Fall 2025 **Chemistry 1000 Midterm #2X** ____/75 marks

Confidentiality Agreement:
I agree not to discuss (or in any other way divulge) the contents of this exam with (or in the presence of) any CHEM 1000 student who has yet to write it. I understand that breaking this agreement would constitute academic misconduct. The minimum penalty would be a mark of 0/75 on this exam.

Signature: _____ Date: _____

1) Please read the test carefully before starting. It has 8 pages of questions (four pages double-sided).
2) You have also been given a data sheet. It does not have a QR code, so nothing written on it will be graded.
3) **DO NOT WRITE ON ANY QR CODE!!!** Work on pages without a QR code will not be graded.
4) You may use a calculator but only for calculation. No other electronic devices are allowed.
5) If your work is not legible, it will be given a mark of zero.
6) Show your work. Answers without supporting reasoning or calculations will not get full credit.
7) Marks will be deducted for incorrect information added to an otherwise correct answer.
8) Marks will be deducted for improper use of significant figures and for missing or incorrect units. Show units in every step of all calculations. Significant figures will only be checked in final answers. If a question has subparts (a, b, c, etc.), the answer to each subpart is considered a "final answer".
9) You have 90 minutes to complete this test.

Question Breakdown

Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**					**Total**
/ 4	/ 6	/ 4	/ 10	/ 4	/ 5	/ 12	/ 9	/ 12	/ 9					/ 75

1. Complete the following table. You may find the partial periodic table (copied from the Data Sheet) helpful. *Misspelled elements will not get full credit.* **[4 marks]**

Atomic Number (*Z*)	Symbol	Name
5		
18		
22		
34		

CHEM 1000 Standard Periodic Table

1																	18
1.0079 **H** 1	2											13	14	15	16	17	2
6.94 **Li** 3	9.0122 **Be** 4											5	12.011 **C** 6	14.0067 **N** 7	15.9994 **O** 8	18.9984 **F** 9	10
22.990 **Na** 11	24.3050 **Mg** 12	3	4	5	6	7	8	9	10	11	12	26.9815 **Al** 13	14	30.9738 **P** 15	32.066 **S** 16	35.4527 **Cl** 17	18
39.0983 **K** 19	40.078 **Ca** 20	21	22	23	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	31	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	95.95 **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	183.84 **W** 74	186.207 **Re** 75	190.2 **Os** 76	192.23 **Ir** 77	195.08 **Pt** 78	196.967 **Au** 79	200.59 **Hg** 80	204.38 **Tl** 81	207.19 **Pb** 82	208.980 **Bi** 83	(209) **Po** 84	(210) **At** 85	(222) **Rn** 86
(223) **Fr** 87	(226) **Ra** 88	**Ac-Lr**	(267) **Rf** 104	(268) **Db** 105	(271) **Sg** 106	(272) **Bh** 107	(270) **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	(292) **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	173.05 **Yb** 70	174.967 **Lu** 71
(227) **Ac** 89	232.038 **Th** 90	231.036 **Pa** 91	238.029 **U** 92	(237) **Np** 93	(244) **Pu** 94	(243) **Am** 95	(247) **Cm** 96	(247) **Bk** 97	(251) **Cf** 98	(252) **Es** 99	(257) **Fm** 100	(257) **Md** 101	(259) **No** 102	(262) **Lr** 103

Radioactive elements: mass number given for longest lived isotope: e.g. (98)

Developed by Prof. R. T. Boeré (updated 2021)

2. Complete the following table, giving the name and symbol for an element meeting each description. *Misspelled elements will not get full credit.* **[6 marks]**

Description	Symbol	Name
The most electronegative element		
The element with a diagonal relationship with magnesium		
One of the two elements whose cation makes water "hard"		
The other element whose cation makes water "hard"		
One of the two elements discussed in CHEM 1000 whose oxide is amphoteric		
The other element discussed in CHEM 1000 whose oxide is amphoteric		

3. Complete the following table. Names should follow the IUPAC conventions taught in class. **[4 marks]**

Misspelled names will not get full credit.

Chemical Formula	Name
Li_2O	
$FeBr_3$	
	copper(I) sulfide
	potassium fluoride

4. Fill in each blank with the word, phrase or symbol that best completes the sentence. If options are provided in brackets after a blank; choose one of them to fill the blank. **[10 marks]**

(a) The process where the surface of a metal reacts with air to form a protective layer is called _____.

