Exam 4 Chm 203 (Dr Mattson) 2 November 2015

Academic Integrity Pledge: *In keeping with Creighton University's ideals and with the Academic Integrity Code, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.*

Signature:

Name:

Chemistry Student Number: _____

Instructions: **Show all work whenever a calculation box is provided!** Write legibly. Include units whenever appropriate. You will receive credit for **how** you worked each problem as well as for the correct answer. If you need more space, you may use the back of the periodic table provided — Write: "See PT" in the answer box and then hand the periodic table in with your exam. On your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and purse-like items must be stored in the rear section of the room. Cell phones must be silent and placed in your backpack/bag/purse – not in your pocket.

$h = 6.626 \times 10^{-34}$ J s
$c = 2.998 \times 10^{8}$ m/s
$N_A = 6.023 \times 10^{23}$ mol^{-1}

1a. (1 pt) What are the units for frequency, ν?

A. s^{-1} B. cm^{-1} C. m D. s E. none of these

1b. (1 pt) What are the units for wavelength, λ?

A. s^{-1} B. cm^{-1} C. m D. s E. none of these

1c. (4 pts) Frequency is related to wavelength by the formula $\nu\lambda = c$. Convert 434 nm to frequency.

Show work for credit whenever a calculation box is provided!

Answer with units: _____

1d. (4 pts) The equation: $E = h\nu = hc/\lambda$ allows us to calculate the energy… (Circle all that apply.)

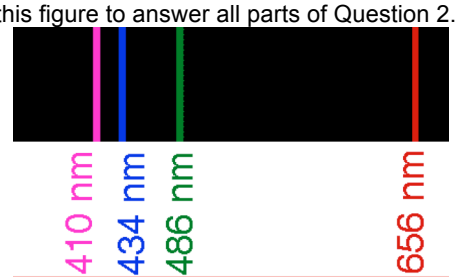
A. associated with a specific wavelength.
B. associated with a mole of hydrogen atoms.
C. released when a wavelength drops in value.
D. corresponding to a specific frequency.

1e. (4 pts) Convert the wavelength in Question 1c to units of kJ/mol.

Show work for credit!

Answer with units: _____

2. Use this figure to answer all parts of Question 2.



2a. (1 pt) What transition is associated with 656 nm?

A. $n = 2 \rightarrow n = \infty$ B. $n = 2 \rightarrow n = 3$
C. $n = \infty \rightarrow n = 2$ D. $n = 2 \rightarrow n = 6$
E. $n = 3 \rightarrow n = 2$ F. $n = 6 \rightarrow n = 2$

2b. (1 pt) Which line is associated with the most energy?

A. 410 nm B. 434 nm C. 486 nm D. 656 nm

2c. (1 pt) What sort of lines are these?

A. absorption B. emission C. transition D. ionization

2d. (2 pts) These lines are all associated in some way with $n = 2$ (either n_i or n_f). Compared to these lines, how would the lines with n = 1 differ?

A. they would involve forbidden transitions
B. they would involve shorter wavelengths
C. they would involve lower frequencies
D. they would involve less energy

3a. (2 pts) How many orbitals could theoretically have n = 1, 2, 3, or 7, respectively?

A. 1, 2, 3, 7 B. 1, 4, 9, 49
C. 2, 8, 18, 98 D. 2, 4, 6, 14

3b. (1 pt) What value(s) of n is/are **required** if $l = 5$?

A. $n > 4$ B. $n = 4$ C. $n > 5$ D. $n = 5$ E. $n > 6$

3c. (2 pts) Circle **all** possible values for n if if $m_l = -3$?

A. $n = 1$ B. $n = 2$ C. $n = 3$ D. $n = 4$ E. $n = 5$

3d. (2 pts) Circle **all** possible values for l if $m_l = 1$?

A. $l = 1$ B. $l = 2$ C. $l = 3$ D. $l = 4$ E. $l = 5$

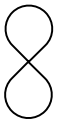
3e. (2 pts) Circle **all** possible values for l if n = 2?

A. $l = 1$ B. $l = 2$ C. $l = 3$ D. $l = 4$ E. $l = 5$

3f. (2 pts) Circle **all** possible values for n for $l = 0$?

A. $n = 1$ B. $n = 2$ C. $n = 3$ D. $n = 4$ E. $n = 5$

3g. (5 pts) Pictured here is an orbital we studied.



(i) What is one set of possible quantum numbers for this orbital?

(ii) How many electrons could occupy this orbital?

(iii) Is this orbital higher in energy than a 1s orbital?

(iv) How many other degenerate orbitals have the same quantum numbers n and l?

4. Consider this portion of the periodic table: (Hint: Write the electron configuration under each atomic symbol)

P	**S**
As	**Se**

4a. (3 pts) Write the full electron configuration for the ground state of P (do not use core notation this time)

4b. (2 pts) How many unpaired electrons are present in a ground state selenium atom?

