UNIVERSITY OF VICTORIA

CHEMISTRY 101: *From Atoms to Materials*

In-term Test 2 November 17th, 2023
6-7 PM

VERSION B

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 24 multiple choice questions on 3 pages.
A Data Sheet is provided.

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

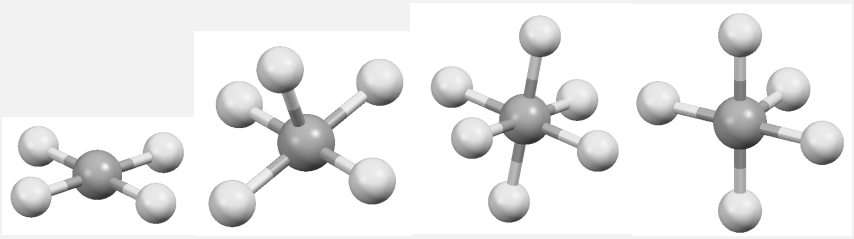
Select the best response for each question and record your answer on the blue bubble sheet.
Hand in the blue bubble sheet at the end of the test.

Only answers entered on the bubble sheet by the student by 7 PM will be marked.

1. Predict which of the following metals will have the highest melting point.
   A. Rb B. Nb C. Sr D. Ag E. Cu

2. Determine the nitrogen-oxygen bond order in the nitrate ion, NO_3^-.
   A. 0.33 B. 0.5 C. 1 D. 1.33 E. 1.5

Questions 3 to 5 refer to the following structures:



J **K** **L** **M**

3. Which of the above structures is/are based on an octahedral electron domain geometry (arrangement)?

   A. **L** only B. **K**, **L** & **M** only C. All of them D. **K** & **M** only E. **J**, **K** & **M** only

4. For the structure labeled **J** above, what atom would be the central atom **A** if the formula of the molecule is **A**F_4?

   A. Sb B. Xe C. Te D. I E. Sn

5. How many lone pairs does the central atom of structure **K** (above) possess?

   A. 0 B. 1 C. 2 D. 4 E. Not possible to determine

6. Which of the following ionic compounds would have the *lowest* **Lattice Energy**?
   A. CaO B. MgO C. BaO D. Al_2O_3 E. In_2O_3

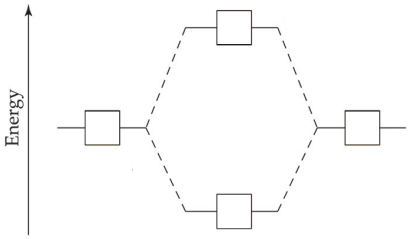
7. How many of these molecules are polar (*i.e.* has a non-zero molecular dipole moment)?
   [AlF_3 SiF_4 PF_5 SF_6]

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

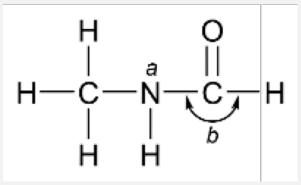
8. What is the molecular geometry of SiF_2Cl_2?
   A. Trigonal pyramidal B. See-saw C. Octahedral D. Tetrahedral E. Square planar

9. Use the following molecular orbital energy diagram to determine the bond order in HHe^+ (i.e. made from an H atom, an He atom, and having a positive charge).

   A. 0 B. 0.5 C. 1 D. 1.5 E. 2



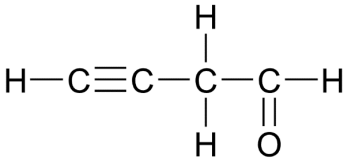
Questions 10-11 refer to the molecule at right. Note that non-bonding electrons are NOT shown.



