NAME:______________________________ Student Number:________________________

Fall 2017 **Chemistry 1000 Midterm #1A** ____/ 60 marks

INSTRUCTIONS:

1) Please read over the test carefully before beginning. You should have 6 pages of questions and a formula/periodic table sheet.
2) If your work is not legible, it will be given a mark of zero.
3) Marks will be deducted for incorrect information added to an otherwise correct answer.
4) Marks will be deducted for improper use of significant figures and for missing or incorrect units.
5) Show your work for all calculations. Answers without supporting calculations will not be given full credit.
6) You may use a calculator.
7) You have 90 minutes to complete this test.

Confidentiality Agreement:
I agree not to discuss (or in any other way divulge) the contents of this test until after 8:00pm Mountain Time on Tuesday, October 17th, 2017 (i.e. 24 hours **after** you finish writing this test). I understand that breaking this agreement would constitute academic misconduct, a serious offense with serious consequences. The minimum punishment would be a mark of 0/60 on this exam and removal of the "overwrite midterm mark with final exam mark" option for my grade in this course; the maximum punishment would include expulsion from this university.

Signature: ______________________________ Date: ________________________________

Course: CHEM 1000 (General Chemistry I)
Semester: Fall 2017
The University of Lethbridge

Spelling matters!

Fluorine = F Fluorene = $C_{13}H_{10}$

Flourine =

Question Breakdown

Q1	/ 18
Q2	/ 3
Q3	/ 4
Q4	/ 5
Q5	/ 5
Q6	/ 4
Q7	/ 4
Q8	/ 9
Q9	/ 8

Total	/ 60

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1. Fill in each blank with the word or short phrase that best completes the sentence.

[18 marks]

(a) Scandium (Sc) has a single naturally occurring isotope. A naturally occurring neutral atom of scandium has _____ protons, _____ neutrons and _____ electrons.

(b) The breakdown of an atom of ${}^{235}_{92}U$ into two smaller nuclides and several neutrons is an example of a nuclear reaction that would be classified as __________________________.

(c) The radiation weighting factor (W_R) is used to convert the _____________________ dose of radiation into the _____________________ dose.

(d) The photoelectric effect experiment showed that light can behave as a ________________.

(e) Electromagnetic radiation that is slightly lower in energy than visible light is called __________________________.

(f) Heisenberg's uncertainty principle says that is impossible to simultaneously determine the location and the _________________________ of an electron with high accuracy.

(g) The principle that tells us that only two electrons with opposite spin can occupy an orbital is called the ____ principle.

(h) The angular momentum quantum number (l) for an *f* orbital is _____.

(i) The number of $6f$ orbitals in one atom is ____, and the allowable values for their magnetic quantum numbers (m_l) are ______________________________. *(List them all.)*

(j) Write the electron configuration for a neutral atom of bromine (Br) using line notation. **<u>Do not use the noble gas abbreviation.</u>**

____

(k) For each of the ions below, write the electron configuration in line notation **<u>using the noble gas abbreviation</u>**.

i. Fe^{3+} _____________________ ii. Ag^{+} _____________________

(l) For each of the ions in part (k), indicate whether it is paramagnetic or diamagnetic.

i. Fe^{3+} _____________________ ii. Ag^{+} _____________________

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2. Complete the table below. **[3 marks]**

Isotope	$^{78}Se^{2-}$	
Number of electrons		36
Number of neutrons		48
Number of protons		
Overall charge	-2	+1

3. **[4 marks]**

(a) Write a balanced nuclear equation for the alpha decay of $^{229}_{90}Th$.

(b) Write a balanced nuclear equation for the beta decay of $^{223}_{87}Fr$.

4. Draw and label a complete set of 3d orbitals. Your pictures must include phase and labeled axes. DO NOT draw radial nodes. **[5 marks]**

Drawings that are not accompanied by a label (name) for the specific orbital will not get full credit.

