1. Classify the bonds in the following compounds as ionic, polar covalent, or non-polar covalent: NH₃, LiF, H₂, respectively.

   A. Polar covalent, ionic, non-polar covalent
   B. Ionic, polar covalent, non-polar covalent
   C. Polar covalent, non-polar covalent, ionic
   D. Ionic, non-polar covalent, polar covalent
   E. Non-polar covalent, ionic, polar covalent

2. In the Lewis structure for acetone, CH₃COCH₃, all of the following bond angles, hybridizations, or electronic geometries are described by some part of the molecule EXCEPT:

   A. 120°
   B. sp³
   C. Tetrahedral
   D. 90°
   E. Trigonal planar

3. In the Lewis structure for methylamine, CH₃NH₂, all the following bond angles, hybridizations, or electronic geometries are described by some part of the molecule EXCEPT:

   A. sp³
   B. Tetrahedral
   C. 120°
   D. 109.5°
   E. None of the above

4. Which of the following best describes the molecular geometry in ozone, O₃?

   A. Angular
   B. Linear
   C. 180°
   D. Pyramidal
   E. Both B and C

5. Rank the polarity of the following Lewis structures:

   1. 
      F
      H—C—H
      H

2. \[ \text{Cl} \]
   \[ \begin{array}{c}
   \text{H} - \text{C} - \text{H} \\
   \text{H}
   \end{array} \]
3. \[ \text{F} \]
   \[ \begin{array}{c}
   \text{H} - \text{C} - \text{F} \\
   \text{H}
   \end{array} \]
4. \[ \text{Cl} \]
   \[ \begin{array}{c}
   \text{Cl} - \text{C} - \text{Cl} \\
   \text{Cl}
   \end{array} \]
5. \[ \text{F} \]
   \[ \begin{array}{c}
   \text{F} - \text{C} - \text{F} \\
   \text{F}
   \end{array} \]

1. IV = V < II < I < III
2. II < I < III < IV < V
3. IV < V < II < I < III
4. I = II < III < IV = V
5. V < IV < III < II < I
6. IV = V < I = II < III

6. How many sigma and pi bonds do the following molecules have?

I. HC=CH
II. H₂C=CH₂
III. H₃C-CH₃
IV. H₂C=C=CH₂

1. I. 3,0; II. 2,0; III. 1, 0; IV. 4,0
2. I. 1,2; II. 1,1; III. 1, 0; IV. 2,2
3. I. 4,1; II. 5,1; III. 7,0; IV. 6,2
4. I. 2,3; II. 4,2; III. 7,0; IV. 4,4
5. I. 3,2; II. 5,1; III. 7,0; IV. 6,2

7. Which of the following are true about hybrid orbitals?

I. They are used because atomic orbitals were not a good model for molecular bonding.
II. They are the result of mixing atomic orbitals of various types.
III. They always include at least one of each orbital type (s, p, and d).
IV. The use of a hybridized orbital model better predicts molecular orbital energy, bonding patterns, as well as molecular shape.
V. Unlike our previous models, which were only approximations of reality, hybridization really does reflect the absolute, empirical truth.

1. I, IV, V
2. I only
3. II only
4. I, II
5. I, III
6. I, II, IV
7. I, II, V

8. Here’s a wacky molecule you might learn about later in organic chemistry or biochemistry, called isoprene. It’s a building block for rubbers:

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CH3
|   
C   CH2
//  //
H2C C
|   
H
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How many of the following orbital types do you spy involved with sigma and pi bonding: s, p, sp, sp², sp³?

1. Eight s, two sp, four sp², one sp³ for sigma and zero p for pi.
2. Eight s, zero sp, twelve sp², four sp³ for sigma and four p for pi.
3. Eight s, zero sp, four sp², one sp³ for sigma and two p for pi.
4. Four s, zero sp, twelve sp², four sp³ for sigma and four p for pi.
5. Eight s, zero sp, twelve p, four sp³ for sigma and four sp² for pi.