Chem 4A Exam 1

TOTAL POINTS

92 / 100

QUESTION 1

1 1A 10 / 10

✓ + 10 pts **Correct Answer (150g of CO2)**

+ 3 pts Correct Balanced Equation (C2H2+5/2O2 -> 2 CO2 + H2O)

+ 4 pts Correct use of stoicheometric mixture (perfect mixture of C2H2 and O2 so that all reactants are reacted, 5 moles of O2 per 2 moles of C2H2)

+ 2 pts Correct Use of Ideal Gas Law (PV=nRT, should get 6.09 moles of reactant gas total)

+ 0 pts Incorrect

+ 0 pts Flag For Review

QUESTION 2

2 1B 10 / 10

✓ - 0 pts **Correct**

- 3 pts Incorrect stoichiometry

- 3 pts Incorrect calculations

- 2 pts Incorrect sig. figs.

- 1 pts Math error

- 5 pts No calculations

- 10 pts Incorrect or blank

- 10 pts Flag for review

QUESTION 3

3 2 20 / 20

✓ + 20 pts **correct answer 77atm**

+ 5 pts correct balanced eq

+ 10 pts O2 limiting

+ 5 pts mole fraction equation

+ 15 pts math error but otherwise correct

+ 0 pts incorrect

QUESTION 4

4 3A 10 / 10

✓ + 10 pts **Correct Answer: 12 mL of IO3-**

+ 4 pts Correct Balanced Equation

+ 2 pts Calculated Correct number of I- moles

+ 0 pts No points

- 2 pts Correct final answer, but Incorrect balanced equation

- 2 pts Incorrect Significant Figures

QUESTION 5

5 3B 10 / 10

✓ + 10 pts **All correct! Nice job--you should be proud of yourself! You're on your way to becoming an excellent chemist (correct answer: 36 mL)**

+ 2 pts Identified that IO$$_3^-$$ is in a 1:3 stoichiometric ratio with I$$_2$$

+ 2 pts Identified 1:1 stoichiometric ratio of I$$_2$$ and SO$$_3^{2-}$$

+ 3 pts Converted mol SO$$_3^{2-}$$ to mL sulfite solution

+ 3 pts Correct answer of 36 mL

- 0.5 pts incorrectly labeled answer

- 2 pts incorrect number of significant figures (should be 2, as per test instructions)

+ 0 pts I'm sorry to report that your answer is entirely incorrect :(

+ 0 pts CAN'T READ FLAG

QUESTION 6

6 4A 9 / 15

✓ + 3 pts **mol H2**

✓ + 3 pts **mass Al/Fe**

✓ + 3 pts **mass to mol metal**

+ 3 pts setup/math

+ 3 pts answer

+ 0 pts FLAG FOR REVIEW

+ 0 pts Click here to replace this description.

+ **0 pts** Click here to replace this description.

QUESTION 7

7 4B 5 / 5

✓ **- 0 pts Correctly uses**

$$s = \sqrt{\frac{\sum\limits_{i=1}^{N}(x-\bar{x})}{N-1}}$$

where $$\bar{x}$$ is the average

- 0 pts Correctly uses

$$S_m = \frac{s}{\sqrt{N}}$$

- 1.5 pts Missing Units

- 1 pts Math error\sig figs

- 2.5 pts Incorrect standard deviation formula or standard deviation of the mean

- 5 pts Incorrect/no work shown

- 5 pts flagged for review

QUESTION 8

8 5.1 A-C 8 / 10

✓ **- 2 pts Incorrect Lewis Structure**

- 2 pts Incorrect Formal Charges

- 3 pts Got part a wrong and that affected B and C

- 3 pts Incorrect Electron Pair Geometry

- 3 pts Incorrect Molecular Geometry

- 1.5 pts Partial Credit for B or C

- 0 pts All correct

- 1 pts partial credit

- 0 pts Click here to replace this description.

