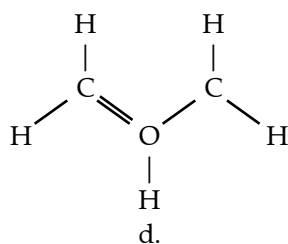
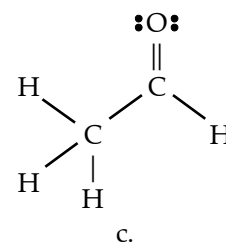
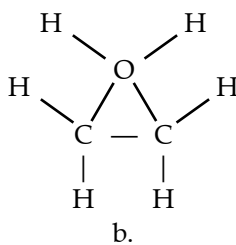
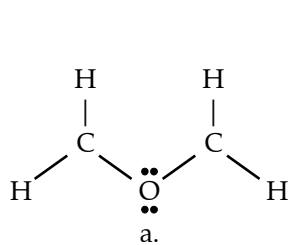
ANS: a

26. Which are resonance structures?



ANS: c

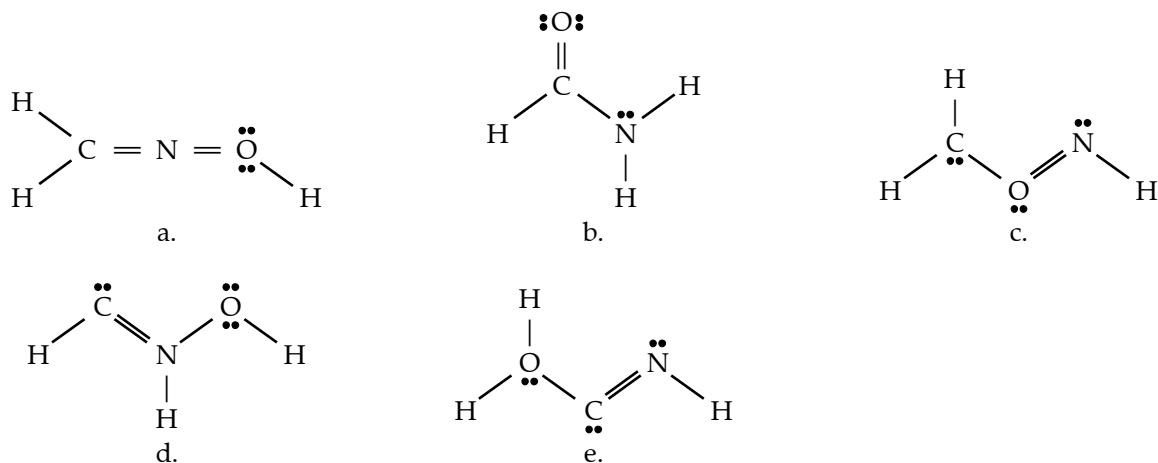
27. Which is the best Lewis structure for $\text{C}_2\text{H}_4\text{O}$?



ANS: c

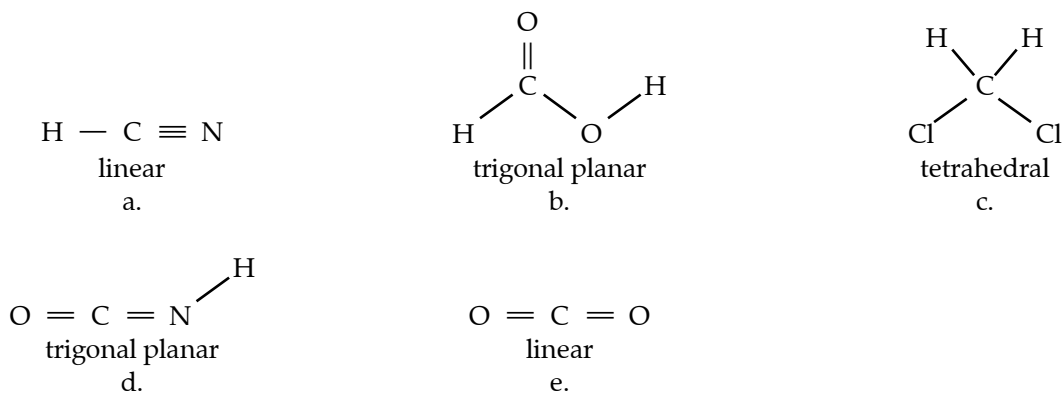
8 A Simple Model for Chemical Bonds

28. Which structural isomer of CH_3NO is most stable?



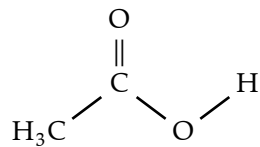
ANS: b

29. Which geometry of the carbon atom does *not* match the corresponding structure?



ANS: d

30. Give the geometry for each carbon atom (left to right).



- a. tetrahedral, trigonal planar
- b. trigonal planar, tetrahedral
- c. trigonal planar, linear
- d. tetrahedral, linear
- e. linear, trigonal planar

ANS: a

31. Predict which species would react with chloride ion, Cl^- .

- a. CH_4
- b. $\bullet\text{CH}_3^-$
- c. CH_3^+
- d. $\bullet\text{NH}_3$
- e. Br^-

ANS: c

Short Answer

32. Name three differences between organic compounds and inorganic compounds.

ANS: Organic—lower melting and boiling points, covalent bonding, molecules.
Inorganic—higher melting and boiling points, ionic bonding, crystal lattice network.

33. Define organic chemistry.

ANS: The study of the compounds of carbon.

