

Name _____

Student Number: _____

Chem 115
Sample Examination #3

This exam consists of seven (7) pages, including this cover page. Be sure your copy is complete before beginning your work. If this test packet is defective, ask for another one.

A copy of the Periodic Table is attached to the end of this exam. You may remove it and use the back side as scratch paper. No work on scratch paper will be graded or collected.

The following information may be useful:

Constants of natureSpeed of light, $c = 2.998 \times 10^8$ m/sPlanck's constant, $h = 6.626 \times 10^{-34}$ J·s $hcR_H = 2.18 \times 10^{-18}$ J/atom = 1312 kJ/molConversions/Metric Prefixes1 nm = 10^{-9} m1 Hz = 1 s^{-1} Equations

$$c = \lambda \nu$$

$$E = h \nu$$

$$E_n = -\frac{hcR_H}{n^2}$$

from which can be derived that

$$\Delta E = -hcR_H \left(\frac{1}{n_{final}^2} - \frac{1}{n_{initial}^2} \right)$$

DO NOT WRITE BELOW THIS LINE

Part I: Multiple-choice	Part II: Problems	Part III: Laboratory
Q1-21 _____ (max 63)	Problem 1 _____ (max 20) Problem 2 _____ (max 8) Extra credit _____ (max 4)	<i>omitted from this sample exam since laboratory is now a separate course</i>

Total (out of 100 points) = *due to Part III omission
no longer sums to 100*

Part I. Multiple-Choice or Short Response

Each multiple-choice question is worth 3 points. This part of the exam is worth 63% of the total points.

1. An argon atom is isoelectronic with

- A) Cl B) Ca C) Ti^{4+} D) N^{3-} E) Rb^+
-

2. The energy of a photon is greatest in the case of

- A) infrared radiation C) visible light
B) ultraviolet radiation D) X-radiation
-

3. In which compound does ionic bonding predominate?

- A) LiBr B) CO C) H_2O D) SiC
-

4. Which ion has the largest radius?

- A) Cl^- B) F^- C) K^+ D) Ca^{2+}
-

5. Which pair of elements has the most similar chemical properties?

- A) C and F C) Li and Be
B) P and As D) As and Se
-

6. Which is an acceptable set of quantum numbers for a 3d electron?

- | | n | l | m_l | m_s |
|----|-----|-----|-------|----------------|
| A) | 3 | 2 | 1 | $+\frac{1}{2}$ |
| B) | 3 | 3 | 1 | $+\frac{1}{2}$ |
| C) | 2 | 2 | -1 | $-\frac{1}{2}$ |
| D) | 2 | 3 | 2 | $-\frac{1}{2}$ |
-

7. Predict which element would have the largest difference between its first and second ionization energies.

- A) sodium
 B) silicon
 C) phosphorus
 D) magnesium

8. The compound of which two elements is most likely to involve covalent bonding?

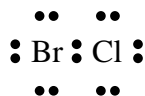
Electronegativities of unknown elements			
Q	0.9	X	3.0
R	1.0	Z	4.0
T	2.8		

- A) **Q** and **Z**
 B) **R** and **T**
 C) **T** and **X**
 D) **R** and **X**
 E) **R** and **Z**

9. Among the alkali metals, cesium (Cs) reacts more rapidly than sodium. To what may this be ascribed?

- A) Cesium has a higher nuclear charge than sodium.
 B) The valence electron in cesium is at a greater average distance from the nucleus.
 C) Cesium has a higher atomic weight than sodium.
 D) Cesium has more electrons than sodium.
 E) Cesium has more neutrons than sodium.

