NAME: (print) _____ UIN #: _____

CHEMISTRY 107

Section 501
Exam #2–Version A
March 11, 2015
Dr. Larry Brown

This is a **50-minute** exam, and contains **8** problems. There should be **8** numbered pages, including this one. There is also a periodic table attached to the back of the exam; you may tear the periodic table page off, and you do not need to turn that page in. Point values for the different questions are as indicated. Some constants and conversion factors you might need are listed below.

Please show ALL of your work as clearly as possible. This will help us award partial credit. Answers without supporting work may not receive credit. You may use a calculator for this exam, but you may NOT retrieve or use any alphanumeric information or algorithms that might be stored in your calculator's memory.

Please PRINT your name and UIN number above, and **SIGN the honor code statement below**. Also, please put your name on every page of the exam, in case a page gets detached from the exam.

Potentially Useful Information

PHYSICAL CONSTANTS		**CONVERSION FACTORS**
Avogadro's Number	$N_A = 6.022 \times 10^{23}$ mol^{-1}	1 atm = 760 torr = 14.7 lb in^{-2}
Gas Constant	R = 0.08206 L atm mol^{-1} K^{-1}	1 atm = 101,324 N m^{-2}
	= 8.314 J mol^{-1} K^{-1}	0°C = 273.15 K
	= 62.364 L torr mol^{-1} K^{-1}	1 m = 10^9 nm = 10^6 μm
Planck's Constant	$h = 6.626 \times 10^{-34}$ J s	1 L = 1,000 mL
Speed of light	$c = 2.9979 \times 10^8$ m s^{-1}	1 kJ = 1,000 J
		1 MJ = 1,000 kJ

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this exam."

SIGNATURE: _____

(18 pts) **1.** Fill in the blanks in each statement below. (You should only need one or two words for each. You may use the same word more than once if appropriate.)
TWO POINTS FOR EACH STATEMENT.

(a). A gas is more likely to behave ideally if the temperature is _____.

(b). _____ have relatively low ionization energies and tend to form positively charged ions.

(c). In any atom, the electrons in the highest occupied shell are called _____.

(d). A photoelectron spectrum for silicon should show a total of _____ distinct peaks.

(e). Wavelength and _____ are two different ways to specify the color of light.

(f). _____ is a measure of the relative tendency for an atom to attract the shared electrons in a chemical bond.

(g). An element whose electron configuration contains one or more unpaired electrons is said to be _____.

(h). The ground state electron configuration for _____ is $[Kr]5s^2 4d^{10} 5p^5$. (Name or symbol is OK.)

(i). Elements in the same _____ in the periodic table tend to have similar chemical properties.

(For Grading)	
Problem	Score
1 (18)	
2 (18)	
3 (9)	
4 (6)	
5 (10)	
6 (15)	
7 (12)	
8 (12)	
TOTAL	

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2. Answer each of the following questions as indicated.

(4 pts) (a). Write the electron configuration for the monatomic ion most likely to be formed by nitrogen. (Write out all of the electrons; do not use any shorthand notations.)

(4 pts) (b). Place the following species in order of <u>increasing</u> <u>radius</u>: I, I^-, Xe, Kr. (Please answer by filling in the blanks below.)

_____ < _____ < _____ < _____
(smallest radius) (largest radius)

(4 pts) (c). Place the following species in order of <u>increasing</u> <u>ionization energy</u>: Rb, Sr^{2+}, Se, Kr. (Please answer by filling in the blanks below.)

_____ < _____ < _____ < _____
(smallest IE) (largest IE)

(3 pts) (d). Place the following bonds in order of <u>increasing</u> <u>polarity</u>: Li–F, I–I, Si–F. (Please answer by filling in the blanks below.)

_____ < _____ < _____
(least polar) (most polar)

(3 pts) (e). All of the following atoms are paramagnetic. Which one should be most strongly paramagnetic? (Please circle your choice.)

