

UNIVERSITY OF VICTORIA

CHEMISTRY 101
From Atoms to Materials

In-term Test 2
June 14th, 2024
9:00-10:00 am
ECS 116

VERSION A

Display your student ID card on your desk.

Do not begin until instructed by the invigilator.

Print and code your last name, first name, and your student ID number on the blue bubble sheet.

This test has 22 multiple choice questions on 5 pages.

A Data Sheet is provided.

The Sharp EL510 is the only approved calculator for this test.

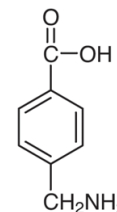
Select the best response for each question and record your answer on the blue bubble sheet.

Hand in the blue bubble sheet at the end of the test.

Only answers entered on the bubble sheet by the student by 10 am will be marked.

1. What is the molecular geometry around the carbon atom of the carboxylic acid in the molecule to the right?

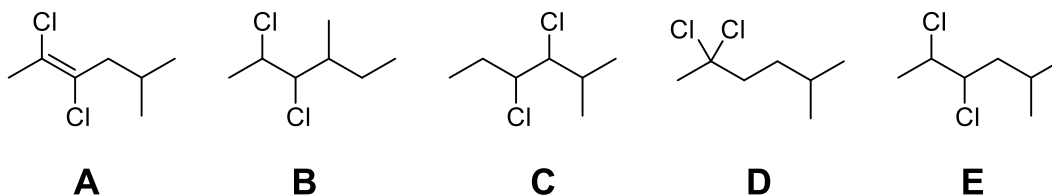
A. Tetrahedral B. Trigonal pyramidal C. T-shaped
D. Trigonal planar E. Square pyramidal



2. The hybridization of the central atom in $[\text{SbCl}_5]^{2-}$ is:

A. sp B. sp^2 C. sp^3 D. sp^3d E. sp^3d^2

3. What is the product when 4-methyl-2-hexene reacts with chlorine (Cl_2)?



4. Which of these statements about molecular orbitals is INCORRECT?

A. Each molecular orbital can hold up to two electrons
B. Molecular orbitals are created by combining atomic orbitals constructively or destructively
C. Molecular orbital theory explains why O_2 is paramagnetic (interacts with magnetic fields)
D. Combining two atomic orbitals on different atoms creates one new molecular orbital
E. The bond order can be calculated from a molecular orbital energy level diagram

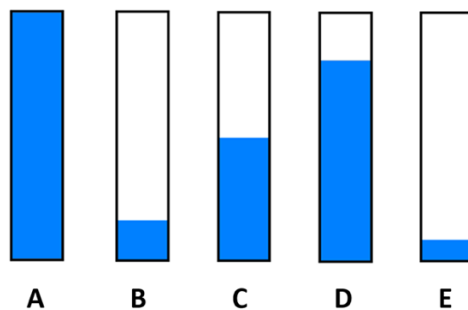
5. Why does the s band span a much larger energy range than the d band in a transition metal?

A. Because the s orbitals overlap more efficiently than the d orbitals with the surrounding atoms
B. Because the s orbital is lower in energy than the d orbitals
C. Because the s band can hold less electrons than the d band
D. Because the s band moves to a higher energy than the d band when electrons are removed
E. Because the s band fills up before the d band

6. Which of these statements about π bonds in organic molecules is INCORRECT?

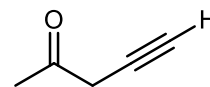
A. π bonds involve side-to-side overlap of unhybridized p orbitals
B. π bonds feature electron density above and below the internuclear axis
C. Any time there is a π bond between two atoms, there is also a σ bond
D. π bonds are weaker than σ bonds because of poorer overlap
E. A triple bond involves three π bonds between two atoms

7. Below are representations of the s - d band structure for 5 different metals. Which would you predict to be the **hardest** metal?

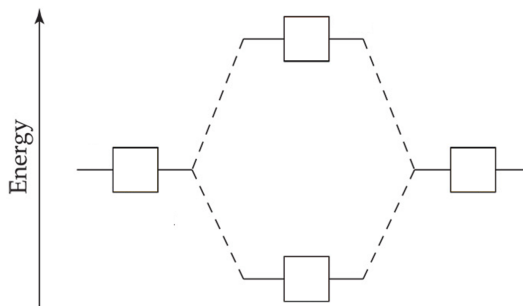


8. Examine the skeletal depiction of the molecule at right and count the number of σ and π bonds.

A. 4 σ , 2 π B. 6 σ , 3 π C. 5 σ , 3 π D. 4 σ , 5 π E. 6 σ , 4 π



9. Use the diagram to help you answer the following question. What is the bond order in H_2^- ?



A. 0 B. 0.33 C. 0.5 D. 0.67 E. 1

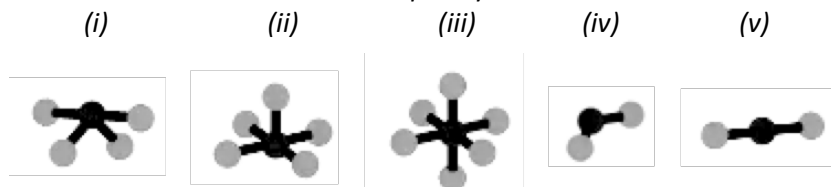
10. Consider the molecule $\text{H}_2\text{C}=\text{CH}_2$, how many sp^2 hybrid **orbitals** does it contain?

