

Chemistry CHM 1311C Test 1

October 22, 2013

Darrin Richeson

Name: _____

Student Number: _____

Laboratory Day (circle one):

Tuesday 2:30

Tuesday 6:30

Wednesday 10:00

Thursday 2:30

Thursday 6:30

Friday 2:30

Laboratory TA: _____

DO NOT TURN THE PAGE OR START THE EXAM UNTIL YOU ARE NOTIFIED.

You will have 80 minutes for the exam.

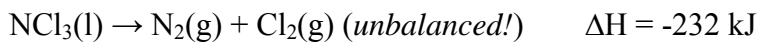
**There are data and a periodic table on the last two pages.
Feel free to remove these and use them.**

Question	Mark
1	/ 5
2	/ 5
3	/ 5
4	/ 5
5	/ 5
Total	/30

Good Luck.

1. You are part of a team of scientists investigating a sports “doping” scandal. A sample suspected of being “The Clear” (slang for tetrahydrogestrinone $C_{21}H_{28}O_2$) is collected during the investigation. A combustion analysis of a 0.1570 g sample of this material yields 0.4586 g of CO_2 and 0.1283 g of H_2O . What is the simplest formula for this sample? Could it be tetrahydrogestrinone?

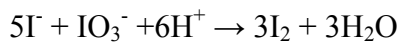
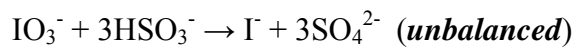
2. A sample of liquid nitrogen trichloride was heated in a 1.50 L, closed container until it decomposed completely into gaseous elements. The resulting mixture exerted a pressure of 744 torr at 75°C.



What is the partial pressure of each gas in the container?

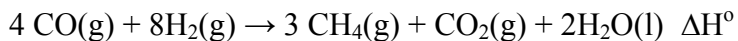
What was the mass of the original sample?

3. Iodine can be prepared from the reduction of sodium iodate (Na^+IO_3^-) using the following series of reactions that are carried out in acid solution:

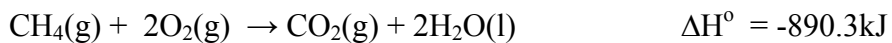


How many grams of iodine are produced from 100 grams of NaHSO_3 if each reaction has a 78.4% yield?

4. Substitute natural gas (SNG) is a gaseous mixture containing $\text{CH}_4(\text{g})$ that can be used as a fuel. One of the reactions for producing SNG is:



Determine the value of ΔH° for this reaction using:



5. For each of the following sets of quantum numbers, give the number of orbitals:

<i>Quantum numbers</i>	Number of Orbitals
$n = 4, l = 2$	
$n = 5, l = 1$	
$n = 6, l = 3$	

Write a full set of quantum numbers for each of the following electrons:

The outermost electron in a Li atom	
The highest energy electron in the ground-state B atom	

Identify each element below:

$[\text{Ar}] 4s^2 3d^{10} 4p^4$	
$[\text{Ar}] 4s^2 3d^5$	

Using the rules of electron configurations, indicate the

Number of unpaired electrons on an atom of P	
Number of 3d electrons in an atom of Br	
Number of 4f electrons in an atom of Au	

Thermodynamic data for temperature = 298.15 K

	ΔH° (kJ/mol)	ΔG° (kJ/mol K)	S° (J/mol K)
PCl ₃ (g)	-287	-267.8	311.8
PCl ₅ (g)	-374.9	-305.0	364.6
POCl ₃ (g)			222.4
SO ₂ Cl ₂ (g)	-364.0	-320.0	311.9
COCl ₂ (g)	-218.8	-204.6	283.5
Cl ₂ (g)	0	0	223.1
O ₂ (g)	0	0	205.11
SO ₂ (g)	-296.8	-300.2	248.2
CO(g)	-110.5	-137.2	197.7
SO ₃ (g)	-395.7	-371.1	256.8
I(g)	106.8	70.25	180.8
I ₂ (g)	62.44	19.33	260.7
I ₂ (s)	0	0	116.1
CH ₄ (g)	-75.0		186.3
CH ₃ OH(l)	-237		126.8
O ₂ (g)	0	0	205.1
N ₂ H ₄ (g)	95.4		238.5
N ₂ O ₄ (g)	11.1		304.4
H ₂ O(g)	-241.8		188.8
N ₂ (g)	0.0		191.6
N ₂ H ₄ (l)	50.6		121.2
N ₂ O ₄ (l)	-19.5		209.2
SnO ₂ (s)	-580.7		52.3
C(s)	0		5.74
Sn(s)			51.2
2CO ₂ (g)	-393.5		213.8
H ₂			130.7
Br ₂ (g)	30.91		245.5
HBr	-36.4		198.7

