NAME:______________________________ Student Number:________________________

Spring 2020 **Chemistry 1000 Midterm #2A** ____/ 80 marks

INSTRUCTIONS:

1) Please read over the test carefully before beginning. This exam consists of 10 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 0/80 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	/ 18
Q2	/ 6
Q3	/ 8
Q4	/ 5
Q5	/ 2
Q6	/ 8
Q7	/ 5
Q8	/ 12
Q9	/ 8
Q10	/ 8

Total	/ 80

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1. Fill in each blank with the word or phrase that best completes the sentences. When choices are offered in brackets after the blank, choose one by either circling it or writing it in the blank. ***If your answer is an element, you must provide the <u>name and symbol for that element</u> for full credit.*** **[18 marks]**

(a) The ability of an element to both hold onto its own electrons and attract electrons is referred to as the ____________________________________ of that element.

(b) The thin protective oxide layer on a metal's surface is known as the ____________________ layer.

(c) The element whose cation gives a green flame is ________________________________.

(e) The noble gases refer to the group ____________________ elements of the periodic table.

(f) Atomic radius generally ______________________ (*increases/decreases*) down a group.

(g) The gas that is produced when strontium metal reacts with water is ______________________________________.

(h) Energy is ____________________ *(consumed/released)* when a covalent bond is formed.

(i) An ionic compound will have a large lattice energy when the charge of the ions is ___________ *(large/small)* and when the distance of the ions is __________ *(large/small)*.

(j) A metal lattice whose layers follow the ABCA pattern is referred to as having ___________________________________ packing.

(k) Two metals who have a diagonal relationship with each other are ____________________ and ___________________________.

(l) The scientific name for K_2O is ____.

(m) The scientific name for $TiCl_4$ is ____.

(n) The chemical formula for copper (II) sulfide is __________________________________.

(o) The group 17 elements are referred to as the ____________________________.

(p) During the chlor-alkali process (electrolysis of aqueous sodium chloride) the species that is oxidized is ____________________ and the species that is reduced is ___________________.

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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**
10		
11		
20		
23		
33		
34		

Chem 1000 Standard Periodic Table

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1																	4.0026 **He** 2
6.941 **Li** 3	4											10.811 **B** 5	12.011 **C** 6	14.0067 **N** 7	15.9994 **O** 8	18.9984 **F** 9	10
11	24.3050 **Mg** 12											13	14	30.9738 **P** 15	32.066 **S** 16	35.4527 **Cl** 17	39.948 **Ar** 18
39.0983 **K** 19	20	44.9559 **Sc** 21	47.88 **Ti** 22	23	51.9961 **Cr** 24	25	26	58.9332 **Co** 27	28	63.546 **Cu** 29	65.39 **Zn** 30	31	72.61 **Ge** 32	33	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	(262) **Lr** 103

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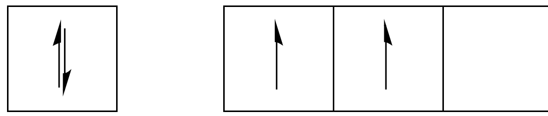
3. **[8 marks]**

(a) Identify the neutral element (**name and symbol**) corresponding to each valence-shell orbital box diagram. *[4 marks]*

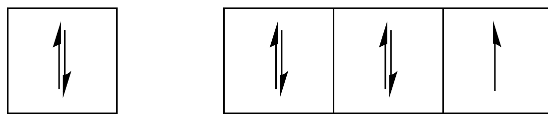
A



3s **3p**

Element

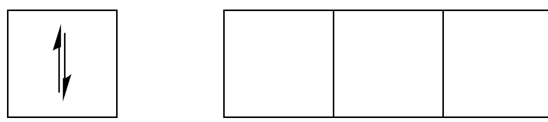
B



2s **2p**

Element

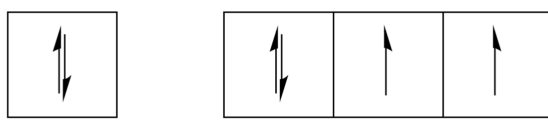
C



5s **5p**

Element

D



3s **3p**

Element

(b) Rank the four neutral elements in part (a) from smallest to largest (use their elemental symbols): *[2 marks]*

smallest _______________ _______________ _______________ _______________ largest

(c) Which element is most likely to form a -1 anion? *[1 marks]*

(d) Which element is most likely to have the highest third ionization energy (E_{i3})? *[1 marks]*

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4. When magnesium carbonate is thermally decomposed, it produces magnesium oxide and carbon dioxide: **[5 marks]**

$$MgCO_{3(s)} \rightarrow MgO_{(s)} + CO_{2(g)}$$

What volume of carbon dioxide gas is produced when 12.622 g of $MgCO_3$ is thermally decomposed? Assume that the carbon dioxide gas is stored at a temperature of 22.45 °C and a pressure of 1.020 bar (102.0 kPa).

