NAME:_____ Student Number:_____

Spring 2013 **Chemistry 1000 Midterm #2A** ____/ 50 marks

INSTRUCTIONS:
1) Please read over the test carefully before beginning. You should have 6 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.

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**Confidentiality Agreement:**
I agree not to discuss (or in any other way divulge) the contents of this exam until after 8pm Mountain Time on Wednesday, March 20th, 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 0/50 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** | / 10 |
| **Q2** | / 5 |
| **Q3** | / 4 |
| **Q4** | / 3 |
| **Q5** | / 3 |
| **Q6** | / 5 |
| **Q7** | / 9 |
| **Q8** | / 5 |
| **Q9** | / 5 |
| **Q10** | / 1 |

| | |
|---|---|
| **Total** | / 50 |

NAME:_____ Student Number:_____

1. For each of the following statements, circle whether they are true **or** false.
If true, briefly explain why.
If false, give an example that proves the statement false. **[10 marks]**

*Note: All marks on this question are for the explanations and/or examples. No credit will be given for a 'true' or 'false' without appropriate support.*

(a) The ionization energy for every element is larger than for the element below it (assuming that there is an element below it). **TRUE / FALSE**

(b) The electron affinity for every element is larger than for the element to its left (assuming that there is an element to its left). **TRUE / FALSE**

(c) Elements in Group 2 form +2 cations but not ions with any other charges.
**TRUE / FALSE**

(d) The radius of a neutral atom of alkali metal is always larger than the radius of a neutral atom of the alkaline earth metal in the same period as it. **TRUE / FALSE**

(e) An atom bonded to three other atoms is always trigonal planar. **TRUE / FALSE**

NAME:_____ Student Number:_____

2. If 5.0 g lithium metal reacts fully with nitrogen, what mass of lithium nitride is produced? *As part of your answer, you must include a balanced chemical equation.* **[5 marks]**

3. Air contains a number of different gases. Sometimes, a scientist needs to create an environment in which some of those gases have been removed from the air. The two gases which are most commonly removed are carbon dioxide and water vapour.

   One way to remove carbon dioxide from air is to pass the air through a tube containing magnesium oxide. **[4 marks]**

(a) Write a balanced chemical equation for the reaction that occurs between the carbon dioxide and the magnesium oxide. *Include states of matter.* *[2 marks]*

(b) How could the magnesium oxide be regenerated so that it could be used to 'clean' more air? *[1 mark]*

(c) Write a balanced chemical equation to show what happens in your answer to part (b). *Include states of matter.* *[1 mark]*

NAME:_____ Student Number:_____

4. The current procedure used for the industrial production of aluminium was developed in the late 1800s. Before then, aluminium was considered a precious metal. Why was aluminium once so difficult to make, and how was this difficulty overcome? **[3 marks]**

5. **[3 marks]**

(a) Why is it essential that the chlorine gas and sodium hydroxide produced when aqueous sodium chloride is electrolyzed are kept separate? Be specific. *[2 marks]*

(b) What is the third product in the electrolysis of aqueous sodium chloride? *[1 mark]*

NAME:_____ Student Number:_____

6. Give the name and symbol for each of the elements below: **[5 marks]**

| | **name** | **symbol** |
|---|---|---|
| i. | $Z = 22$ | |
| ii. | $Z = 25$ | |
| iii. | $Z = 28$ | |
| iv. | $Z = 31$ | |
| v. | $Z = 34$ | |

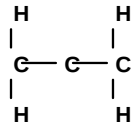
**Partial Periodic Table (copied from data sheet)**

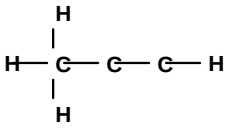
| **1** | | | | | | | | | | | | | | | | | **18** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0079 **H** 1 | **2** | | | | | | | | | | | **13** | **14** | **15** | **16** | **17** | 4.0026 **He** 2 |
| 6.941 **Li** 3 | 9.0122 **Be** 4 | | | | | | | | | | | 10.811 **B** 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 | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **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 | | | | | | | | | | | | | | | | |
| 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 | | | | | | | |

