


**Version
B**

UNIVERSITY OF VICTORIA
CHEMISTRY 101
Midterm Test 1
October 13, 2017
5-6 pm (60 minutes)

**Version
B**

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

Answer all multiple choice questions on the bubble sheet provided. Use a pen (or soft pencil). Complete the identification portion of the bubble sheet according to the example shown, using your own name and student ID number. Indicate your Test Version (A or B) in the line labeled 'Form'.



University
of Victoria

Legibly write your student number in the boxes below and fill in the corresponding circle below each number. Legibly write your name, the course, your instructor's name, and the date in the boxes below and place your signature in the appropriate box. Do not begin the exam itself until instructed to do so.

Sample Only

General Purpose

Five-Response

Answer Sheet

BLU

Student Identification

v	0	0	8	7	6	5	4	3
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Use Pen or Soft Pencil

Fill in the entire circle that corresponds to your answer for each question on the exam. Completely erase or cross out any response that you would like to change (e.g. ☐ ☒ ☐ ☐ ☐). Use HB pencil or Pen.

Code Answers Here

A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
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Numbering continues on reverse side.

1 ☐ ☐ ☐ ☐ ☐ 16 ☐ ☐ ☐ ☐ ☐ 31 ☐ ☐ ☐ ☐ ☐ 46 ☐ ☐ ☐ ☐ ☐

Family Name	Print Last Name Here
Given Name	Print First Name Here
Course	Chem 101
Section	A0...?
Instructor	Briggs or McIndoe
Date	13 October 2017
Signature	<i>Sign Here</i>
<p>I declare that: all the person(s) named I am formally registered as a student in the course indicated on this document.</p>	
Leave blank unless otherwise instructed	
Form	Shade Version here A or B
Special	Leave this row blank

Hand in only the bubble sheet at the end of the test period (60 minutes).

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 or the Sharp EL-510 RNB are the only ones approved for use in Chemistry 101.

DO NOT BEGIN UNTIL TOLD TO DO SO BY THE INVIGILATOR

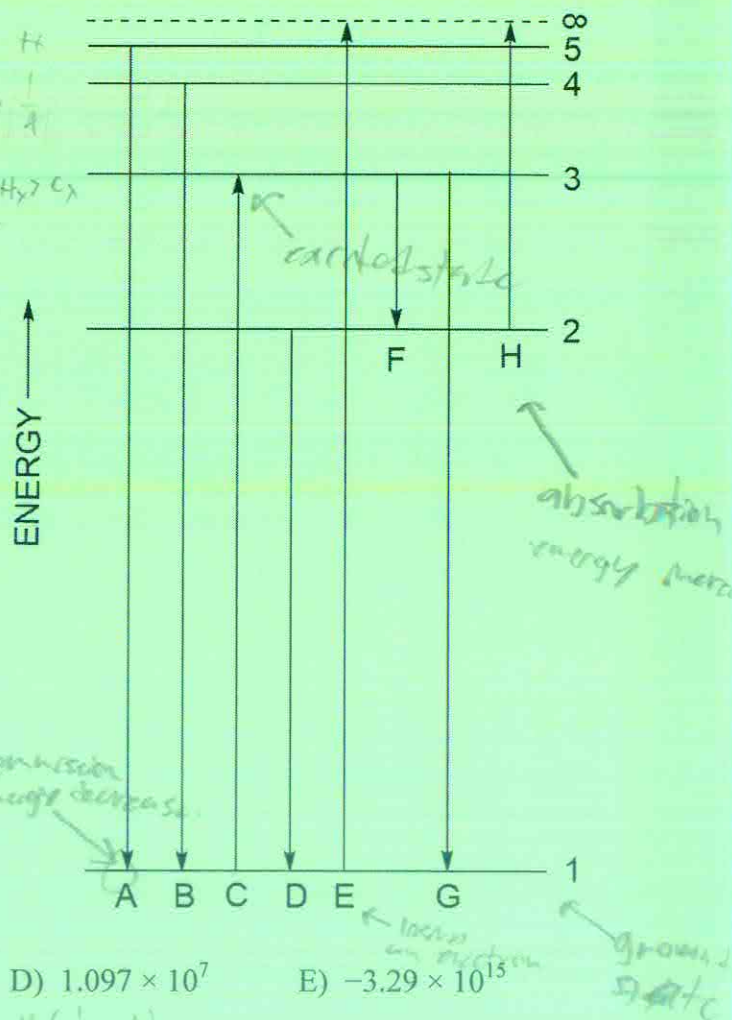
This test consists entirely of multiple choice questions and is worth 25 marks. There is one mark per question. The answers for the 25 questions must be coded on the optical sense form (bubble sheet) using a pen or a soft pencil.

