SECTION: (circle one): A01 (Dr. Burford) A02 (Dr. McIndoe) A03 (Dr. Briggs)

NAME _____ **Student No**. V00_____
(Please print clearly.)

SIGNATURE _____ (I am the above-named student.)

DISPLAY YOUR STUDENT ID CARD ON THE TOP OF YOUR DESK NOW

Version A	**UNIVERSITY OF VICTORIA** **CHEMISTRY 101** **Midterm Test 2** **November 18, 2011** **5-6 pm**	**Version A**

Answers written partially or completely in pencil cannot be remarked.

Answer all Part I (multiple choice) questions on the bubble sheet provided.

Answer all Part II questions on this paper. Hand in the entire test paper and the bubble sheet at the end of the test period (60 minutes). TOTAL MARKS = 50.

The basic Sharp EL510 calculator is the only one approved for use in Chemistry 101. A Data Sheet accompanies this test.

DO NOT BEGIN UNTIL TOLD TO DO SO BY THE INVIGILATOR

This test has two parts:

PART I is a multiple choice section and is worth 26 marks. The answers for the 14 questions in this part must be coded on the optical sense form using a ***SOFT PENCIL***.

PART II consists of written answers and is worth 24 marks. Answer these questions on this examination paper. ***Answers written partially or completely in pencil cannot be re-marked.***

Hand in this entire test paper AND your optical sense form (bubble sheet) at the end of the examination period (60 minutes). The basic Sharp EL510 calculator is the only one approved for use in Chemistry 101. A Data Sheet accompanies this test.

Marks for Written Answers (Part II)

Question 1 [3]	
Question 2 [4]	
Question 3 [9]	
Question 4 [2]	
Question 5 [6]	
TOTAL (/24)	

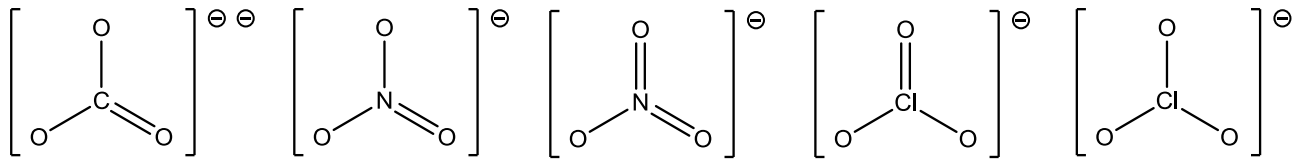
Multiple Choice (/26)	**Raw Written Score (/24)**	**Raw Score /50**	**TOTAL MARK (%)**

PART I – Multiple Choice: ***Select the*** **BEST** ***response for each question below*****. [Total marks = 26]**

1. This is exam Version A. **<u>Mark "A" as the answer to question 1 on the optical sense form.</u>**

2. The following Lewis structures are shown without non-bonding electrons. Each structure may be assumed to have the correct number of electrons for its charge. Which of the following Lewis structures is invalid? That is, which one cannot be a valid Lewis/resonance structure in a description of the bonding in that species?

A. B. C. D. E.



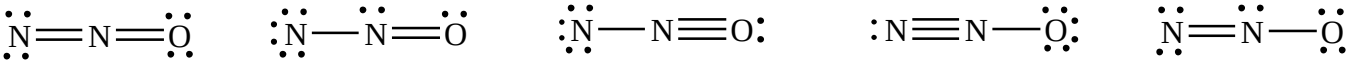
3. Predict the shape of the XeO_4 molecule.

A. trigonal planar B. tetrahedral C. trigonal pyramid

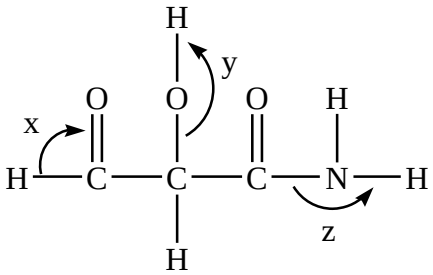
D. see saw E. square planar

4. Which one of the following resonance structures of nitrous oxide represents the most significant contributor to the bonding in this neutral molecule?

A. B. C. D. E.



5. To a close approximation, the bond angles marked x, y, and z in the molecule below are x)_____, y)_____, and z) _____ respectively.



