NAME:______________________________ Student Number:________________________

Fall 2017 **Chemistry 1000 Midterm #2A** ____/ 75 marks

INSTRUCTIONS:

1) Please read over the test carefully before beginning. You should have 8 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.

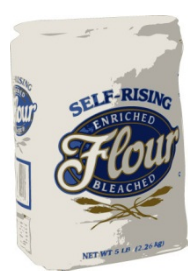
Confidentiality Agreement:
I agree not to discuss (or in any other way divulge) the contents of this exam until after 8:00pm Mountain Time on Tuesday, November 7th, 2017 (i.e. 24 hours **after** you finish writing this test). I understand that breaking this agreement would constitute academic misconduct, a serious offense with serious consequences. The minimum punishment would be a mark of 0/75 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	/ 16
Q2	/ 6
Q3	/ 6
Q4	/ 3
Q5	/ 8
Q6	/ 4
Q7	/ 7
Q8	/ 7
Q9	/ 10
Q10	/ 8

Total	/ 75

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1. Fill in each blank with the word or phrase that best completes the sentence. **[16 marks]**

If your answer is an element, you must provide the <u>name and symbol for that element</u> for full credit. *For ionic compounds, only the formula is necessary (unless it is a "The name for… is" question).*

(a) An example of a metal that reacts with water at room temperature is ____.

(b) An example of a metal that does **<u>not</u>** react with water at room temperature is ____.

(c) The element whose cations give a violet flame test is ________________________________.

(d) The alkali metal with the largest ionization energy is ________________________________.

(e) Alkaline earth metals tend to make ions with a charge of ______.

(f) The passivation layer on the surface of aluminium metal is made of _______.

(g) An example of an ionic compound that gives off carbon dioxide gas when heated is ______________.

(h) Two common packing arrangements for atoms in a metal lattice are ____

and ____.

(Alternative phrasing: "Two common types of metal lattice are ___ and ___.")

DO NOT use abbreviations.

(i) As a general rule, lattice energy increases when ____________________________ increases.

(j) As a general rule, lattice energy decreases when ___________________________ increases.

(k) The energy released when a neutral atom in the gas phase gains an electron is that element's ____.

(l) The name for NaF is ____.

(m) The name for FeS is ____.

(n) The name for $CoCl_3$ is ____.

(o) Dissolving CO_2 in water makes the water more ____________________________________.

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2. Complete the following table. You may find the partial periodic table (copied from the Data Sheet) helpful. *Misspelled elements will not get full credit.* **[6 marks]**

Atomic Number (*Z*)	Symbol	Name
2		
4		
11		
14		
19		
20		

CHEM 1000 Partial Periodic Table

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1																	2
3	4											5	12.011 **C** 6	14.0067 **N** 7	15.9994 **O** 8	18.9984 **F** 9	20.1797 **Ne** 10
11	12											26.9815 **Al** 13	14	30.9738 **P** 15	32.066 **S** 16	35.4527 **Cl** 17	39.948 **Ar** 18
19	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	33	78.96 **Se** 34	79.904 **Br** 35	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	(260) **Lr** 103

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3. **[6 marks]**

(a) Write the electron configuration for each of the ions below. Use the noble gas abbreviation. *Do NOT abbreviate so much that the valence electrons are not explicitly listed! [3 marks]*

i. Se^{2-}

ii. Br^{-}

iii. Cl^{-}

(b) Rank the ions from smallest to largest (by radius). *[1 mark]*

smallest __________________ __________________ __________________ largest

(c) Justify your ranking. *[2 marks]*

4. For each of the following statements, circle whether it is TRUE or FALSE. **[3 marks]**

IF a statement is FALSE, briefly explain why ***or*** provide an example that proves the statement to be false. *This is required to get credit for choosing "FALSE".*

(a) Na^{+} is highly reactive and does not occur in nature. TRUE / FALSE

(b) All salts of group 2 metals are soluble in water. TRUE / FALSE

(c) The reactivity of group 2 metals increases with increasing mass. TRUE / FALSE

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5. Write balanced chemical equations for each of the following reactions. **[8 marks]**
Include states of matter. If no reaction occurs, write "NO REACTION".

