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**SECTION: (circle one):** A01 MR (Dr. Burford)      A02 (Dr. Briggs)      A03 MWR (Dr. Burford)

**NAME** \_\_\_\_\_ **Student No.** V0 \_\_\_\_\_  
(Please print clearly.)

**SIGNATURE** \_\_\_\_\_ (I am the above-named student.)

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

<b>Version A</b>	<b>UNIVERSITY OF VICTORIA</b>  <b>CHEMISTRY 101</b> <b>Midterm Test 1</b> <b>October 12, 2012</b> <b>5-6 pm</b>	<b>Version A</b>
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Answers written partially or completely in pencil cannot be remarked.

**Answer all Part I (multiple choice) questions on the bubble sheet provided.**  
**PRINT and shade in only your surname, first name, and the last 7 digits of your student ID number on the bubble sheet. i.e. Omit the leading V0.** Do NOT include any info about the course, section or date on the bubble sheet.

**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.**

**A DATA sheet is included, unstapled, inside the cover page of this test.**

**This test has 7 pages (not including the DATA sheet). Count the pages before you begin.**

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

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**DO NOT BEGIN UNTIL TOLD TO DO SO BY THE INVIGILATOR**

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**This test has two parts:**

**PART I** is a multiple choice section and is worth 38 marks. The answers for the 20 questions in this part must be coded on the optical sense form (bubble sheet) using a **SOFT PENCIL**.

**PART II** consists of written answers and is worth 12 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).**

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**Marks for Written Answers (Part II)**

Question 1 [2]	
Question 2 [3]	
Question 3 [1]	
Question 4 [4]	
Question 5 [2]	
TOTAL (/12)	



Multiple Choice (/38)	Raw Written Score (/12)	<u>Raw Score /50</u>	<u>TOTAL MARK (%)</u>

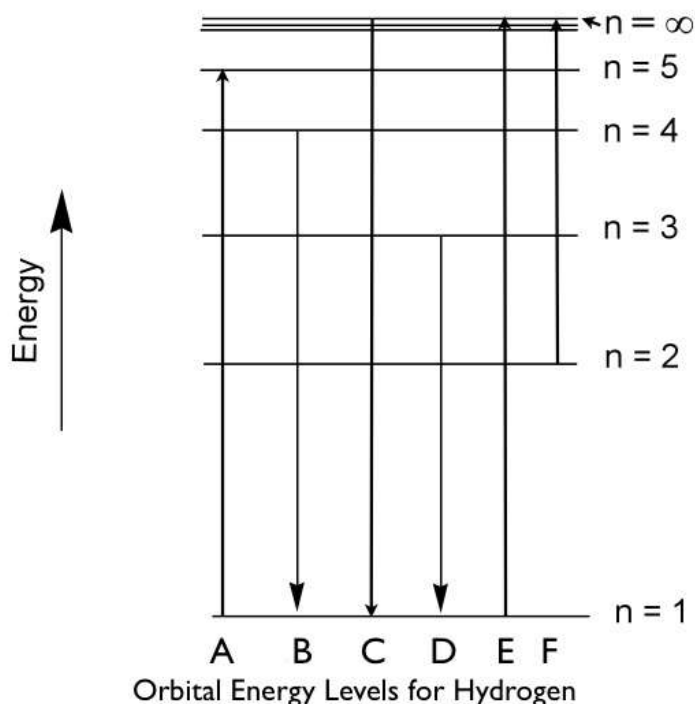
**PART I – Multiple Choice:** *Select the BEST response for each question below. [Total marks = 38]*

1. This is exam Version A. Mark “A” as the answer to question 1 on the optical sense form.

Use the orbital energy level diagram for hydrogen shown at the right to answer questions 2 to 4 below.

2. Which of the following statements is INCORRECT?

- A) Transition A represents an absorption.  
 B) Transition D represents an emission.  
 C) Transition A represents excitation of an electron to the fourth excited state.  
 D) The energy corresponding to transition F corresponds to  $I_1$ , the first ionization energy.  
 E) The hydrogen atom loses energy when it undergoes transition B.