10. The BrCl molecule may be represented by the electronic formula



The polarity is best represented by

- A) $\delta^- \quad \delta^-$
 B) $\delta^+ \quad \delta^-$
 C) $\delta^+ \quad \delta^+$
 D) $\delta^- \quad \delta^+$

11. The element in Period 5, Group 3A, has the outer electron configuration

- A) $5s^2 5p^1$ B) $3s^2 3p^5$ C) $3s^2 3p^3$ D) $5s^2 5p^3$
-

12. In what respect does an atom of magnesium differ from a magnesium ion (Mg^{2+})?

- A) The ion has a more stable electronic arrangement than the atom.
B) The positive charge on the nucleus of the ion is two units greater than the nuclear charge on the atom.
C) The ion has two more protons than the atom.
D) The ion will react more readily with free Cl_2 .
E) The ion has two more planetary electrons than the atom.
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13. Emission spectra (line spectra) may be attributed to an electron

- A) spiraling into a nucleus.
B) changing its atomic energy level.
C) reversing its direction of spin.
D) escaping from the atom.
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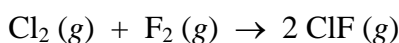
14. The ground-state electronic configuration of the manganese (Mn) atom is

- A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^5$
B) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$
C) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^5$
D) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$
-

15. Which set of quantum numbers is possible for an electron in an atom?

- A) $n = 3, l = 0, m_l = 1, m_s = -1/2$
B) $n = 2, l = 2, m_l = -2, m_s = -1/2$
C) $n = 5, l = 2, m_l = 2, m_s = +1/2$
D) $n = 4, l = 3, m_l = -4, m_s = +1/2$
-

16. Calculate ΔH° for the chemical reaction



Bond	Bond energy (kJ·mol ⁻¹)
Cl-Cl	243
F-F	159
Cl-F	255

- A) -147 kJ B) -108 kJ C) +171 kJ D) +912 kJ

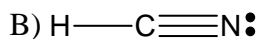
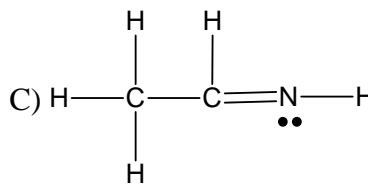
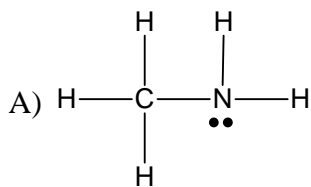
17. What is the number of unpaired electrons in an isolated free iron atom (atomic number 26) in the ground state?

- A) zero B) one C) two D) three E) four
-

18. The ionization potential is

- A) the voltage required to remove an electron from an atom or ion.
B) the voltage required to cause a weak electrolyte to ionize.
C) the same as the electrode potential.
D) the same as the ionization constant.
E) lower for the inert gases than for all other elements.
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19. Which compound contains the *longest* carbon-to-nitrogen bond?



D) All are equal.

20. Arrange the elements Li, Ne, Na and Ar in increasing order of the energy required to remove the first electron from their respective atoms.

- A) $\text{Na} < \text{Li} < \text{Ar} < \text{Ne}$ C) $\text{Na} < \text{Li} < \text{Ne} < \text{Ar}$
B) $\text{Li} < \text{Na} < \text{Ar} < \text{Ne}$ D) $\text{Ar} < \text{Ne} < \text{Na} < \text{Li}$
-

21. Which electron transition is associated with the largest *emission* of energy?

- A) $n = 2$ to $n = 1$ C) $n = 2$ to $n = 4$
B) $n = 2$ to $n = 3$ D) $n = 3$ to $n = 2$
-

Part II. Problems

Points possible per question and per part are indicated in curly braces {...}.

1. {20 pts}

a) Draw the Lewis structures and answer the questions about them. If resonance structures exist, draw all the resonance structures. {7 pts each}

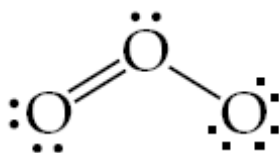


Provide evidence for how you determined the total number of valence electrons in the molecule.



What is the Si-O bond order?

b) Label the formal charges on each atom in the Lewis structure of ozone (O_3) shown below. {6 pts}



2. Compare potassium and calcium in terms of their

- most common ionic charge, and
- ionization energy.

In each case, account for the difference between the two elements. That is, explain *why* they are different. {8 pts}

Extra credit {up to 4 pts}: The lattice energy of CaO is 3,414 kJ/mol while the lattice energy of KF is 808 kJ/mol. Explain this both qualitatively and quantitatively.