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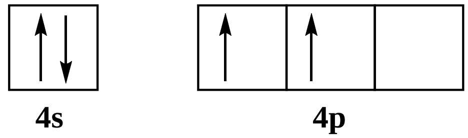
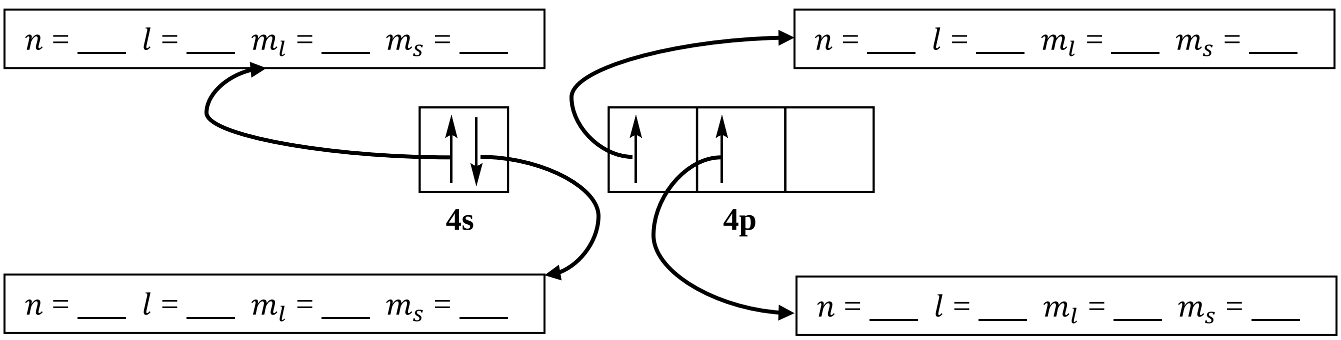
5. Consider the following valence orbital occupancy diagram: **[5 marks]**



(a) Which neutral element is this diagram describing? *[1 mark]*

(b) Fill in the blanks on the diagram below to assign a valid set of quantum numbers to each electron on this valence orbital occupancy diagram: *[4 marks]*



6. **[4 marks]**

(a) Calculate the energy change for the reaction in which a positron and electron are annihilated. Report your answer in J. *[3 marks]*

(b) Does your answer indicate that energy is absorbed or released by this reaction? How do you know? *[1 mark]*

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7. Rhenium has two naturally occurring isotopes: ^{185}Re and ^{187}Re. The isotopic masses of ^{185}Re and ^{187}Re are 184.952 955 u and 186.955 750 u, respectively.

   Calculate the percent abundances of the two naturally occurring isotopes of rhenium. *Your answer must make it clear which abundance is for which isotope.* **[4 marks]**

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8. The ^{18}F isotope is regularly used in positron emission tomography (PET). **[9 marks]**

(a) Write a balanced nuclear equation for the reaction in which ^{18}F emits a positron. *[2 marks]*

(b) Briefly explain why ^{18}F undergoes positron emission. *[2 marks]*

(c) Based on your answer to part (b), there should be one other type of nuclear decay that you might predict ^{18}F to undergo. If you didn't have experimental data that told you a positron was emitted, what would be the other type of nuclear decay predicted for ^{18}F? *[1 mark]*

(d) ^{18}F has a half life of 109.8 minutes. If you start with a sample containing 5.34 mmol ^{18}F, how much ^{18}F will be left after 5 hours? *[4 marks]*

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9. **[8 marks]**

(a) Calculate the energy of an electron in a 2*s* orbital in a hydrogen atom. *[1 mark]*

(b) Calculate the energy of an electron in a 4*s* orbital in a hydrogen atom. *[1 mark]*

(c) What wavelength of light should you use to excite an electron in a hydrogen atom from the 2*s* orbital to the 4*s* orbital?

Express your final answer using an appropriate SI prefix so that the value is between 0.1 and 1000. *[4 marks]*

(d) Does the wavelength change if the electron is excited from the 2*s* to the 4*p* orbital of the hydrogen atom? If so, does it get longer or shorter? If not, why not? *[2 marks]*

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Some Useful Constants and Formulae

Fundamental Constants and Conversion Factors

Atomic mass unit (u)	$1.660\ 539 \times 10^{-27}$ kg	Planck's constant	$6.626\ 070 \times 10^{-34}$ J·Hz^{-1}
Avogadro's number	$6.022\ 141 \times 10^{23}$ mol^{-1}	Proton mass	1.007 277 u
Bohr radius (a_0)	$5.291\ 772 \times 10^{-11}$ m	Neutron mass	1.008 665 u
Electron charge (e)	$1.602\ 177 \times 10^{-19}$ C	Rydberg Constant (R_H)	$2.179\ 872 \times 10^{-18}$ J
Electron mass	$5.485\ 799 \times 10^{-4}$ u	Speed of light in vacuum	$2.997\ 925 \times 10^{8}$ m·s^{-1}

