Entry Level Test Answer Key

1. Organic chemistry is the study of compounds containing the chemical element carbon.

   Relevant section of *Organic Chemistry*, 8th ed.: Introduction

2. Organic and inorganic compounds are different because the former contain a "vital force" and the latter do not.

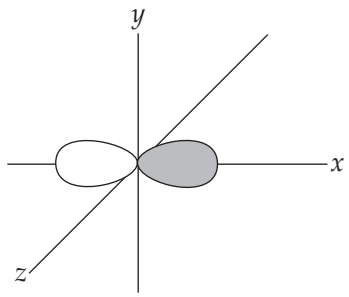
   False.

   Relevant section of *Organic Chemistry*, 8th ed.: Introduction

3. An orbital is the space in which a given electron spends 90-95% of its time.

   Relevant section of *Organic Chemistry*, 8th ed.: 1.2

4. Shape of a $2p_x$ orbital:



   Relevant section of *Organic Chemistry*, 8th ed.: 1.2

5. The plane passing between the two lobes of a p orbital is a region of zero electron density. It is called a nodal plane.

   Relevant section of *Organic Chemistry*, 8th ed.: 1.2

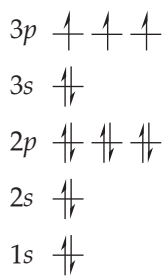
6. The Pauli exclusion principle states that only two electrons can occupy one orbital, and that they must have opposite spin.

   Relevant section of *Organic Chemistry*, 8th ed.: 1.3

7. Atomic orbitals in order of increasing energy: $1s$, $2s$, $2p$, $3s$, $3p$, $4s$, $3d$.

   Relevant section of *Organic Chemistry*, 8th ed.: 1.3

8. Ground-state configuration of phosphorus: $1s^2 2s^2 2p^6 3s^2 3p^3$.

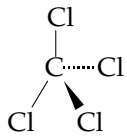


Relevant section of *Organic Chemistry*, 8th ed.: 1.3

9. In a molecule of methane all of the atoms lie in the same plane.
False.

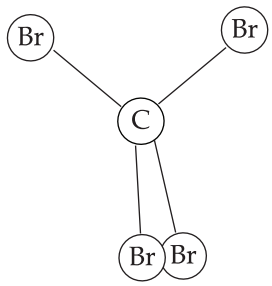
Relevant section of *Organic Chemistry*, 8th ed.: 1.4

10. Sketch of a molecule of tetrachloromethane:



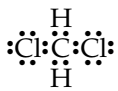
Relevant section of *Organic Chemistry*, 8th ed.: 1.4

11. Ball-and-stick model of tetrabromomethane:

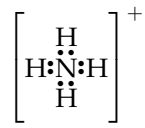


Relevant section of *Organic Chemistry*, 8th ed.: 1.4

12. Lewis structures:

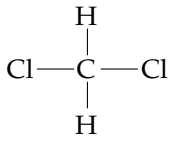
a. 

b. 

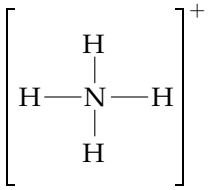
c. 

Relevant section of *Organic Chemistry*, 8th ed.: 1.4

13. Kekulé structures:

    a. 

    b. H—S—H

    c. 

    Relevant section of *Organic Chemistry*, 8th ed.: 1.4

14. A covalent bond forms when two atoms approach each other and their atomic orbitals overlap, allowing the sharing of a pair of electrons.

    Relevant section of *Organic Chemistry*, 8th ed.: 1.5

15. a. A 2*p* orbital on each of the two fluorine atoms must overlap to form the covalent bond.

    b. The 1*s* orbital of hydrogen and a 3*p* orbital of chlorine must overlap to form the covalent bond.

    Relevant section of *Organic Chemistry*, 8th ed.: 1.5

16. You would expect the bond in HI to be longer and weaker than the bond in HF, because iodine uses a 5*p* orbital to overlap with the 1*s* orbital of hydrogen, while fluorine uses a 2*p* orbital. The 5*p* orbital is bigger than the 2*p*, and cannot overlap as efficiently.

    Relevant section of *Organic Chemistry*, 8th ed.: 1.5

17. The mathematical mixing of one *s* orbital and three *p* orbitals to form four new orbitals is called sp^3-hybridization.

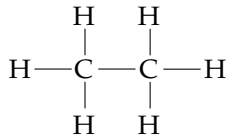
    Relevant section of *Organic Chemistry*, 8th ed.: 1.6

18. a. Each of the four C—H bonds in methane is formed by the overlap of the 1*s* orbital of a hydrogen atom with an sp^3-hybrid orbital of the central carbon atom.

    b. All of the bond angles in methane are 109.5°.