- 0 pts Flag for review (can't read)

QUESTION 9

9 5.2 A-C 10 / 10

- 2 pts Formal charge

- 2 pts lewis structure

- 3 pts electron pair geometry

- 3 pts molecular geometry

✓ **- 0 pts Full Credit**

- 0 pts Flag For Review

Chemistry 4A, Exam I
September 13, 2017
Professor R. J. Saykally

Name _____

_____

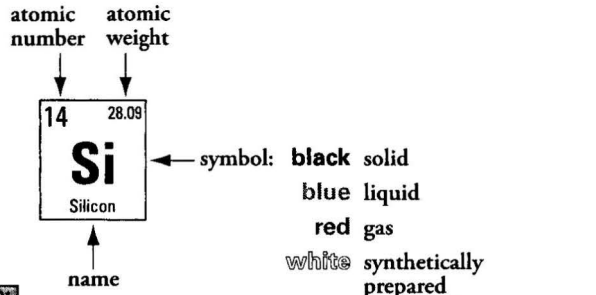
1. (20) _____
2. (20) _____
3. (20) _____
4. (20) _____
5. (20) _____

TOTAL EXAM SCORE (100) _____

Rules:

- Work all problems to 2 significant figures
- No lecture notes or books permitted
- No programmable or graphing calculators permitted
- Time: 50 minutes
- Show all work to get partial credit
- All answers must be written in the boxes provided
- Periodic Table, Tables of Physical Constants, and Conversion Factors included

Periodic Table of the Elements



black solid
blue liquid
red gas
white synthetically prepared
most stable isotope
grey synthetically prepared; later found in trace amounts in nature

- alkali metals
- alkaline earth metals
- transition metals
- other metals
- metalloids
- noble gases
- halogens
- other non-metals
- unknown chemical properties
- discovery claimed

BERKELEY LAB
WORKFORCE DEVELOPMENT & EDUCATION OFFICE

1 1.01 H Hydrogen																	2 4.003 He Helium
3 6.94 Li	4 9.01 Be											5 10.81 B Boron	6 12.01 C Carbon	7 14.01 N Nitrogen	8 15.999 O Oxygen	9 18.998 F Fluorine	10 20.18 Ne Neon
11 22.99 Na	12 24.31 Mg												14 28.09 Si Silicon	15 30.97 P Phosphorus	16 32.06 S Sulfur	17 35.45 Cl Chlorine	18 39.95 Ar Argon
19 39.10 K Potassium	20 40.08 Ca Calcium	21 44.96 Sc Scandium	22 47.90 Ti Titanium	23 50.94 V Vanadium	24 51.996 Cr Chromium	25 54.94 Mn Manganese	26 55.85 Fe Iron	27 58.93 Co Cobalt	28 58.69 Ni Nickel	29 63.55 Cu Copper	30 65.41 Zn Zinc		32 72.64 Ge Germanium	33 74.92 As Arsenic	34 78.96 Se Selenium	35 79.90 Br Bromine	36 83.80 Kr Krypton
37 85.47 Rb Rubidium	38 87.62 Sr Strontium	39 88.91 Y Yttrium	40 91.22 Zr Zirconium	41 92.91 Nb Niobium	42 95.94 Mo Molybdenum	43 (98) Tc*** Technetium	44 101.07 Ru Ruthenium	45 102.91 Rh Rhodium	46 106.42 Pd Palladium	47 107.87 Ag Silver	48 112.41 Cd Cadmium			51 121.76 Sb Antimony	52 127.60 Te Tellurium	53 126.90 I Iodine	54 131.29 Xe Xenon
55 132.91 Cs Cesium	56 137.33 Ba Barium	57 138.91 La ▶ Lanthanum	72 178.49 Hf Hafnium	73 180.95 Ta Tantalum	74 183.84 W Tungsten	75 186.21 Re Rhenium	76 190.23 Os Osmium	77 192.22 Ir Iridium	78 195.08 Pt Platinum	79 196.97 Au Gold	80 200.59 Hg Mercury				84 (209) Po Polonium	85 (210) At* Astatine	86 (222) Rn Radon
87 (223) Fr Francium	88 226.03 Ra Radium	89 227.03 Ac ▶ Actinium	104 (261) Rf* Rutherfordium	105 (262) Db* Dubnium	106 (266) Sg* Seaborgium	107 (264) Bh Bohrium	108 (277) Hs Hassium	Mt	Ds	Rg	Cn	113 — Uut Ununtrium	Fl	115 — Uup Ununpentium	Lv	117 — Uus Ununseptium	118 — Uuo Ununoctium