NAME:_____ Student Number:_____

7. **[9 marks]**

(a) Complete the Lewis structures for the two molecules whose skeletons are shown below. *[2 marks]*





(b) Rank the bonds in the two molecules above from shortest to longest. *[2 marks]*
*You may group together bonds of the same type.*

(c) Identify the molecular geometry of each carbon atom in both molecules. *[3 marks]*
*Answer this question by labeling your answers to part (a).*

(d) In the space below, redraw each molecule to clearly show its shape. *[2 marks]*

8. **[5 marks]**

(a) Calculate the approximate enthalpy change for the reaction below: *[4 marks]*

$$N_2H_2 + H_2 \rightarrow N_2H_4$$

(b) Is this process exothermic or endothermic? In ten words or less, justify your answer. *[1 mark]*

NAME:_____ Student Number:_____

9. **[5 marks]**

(a) Draw **all** valid resonance structures for the sulfite ion ($SO_3^{2-}$). *[4 marks]*
*You must show all non-zero formal charges on the appropriate atoms.*

(b) What is the average S-O bond order in $SO_3^{2-}$? *[1 mark]*

10. Draw a valid Lewis structure for sulfurous acid ($H_2SO_3$). *[1 mark]*
*You must show all non-zero formal charges on the appropriate atoms.*

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 ($R_H$) | $2.179\,872 \times 10^{-18}$ J |
| Electron mass | $5.485\,799 \times 10^{-4}$ u | Speed of light in vacuum | $2.997\,925 \times 10^{8}$ m·s$^{-1}$ |
| Ideal gas constant (R) | 8.314 462 J·mol$^{-1}$·K$^{-1}$<br>8.314 462 m$^3$·Pa·mol$^{-1}$·K$^{-1}$ | Standard atmospheric pressure | 1 bar = 100 kPa |

## Formulae

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

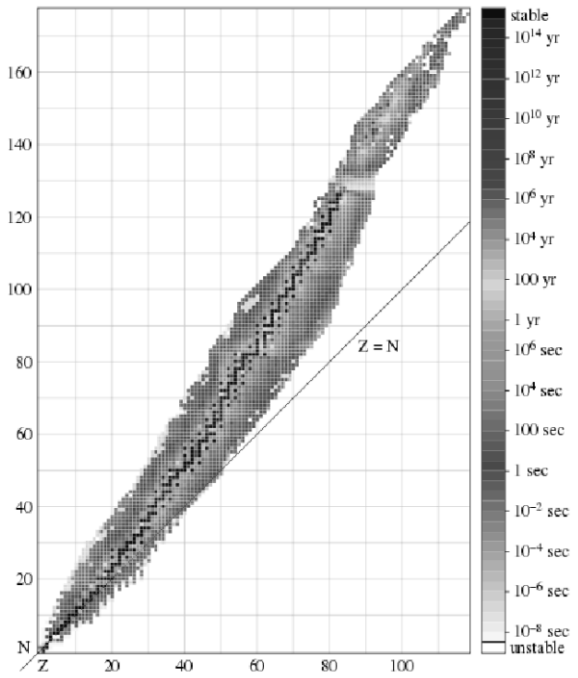
$$r_n = a_0 \frac{n^2}{Z} \qquad E_n = -R_H \frac{Z^2}{n^2} \qquad E_k = \frac{1}{2}mv^2 \qquad PV = nRT$$

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

## Bond Dissociation Enthalpy Values

| | $\Delta_{BD}H$ (kJ/mol) |
|---|---|
| H-H | 435 |
| C-H | 415 |
| N-H | 390 |
| O-H | 460 |
| C-C | 345 |
| C=C | 615 |
| C≡C | 835 |
| N-N | 160 |
| N=N | 420 |
| N≡N | 945 |
| O-O | 145 |
| O=O | 495 |

