

MEMORIAL UNIVERSITY OF NEWFOUNDLAND

St. John's, Newfoundland and Labrador

Chemistry 1010

December 8, 2014

FINAL EXAMINATION

TIME: 2.5 hours

NAME: _____ STUDENT NUMBER: _____

Instructor/class: (circle) **Poirier 10 am** **Hattenhauer 12 noon** **Hattenhauer 2 pm**

READ THE FOLLOWING CAREFULLY.

1. This examination has 11 pages of three sections. SECTION A is multiple choice and "fill in the blank", SECTION B is short-answer and SECTION C is long-answer questions. Ensure that this examination paper is complete, i.e. that all pages are present.
2. Failure to submit this paper in its entirety at the end of the examination may result in disqualification.
3. A Periodic Table and physical constants are provided. These follow the last page of the examination and may be detached for use during the examination.
4. Answer each question in the space provided. Should you require more space, use the back of the previous page and **indicate clearly** where this has been done.
5. When answering questions in **all** SECTIONS, **show all relevant calculations and justify simplifying assumptions.**
6. Numerical answers should be reported to the **appropriate number of significant digits and units.**

Do not write in the enclosed area below.

Questions	Value	Mark
Section A	30	
B1, B2, B3	14	
B4, B5, B6	15	
B7, B8	9	
C1	7	
C2	6	
C3	6	
C4	7	
C5	6	
Total	100	

Section A

Multiple Choice/ "Fill in Blank" Questions

You should allow ~ 40 min for this section. Circle the letter corresponding to your chosen answer for each question. Each question is worth 2 marks.

- A1. How many mm does a 433 km sample contain?
- a) 4.33×10^{-4} mm
 - b) 4.44×10^7 mm
 - c) 4.33×10^{-3} mm
 - d) 4.33×10^6 mm
 - e) 4.33×10^8 mm
- A2. If the number of moles of gas is doubled at constant temperature and volume, the pressure of the gas
- a) is halved.
 - b) is doubled.
 - c) is quadrupled.
 - d) remains the same.
 - e) none of the above.
- A3. In forming ions to reach a noble gas electron configuration, which of the following elements would form an ion with the largest ionic radii?
- a) Sr
 - b) Br
 - c) Na
 - d) Rb
 - e) As
- A4. Which is the molecular formula of a compound with an empirical formula of C_2HCl and a molar mass of $181.44 \text{ g} \cdot \text{mol}^{-1}$?
- a) $C_4H_2Cl_2$
 - b) $C_6H_3Cl_3$
 - c) C_2HCl
 - d) $C_8H_4Cl_4$
 - e) none of these
- A5. Which equation represents the *reduction half reaction* for the following redox reaction:
- $$\text{Zn(s)} + \text{Cu(NO}_3)_2(\text{aq}) \rightarrow \text{Cu(s)} + \text{Zn(NO}_3)_2(\text{aq})$$
- a) $\text{Cu}^{2+} + 2 \text{e}^- \rightarrow \text{Cu(s)}$
 - b) $\text{Cu(s)} + 2 \text{e}^- \rightarrow \text{Cu}^{2+}$
 - c) $\text{Zn}^{2+} \rightarrow \text{Zn(s)} + 2 \text{e}^-$
 - d) $\text{Zn}^{2+} + 2 \text{e}^- \rightarrow \text{Zn(s)}$