Select the BEST response for each question below.

Use the orbital energy level diagram for hydrogen shown at the right to answer questions 1 to 3 below.

1. Which of the following statements is INCORRECT?

- A) Transition H represents an absorption.
- B) Transition A represents an emission.
- C) Transition C represents excitation of a ground state electron to an excited state.
- D) The energy corresponding to transition E corresponds to I_1 , the first ionization energy.
- E) A longer wavelength photon is involved in transition C than transition H.



2. Using a formula from the DATA sheet, calculate the frequency (in s^{-1}) of the photon corresponding to transition E.

- A) 3.29×10^{-15} B) 3.29×10^{15} C) 2.73 D) 1.097×10^7 E) -3.29×10^{15}

3. Using a formula from the DATA sheet, calculate the energy change (in Joules) corresponding to the transition labeled H.

- A) 5.45×10^{-19} B) -5.45×10^{-19} C) 2.18×10^{-18} D) 5.45×10^{19} E) 8.72×10^{-18}

4. Which of the following phenomena can be explained by the classical wave theory of light?

- A. emission spectra B. the photoelectric effect C. blackbody radiation
- D. destructive interference E. none of A, B, C or D.

does not explain emission & photoelectric effect

5. Sodium-vapor streetlamps are efficient because they emit light at a wavelength of 589 nm, near the peak sensitivity of the human eye. A typical streetlamp runs at 100 watts (that is, 100 joules per second).

How many photons would such a lamp emit in one second?

- A. 2.96×10^{20} B. 5.89×10^4 C. 3.38×10^{-19} D. 3.38×10^{-17} E. 2.96×10^{18}

Handwritten notes for Question 5:

- $E = \frac{hc}{\lambda}$
- $\lambda = \frac{c}{\nu}$
- $E = h\nu = \frac{hc}{\lambda}$
- $100 \text{ J} = 100 \text{ W} \cdot 1 \text{ s}$
- $C = 3 \cdot 10^8$
- $589 \text{ nm} = 589 \times 10^{-9} \text{ m}$
- $100 \text{ J} = (6.63 \cdot 10^{-34} \text{ J} \cdot \text{s}) \cdot \left(\frac{3 \cdot 10^8 \text{ m/s}}{589 \times 10^{-9} \text{ m}} \right) \cdot N$
- $N = 2.96 \times 10^{20}$

6. In an experiment involving the photoelectric effect, an electron is ejected from a metal surface with a velocity of $2.76 \times 10^6 \text{ m s}^{-1}$. If the uncertainty in the velocity of this electron is $1 \times 10^4 \text{ m s}^{-1}$, what is the uncertainty in the position of the electron in nanometers (nm)?

- A. 5.8×10^{-9} B. 5.8 C. 1.00×10^{-10} D. 73 E. 5.3×10^{-30}

Handwritten notes for Question 6:

- $\Delta x (\Delta mv) \geq \frac{h}{4\pi}$
- $\Delta x \geq \frac{h}{4\pi(\Delta mv)} = 22 \text{ nm}$

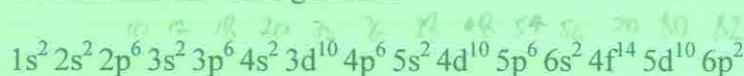
7. How many nodes are there in each of the 5s, 5p, 5d and 5f orbitals?