3. Our course textbook gives the following formula for the wavelength of light corresponding to an electron transition in a hydrogen atom:

$$\frac{1}{\lambda} = R_H \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

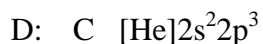
Where  $R_H$  (the Rydberg constant) =  $1.097 \times 10^7 \text{ m}^{-1}$  and where, of course, wavelength is not permitted to have negative values.

What is the frequency (in  $\text{s}^{-1}$ ) of the photon corresponding to transition C?

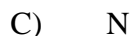
- A)  $1.097 \times 10^7$     B)  $3.29 \times 10^{-15}$     C) 2.73    D)  $3.29 \times 10^{15}$     E) 3.66
4. Using a formula from the data sheet, calculate the energy change (in Joules) corresponding to the transition labeled F.
- A)  $5.45 \times 10^{-19}$     B)  $-5.45 \times 10^{-19}$     C)  $2.18 \times 10^{-18}$     D)  $5.45 \times 10^{19}$     E)  $8.72 \times 10^{-18}$
5. Using data and the appropriate formula from the DATA sheet, calculate the de Broglie wavelength (in meters) of an electron that is ejected from a metal surface with a velocity of  $7.26 \times 10^6 \text{ m s}^{-1}$ .

- A)  $1.00 \times 10^{10}$     B)  $7.28 \times 10^{-4}$     C)  $1.00 \times 10^{-10}$     D)  $9.12 \times 10^{-41}$     E)  $5.50 \times 10^{-17}$

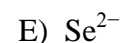
6. Which electron configuration is CORRECT for the element given?



7. Which of the following elements has the most negative (most favourable) value (in  $\text{kJ mol}^{-1}$ ) for its electron affinity?



8. Which of the following ions does NOT have a filled outer shell electron configuration?



9. Which set of three quantum numbers **DOES NOT** specify an orbital? That is, which set is not an allowed combination of quantum numbers?

A.  $n = 2, \ell = 1, m_\ell = -1$

B.  $n = 3, \ell = 3, m_\ell = 2$

C.  $n = 3, \ell = 2, m_\ell = 0$

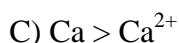
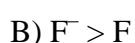
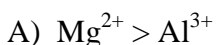
D.  $n = 4, \ell = 3, m_\ell = -1$

E.  $n = 5, \ell = 4, m_\ell = 4$

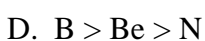
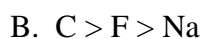
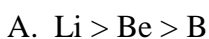
10. If  $A > B$  means that the ELECTRONEGATIVITY of A is greater than that of B, which inequality is FALSE?



11. If  $A > B$  means that the radius of A is greater than the radius of B, which of the following is INCORRECT?



12. Which one of the following responses contains the CORRECT order (from largest to smallest) of effective nuclear charge ( $Z_{\text{eff}}$ ) (i.e. for the outermost electron(s), the valence electron(s))?



