NAME:______________________________ Student Number:________________________

Spring 2020 **Chemistry 1000 Midterm #1A** ____/ 60 marks

INSTRUCTIONS:
1) Please read over the test carefully before beginning. This exam consists of 11 questions.
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.

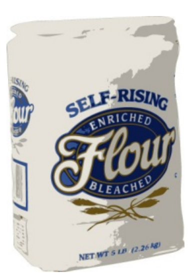
Confidentiality Agreement:
I agree not to discuss (or in any other way divulge) the contents of this exam until they have all been marked and returned. I understand that breaking this agreement would constitute academic misconduct, a serious offense with serious consequences. The minimum punishment would 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: Spring 2020
The University of Lethbridge

Spelling matters!

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

Flourine =



Question Breakdown

Q1	/ 4
Q2	/ 8
Q3	/ 3
Q4	/ 5
Q5	/ 4
Q6	/ 6
Q7	/ 4
Q8	/ 4
Q9	/ 6
Q10	/ 4
Q11	/ 12

Total	/ 60

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1. Complete the following table. **[4 marks]**

Symbol	**# protons**	**# neutrons**	**# electrons**
$^{97}_{43}Tc$			
$^{129}_{53}I^{-}$			
	22	26	18

2. Draw and label the following orbitals. *Each orbital must be drawn on a labeled set of axes and must show relative phase. You are not required to show any radial nodes.* **[8 marks]**

(a) a 5s orbital

(b) a $4p_y$ orbital

(c) a $3d_{z^2}$ orbital

(d) a $3d_{x^2-y^2}$ orbital

3. The $^{20}_{9}F$ nuclide is unstable and will undergo decay to form a more stable nuclide. What is the most probable mode of decay for $^{20}_{9}F$? Briefly explain your answer. **[3 marks]**

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4. Thallium has two naturally occurring isotopes. ^{203}Tl has a natural abundance of 29.524% and an atomic mass of 202.9723 u. Calculate the natural abundance and the atomic mass for ^{205}Tl. **[5 marks]**

5. **[4 marks]**

(a) Draw an orbital occupancy diagram ("orbital box diagram") for a neutral ground state iron atom (Fe). Include all electrons and label all subshells.

(b) How many valence electrons does a neutral ground state iron atom have?

(c) Is a neutral ground state iron atom paramagnetic or diamagnetic?

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6. Write electron configurations for each of the following species in the ground state. *Use the noble gas notation, but always show all electrons in the valence shell explicitly.*

[6 marks]

(a) Ru^{4+}

(b) In

(c) As^{3-}

7. There are seven classes of nuclear reactions. Classify each of the following as one of the seven different types of nuclear reactions. **[4 marks]**

(a) $^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{152}_{60}Nd. + ^{81}_{32}Ge + 3^{1}_{0}n$

(b) $^{36}_{13}Al + ^{0}_{-1}e \longrightarrow ^{26}_{12}Mg$

(c) $^{64}_{29}Cu \longrightarrow ^{64}_{28}Ni + ^{0}_{1}\beta^{+}$

(d) $^{2}_{1}H + ^{1}_{1}H \longrightarrow ^{3}_{2}He$

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8. A sample of Radon-222 ($^{222}_{86}Rn$) has an initial activity of 7.0 x 10^4 Bq. After 6.6 days, its activity is 2.1 x 10^4 Bq. Calculate the half-life of radon-222. **[4 marks]**

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9. Calculate the energy change for the following fission reaction: **[6 marks]**

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{152}_{60}Nd. + {}^{81}_{32}Ge + 3{}^{1}_{0}n$$

(a) Report your answer in J.

(b) Report your answer in J/mol.

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10. Radon-222 (^{222}Rn) transmutes to a stable nuclide by emitting α and β particles. The first four steps of this decay series are α-decay, α-decay, β-decay, and β-decay. Write this sequence as four separate, balanced nuclear reactions. **[4 marks]**

11. Fill in each blank with the word or short phrase that best completes the sentence. **[12 marks]**

(a) In the photoelectric effect experiment, whether or not a current will flow depends on the ________________________ of the incident light.

(b) A wave with a wavelength of 12 nm has ______________________ energy than a wave with a wavelength of 32 nm.

(c) The ______________________________ states that no two electrons in an atom can have the same set of quantum numbers.

(d) An electron in a 6*f* orbital has n = ______ and ℓ = _______.

(e) The maximum number of electrons in a single atom that can have $n = 2$, $\ell = 0$ and $m_s = -½$ is _______.

(f) The unit for the equivalent dose of radiation is the ___________________. The equivalent dose is essentially the _____________________________multiplied by a radiation weighing factor (W_R).

(g) A neutral atom of chlorine has ________ core electrons and _________ valence electrons.

(h) According to the Bohr model of the atom, electrons within an allowed _______________ can move without radiating. Bohr calculated the energy of the electron in a hydrogen atom using this equation: _____________________.

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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 x 10^{-18} J
Electron mass	$5.485\ 799 \times 10^{-4}$ u	Speed of light in vacuum	2.997 925 x 10^{8} m·s^{-1}

Formulae

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

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

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

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

${}^{4}_{2}\alpha$	4.002 603 254 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
${}^{235}_{92}U$	235.043 930 u
${}^{152}_{60}Nd$	151.924 692 u
${}^{81}_{32}Ge$	80.928 832 u

Band of Stability Graph

The graph below shows the band of stability. The black dots represent all known stable isotopes.