Formulae

$$c = \nu\lambda \qquad E = h\nu \qquad p = mv \qquad \lambda = \frac{h}{p} \qquad \Delta x \cdot \Delta p > \frac{h}{4\pi}$$

$$r_n = a_0 \frac{n^2}{Z} \qquad E_n = -R_H \frac{Z^2}{n^2} \qquad E_k = \frac{1}{2}mv^2$$

$$\Delta E = \Delta mc^2 \qquad A = -\frac{\Delta N}{\Delta t} \qquad A = kN \qquad \ln\left(\frac{N_2}{N_1}\right) = -k(t_2 - t_1) \qquad \ln(2) = k \cdot t_{1/2}$$

Chem 1000 Standard Periodic Table

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1.0079 **H** 1																	4.0026 **He** 2
6.941 **Li** 3	9.0122 **Be** 4											10.811 **B** 5	12.011 **C** 6	14.0067 **N** 7	15.9994 **O** 8	18.9984 **F** 9	20.1797 **Ne** 10
22.9898 **Na** 11	24.3050 **Mg** 12											26.9815 **Al** 13	28.0855 **Si** 14	30.9738 **P** 15	32.066 **S** 16	35.4527 **Cl** 17	39.948 **Ar** 18
39.0983 **K** 19	40.078 **Ca** 20	44.9559 **Sc** 21	47.88 **Ti** 22	50.9415 **V** 23	51.9961 **Cr** 24	54.9380 **Mn** 25	55.847 **Fe** 26	58.9332 **Co** 27	58.693 **Ni** 28	63.546 **Cu** 29	65.39 **Zn** 30	69.723 **Ga** 31	72.61 **Ge** 32	74.9216 **As** 33	78.96 **Se** 34	79.904 **Br** 35	83.80 **Kr** 36
85.4678 **Rb** 37	87.62 **Sr** 38	88.9059 **Y** 39	91.224 **Zr** 40	92.9064 **Nb** 41	95.94 **Mo** 42	(98) **Tc** 43	101.07 **Ru** 44	102.906 **Rh** 45	106.42 **Pd** 46	107.868 **Ag** 47	112.411 **Cd** 48	114.82 **In** 49	118.710 **Sn** 50	121.757 **Sb** 51	127.60 **Te** 52	126.905 **I** 53	131.29 **Xe** 54
132.905 **Cs** 55	137.327 **Ba** 56	**La-Lu**	178.49 **Hf** 72	180.948 **Ta** 73	183.85 **W** 74	186.207 **Re** 75	190.2 **Os** 76	192.22 **Ir** 77	195.08 **Pt** 78	196.967 **Au** 79	200.59 **Hg** 80	204.383 **Tl** 81	207.19 **Pb** 82	208.980 **Bi** 83	(210) **Po** 84	(210) **At** 85	(222) **Rn** 86
(223) **Fr** 87	226.025 **Ra** 88	**Ac-Lr**	(265) **Rf** 104	(268) **Db** 105	(271) **Sg** 106	(270) **Bh** 107	(277) **Hs** 108	(276) **Mt** 109	(281) **Ds** 110	(280) **Rg** 111	(285) **Cn** 112	(284) **Nh** 113	(289) **Fl** 114	(288) **Mc** 115	(293) **Lv** 116	(294) **Ts** 117	(294) **Og** 118

138.906 **La** 57	140.115 **Ce** 58	140.908 **Pr** 59	144.24 **Nd** 60	(145) **Pm** 61	150.36 **Sm** 62	151.965 **Eu** 63	157.25 **Gd** 64	158.925 **Tb** 65	162.50 **Dy** 66	164.930 **Ho** 67	167.26 **Er** 68	168.934 **Tm** 69	173.04 **Yb** 70	174.967 **Lu** 71
227.028 **Ac** 89	232.038 **Th** 90	231.036 **Pa** 91	238.029 **U** 92	237.048 **Np** 93	(240) **Pu** 94	(243) **Am** 95	(247) **Cm** 96	(247) **Bk** 97	(251) **Cf** 98	(252) **Es** 99	(257) **Fm** 100	(258) **Md** 101	(259) **No** 102	(262) **Lr** 103

Developed by Prof. R. T. Boeré (updated 2016)

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Some Useful Masses

$^{4}_{2}\alpha$	4.001 506 179 u
$^{1}_{1}p$	1.007 276 467 u
$^{1}_{0}n$	1.008 664 916 u
$^{0}_{+1}\beta$	0.000 548 579 9 u
$^{0}_{-1}\beta$	0.000 548 579 9 u

Band of Stability Graph

The graph below shows the band of stability. Stable isotopes are in black. Isotopes that exist but are not stable are shown in varying shades of gray with the shades of gray corresponding to different half-lives.

The original version of the graph used a rainbow colour scale.

http://commons.wikimedia.org/wiki/File:Isotopes_and_half-life_eo.svg