4c. (2 pts) What are the quantum numbers n and *l* for the last electron in a ground state arsenic atom?

n = **l =**

4d. (2 pts) How many electrons in total have n = 3 for a ground state sulfur atom?

4e. (2 pts) How many electrons in total have *l* = 1 for a ground state sulfur atom?

4f. (2 pts) How many electrons in total for a ground state sulfur atom have *l* = 0?

4g. (2 pts) How many valence electrons are there in a arsenic atom?

4h. (2 pts) How many orbitals (for any atom) have both n = 3 and *l* = 2?

4i. (2 pts) The electron configuration [Ar] $4s^2$ $3d^{10}$ $4p^2$ $5f^1$ is a possible excited state for which atom?

4j. (3 pts) Write **one possible** set of quantum numbers for the $5f^1$ electron in Question 4i.

n = ***l* =** m_l **=** m_s **=**

4k. (2 pts) What is the transition that takes place when the $5f^1$ electron relaxes back to the ground state?

n = → **n =**

4l. (2 pts) What is the transition that takes place when a valence electron of sulfur is ionized?

n = → **n =**

5. Continue using the small portion of the periodic table above (top of the page) for all parts of Question 5.

5a. (2 pts) Which element in each pair has the largest effective nuclear charge? Circle 2 answers!

P or S As or Se

5b. (4 pts) Which element in each pair has the largest atomic radius? Circle 4 answers!

P or S As or Se P or As S or Se

5c. (4 pts) Which element in each pair has the largest first ionization energy? Circle 2 answers!

P or As S or Se

5d. (3 pts) Which element in each pair has the largest electron affinity? Circle 3 answers! (Phosphorus and arsenic have almost identical electron affinities.)

P or S As or Se S or Se

5e. (2 pts) Which atom has the largest fifth ionization energy?

5f. (2 pts) Which atom has the largest sixth ionization energy?

6. (4 pts) Circle the largest member in each group. Circle 4 answers!

S^{2-} Cl^- or Cl Mg^{2+} Na^+ or Na

S^{2-} Se^{2-} or Te^{2-} Be^{2+} Mg^{2+} or Ca^{2+}

7. (4 pts) What element has electron configuration…

[Ar] $4s^2$ $3d^{10}$ $4p^6$ as a +2 ion?

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ as a +1 ion?

[Ar] $4s^0$ $3d^5$ as a +2 ion?

$1s^2$ $2s^2$ $2p^6$ as a -1 ion?

8. (4 pts) Circle the member of each pair with the largest lattice energy. Circle 4 answers!

MgS or NaCl $MgCl_2$ or FeF_3

$FeSO_4$ or $FePO_4$ Na_2SO_4 or Na_3P

9. (10 pts) Nomenclature. Complete the following table. (If your are nomenclature certified, skip this question.)

ammonium sulfite	
nitric acid	
potassium bicarbonate	
copper(I) sulfide	
dinitrogen tetroxide	
	$HClO_2$
	$Mn(ClO_3)_2$
	$HBrO_3$
	NI_3
	HCl(aq)

Total score (out of 100): _____

A+ ≥ 95% A ≥ 90% B+ ≥ 85% B ≥ 80% C+ ≥ 75% C ≥ 70% D ≥ 60%

Answers

1a. A; 1b. C; 1c. $6.9 \times 10^{14}\ s^{-1}$; 1d. A and D; 1e. 276 kJ/mol

2a. E; 2b. A; 2c. B; 2d. B

3a. B; 3b. C; 3c. D and E; 3d. A, B, C, D, and E; 3e. A; 3f. A, B, C, D, and E

3g. (i) n = 2 (or more), $l = 1$, $m_l = -1, 0, +1$; (ii) 2; (iii) Yes; (iv) 2

4a. P $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$; 4b. 2; 4c. n = 4, $l = 1$; 4d. 6

4e. 10; 4f. 6; 4g. 5 (or 15); 4h. 5 4i. As

4j. n = 5, $l = 3$, $m_l = -3 \ldots +3$; $m_s = -\frac{1}{2}$ or $+\frac{1}{2}$; 4k. n = 5 → n = 4; 4l. n = 3 → n = ∞

5a. S, Se; 5b. P, As, As, Se; 5c. P, S; 5d. S, Se, S 5e. S 5f. P

6. S^{2-}; Na; Te^{2-}; Ca^{2+}

7. Sr, K, Mn, F

8. MgS; FeF_3; $FePO_4$; Na_3P

9.

ammonium sulfite	$(NH_4)_2SO_3$
nitric acid	HNO_3
potassium bicarbonate	$KHCO_3$
copper(I) sulfide	Cu_2S
dinitrogen tetroxide	N_2O_4
chlorous acid	$HClO_2$
manganese(II) chlorite	$Mn(ClO_3)_2$
bromic acid	$HBrO_3$
nitrogen triiodide	NI_3
hydrochloric acid	HCl(aq)