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

Handwritten notes for Question 7:

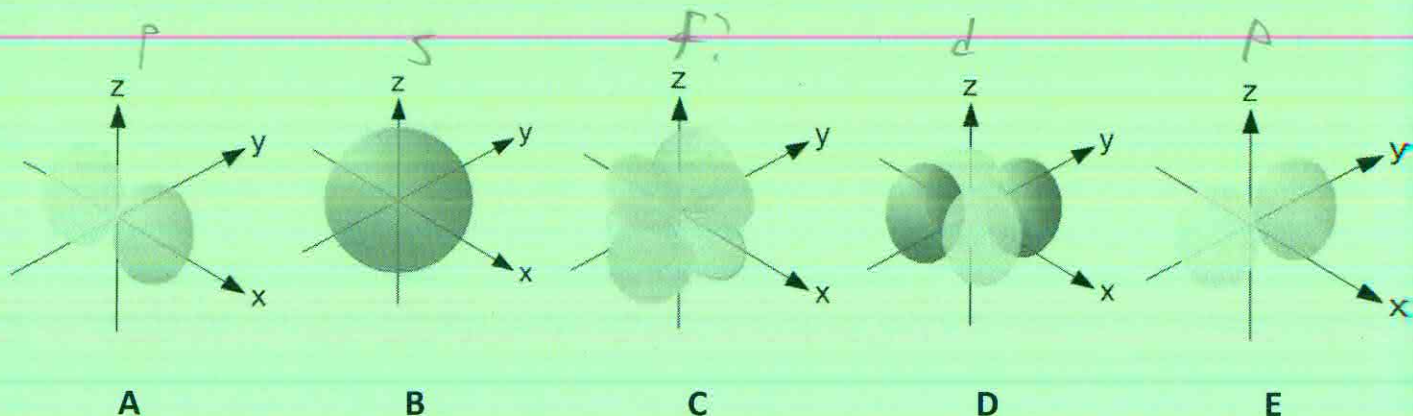
- $n = 5$
- $\text{nodes} = n - 1$

8. Consider the following electron configuration (written in Aufbau order). What neutral ground state element has this configuration?



- A. Bi B. Sb C. Pb D. Tl E. Hg

Below are some depictions of orbitals. Questions 9 - 12 refer to these pictures.



9. Which of these orbitals has an ℓ value (angular momentum quantum number) of 2?

- A. A B. B C. C D. D E. E

0, 1, 2 }
s p d f
↑

10. Which of these orbitals is NOT an s , p or d orbital?

- A. A B. B C. C D. D E. E

11. Which set of quantum numbers n , ℓ can be valid for the orbital **A** in the figure above?

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

there is no 1 p orbital

12. Which set of quantum numbers n , ℓ , m_ℓ , m_s can be valid for an electron in orbital **B** in the figure above?

- A. 0, 0, 0, $+\frac{1}{2}$ B. 1, 0, 1, $-\frac{1}{2}$ C. 2, 0, 0, $+\frac{1}{2}$ D. 1, 1, 0, $-\frac{1}{2}$ E. 1, 1, 1, $+\frac{1}{2}$

n l m_l m_s

13. Which of these ions does NOT have the same electronic configuration as a noble gas?

- A. Te^{2-} B. Y^{3+} C. Be^+ D. O^{2-} E. I^-

Xe

Kr

Li

Ne

Xe

14. What is the correct condensed electron configuration for Tl^{3+} ?

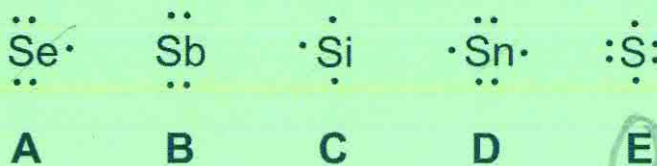
- ☐ [Kr] $6s^2 4f^{14} 5d^{10}$
- ☐ [Xe] $6s^2 4f^{14} 5d^{10} 6p^2$
- ☐ [Kr] $6s^2 4f^{14} 5d^8$
- ☐ [Xe] $6s^2 4f^{14} 5d^8$
- ☒ [Xe] $4f^{14} 5d^{10}$

15. Which of the following elements is expected to have the largest (*i.e.* most negative, most favorable) electron affinity?