(a) Lithium metal is heated with nitrogen gas.

(b) Potassium metal is added to water.

(c) Barium carbonate $(BaCO_3)$ is added to a solution of aqueous acid.

(d) Aqueous sodium chloride is subjected to electrolysis in the chlor-alkali process.

6. Beryllium and aluminium are related by the diagonal relationship, indicating that their chemistry shows some similarities. **[4 marks]**

(a) Both beryllium metal and aluminium metal react with aqueous base. Write a balanced chemical equation for one of these reactions. *[2 marks]*

(b) Give another example of the diagonal relationship between beryllium and aluminium. *[1 mark]*

(c) Give the names of another pair of elements that have a similar diagonal relationship. *[1 mark]*

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7. Aluminium metal is prepared by electrolysis of molten Al_2O_3. **[7 marks]**

(a) Why is it necessary for the Al_2O_3 to be melted before it can be electrolyzed? *[1 mark]*

(b) Aluminium ore (bauxite) is not pure. Give an example of one contaminant that must be removed before the Al_2O_3 can be electrolyzed. *[1 mark]*

(c) How is the bauxite purified before it is electrolyzed? *[5 marks]*

- Write balanced chemical equations for each reaction in the purification process. Your last equation should have Al_2O_3 as a product. *Include states of matter.*
- Identify any points at which a separation is necessary (e.g. a filtration or similar) and clearly identify which component contains the aluminium.

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8. Once pure Al_2O_3 has been obtained, it is electrolyzed. **[7 marks]**

(a) Complete the following chemical equation for the electrolysis of Al_2O_3 by balancing it and adding states of matter. *[2 marks]*

$$\_\_\_\ Al_2O_3(\quad) + \_\_\_\ C(\quad) \rightarrow \_\_\_\ Al(\quad) + \_\_\_\ CO_2(\quad)$$

(b) What mass of carbon must be consumed in order to produce 2.50 tons of aluminium metal (1 ton = 1000 kg)? *[5 marks]*

Report your answer in kg.

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9. **[10 marks]**

(a) Complete the table below. If more than one valid resonance structure can be drawn for the ion, **draw all valid resonance structures**. *[6 marks]*
Include any non-zero formal charges on the appropriate atom(s).

Chemical Formula	**Lewis Diagram(s)**
NO_2^-	
NO_2^+	
N_3^-	

(b) Based on your Lewis diagram(s), *[2 marks]*

i. What is the average $N-O$ bond order in NO_2^-?

ii. What is the average $N-O$ bond order in NO_2^+?

(c) Based on your Lewis diagram(s), *[2 marks]*

i. What is the bond angle for NO_2^-? *Use ~ to indicate an angle that is not exact.*

ii. What is the bond angle for NO_2^+? *Use ~ to indicate an angle that is not exact.*

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10. **[8 marks]**

(a) Complete the table below. Draw **one** valid Lewis diagram for each molecule. *[6 marks]*
Include any non-zero formal charges on the appropriate atom(s).

Chemical Formula	**Lewis Diagram**	**Electron Group Geometry (in words)**	**Molecular Geometry (in words)**
PF_3			
SF_4			

(b) Re-draw each of the molecules to show the correct geometry according to VSEPR.
You do not need to label bond angles. *[2 marks]*

i. PF_3

ii. SF_4

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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)	$2.179\ 872 \text{ x } 10^{-18}$ 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}
Ideal gas constant (R)	8.314 462 J·mol^{-1}·K^{-1} 8.314 462 m^3·Pa·mol^{-1}·K^{-1}	Standard atmospheric pressure	1 bar = 100 kPa

Formulae

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

$r_n = a_0 \frac{n^2}{Z}$ $\quad E_n = -R_H \frac{Z^2}{n^2}$ $\quad E_k = \frac{1}{2} m v^2$ $\quad PV = nRT$

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

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