34. What is the historical basis for the term “organic”?

ANS: It was observed that certain compounds were produced from living organisms (from biological organs), so it was theorized that this relationship gave these “organic” compounds the ability or “vital force” to give life to biological systems.

35. What elements are represented by Lewis structures which each have four dots?

ANS: C, Si, Ge, Sn, Pb

36. List the elements least likely to form chemical bonds.

ANS: He, Ne, Ar, Kr, Xe, Rn

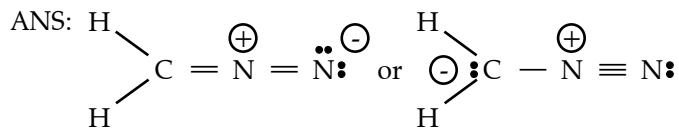
37. Define ionic bonding.

ANS: Electrostatic attraction between cation (positive) and anion (negative) which results from the transfer of one or more electrons from the metal (forming a stable cation) to the non metal (forming a stable anion).

38. Define covalent bonding.

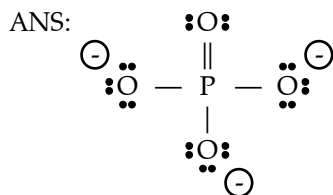
ANS: Bonded atoms share electrons so that each atom has a full shell, i.e., that of a noble gas.

39. Draw a valid Lewis structure for CH_2N_2 and show the formal charges on each atom. (Hint: Both H atoms are connected to C, and the N atoms are connected to each other.)

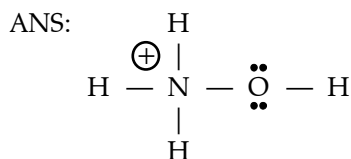


10 A Simple Model for Chemical Bonds

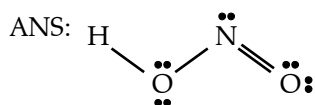
40. Draw a valid Lewis structure for PO_4^{3-} and show the formal charges on each atom. (Hint: There are no O–O bonds.)



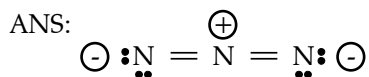
41. Draw a Lewis structure for hydroxylammonium ion: $^+\text{NH}_3\text{OH}$.



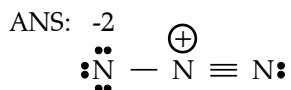
42. Draw a Lewis structure for HNO_2 (an oxyacid that is not a peroxide).



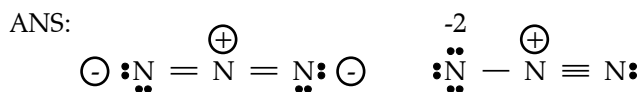
43. a) Draw a Lewis structure for azide ion: (N_3^-)



b) Draw another resonance structure for azide ion.



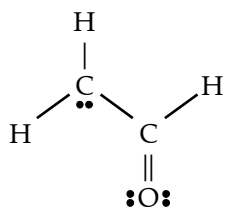
c) Show the formal charges of each nitrogen in both structures.



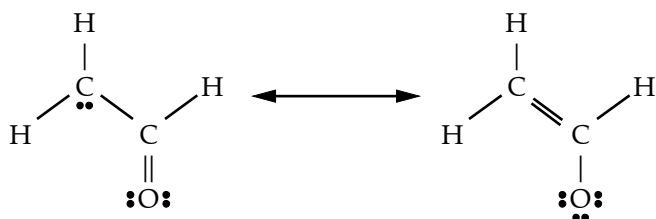
d) Predict whether the two bonds in azide are the same or different. Explain.

ANS: They should be the *same*, because any structure that makes more bonds on one side can be duplicated on the other side.

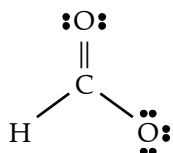
44. Draw another resonance structure for



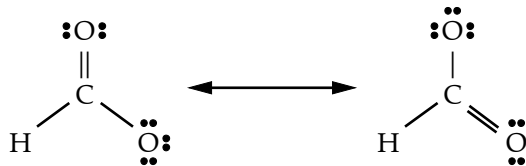
ANS:



45. Draw a resonance structure for

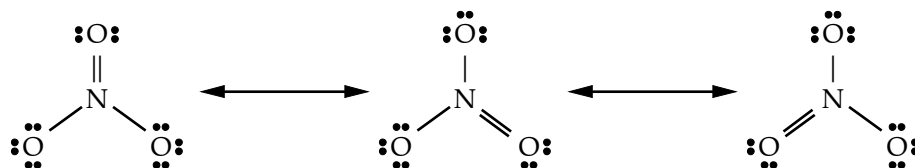


ANS:



46. All of the N–O bonds in nitrate ion (NO_3^-) are identical. Draw structures and explain.

ANS: All of the bonds between N and O are equivalent. Each bond is really approximately $1\frac{1}{3}$ bond since there are three resonance structures and each of the N–O bonds is a double bond in one of the three structures.



12 A Simple Model for Chemical Bonds

47. Explain the direction and relative sizes of the dipole moments for NH_3 ($\mu = 1.46 \text{ D}$) and NF_3 ($\mu = 0.24 \text{ D}$).

ANS: In NH_3 , the dipole moment is toward the more electronegative nitrogen, and toward the lone pair. In NF_3 the dipoles of the N-F bonds are directed toward the more electronegative fluorine, and away from the lone pair, so the resultant dipole moment is much smaller and away from the lone pair.