- A. Kr B. Ca C. As D. Cl E. K

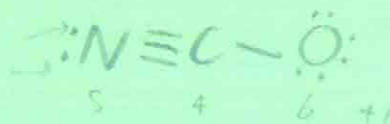
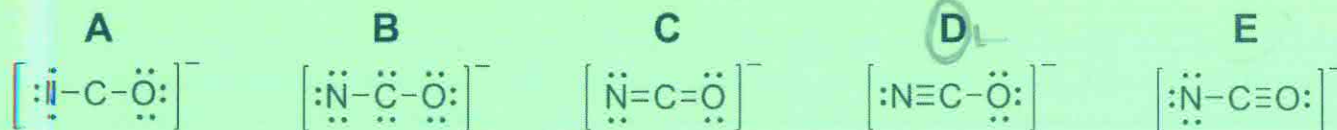
Start with up & right...

16. Which of these atoms as shown below has a correct Lewis symbol?



5 base Ar - 2 elec.

17. Which of these is the best Lewis structure for the isocyanate ion $[\text{NCO}]^-$?



18. Based on relative electronegativities, which of these is the MOST polar bond?

- A. O-Cl B. Br-I C. C-Cl D. S-Cl E. C-I

Polar bonds are covalent only.

Cl & C have the biggest difference in electronegativity.

19. Which of these ionic compounds has the highest lattice energy?

- A. MgO ~~B. CaCO~~ C. MgF₂ D. CaCl₂ E. NaBr

energy to separate atoms.

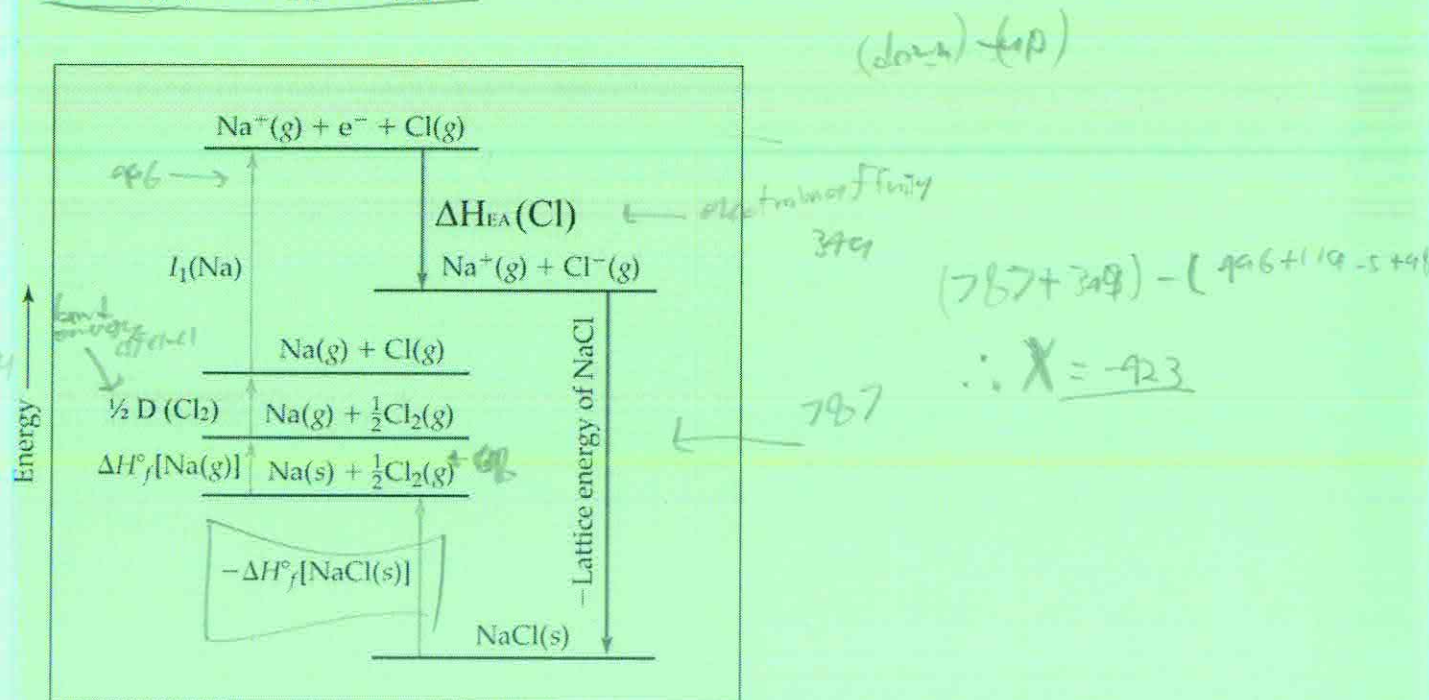
think: Oxygen creates high lattice energies as does Mg.