Al C F Li N S

3. Consider a particular electron in a silicon (Si, $Z = 14$) atom. The electron has the following quantum numbers: $n = 2, l = 1, m_l = 0$. (Please write your answers on the lines provided.)

(3 pts) (a). What type of orbital ($1s$, $4d$, etc.) does this electron occupy? _____

(3 pts) (b). *Assuming the atom is in its ground state electron configuration*, what is the maximum number of electrons in any one silicon atom that could have this set of quantum numbers?

_____

(3 pts) (c). List all the possible values for the m_s quantum number for this electron. _____

4. Consider the following samples of gas, and then answer the questions below by circling the correct choice. (No need to show work here.)

1.0 L of CH_4 at 25°C and 1 atm

1.0 L of F_2 at 25°C and 2 atm

(2 pts) (a). Which sample's molecules have the highest average speed?

the F_2 the CH_4 both the same

(2 pts) (b). Which sample's molecules have the highest average kinetic energy?

the F_2 the CH_4 both the same

(2 pts) (c). Which sample contains the most molecules?

the F_2 the CH_4 both the same

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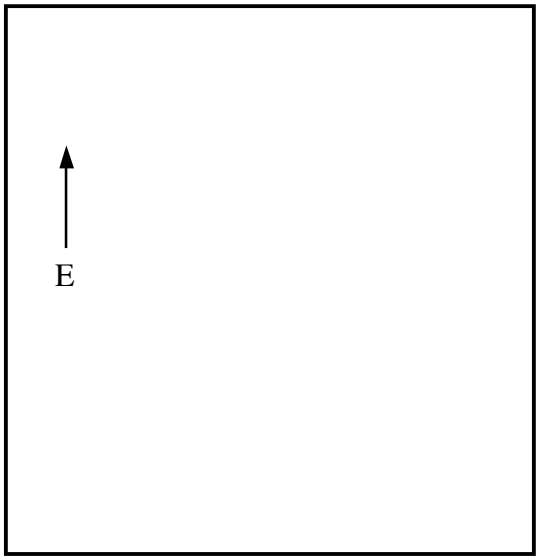
(10 pts) **5.** A 1.50-L flask contains a sample of helium gas. When 1.608 g of krypton (Kr, $Z = 36$) is injected into the flask, the total pressure of the helium and krypton mixture is found to be 948 torr at 24.0°C. What mass of helium is in the flask? (The volume of the flask and the amount of helium in the flask remain the same throughout; the krypton is simply being added to the same flask that already contains the helium.)

6. An atom originally in its ground state absorbs a photon (we can call it 'A') with a wavelength of 100.0 nm as it makes a transition to a higher energy state. The atom then emits two photons: one (B) with wavelength 500.0 nm to reach an intermediate energy level, and then a second (C) to return to the ground state.

(5 pts) (a). In the box to the right, sketch an energy level diagram depicting this process. Label the various transitions as A, B, and C to show which one corresponds to each of the photons. (λ_A = 100 nm, λ_B = 500 nm, and λ_C is unknown.)



(10 pts) (b). Find the frequency of photon C (the second emitted photon).

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(12 pts) **7.** Nickel metal will react with CO gas to form a compound called nickel tetracarbonyl ($Ni(CO)_4$), which is a gas at temperatures above ~45°C.

A 1.50-L glass bulb is filled with CO gas to a pressure of 1.20 atm at 73.0°C, and then 0.5869 g of pure Ni is added. If the reaction described above occurs and goes to completion at constant temperature, what will the final *total* pressure in the bulb be? (You can assume that any volume occupied by the solid nickel is negligible compared to the volume of the flask.)

(12 pts) **8.** When a photoelectric effect experiment was carried out using a metal 'M' and light at wavelength λ_1, electrons were emitted with a kinetic energy of 1.9×10^{-19} J. The wavelength was reduced to 1/2 of its original value and the experiment was repeated (still using the same metal target). This time electrons were emitted with a kinetic energy of 8.1×10^{-19} J. Find the electron binding energy for metal M. (The actual wavelengths used were not recorded, but it <u>is</u> still possible to find the binding energy.)