A) 120°, 109°, 109° B) 120°, 109°, 120° C) 120°, 109.5°, 180°

D) 90°, 180°, 109° E) 120°, 120°, 120°

6. The molecule in question 5 above has _____sigma (σ) and _____ pi (π) bonds, respectively.

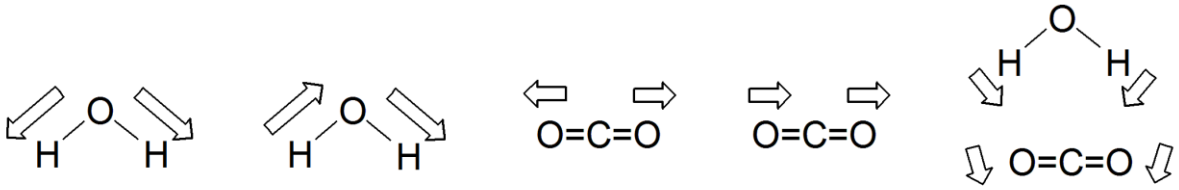
A) 9, 2 B) 13, 2 C) 2, 11 D) 11, 2 E) 4, 3

7. Which of the following the molecules would have a net molecular dipole moment (*i.e.* μ not equal to zero).

A) SO_3 B) CCl_4 C) NH_3

D) SF_6 E) O_2

8. Infra-red (IR) absorption is observed when molecular vibrations change the magnitude of the dipole moment of the molecule. Which one of the following vibrations of water and carbon dioxide does NOT cause IR absorption in an infrared spectrum?



A. H_2O symmetric stretch

B. H_2O asymmetric stretch

C. CO_2 symmetric stretch

D. CO_2 asymmetric stretch

E. H_2O or CO_2 bend

9. Estimate which bond angle is smallest based on the VSEPR model.

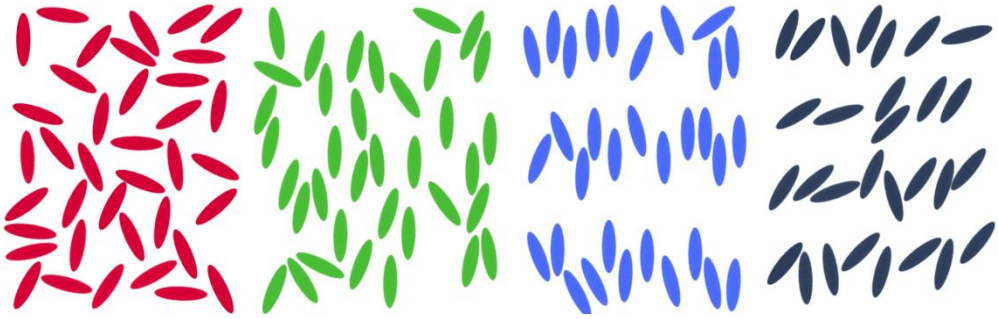
A. H-Si-H in SiH_4 B. H-P-H in PH_3 C. H-S-H in H_2S

D. H-C-H in $H_2C{=}O$ E. H-C-H in $H_2C{=}S$

10. Which property is NOT a characteristic of ionic liquids?

A. Non-volatile
B. Non-flammable
C. Ordered phase above the melting point
D. Mismatch of size/shape of anion and cation
E. Polyatomic cations and anions

11. Which of the sketches below depicts a nematic liquid crystal phase?



A. B. C. D. E. none of them

12. Which **ONE** of the following pairs of **molecule** and **intermolecular force** is CORRECT?

A. Benzene (C_6H_6), dipole-dipole.

B. CF_4, only London dispersion

C. CH_3CN, hydrogen bonding

D. PF_3, only London dispersion

E. CaF_2, dipole-dipole

13. Tungsten (W) has the highest melting point of all the pure metals (3422 °C). Using your knowledge of metallic bonding, choose the best explanation for this fact from the selection below.

A. Tungsten has electrons in the 5d subshell.

B. Tungsten's molecular orbitals form a continuous band.

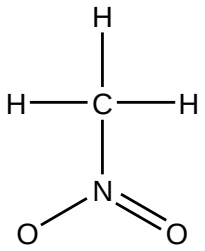
C. Tungsten has a half-filled s-d molecular orbital band, so the forces between atoms are of maximum strength.

D. Tungsten has as many anti-bonding electrons as bonding electrons, so the forces between atoms are of maximum strength.

E. Tungsten has a large first ionization energy, so it will not form an ionic lattice.

PART II – Written Answers to Questions. [Total Marks = 24]
Write your answers directly on this test paper. **Show all your work.** This helps us to award part marks instead of zero where appropriate. Hand in the entire test paper at the end of the test period.

