NAME:__________________________ Student Number:_____________________

Fall 2012 **Chemistry 1000 Practice Midterm #1B** ____/ 55 marks

INSTRUCTIONS:
1) Please read over the test carefully before beginning. You should have 7 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 exam until after 8:30pm Mountain Time on Monday, October 15th, 2012. I understand that breaking this agreement would constitute academic misconduct, a serious offense with serious consequences. The minimum punishment would be a mark of 0/55 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 2012
The University of Lethbridge

Spelling matters!

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

Flourine =

Question Breakdown

Q1	/ 2
Q2	/ 3
Q3	/ 6
Q4	/ 3
Q5	/ 3
Q6	/ 5
Q7	/ 8
Q8	/ 2
Q9	/ 5
Q10	/ 2
Q11	/ 6
Q12	/ 5
Q13	/ 5

Total	/ 55

NAME:____________________________ Student Number:______________________

1. What does the term “equivalent dose” mean? Why is this concept useful? **[2 marks]**

2. Balance the following nuclear reactions. **[3 marks]**
Note that you will need to infer some products.

(a) ^{64}Ga emits a positron.

(b) ^{239}U decays to ^{239}Np.

(c) ^{232}Am undergoes spontaneous fission, producing ^{85}Kr, two neutrons and another nucleus.

3. Complete the following table: **[6 marks]**

Symbol	***Z***	***N***	**Stable? (yes/no)**	**Predicted Type of Decay***
$^{103}_{45}Rh$				
	35	53		
$^{32}_{18}Ar$				

*If you have indicated that an isotope is stable, do not fill in the box for its “predicted type of decay”.

NAME:______________________________ Student Number:________________________

4. For each of the following species, write the ground state electron configuration.
Use the noble gas abbreviation. **[3 marks]**

(a) Zr

(b) Fe^{3+}

(c) S^{2-}

5. Complete the following statements by filling in the blanks. **[3 marks]**

(a) Zr has _____ core electrons and _____ valence electrons.

(b) Fe^{3+} has _____ core electrons and _____ valence electrons.

(c) S^{2-} has _____ core electrons and _____ valence electrons.

6. Draw and label a complete set of 3*d* orbitals. **[5 marks]**
Each orbital must be drawn on a labeled set of axes and must show relative phase.

NAME:______________________________ Student Number:________________________

7. Protactinium (Pa) has a ground-state electron configuration of [Rn] $7s^2$ $6d^1$ $5f^2$. **[8 marks]**

(a) What is unusual about this ground-state electron configuration? *[1 mark]*

(b) Provide a valid set of quantum numbers for each of the valence electrons in an atom of Pa by completing the table below. *[4 marks]*

electron	n	l	m_l	m_s
7s				
7s				
6d				
5f				
5f				

(c) Explain the difference between the terms “diamagnetic” and “paramagnetic”. *[2 marks]*

(d) Is a neutral atom of Pa diamagnetic or paramagnetic? *[1 mark]*

8. For each of the charges below, give an example of an element whose most stable ion has that charge. You may give the name <u>or</u> symbol for the element. **[2 marks]**

___________________ makes a dication (+2 charge).

___________________ makes a monoanion (-1 charge).

NAME:______________________________ Student Number:________________________

9. Answer the following questions concerning the Bohr model of the atom. **[5 marks]**

(a) It is only possible to calculate the energy of electrons in atoms of one neutral element using the Bohr model of the atom. What is this element? What is the relevant difference between this element and every other element? *[2 marks]*

(b) Briefly explain how the observation of line spectra was used as experimental evidence against the Rutherford model of the atom, requiring development of a new atomic model (the Bohr model). *[3 marks]*

10. A sample of boron is analyzed by mass spectrometry and found to have the following composition:

Isotope	**Mass**	**Abundance**
^{10}B	10.012 937 u	19.8%
^{11}B	11.009 305 u	80.2%

Calculate the molar mass of this sample of boron to the correct number of significant figures. **[2 marks]**

NAME:____________________________ Student Number:______________________

11. Copper metal has a threshold energy of 7.5×10^{-19} J. A sample of copper is struck with a photon and an electron is ejected with a kinetic energy of 1.30×10^{-18} J. **[6 marks]**

(a) Calculate the maximum possible wavelength of the photon. *[4 marks]*
Express your answer using an appropriate SI prefix so that the value is between 0.1 and 1000.