10. How many lone pairs are there on the nitrogen atom labeled '***a***'?
A. 2 B. 4 C. 0 D. 3 E. 1

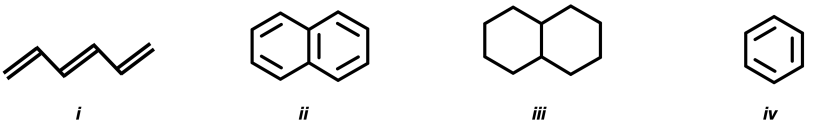
11. What is the bond angle marked '**b**'?
A. slightly under 120° B. 109.5° C. 120° D. 180° E. slightly over 120°

12. How many sigma (σ) bonds and how many pi (π) bonds are there in the following molecule?
A. σ, 3 π B. 11 σ, 5 π C. 6 σ, 5 π D. 11 σ, 3 π E. 8 σ, 3 π



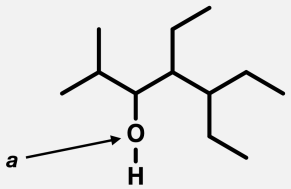
13. In a square pyramidal molecule, the hybridization must be:
A. sp^3d B. sp^3d^2 C. sp^4 D. sp^2 E. sp^3

14. Which of the following molecules are aromatic?



A. *i,ii* B. *iii,iv* C. *ii,iv* D. *i,iii* E. All four are

The next 3 questions on based on this figure:



15. The empirical formula corresponding to the skeletal structure shown is:
A. $C_{12}H_{26}O$ B. $C_{13}H_{22}O$ C. $C_{12}H_{25}O$ D. $C_{10}H_{25}O_2$ E. $C_{11}H_{23}O$

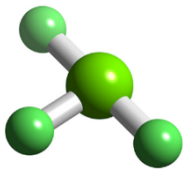
16. The hybridization of the atom labelled '***a***' is:
A. sp^3d^2 B. sp C. sp^2 D. sp^3 E. sp^3d

17. The most accurate name for the skeletal structure shown is:
A. 3,4-diethyl-6-methyl-5-heptanol B. 4-butanol-2-ethyl-hexane
C. 4-isopropyl-2-methyl-3-hexanol D. 2,3-diethyl-1-isopropyl-pentanol
E. 4,5-diethyl-2-methyl-3-heptanol

18. In which of the following compounds does every atom have an octet of electrons (8 electrons) in the Lewis structure?

A. IF_5 B. SF_6 C. SiF_4 D. NO_2 E. BF_3

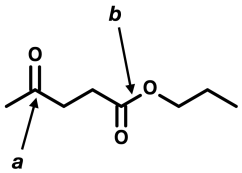
19. Which of these molecules have the shape shown to the right?



A. $GaBr_3$ B. BrF_3 C. AsH_3 D. PCl_3 E. NH_3

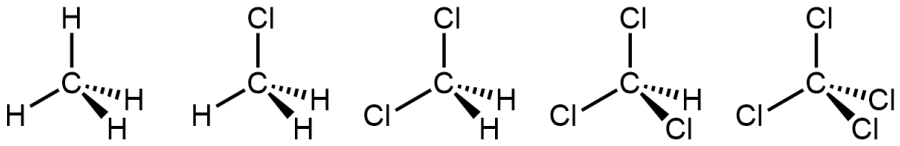
20. Which of the following statements about Valence Bond Theory is false?
   A. Mixing *n* atomic orbitals will generate 2*n* hybrid atomic orbitals
   B. The key to bond strength is strong overlap of the (hybrid or atomic) orbitals on two atoms
   C. Bonding occurs using half-filled orbitals on two atoms
   D. Hybridization involves constructive/destructive interference of atomic orbitals to create new shapes
   E. Hybridization of atomic orbitals works hand-in-hand with VSEPR theory to help us understand how electrons create a particular molecular geometry

21. The functional groups labelled '**a**' and '**b**' in the molecule at right are:



   A. Ketone, Amide B. Aldehyde, Ether C. Alcohol, Ester
   D. Ketone, Ester E. Ester, Ether

22. How many of the molecules below are non-polar?



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

23. Calculate the approximate enthalpy change of the following chemical reaction (burning hydrogen gas) in kJ/mol:

$$\tfrac{1}{2}\ O_2(g) + H_2(g) \rightarrow H_2O(g)$$

A. -429 B. -7 C. +213 D. -356 E. -254.5

24. A plot of change in potential energy versus distance for two H atoms combining to form H_2 is shown to the right. Which point (A, B, C, D, E) represents the average bond length of the H_2 molecule?