NAME:______________________________ Student Number:______________________

Spring 2013 **Chemistry 1000 Practice Midterm #1C** ____/ 52 marks

INSTRUCTIONS:

1) Please read over the test carefully before beginning. You should have six 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 8:00pm Mountain Time on Wednesday, February 13th, 2013. I understand that breaking this agreement would constitute academic misconduct, a serious offense with serious consequences. The minimum punishment would be a mark of 0/52 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 2013
The University of Lethbridge

Spelling matters!

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

Flourine =

Question Breakdown

Q1	/ 5
Q2	/5
Q3	/5
Q4	/ 4
Q5	/ 2
Q6	/ 7
Q7	/ 4
Q8	/ 8
Q9	/ 5
Q10	/ 3
Q11	/ 4

Total	/ 52

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1. **[5 marks]**

(a) Draw the orbital occupancy diagram (aka "orbital box diagram") for sulfur (S). *Clearly label each subshell.* *[2 marks]*

(b) Write the electron configuration for sulfur. *Do not use the noble gas abbreviation.* *[1 mark]*

(c) What is the charge of the most common ion of sulfur? Why? *[2 marks]*

2. **[5 marks]**

(a) Draw the <u>valence</u> orbital occupancy diagram (aka "orbital box diagram") for copper (Cu). *Clearly label each subshell.* *[2 marks]*

(b) Write the electron configuration for copper. *Use the noble gas abbreviation.* *[1 mark]*

(c) Briefly explain what is unusual about the electron configuration of copper. *[1 mark]*

(d) Write the electron configuration for the Cu^{+} ion. *Use the noble gas abbreviation*. *[1 mark]*

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3. The emission spectrum for hydrogen atoms contains four wavelengths of visible light:

410 nm, 434 nm, 486 nm, 656 nm

These lines are red, violet (purple), blue and cyan (blue-green). **[5 marks]**

(a) Match each colour to the appropriate wavelength: *[1 mark]*

red = _______ nm violet = _______ nm

(b) Why was it an important observation that hydrogen atoms can only emit a limited number of wavelengths of light? How did this observation change our understanding of the structure of the atom? *[4 marks]*

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4. A laser delivers light with a wavelength of 4.8 nm, and each pulse delivers 6.42×10^{-11} J of energy. If a single pulse from this laser is used to demonstrate the photoelectric effect, what is the maximum number of electrons that could be ejected from atoms in the metal? **[4 marks]**

5. Use the equation $\Delta x \cdot \Delta p > \frac{h}{4\pi}$ to demonstrate why Heisenberg's uncertainty principle has the greatest effect on particles with small masses. **[2 marks]**

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6. **[7 marks]**

(a) How many different orbitals in a single atom can have $n = 3$? *[1 mark]*

(b) How many different electrons in a single atom can have $n = 3$? *[1 mark]*

(c) List all the orbitals in a single atom with $n = 3$ <u>and</u> clearly indicate the value of l for each orbital. *You do <u>not</u> need to draw pictures of the orbitals.* *[5 marks]*

7. **[4 marks]**

(a) Draw a $6d_{xy}$ orbital. *Include labeled axes and clearly show the phases. Do NOT draw the radial nodes.* *[1 mark]*

(b) Give one set of quantum numbers that could correspond to an electron in a $6d_{xy}$ orbital. *[2 marks]*

(c) How many radial nodes are there in a $6d_{xy}$ orbital? *[1 mark]*

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8. Complete the table below. Only complete the last column for isotopes which you have identified as radioactive. **[8 marks]**

Isotope	**N**	**Z**	**Radioactive?** *(circle yes or no)*	**Predict mode(s) of decay: name the type of decay <u>and</u> write a balanced chemical equation** *(for radioactive isotopes only)*
^{23}Na			yes / no	
^{30}Na			yes / no	
	25	30	yes / no	

9. **[5 marks]**

(a) Explain why half-life is an important consideration when choosing an isotope for radioactive dating of a sample. Your answer should clearly address the consequences of choosing an isotope with an inappropriate half-life. *[4 marks]*

(b) Suggest a range of reasonable half-lives for isotopes that would be useful in radioactive dating of a sample suspected to be 25,000 years old. *[1 mark]*

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10. If a sample of radioactive material has a half-life of 16 hours, how long will it take for 80.% of the sample to decay? **[3 marks]**

11. The first step in the actinium decay chain is the decay of ^{239}Pu to ^{235}U. Calculate the energy change for this reaction. *Report your answer in J/mol.* **[4 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

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

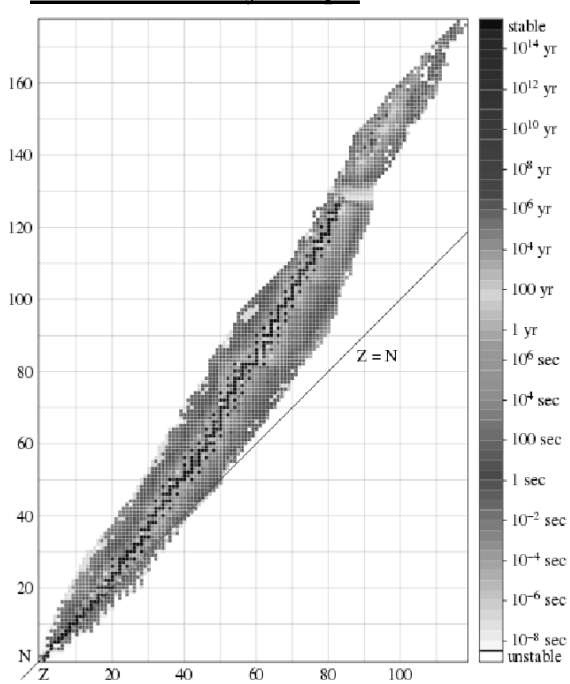
$r_n = a_0 \frac{n^2}{Z}$ $E_n = -R_H \frac{Z^2}{n^2}$ $E_k = \frac{1}{2}mv^2$

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

Some Useful Masses

$^{239}_{94}Pu$	239.052 163 u
$^{235}_{92}U$	235.043 930 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

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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