- A6. Which of the following is not a basic postulate of the kinetic molecular theory of gases?
- The average kinetic energy increases with increased temperature.
 - The size of the particle is negligibly small compared to the empty space.
 - Gas molecules do not interact with each other.
 - Gas molecules collide with one another but it is not an elastic collision.
- A7. A balloon contains 0.76 mol N₂, 0.18 mol O₂ and 0.051 mol He at a total pressure of 744 mm Hg. What is the partial pressure of O₂?
- 19 mm Hg
 - 570 mm Hg
 - 135 mm Hg
 - 38 mm Hg
 - 67 mm Hg
- A8. What is the name of the compound which has the formula N₂O?
- Ans: _____
- A9. Which of the following is (are) chemical change(s)?
- rusting iron
 - boiling ethanol
 - burning of propane
- 1 only
 - 3 only
 - 1 and 2 only
 - 1 and 3 only
 - 1, 2 and 3
- A10. Indicate the statement that is TRUE.
- Valence electrons effectively shield one another from nuclear charge.
 - Core electrons effectively shield valence electrons from nuclear charge.
 - Valence electrons are the most difficult of all electrons to remove.
 - Core electrons are the easiest of all the electrons to remove.
 - None of the above are true.
- A11. The stable isotopes of Gallium are ⁶⁹Ga and ⁷¹Ga. The numbers 69 and 71 represent the
- atomic masses.
 - mass numbers.
 - number of neutrons.
 - number of protons.
 - relative abundances

A12. What is the molarity (M) of a formaldehyde (CH₂O) solution containing 225 mg of formaldehyde in 1.0 L? Molar mass of formaldehyde is 30.0259 g · mol⁻¹.

Ans: _____

A13. How many valence electrons does an atom of Si possess?

Ans: _____

A14. Place the following elements in order of increasing atomic radius.

Ge F Si

- a) Ge < Si < F
- b) F < Ge < Si
- c) Si < Ge < F
- d) Ge < F < Si
- e) F < Si < Ge

A15. Place the following in order of increasing (1st) Ionization Energy.

K Ca Rb

- a) Ca < K < Rb
- b) Ca < Rb < K
- c) Rb < Ca < K
- d) Rb < K < Ca
- e) K < Ca < Rb

SECTION B **SHORT ANSWER QUESTIONS**
SHOW ALL CALCULATIONS

Allow ~ 50 min to complete

[3] B1. To what volume (in mL) should you dilute 50.0 mL of a 12.0 mol L⁻¹ nitric acid solution to obtain a 0.100 mol L⁻¹ nitric acid solution?


[3] B2. What is the λ of light (in nm) corresponding to blue light if the $\nu = 6.34 \times 10^{14} \text{ s}^{-1}$

[8] B3. (a) Write the abbreviated electron configurations for

Sc _____

Cl⁻ _____

(b) Draw the complete electronic orbital diagram for P

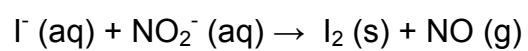
Example: He is 
1s

(c) List the 4 quantum numbers that describes one of the electrons in the highest energy orbitals.

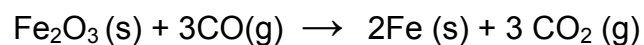
[6] B4. Complete the following table:

Formula	Cation	Anion	Name of compound
	Fe^{3+}	O^{2-}	
			potassium carbonate
$\text{HNO}_3(\text{aq})$			
	Na^+	HSO_4^-	

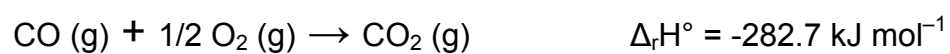
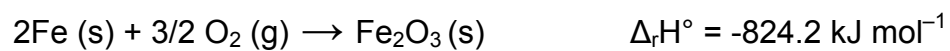
[6] B5. Balance the following oxidation-reduction reaction in acidic aqueous solution:



[3] B6. Calculate the enthalpy of reaction for:



Using the following reactions and enthalpies:



[4] B7. A sample of a diatomic gas has a mass of 9.271 g. Its volume at STP is 5.54 L. Calculate its molar mass and determine the identity of the gas.

[5] B8. (a) Draw the shape of a $2p_z$ orbital.

(b) Write down values for quantum # n and l for the $2p$ orbital.