20. Elemental sodium and chlorine react vigorously and exothermically in a formation reaction to produce table salt, NaCl.

The following figure is a graph of the Born-Haber cycle for sodium chloride (NaCl). It is not drawn to scale. The energy units are kJ mol^{-1} .

The enthalpy of sublimation (vaporization, atomization) of sodium = $\Delta H_f^\circ [\text{Na(g)}] = 98 \text{ kJ/mol}$.

Using this Born-Haber cycle and information from the Data Sheet calculate the enthalpy of formation of NaCl(s) (i.e. $\Delta H_f^\circ [\text{NaCl(s)}]$).



- A. +303 B. -443 C. -423 D. -303 E. +423

21. Which of these elements has the highest second ionization energy?

- A. Mg B. P C. Al D. Na E. Cl

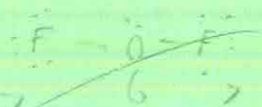
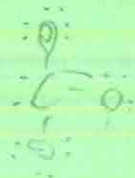
(I₂) from data sheet.

22. How many non-bonding valence electrons are there in a molecule of SeCl₂?

- A. 0 B. 12 C. 16 D. 18 E. 20



23. For which one of the following molecules or ions do we invoke resonance in describing the bonding?

A. N_2 B. CF_4 C. CO_3^{2-} D. PCl_5 E. OF_2 

24. Which of the following relationships is/are CORRECT when comparing lattice energies?

i. $BaO > KF$ ii. $CsBr > RbBr > NaCl$ iii. $BaF_2 > CaF_2$ iv. $NaCl > MgCl_2$ v. $NaCl > NaBr$

A. i & v only

B. ii only

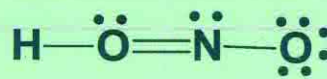
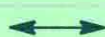
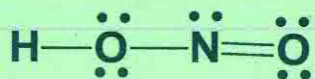
C. i & iii only

D. iii & v only

E. i, ii & iii

See data sheet.

25. Consider the two resonance structures for nitrous acid (HNO_2) shown below. What is the formal charge on the oxygen atom indicated by the arrow in each of the two resonance structures respectively?



A. +1, 0

B. -1, 0

C. 0, 0

D. 0, -1

E. 0, +1

$$\begin{array}{r} 6 \\ -6 \\ \hline 0 \end{array}$$

$$\begin{array}{r} 6 \\ -7 \\ \hline -1 \end{array}$$

(0, -1)

END

1. The first part of the document is a list of names and addresses of the members of the committee.

2. The second part is a list of the names and addresses of the members of the committee who have been elected to the office of the Secretary.

3. The third part is a list of the names and addresses of the members of the committee who have been elected to the office of the Treasurer.

4. The fourth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Chairman.

5. The fifth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Vice-Chairman.

6. The sixth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Secretary.

7. The seventh part is a list of the names and addresses of the members of the committee who have been elected to the office of the Treasurer.

8. The eighth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Chairman.

9. The ninth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Vice-Chairman.

10. The tenth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Secretary.

11. The eleventh part is a list of the names and addresses of the members of the committee who have been elected to the office of the Treasurer.

12. The twelfth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Chairman.

13. The thirteenth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Vice-Chairman.

14. The fourteenth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Secretary.

15. The fifteenth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Treasurer.

16. The sixteenth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Chairman.

17. The seventeenth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Vice-Chairman.

18. The eighteenth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Secretary.

19. The nineteenth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Treasurer.

20. The twentieth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Chairman.

21. The twenty-first part is a list of the names and addresses of the members of the committee who have been elected to the office of the Vice-Chairman.

22. The twenty-second part is a list of the names and addresses of the members of the committee who have been elected to the office of the Secretary.

23. The twenty-third part is a list of the names and addresses of the members of the committee who have been elected to the office of the Treasurer.

24. The twenty-fourth part is a list of the names and addresses of the members of the committee who have been elected to the office of the Chairman.