Report your answer in L.

5. List 2 ways in which metals and nonmetals differ. **[2 marks]**

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

(a) Magnesium metal reacts with nitrogen gas. *[2 marks]*

(b) Barium metal reacts with water. *[2 marks]*

(c) Calcium carbonate ($CaCO_3$) is added to a solution of aqueous acid $\left(H^{+}_{(aq)}\right)$. *[2 marks]*

(d) Strontium metal reacts with chlorine gas. *[2 marks]*

7. Beryllium oxide is amphoteric, that is, it reacts with both acids and bases. **[5 marks]**

(a) Write a balanced chemical equation for its reaction with aqueous acid $\left(H^{+}_{(aq)}\right)$.
Include states of matter. *[2 marks]*

(b) Write a balanced chemical equation for its reaction with aqueous base $\left(OH^{-}_{(aq)}\right)$.
Include states of matter. *[2 marks]*

(c) What element does beryllium share a diagonal relationship with? *[1 marks]*

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8. For each of the following molecules/ions: **[12 marks]**

- draw a valid Lewis Diagram
- Identify its Electron Group Geometry
- Identify its Molecular Geometry

(a) $SnCl_2$. *[4 marks]*
Include any non-zero formal charges on the appropriate atom(s).

(b) BrF_3 . *[4 mark]*
Include any non-zero formal charges on the appropriate atom(s).

(c) TeF_5^-. *[4 mark]*
Include any non-zero formal charges on the appropriate atom(s).

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9. The carbonate ion has the chemical formula CO_3^{2-}. **[8 marks]**

(a) Draw all three resonance structures of CO_3^{2-} which have minimized formal charge. *Include any non-zero formal charges on the appropriate atom(s).* *[4 marks]*

(b) What is the average $C-O$ bond order for the carbonate ion? *[1 mark]*

(c) Carbonic acid has the chemical formula H_2CO_3. Draw a Lewis diagram for H_2CO_3 in which you have minimized formal charge. *[2 marks]*
Include any non-zero formal charges on the appropriate atom(s).

(d) Compare the lengths of the $C-O$ bonds in H_2CO_3. Which $C-O$ bond(s) do you expect to be longer/shorter? *[1 mark]*

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10. A nitrile oxide (HCNO) is a simple organic molecule which contains 1 hydrogen, 1 carbon, 1 nitrogen, and 1 oxygen atom. It has two valid resonance structures. **[8 marks]**

(a) Draw the two Lewis diagrams for each of its resonance structures given that the connectivity of nitrile oxide is H—C—N—O. *[4 mark]*
Include any non-zero formal charges on the appropriate atom(s).

(b) For both resonance structures, indicate the molecular geometry around each of the central C and N atoms. *[2 marks]*

(c) Of the two resonance structures, which one do you think better represents the overall structure of the molecule? Briefly explain your reasoning. *[2 mark]*

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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	Kelvin temperature scale	0 K = -273.15 °C
Avogadro's number	$6.022\ 141 \times 10^{23}$ mol^{-1}	Planck's constant	$6.626\ 070 \times 10^{-34}$ J·Hz^{-1}
Bohr radius (a_0)	$5.291\ 772 \times 10^{-11}$ m	Proton mass	1.007 277 u
Electron charge (e)	$1.602\ 177 \times 10^{-19}$ C	Neutron mass	1.008 665 u
Electron mass	$5.485\ 799 \times 10^{-4}$ u	Rydberg Constant (R_H)	$2.179\ 872 \times 10^{-18}$ J
Ideal gas constant (R)	8.314 462 J·mol^{-1}·K^{-1}	Speed of light in vacuum	$2.997\ 925 \times 10^{8}$ m·s^{-1}
	8.314 462 m^3·Pa·mol^{-1}·K^{-1}	Standard atmospheric pressure	1 bar = 100 kPa
		Volume	1000 L = 1 m^3

Formulae

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

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

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

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