13. Four atoms are arbitrarily labeled Q, R, S, and T. Their electronegativities are as follows:  $Q = 3.8$ ,  $R = 3.3$ ,  $S = 2.8$ ,  $T = 1.3$ . The atoms of these elements form the following compounds: QR, QT, RT, and QS. Which of the following choices arranges these molecules in DECREASING order of ionic character (*i.e.* most ionic first, most covalent last)?
- A)  $RT > QT > QS > QR$     B)  $QT > RT > QS > QR$     C)  $QR > QS > RT > QT$   
D)  $RT > QR > QS > QT$     E)  $QS > QR > QT > RT$
14. Which of the following is a CORRECT order of atomic radii from smallest to largest?
- A)  $H < He < Li$     B)  $P < Al < Na$     C)  $C < O < N$   
D)  $P < As < Se$     E)  $Si < N < Ge$
15. Which atom has the highest second ionization energy ( $I_2$ )?
- A) Mg    B) Al    C) S    D) Na    E) Si
16. Of the molecules LiF, HF, HCl,  $H_2O$  and KCl, the covalently bonded compounds are:
- A) KCl and  $H_2O$     B) HF and KCl    C) LiF and KCl    D) LiF and HF    E) HF, HCl and  $H_2O$
17. Identify the ion that has the following electron configuration.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$
- A)  $Co^+$     B)  $Cu^+$     C)  $Cu^{2+}$   
D)  $Ni^{2+}$     E)  $Zn^{2+}$
18. Which of the following pairs of ions are isoelectronic?
- A)  $Br^-$  and  $Sr^{2+}$     B)  $Si^{4-}$  and  $C^{4-}$     C)  $O^{2-}$  and  $Cl^-$   
D)  $Si^{4-}$  and  $Sn^{4+}$     E)  $Ca^{2+}$  and  $Zn^{2+}$
19. A Lewis structure for the  $NO^+$  ion that obeys the octet rule for both atoms must show how many bonds?
- A. zero    B. one    C. two  
D. three    E. four
20. Which of the following represents a possible electron configuration for an EXCITED STATE of the oxygen atom (O)?
- A.  $[He]2s^2 2p^4$     B.  $[He]2s^2 2p^4 3s^1$     C.  $[He]2s^2 4p^1$     D.  $[He]2s^3 2p^3$     E.  $[He]2s^2 2p^3 3s^1$

**Part II written answers to questions:**

Write your answers directly on this test paper. Show all your work.

Hand in the *entire test paper* at the end of the test period. [Total marks = 12]

**[2 MARKS]**

1. (a) [1 MARK] If core electrons were perfect at screening valence electrons from the nuclear charge, what would be the effective nuclear charge ( $Z_{\text{eff}}$ ) 'experienced by' the 4s valence electron of potassium (K)? Show or explain briefly how you arrive at your answer.

Ans:  $Z_{\text{eff}}$  would be = 1  $Z_{\text{eff}}$  is Z minus screening. Screening is by 18 core electrons and  $Z = 19$ .

- (b) [1 MARK] The real value is  $Z_{\text{eff}} = 3.5$ . Explain the discrepancy between this value and your answer in part (a).

Screening/shielding by core electrons is not perfect.

**[3 MARKS]**

2. Aluminum (Al) has three valence electrons.

Write three sets of the **four quantum numbers** ( $n, \ell, m_{\ell}, m_s$ ) that are valid quantum numbers for these three electrons. If you write more than three sets, only the first three will be marked.

**ANSWER** (3, 0, 0, +1/2) (3, 0, 0, -1/2)

& one of (3, 1, -1, +1/2), (3, 1, -1, -1/2), (3, 1, 0, +1/2), (3, 1, 0, -1/2), (3, 1, 1, +1/2), (3, 1, 1, -1/2)

**[1 MARK]**

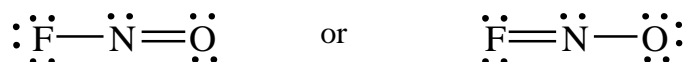
3. Write out the full electron configuration (*i.e.* not the condensed electron configuration) for the cobaltous ion  $\text{Co}^{2+}$ .

Answer:  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$

**[4 MARKS]**

4. Draw **ONE** valid Lewis structure that obeys the octet rule for nitrosyl fluoride FNO. (The atoms are connected in the order shown.)

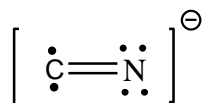
Show all bonding pairs of electrons as lines and all non-bonding valence electrons as dots.



Structures need 18 electrons, three bonds, octet rule OK, and order of atoms correct.

**[2 MARK]**

5. List two things that are wrong with the following Lewis structure. If you list more than two, only the first two will be marked. (You do not need to use the concept of formal charge to answer this question.)



Answer: any two of

- 1) The octet rule is not satisfied for carbon.
- 2) Electrons are normally paired in molecules.
- 3) Another structure is possible that has more bonds (and all electrons paired).

+++++ **THE END** +++++