Gas Law

$$PV = nRT$$

$$P_{\text{Total}} = P_1 + P_2 + P_3 + \dots$$

$$d = m/V = P(\text{MW}) / RT$$

$$KE = (1/2)mv_{\text{av}}^2$$

$$\sqrt{v^2} = \sqrt{\frac{3RT}{M}}$$

$$\frac{\text{Rate}_A}{\text{Rate}_B} = \sqrt{\frac{M_b}{M_a}}$$

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

Equilibrium

$$K_p = K(RT)^{\Delta n}$$

Acid/Base

$$\text{pOH} = -\log [\text{OH}^-]$$

$$\text{pH} = -\log[\text{H}^+]$$

$$\text{pH} + \text{pOH} = 14$$

$$K_a \times K_b = K_w$$

$$\text{pH} = \text{p}K_a + \log \left[\frac{[\text{A}^-]}{[\text{HA}]} \right]$$

$$\text{pH} = \frac{\text{p}K_{a1} + \text{p}K_{a2}}{2}$$

Data For Water

Density $\rho = 1.00 \text{ g/mL}$ (25°C)

$C = 2.13 \text{ J g}^{-1} \text{ K}^{-1}$ (solid)

$C = 4.18 \text{ J g}^{-1} \text{ K}^{-1}$ (liquid)

$C_p = 2.01 \text{ J g}^{-1} \text{ K}^{-1}$ (gas)

Thermodynamics

$$\Delta U = q + w$$

$$w_{\text{system}} = -P\Delta V$$

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

$$q_p = \Delta U + P\Delta V$$

$$C_p = C_v + R$$

$$\Delta H_{\text{rxn}}^\circ = \sum n_p \Delta H_f^\circ(\text{products}) - \sum n_r \Delta H_f^\circ(\text{reactants})$$

$$q_{\text{rev}} = -w_{\text{max}} = nRT \ln(V_2/V_1)$$

$$\Delta S = q_{\text{rev}} / T$$

$$\Delta S_{T_1-T_2} = nC_p \ln(T_2/T_1)$$

$$\Delta S_{T_1-T_2} = nC_v \ln(T_2/T_1)$$

$$\Delta S_{\text{surroundings}}^\circ = \frac{q_{\text{surroundings}}}{T} = \frac{-\Delta H_{\text{sys}}}{T}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta G = \Delta G^\circ + RT \ln(Q)$$

$$\Delta G^\circ = -RT \ln(K)$$

$$\ln(K_2/K_1) = -\Delta H^\circ/R (1/T_2 - 1/T_1)$$

Constants

Avogadro's Number
 Boltzmann's constant
 Faraday's constant
 Gas constant
 Planck's constant
 Speed of Light

N
 k
 F
 R
 R
 R
 h
 c

6.022×10^{23}
 1.30866×10^{-23}
 $96,485$
 8.314
 8.314
 0.08206
 6.62608×10^{-34}
 2.99792458×10^8

mol^{-1}
 $\text{J} \cdot \text{K}^{-1}$
 $\text{C} \cdot \text{mol}^{-1}$
 $\text{J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$
 $\text{kPa} \cdot \text{L} / (\text{mol} \cdot \text{K})$
 $\text{atm} \cdot \text{L} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$
 $\text{J} \cdot \text{s}$
 $\text{m} \cdot \text{s}^{-1}$

Mokleur's Periodic table of the elements

18 VIIIA		17 VIIA		16 VIA		15 VA		14 IVA		13 IIIA		12 IIB		11 IB		10 VIII		9 VII		8 VI		7 VB		6 VIB		5 VB		4 IVB		3 IIIB		2 IIA		1 IA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
He 2 4.002602 Helium		F 9 18.9984032 Fluorine		O 8 15.9994 Oxygen		N 7 14.00674 Nitrogen		C 6 12.011 Carbon		B 5 10.811 Boron		Ne 10 20.1797 Neon		Ar 18 39.948 Argon		Kr 36 83.80 Krypton		Xe 54 131.29 Xenon		Rn 86 222.0176 Radon		Uuo 118 293 Ununoctium		Lu 71 174.967 Lutetium		Yb 70 173.04 Ytterbium		Tm 69 168.93421 Thulium		Er 68 167.26 Erbium		Ho 67 164.93032 Holmium		Dy 66 162.50 Dysprosium		Tb 65 168.93423 Terbium		Gd 64 157.25 Gadolinium		Eu 63 151.965 Europium		Sm 62 150.36 Samarium		Pm 61 144.9127 Promethium		Nd 60 144.24 Neodymium		Pr 59 140.90765 Praseodymium		Ce 58 140.115 Cerium																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
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