(b) What kind of electromagnetic radiation is this? *[1 mark]*

(c) This question describes an example of what phenomenon? *[1 mark]*

NAME:______________________________ Student Number:________________________

12. Heavy nuclei are made by very high-energy processes in supernovae, but also by slower neutron capture processes (accompanied by some number of beta decays) in very old and large stars (red giants), where a number of nuclear reactions occur that produce neutrons.

For example, ^{95}Zr is made in red giants when ^{94}Zr captures a neutron. **[5 marks]**

(a) Calculate the energy change per mole for this process. *[4 marks]*

(b) Is this process energetically favorable? *[1 mark]*

NAME:______________________________ Student Number:________________________

13. Most smoke detectors contain approximately 37 kBq of americium-241 (^{241}Am). ^{241}Am is an alpha emitter with a half-life of 432 years. The alpha radiation ionizes the air entering the detection chamber, which allows a small current to flow. Ions tend to stick to smoke particles, which reduces the current. If a current drop is detected, the alarm sounds. **[5 marks]**

(a) A typical smoke detector will remain in service for 8 to 10 years. What will the activity of the ^{241}Am source be after 10 years? *[4 marks]*

(b) Based on your answer to part (a), do you think that the 10 year recommended lifespan is due to loss of radioactivity or to other factors (aging of electronics, etc.)? *[1 mark]*

NAME:______________________________ Student Number:________________________

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)	$2.179\ 872 \text{ x } 10^{-18}$ J
Electron mass	$5.485\ 799 \times 10^{-4}$ u	Speed of light in vacuum	$2.997\ 925 \text{ x } 10^{8}$ m·s^{-1}

Formulae

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

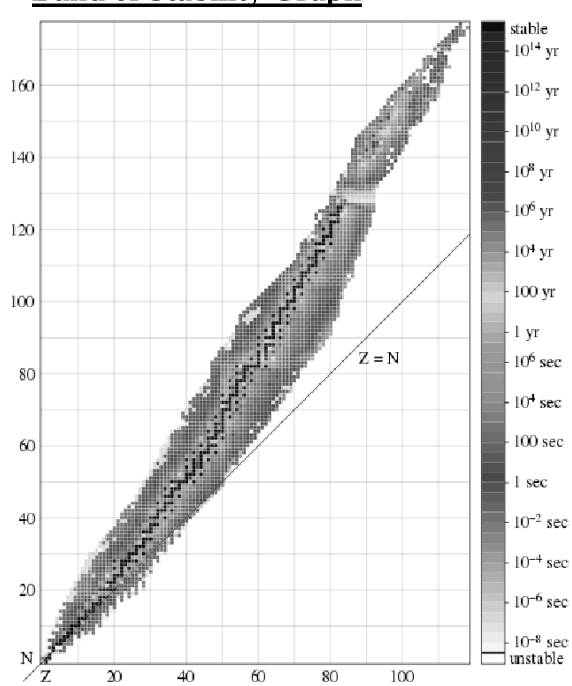
$r_n = a_0 \dfrac{n^2}{Z}$ $\qquad E_n = -R_H \dfrac{Z^2}{n^2}$ $\qquad E_k = \dfrac{1}{2}mv^2$

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

Some Useful Masses

$^{95}_{40}Zr$	94.908 042 u
$^{94}_{40}Zr$	93.906 314 u
$^{4}_{2}\alpha$	4.001 506 179 u
$^{1}_{1}p$	1.007 276 467 u
$^{1}_{0}n$	1.008 664 916 u

Band of Stability Graph



The graph at the right 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

NAME:______________________________ Student Number:________________________

CHEM 1000 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**	(261) **Rf** 104	(262) **Db** 105	(263) **Sg** 106	(262) **Bh** 107	(265) **Hs** 108	(266) **Mt** 109	(281) **Dt** 110	(283) **Rg** 111							

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	(260) **Lr** 103

Developed by Prof. R. T. Boeré