## 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 | | | | | | | | | | | | | | | | | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0079<br>**H**<br>1 | **2** | | | | | | | | | | | **13** | **14** | **15** | **16** | **17** | 4.0026<br>**He**<br>2 |
| 6.941<br>**Li**<br>3 | 9.0122<br>**Be**<br>4 | | | | | | | | | | | 10.811<br>**B**<br>5 | 12.011<br>**C**<br>6 | 14.0067<br>**N**<br>7 | 15.9994<br>**O**<br>8 | 18.9984<br>**F**<br>9 | 20.1797<br>**Ne**<br>10 |
| 22.9898<br>**Na**<br>11 | 24.3050<br>**Mg**<br>12 | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | 26.9815<br>**Al**<br>13 | 28.0855<br>**Si**<br>14 | 30.9738<br>**P**<br>15 | 32.066<br>**S**<br>16 | 35.4527<br>**Cl**<br>17 | 39.948<br>**Ar**<br>18 |
| 39.0983<br>**K**<br>19 | 40.078<br>**Ca**<br>20 | | | | | | | | | | | | | | | | |
| 85.4678<br>**Rb**<br>37 | 87.62<br>**Sr**<br>38 | 88.9059<br>**Y**<br>39 | 91.224<br>**Zr**<br>40 | 92.9064<br>**Nb**<br>41 | 95.94<br>**Mo**<br>42 | (98)<br>**Tc**<br>43 | 101.07<br>**Ru**<br>44 | 102.906<br>**Rh**<br>45 | 106.42<br>**Pd**<br>46 | 107.868<br>**Ag**<br>47 | 112.411<br>**Cd**<br>48 | 114.82<br>**In**<br>49 | 118.710<br>**Sn**<br>50 | 121.757<br>**Sb**<br>51 | 127.60<br>**Te**<br>52 | 126.905<br>**I**<br>53 | 131.29<br>**Xe**<br>54 |
| 132.905<br>**Cs**<br>55 | 137.327<br>**Ba**<br>56 | **La-Lu** | 178.49<br>**Hf**<br>72 | 180.948<br>**Ta**<br>73 | 183.85<br>**W**<br>74 | 186.207<br>**Re**<br>75 | 190.2<br>**Os**<br>76 | 192.22<br>**Ir**<br>77 | 195.08<br>**Pt**<br>78 | 196.967<br>**Au**<br>79 | 200.59<br>**Hg**<br>80 | 204.383<br>**Tl**<br>81 | 207.19<br>**Pb**<br>82 | 208.980<br>**Bi**<br>83 | (210)<br>**Po**<br>84 | (210)<br>**At**<br>85 | (222)<br>**Rn**<br>86 |
| (223)<br>**Fr**<br>87 | 226.025<br>**Ra**<br>88 | **Ac-Lr** | (261)<br>**Rf**<br>104 | (262)<br>**Db**<br>105 | (263)<br>**Sg**<br>106 | (262)<br>**Bh**<br>107 | (265)<br>**Hs**<br>108 | (266)<br>**Mt**<br>109 | (281)<br>**Dt**<br>110 | (283)<br>**Rg**<br>111 | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 138.906<br>**La**<br>57 | 140.115<br>**Ce**<br>58 | 140.908<br>**Pr**<br>59 | 144.24<br>**Nd**<br>60 | (145)<br>**Pm**<br>61 | 150.36<br>**Sm**<br>62 | 151.965<br>**Eu**<br>63 | 157.25<br>**Gd**<br>64 | 158.925<br>**Tb**<br>65 | 162.50<br>**Dy**<br>66 | 164.930<br>**Ho**<br>67 | 167.26<br>**Er**<br>68 | 168.934<br>**Tm**<br>69 | 173.04<br>**Yb**<br>70 | 174.967<br>**Lu**<br>71 |
| 227.028<br>**Ac**<br>89 | 232.038<br>**Th**<br>90 | 231.036<br>**Pa**<br>91 | 238.029<br>**U**<br>92 | 237.048<br>**Np**<br>93 | (240)<br>**Pu**<br>94 | (243)<br>**Am**<br>95 | (247)<br>**Cm**<br>96 | (247)<br>**Bk**<br>97 | (251)<br>**Cf**<br>98 | (252)<br>**Es**<br>99 | (257)<br>**Fm**<br>100 | (258)<br>**Md**<br>101 | (259)<br>**No**<br>102 | (260)<br>**Lr**<br>103 |

Developed by Prof. R. T. Boeré