(b) The two types of closest packed crystal lattices are _____ closest packed and _____ closest packed.

(c) The three products of electrolysis of aqueous sodium chloride are _____, _____, and _____.

Provide chemical formulas including states of matter.

(d) When calcium carbonate is heated to a high enough temperature, it breaks down. The gas produced is _____.

(e) An ionic compound has a large lattice energy when the charge of the ions is _____ *(large/small)* and when the distance between the ions is _____ *(large/small)*.

(f) Lewis diagrams for the same molecule/ion in which some electrons are drawn in different locations but none of the atoms move are called _____.

5. In the industrial process for refining aluminium, before electrolysis can be performed the impure bauxite ore is treated with aqueous base. Explain what this step accomplishes and write a balanced chemical equation for the reaction. **[4 marks]**

6. **[5 marks]**

(a) Write a balanced chemical equation for the electrolysis of molten* sodium chloride. *[1 mark]*

*Include states of matter. *"Molten" is another word for "melted" or "liquid".*

(b) If we want to make 125 kg of sodium metal, what mass of sodium chloride must be electrolyzed?
Report your answer in kg. *[4 marks]*

7. Write a balanced chemical equation for each of the following reactions if a reaction is expected at room temperature. **[12 marks]**

Include states of matter. If no reaction occurs, write "NO REACTION".

(a) Lithium metal is added to liquid bromine $\left(Br_{2(l)}\right)$.

(b) Calcium metal is exposed to nitrogen gas $\left(N_{2(g)}\right)$.

(c) Potassium metal is added to water.

(d) Aluminium metal is added to water.

(e) Beryllium metal is added to concentrated aqueous sodium hydroxide $\left(NaOH_{(aq)}\right)$.

(f) Potassium carbonate is added to concentrated aqueous hydrochloric acid $\left(HCl_{(aq)}\right)$.

8. Given the following elements: **[9 marks]**

$Al \qquad Ca \qquad S$

(a) Rank the atoms in order of atomic radius, from smallest to largest. *[1 mark]*

smallest radius _____ _____ _____ largest radius

(b) Rank the atoms in order of electron affinity, from smallest to largest. *[1 mark]*

smallest electron affinity _____ _____ _____ largest electron affinity

(c) For each element, write the formula (including charge) for the ion that will be most commonly observed, and write the electron configuration for that ion. Do not use noble gas notation. *[6 marks]*

Al

Ca

S

(d) Rank the ions from part (c) in order of radius, from smallest to largest. *[1 mark]*

smallest radius _____ _____ _____ largest radius

9. Complete the table below. **[12 marks]**

Include any non-zero formal charges on the appropriate atom(s).

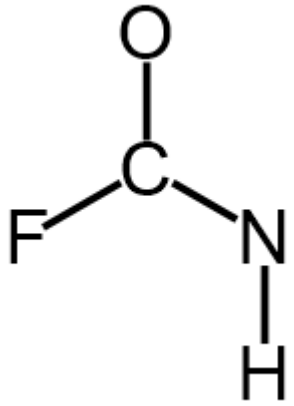
If more than one valid resonance structure can be drawn for a formula, just draw one of them.

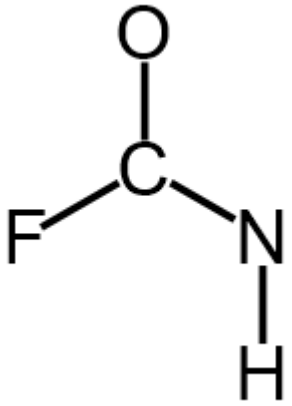
Formula	Lewis Diagram	Electron Group Geometry *(in words)*	Molecular Geometry *(in words)*
$AlCl_3$			
SF_4			
NO_3^-			

10. **[9 marks]**

(a) There are two formal-charge-minimized resonance structures for the $CFO(NH)^-$ anion. Draw these resonance structures using the skeletal structures given below as a starting point. *[4 marks]*

Include any non-zero formal charges on the appropriate atom(s).





(b) Assume the two resonance structures contribute equally to the average structure. Give the average bond order for each bond to carbon. *[3 marks]*

$C-O$ bond order is _____

$C-N$ bond order is _____

$C-F$ bond order is _____

(c) In reality, the two resonance structures do not contribute equally. Circle the resonance structure that is 'better' (contributes more to the averaged molecular structure). *[1 mark]*

(d) Based on your answer in (c), is the real average $C-O$ bond order higher or lower than your answer in (b)? *[1 mark]*