$n =$

$l =$

SECTION C

LONG ANSWER QUESTIONS

Note: Show all calculations **Allow a minimum 60 min to complete**

- [7] C1. Tartaric acid contains only carbon, hydrogen and oxygen. Combustion of a 12.01 g sample of this compound produced 14.08 g of CO₂ and 4.32 g H₂O. Find the empirical formula for tartaric acid.

Given: Molar mass (H₂O) = 18.0153 g mol⁻¹
 Molar mass (CO₂) = 44.0095 g mol⁻¹

- [6] C2. Write balanced molecular, total ionic and net ionic equations for the following reaction; indicate the phase (*s*, *l*, *g* or *aq*) for each reactant and product.
The formation of a precipitate when aqueous calcium iodide and aqueous potassium sulfate are mixed.

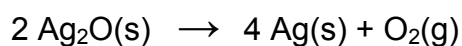
Molecular: _____

Total Ionic: _____

Net Ionic: _____

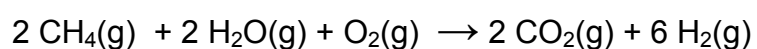
- [6] C3. The oxygen gas formed in the following reaction is collected over water at 25.0 °C at a total pressure of 734.1 torr. If the total volume of gas collected is 388 mL how many grams of Ag₂O were consumed? The vapour pressure of water at 25.0 °C is 23.78 torr.

Molar Mass (Ag₂O) = 231.7358 g mol⁻¹



- [7] C4. When 1.025 g of naphthalene ($C_{10}H_8$, molar mass of $128.1702 \text{ g mol}^{-1}$) undergoes combustion in a bomb calorimeter, the temperature rises from $24.25 \text{ }^\circ\text{C}$ to $32.33 \text{ }^\circ\text{C}$. Find $\Delta_r U$ for the combustion of naphthalene in kJ mol^{-1} . The heat capacity of the bomb calorimeter, determined in a separate experiment is $5.11 \text{ kJ }^\circ\text{C}^{-1}$.

- [6] C5. Hydrogen gas used in fuel cell technology can be prepared industrially from a reaction of methane with water vapour and oxygen:



Using the standard enthalpies of formation below, calculate $\Delta_r H^\circ$ for the reaction as written.

<u>Substance</u>	<u>$\Delta_f H^\circ$ (kJ mol^{-1})</u>
$\text{CH}_4(\text{g})$	- 74.6
$\text{H}_2\text{O}(\text{g})$	- 241.83
$\text{CO}_2(\text{g})$	- 393.5

PERIODIC TABLE OF THE ELEMENTS

6 C 12.0107	atomic number
atomic mass	

KEY

1 H 1.0079																	18 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.0107	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797
11 Na 22.9898	12 Mg 24.3050											13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.065	17 Cl 35.453	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9380	26 Fe 55.8475	27 Co 58.9332	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.409	31 Ga 69.723	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.798
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.75	52 Te 127.60	53 I 126.9045	54 Xe 131.29
55 Cs 132.9054	56 Ba 137.327	57 La 139.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.9665	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.9804	84 Po (210)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)									

58 Ce 140.116	59 Pr 140.9077	60 Nd 144.24	61 Pm (147)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.9303	68 Er 167.259	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.967
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90 Th 232.0381	91 Pa 231.0359	92 U 238.0289	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)
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Parenthesis Indicates the most stable isotope

SOME USEFUL CONSTANTS

Quantity and Symbol Value

Avogadro Constant, N $6.022 \times 10^{23} \text{ particles} \cdot \text{mol}^{-1}$

Density of $\text{H}_2\text{O}(\ell)$ at 4°C 1.00 g mL^{-1}

Standard Temperature and Pressure (STP) $273.15 \text{ K} = 0.00^\circ\text{C}$ and 1.000 bar

Molar Volume of an Ideal Gas at STP 22.71 L mol^{-1}

Ideal Gas Constant, R $0.08314 \text{ L bar mol}^{-1} \text{ K}^{-1} = 8.314 \text{ L kPa mol}^{-1} \text{ K}^{-1} =$

