

LAST NAME: \_\_\_\_\_

FIRST NAME: \_\_\_\_\_

Student Number: \_\_\_\_\_

# CHM 1311 B

## Midterm #1

### Fall 2013

*Please keep your work covered at all times and keep your eyes on your own paper! Cheating or any appearance of cheating will result in an F in the course and possible expulsion from the university.*

**There are 10 pages in this test. A periodic table and data sheets are provided at the end. You may rip these pages off of the exam and use them to cover your work during the test. Any scratch work should be done on the back of these pages.**

**Please show all work to receive partial credit.**

**You have 75 minutes to complete the test.**

<b>Question</b>	<b>Points Possible</b>	<b>Points Earned</b>	<b>TA Initial</b>
<b>1</b>	<b>12</b>		
<b>2</b>	<b>12</b>		
<b>3</b>	<b>16</b>		
<b>4</b>	<b>10</b>		
<b>TOTAL</b>	<b>50</b>		

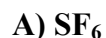
**#1. (12 points) Short Answer Questions**

a) Name the following compounds:



b) What is the molecular formula of aluminium hydroxide?

c) Circle the gas that would have the lowest density at standard temperature and pressure.



d) For the list of gases shown above, name the gas with the highest average speed at standard temperature and pressure.

e) At standard temperature and pressure, what type of interaction is dominant in a real gas that has a volume that is larger than the volume predicted by the ideal gas law?

f) A system absorbs 623 J of heat while doing 457 J of work. What is the value of  $\Delta U$ ?

**Chapter 5, not on this midterm.**

g) Write the appropriate symbol for the species containing 45 neutrons, 35 protons, and 36 electrons.

h) Name the subatomic particle that is produced in a cathode ray tube.

i) How many millilitres of a liquid would fit into a cylinder with a radius of 3.0 m and height of 69 cm? (Volume of a cylinder =  $\pi r^2 h$ )

**#2. (12 points) The combustion of 0.246 g of an organic compound gives 0.656 g CO<sub>2</sub>, 0.134 g H<sub>2</sub>O, and  $1.86 \times 10^{-3}$  mol N<sub>2</sub> gas.**

- a) Does this organic compound contain any oxygen? Use a calculation to support your answer. (6 marks)**

- b) What is the empirical formula of this organic compound? (2 marks)**

**Answer:** \_\_\_\_\_

- c) Given that  $\text{H}_2(\text{g})$  has an effusion rate that is approximately 8-times faster than the effusion rate of this compound, what is the molecular formula of this organic compound? (4 marks)

Answer: \_\_\_\_\_

#3. In the following reaction:



$\text{O}_2$  was collected over water at  $25.2^\circ\text{C}$ . When the tube collecting the gas was lowered such that the level of water inside the tube matched the level outside the tube, the volume was 674 mL. A barometer in the lab showed a pressure reading of 765.0 mmHg on the day of the experiment, while the vapour pressure for water at this temperature is 23.8 mmHg.

- a) What is the mole fraction of  $\text{O}_2$  in the gas collected over water? (2 marks)

Answer: \_\_\_\_\_

- b) Calculate the percent yield of the reaction, given that the reaction was performed with 14.0 g of  $\text{KClO}_3$ . (7 marks)**

**Answer:** \_\_\_\_\_

- c) Draw an energy level diagram, given that this is an exothermic reaction. Include labels for  $U_{\text{reactants}}$ ,  $U_{\text{products}}$  and indicate the type(s) of energy transfer and the direction of the transfer in this diagram. (4 marks)

**Chapter 5, not on this midterm.**

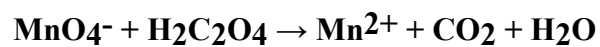
- d) Based on your diagram in c), will the absolute value of  $\Delta H$  be greater than, less than or equal to the absolute value of  $\Delta U$  for this reaction? Show  $\Delta H$  in the energy level diagram drawn in c). (2 marks)

**Chapter 5, not on this midterm.**

- e) If exactly the same reaction was performed in a rigid-walled container, would  $\Delta H$  be greater than, less than or equal to the  $\Delta H$  shown in part d)? Justify your answer with one sentence. (1 mark)

**Chapter 5, not on this midterm.**

**#4. For the following reaction in aqueous solution:**



- a) Write the oxidation numbers below each element in the reaction above (2 marks)
- b) Based on your answer in a), what is the oxidizing agent in this reaction? (1 mark)
- c) Balance this equation in acidic solution (7 marks).