A. 1 B. 2 C. 3 D. 6 E. 8

11. Which of the following does NOT have delocalized π electrons?

A. CO_3^{2-} B. O_3 C. NO_3^- D. N_2 E. SO_4^{2-}

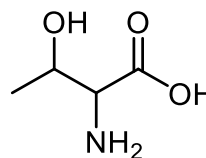
12. Which of these molecules could be sp^3d hybridized?



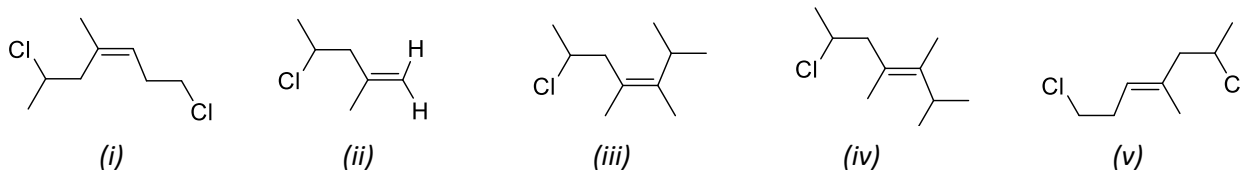
- A. *i* only B. *ii* only C. *v* only D. *i, ii, v* only E. *i and v* only

13. The molecule to the right is an essential amino acid. How many chiral carbon atoms are in it?

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



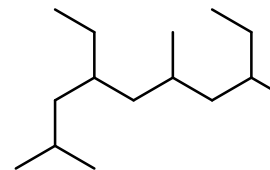
14. Which structure(s) represent(s) **trans** alkenes?



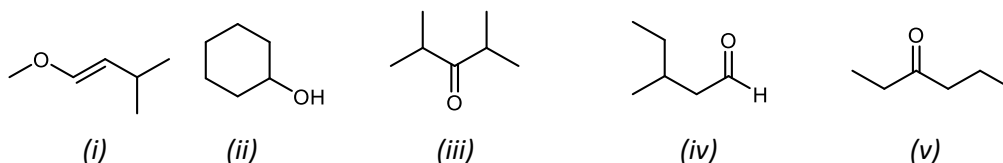
- A. *iii* only B. *iv* only C. *v* only D. *iv and v* only E. *i, ii, and iii* only

15. What is the name of the molecule at right?

- A. 4,8-diethyl-2,6-dimethylnonane B. 7-ethyl-3,5,9-trimethyldecane
C. 4-ethyl-2,6,8-trimethyldecane D. 2,6-diethyl-4,8-dimethylnonane
E. 2,4,6,8-tetramethyldecane

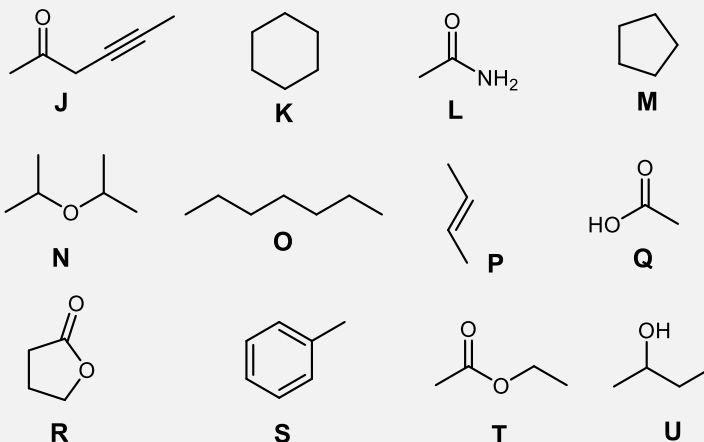


16. Which of these molecules is/are **NOT** an isomer of the others?



- A. *i* only B. *iv* only C. *iii* only D. *i and iii* only E. *ii and iv* only

The following 4 questions refer to this set of molecules labelled J to U:



17. Which of these molecules contain(s) an alcohol functional group?
A. **Q** only B. **U** only C. **N** only D. **Q** and **U** only E. **Q, U, N** and **L** only
18. Which of these molecules is (are) a hydrocarbon?
A. **O** only B. **K, M,** and **O** only C. **K, M, O, P,** and **S** only
D. **K, M, O,** and **S** only E. **S,** and **P** only
19. Which of these molecules contain(s) an ester functional group?
A. **R** and **T** only B. **N** only C. **J, L, Q, R,** and **T** only
D. **Q** and **R** only E. **U** only
20. Which of these molecules contain(s) an ether functional group?
A. **N** only B. **R** and **T** only C. **J, L, Q, R,** and **T** only
D. **Q** and **R** only E. **U** only
21. Which of these statements about bonding is INCORRECT?
A. The number of hybrid orbitals in an atom is the same as the number of electron domains (regions) it has
B. σ bonds are usually stronger than π bonds
C. Molecules with multiple resonance structures exhibit delocalized bonding
D. A molecule with tetrahedral geometry is sp^3 hybridized
E. An sp hybridized atom also has **one** unhybridized p orbital
22. A tiny chunk of tungsten (W) metal contains one billion atoms. How many electrons are in the s-d band of this metal chunk?
A. 1 billion B. 2 billion C. 3 billion D. **6 billion** E. 12 billion