    Relevant section of *Organic Chemistry*, 8th ed.: 1.6

19. Kekulé structure of ethane:



The C—C bond is a σ bond formed by the overlap of an sp^3 orbital from each carbon atom.

All the C—H bonds are σ bonds involving an sp^3 orbital from carbon and a 1*s* orbital from hydrogen.

Relevant section of *Organic Chemistry*, 8th ed.: 1.7

20. The carbon-carbon bond in ethylene consists of a σ bond formed by the head-on overlap of two sp^2-hybrid orbitals, and a π bond formed by the side-on overlap of two (unhybridized) 2*p* orbitals.

Relevant section of *Organic Chemistry*, 8th ed.: 1.8

21. The triple bond in acetylene consists of a σ bond formed by the head-on overlap of two *sp* hybrid orbitals and two π bonds, each formed by the side-on overlap of two (unhybridized) 2*p* orbitals.

Relevant section of *Organic Chemistry*, 8th ed.: 1.9

22. The carbon-hydrogen bonds in acetylene are each formed by the overlap of an *sp* hybrid orbital from a carbon atom and the 1*s* orbital of a hydrogen atom.

Relevant section of *Organic Chemistry*, 8th ed.: 1.9

23. The H—C—C bond angle in ethane is 109.5°, in ethylene 120°, in acetylene 180°.

Relevant section of *Organic Chemistry*, 8th ed.: 1.7-1.9

24. Approximate lengths of carbon-carbon bonds:

    a. 154 pm
    b. 133 pm
    c. 120 pm

Relevant section of *Organic Chemistry*, 8th ed.: 1.9

25. The C—C—C bond angle in the compound allene is 180°. The central carbon atom in this compound is *sp*-hybridized. The carbon-carbon bonds in allene will be both shorter and stronger than those in propane.

Relevant section of *Organic Chemistry*, 8th ed.: 1.9

26. Each of the nitrogen atoms in hydrazine is sp^3-hybridized.

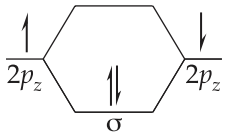
Relevant section of *Organic Chemistry*, 8th ed.: 1.10

27. Types of hybridization:

    a. phosphorus in PH_3—sp^3
    b. oxygen in OF_2—sp^3

    Relevant section of *Organic Chemistry*, 8th ed.: 1.10

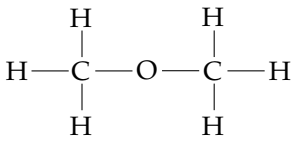
28. Molecular orbitals of the fluorine molecule:

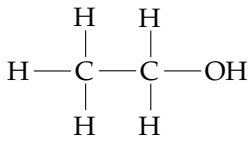


    Relevant section of *Organic Chemistry*, 8th ed.: 1.11

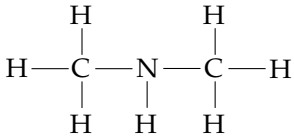
29. Kekulé structures:

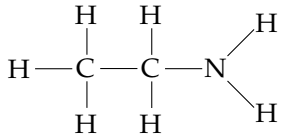
    a.





    b.





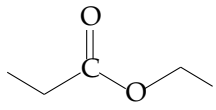
    Relevant section of *Organic Chemistry*, 8th ed.: 1.12

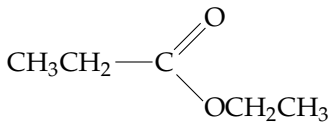
30. Molecular formulas:

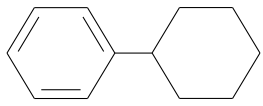
    a. $C_5H_{10}O_2$
    b. $C_{12}H_{16}$

    Relevant section of *Organic Chemistry*, 8th ed.: 1.12

31. Shorthand or skeletal structures:

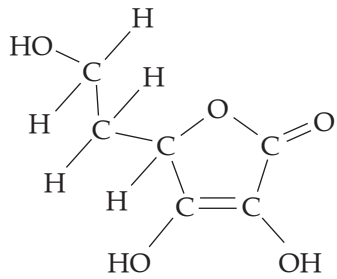






    Relevant section of *Organic Chemistry*, 8th ed.: 1.12

32. Kekulé structure of vitamin C:



Relevant section of *Organic Chemistry*, 8th ed.: 1.12

33. Molecular formula of caffeine:

$C_8H_{10}N_4O_2$

Relevant section of *Organic Chemistry*, 8th ed.: 1.12

34. Only you will know whether you were successful on this question. When you have mastered the objective, you should not only be able to make the models of the given compound, but should also feel comfortable when handling molecular models.

Relevant section of *Organic Chemistry*, 8th ed.: 1.12. You will also find this *Study Guide* useful.