$8.314 \text{ J mol}^{-1} \text{ K}^{-1} = 8.206 \times 10^{-2} \text{ L atm mol}^{-1} \text{ K}^{-1}$

Specific Heat Capacity of $\text{H}_2\text{O}(\ell)$ $4.184 \text{ J g}^{-1} \text{ K}^{-1}$

ΔH_{fusion} , $\text{H}_2\text{O}(\text{s})$ at 273 K 6.02 kJ mol^{-1}

$\Delta H_{\text{vaporization}}$, $\text{H}_2\text{O}(\ell)$ at 373 K 41.1 kJ mol^{-1}

Planck Constant, h $6.626 \times 10^{-34} \text{ J s}$

Velocity of Light in a vacuum, c $2.998 \times 10^8 \text{ m s}^{-1}$

Ionization Constant of Water, K_w , at 25°C 1.008×10^{-14}

Faraday Constant, F $9.6485 \times 10^4 \text{ C mol}^{-1}$

$\text{C} = 1 \text{ Ampere (a) x seconds(s)}$

Rydberg constant, R_H $1.0973 \times 10^7 \text{ m}^{-1}$

CONVERSION FACTORS

$1 \text{ bar} = 100 \text{ kPa(exactly)} = 750.1 \text{ torr (mmHg)} = 0.9869 \text{ atm}$

$1 \text{ atomic mass unit, } u = 1.660 \times 10^{-27} \text{ kg}$

$1 \text{ cal} = 4.184 \text{ J}$

$1 \text{ mL} = 1 \text{ cm}^3$

$1 \text{ bar L} = 100 \text{ J}$

You may detach this page if you wish. It must be handed in with the examination paper!

Edited September 2014

Do not turn the paper over until you are told that you may do so.

You may not leave the examination room during the first half hour or during the last half hour of the examination.

**At the end of the examination:
When you are told to stop writing you must do so.**

ACADEMIC OFFENCES

Academic offences shall be deemed to include, but shall not be limited to, the following:

1. **Cheating on examinations, theses, assignments, work term reports, projects, internship reports, or any other tests.**
Cheating includes copying from another student's work or allowing another student to copy from one's own work, consulting with any unauthorized person during an examination or test, or using unauthorized aids; or knowingly recording or reporting false empirical or statistical data. The work referred to includes examinations, theses, assignments, work term reports, projects, internship reports, or any other tests which are to be used in judging the student's performance in a course or programme of study, or on any special tests which the University may offer.
2. **Impersonating another student or allowing oneself to be impersonated.**
By impersonation is meant the imitation of a student or entrance into an arrangement with another person to be impersonated for purposes of taking examinations or tests or carrying out laboratory or other assignments.
3. **Plagiarism.**
Plagiarism is the act of presenting the ideas or works of another as one's own. This applies to all material such as essays, laboratory reports, work term reports, design projects, seminar presentations, statistical data, computer programmes and research results. The properly acknowledged use of sources is an accepted and important part of scholarship. Use of such material without acknowledgement, however, is contrary to accepted norms of academic behaviour.
4. **Theft of examination papers or other material.**
By theft is meant obtaining by any improper means examination papers, tests, or any other such material.
5. **Use and/or distribution of stolen material.**
The use of material which the student knows to have been improperly obtained and/or the distribution of such material is considered to be an academic offence.
6. **Submitting false information.**
This offence includes falsifying academic forms or records, submitting false credentials, medical or other certificates, or making a false, misleading or incomplete declaration to the University.
7. **Submitting work for one course which has been or is being submitted for another course without express permission to do so.**
This includes the presentation of an essay, report or assignment to satisfy some or all of the requirements of a course when that essay, report, or assignment has been previously submitted or is concurrently being submitted for another course without the express permission of the professor(s) involved.

NOTE: Procedures to be followed and penalties to be assessed in cases of academic dishonesty are outlined in the University Calendar.