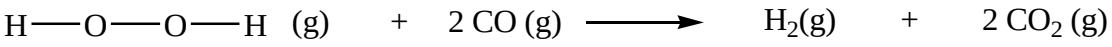
1. [3 Marks] (a) Complete the following Lewis structure of nitromethane by filling in the appropriate number of pairs of non-bonding electrons on the appropriate atoms. Then draw a second different Lewis structure for this molecule that obeys the octet rule. Then use these structures and the DATA sheet to estimate the length of the nitrogen-to-oxygen bond in nitromethane.



(b) Nitromethane has a boiling point of 103°C. What kind of intermolecular forces contribute most to giving this small molecule such a high boiling point? Circle ONE.

Ionic Ion-Dipole Dipole-Dipole Hydrogen Bonding London Dispersion

2. [4 MARKS]
The reaction of hydrogen peroxide (H_2O_2) with carbon monoxide (CO) to form hydrogen (H_2) and carbon dioxide (CO_2) is shown below. The bond dissociation energy (D) of the carbon-to-oxygen bond in CO is 1072 kJ mol^{-1}. Using data from the data sheet calculate an approximate enthalpy of reaction ($\Delta H_{reaction}$) for this process.



3. [9 Marks]

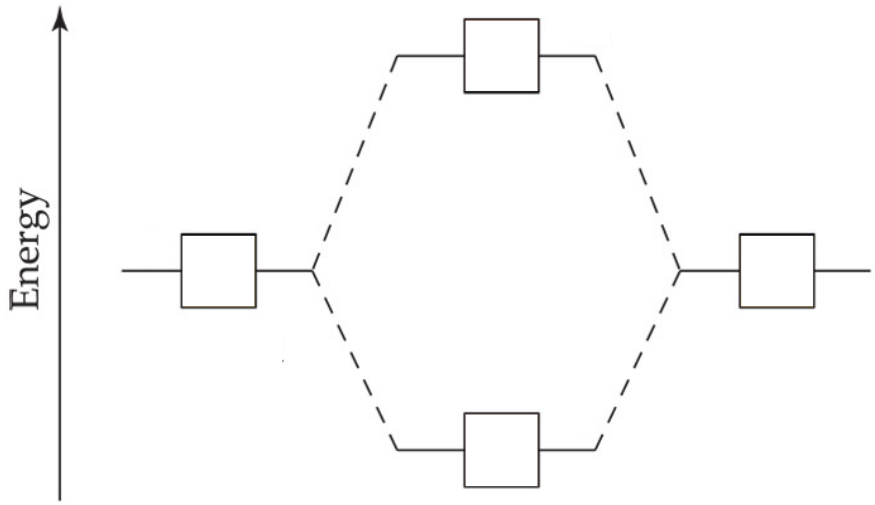
Complete the following table by filling in the appropriate information or drawing in each empty cell:

Molecular formula	KrF_2	$ClFO_3$ (Cl is central atom)	SbH_3
Lewis structure	[1]	[1]	[1]
Electron domain shape (central atom)	[0.5]	[0.5]	tetrahedral
Hybridization of central atom	sp^3d	[0.5]	[0.5]
Molecular shape **(sketch, but do not sketch orbitals)**	F—Kr—F [1]		[1]
Name of molecular shape**.**	linear	[0.5]	[0.5]
Is the molecule polar? (yes/no)	no	[0.5]	[0.5]

4. [2 MARKS] Consider the following molecular orbital energy diagram, which applies to diatomic species that use only 1s orbitals.

a) Using arrows to represent electrons (↑↓), use this diagram to represent the electron configuration of the He_2^+ ion.

b) Calculate the bond order in this ion.

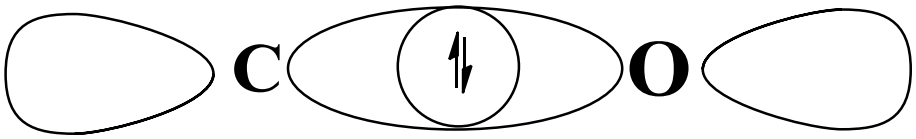


5. **[6 MARKS]**

Consider the carbon monoxide molecule CO.

(a) Draw one Lewis structure for CO that obeys the octet rule. Show any non-zero formal charges on the C and O atoms. [2MARK]

(b) Based on the structure in part (a) above, **complete the sketch below**. That is, ensure that the completed drawing includes all the atomic orbitals used to form ALL sigma (σ) bonds and pi (π) bonds in this molecule, as well as any orbitals containing lone pairs of electrons. Show clearly how the orbitals overlap to form bonds. **Label all the orbitals, including all the ones already shown (what type of hybrid orbital). Label <u>all</u> bonds as sigma (σ) or pi (π). [4 MARKS]**



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