**Final balanced chemical equation:**

**Constants and Conversion Factors**

$$\begin{array}{llll}
 1 \text{ mmHg} = 1 \text{ torr} & 760 \text{ mmHg} = 1 \text{ atm} & 1 \text{ atm} = 101.325 \text{ kPa} & 1 \text{ atm} = 1.013125 \text{ bar} \\
 1 \text{ cm}^3 = 1 \text{ mL} & 1 \text{ dm}^3 = 1000 \text{ mL} = 1 \text{ L} & & 1 \text{ m}^3 = 1000 \text{ L} \\
 1 \text{ cal} = 4.184 \text{ J} & & & 
 \end{array}$$

Avogadro's Number	$N$	$6.022 \times 10^{23} \text{ mol}^{-1}$
Atomic mass unit	$u$	$1.66054 \times 10^{-27} \text{ kg}$
Gas constant	$R$	$8.31451 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$
	$R$	$0.08206 \text{ atm} \cdot \text{L} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$
	$R$	$8.31451 \text{ m}^3 \text{ Pa} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$
	$R$	$0.0831451 \text{ bar L} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$

**Equations**

$$T(\text{in K}) = T(\text{in } ^\circ\text{C}) + 273.15 \text{ K}$$

$$n = \frac{m}{M}$$

$$\% \text{ Yield} = \frac{\text{actual yield}}{\text{theoretical yield}}$$

$$c(\text{mol/L}) = \frac{n}{V}$$

$$c_1 V_1 = c_2 V_2$$

$$pV = nRT$$

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

$$p_T = p_1 + p_2 + p_3 + \dots$$

$$p_A = X_A \times p_T$$

$$d = \frac{m}{V} = \frac{p \cdot MM}{RT}$$

$$E_K = \frac{1}{2} m v^2$$

$$u_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{\text{Rate A}}{\text{Rate B}} = \sqrt{\frac{M_B}{M_A}}$$

$$\left( p + \frac{n^2 a}{V^2} \right) (V - nb) = nRT$$

$$w = -p\Delta V$$

$$\Delta U = U_{final} - U_{initial} = q + w$$

$$\Delta H = \Delta U + p\Delta V$$

MAIN-GROUP ELEMENTS

# The Modern Periodic Table

MAIN-GROUP ELEMENTS

1		TRANSITION ELEMENTS										MAIN-GROUP ELEMENTS									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18				
H 1.008	He 4.003	Li 6.941	Be 9.012	B 10.81	C 12.01	N 14.01	O 16.00	F 19.00	Ne 20.18	Na 22.99	Mg 24.31	Al 26.98	Si 28.09	P 30.97	S 32.07	Cl 35.45	Ar 39.95				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18				
1 H	2 He	3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar				
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr				
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe				
85.47	87.62	88.91	91.22	92.91	95.94	(98)	101.1	102.9	106.4	107.9	112.4	114.8	118.7	121.8	127.6	126.9	131.3				
55 Cs	56 Ba	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn					
132.9	137.3	178.5	180.9	183.9	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	(209)	(210)	(222)					
87 Fr	88 Ra	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo					
(223)	(226)	(263)	(262)	(266)	(267)	(277)	(268)	(281)	(272)	(285)	(284)	(289)	(288)	(292)	(294)						

4  
Be  
9.012

Atomic number  
Atomic symbol  
Atomic mass (u)

Metals (main-group)  
Metals (transition)  
Metals (inner transition)  
Metalloids  
Nonmetals

INNER TRANSITION ELEMENTS

6	7	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
Lanthanides	Actinides	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
		138.9	140.1	140.9	144.2	(145)	150.4	152.0	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
		(227)	(232.0)	(231)	(238.0)	(237)	(242)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(260)

As of June 2012, elements 114 and 116 have been officially recognized. Elements 113, 115, 117, and 118 are pending verification by IUPAC.