Lanthanide series ▶	58 140.12 Ce Cerium	59 140.91 Pr Praseodymium	60 144.24 Nd Neodymium	61 (145) Pm Promethium	62 150.36 Sm Samarium	63 151.96 Eu Europium	64 157.25 Gd Gadolinium	65 158.93 Tb Terbium	66 162.50 Dy Dysprosium	67 164.93 Ho Holmium	68 167.26 Er Erbium	69 168.93 Tm Thulium	70 173.04 Yb Ytterbium	71 174.97 Lu Lutetium
Actinide series ▶	90 232.04 Th Thorium	91 231.04 Pa Protactinium	92 238.03 U Uranium	93 237.05 Np* Neptunium	94 (244) Pu* Plutonium	95 (243) Am** Americium	96 (247) Cm* Curium	97 (247) Bk* Berkelium	98 (251) Cf* Californium	99 (252) Es* Einsteinium	100 (257) Fm* Fermium	101 (258) Md* Mendelevium	102 (259) No* Nobelium	103 (262) Lr* Lawrencium

* Discovered at Lawrence Berkeley National Laboratory
** Discovered in Chicago by Berkeley team
*** Discovered in Italy using a sample from Berkeley cyclotron bombardment

Physical Constants

Standard Acceleration of terrestrial gravity	$g = 9.80665\ \text{m s}^{-2}$ (exactly)
Avogadro's number	$N_0 = 6.022137 \times 10^{23}$
Bohr radius	$a_0 = 0.52917725\ \text{Å} = 5.2917725 \times 10^{-11}\ \text{m}$
Boltzmann's constant	$k_B = 1.38066 \times 10^{-23}\ \text{J K}^{-1}$
Electron Charge	$e = 1.6021773 \times 10^{-19}\ \text{C}$
Faraday constant	$\mathcal{F} = 96{,}485.31\ \text{C mol}^{-1}$
Masses of fundamental particles:	
Electron	$m_e = 9.109390 \times 10^{-31}\ \text{kg}$
Proton	$m_p = 1.672623 \times 10^{-27}\ \text{kg}$
Neutron	$m_n = 1.674929 \times 10^{-27}\ \text{kg}$
Ratio of proton mass to electron mass	$m_p/m_e = 1836.15270$
Permittivity of vacuum	$\epsilon_0 = 8.8541878 \times 10^{-12}\ \text{C}^2\ \text{J}^{-1}\ \text{m}^{-1}$
Planck's constant	$h = 6.626076 \times 10^{-34}\ \text{J s}$
Speed of light in vacuum	$c = 2.99792458 \times 10^{8}\ \text{m s}^{-1}$ (exactly)
Universal gas Constant	$R = 8.31451\ \text{J mol}^{-1}\ \text{K}^{-1} = 0.0820578\ \text{L atm mol}^{-1}\ \text{K}^{-1}$

Conversion Factors

Standard Atmosphere	$1\ \text{atm} = 1.01325 \times 10^{5}\ \text{Pa} = 1.01325 \times 10^{5}\ \text{kg m}^{-1}\ \text{s}^{-2}$ (exactly)
Atomic mass unit	$1\ \text{u} = 1.660540 \times 10^{-27}\ \text{kg}$
	$1\ \text{u} = 1.492419 \times 10^{-10}\ \text{J} = 931.4942\ \text{MeV}$ (energy equivalent from E = mc2)
Calorie	$1\ \text{cal} = 4.184\ \text{J}$ (exactly)
Electron volt	$1\ \text{eV} = 1.6021773 \times 10^{-10}\ \text{J} = 96.48531\ \text{kJ mol}^{-1}$
Foot	1 ft = 12 in = 0.3048 m (exactly)
Gallon (U.S.)	1 gallon = 4 quarts = 3.78541 L (exactly)
Liter-atmosphere	1 L atm = 101.325 J (exactly)
Metric ton	1 metric ton = 1000 kg (exactly)
Pound	1 lb = 16 oz = 0.45359237 kg (exactly)

Chemistry 4A Fall 17, Exam I Name _____

Question 1 (10 points each)

A) What mass (g) of CO_2 is made when 3.0 L of a <u>stoichiometric mixture</u> of acetylene (C_2H_2) and oxygen at 50 atm, 300 K is combusted?

$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$

$P_{C_2H_2} = P_1 \quad P_{O_2} = P_2$

$P_A = P_1 + P_2$

$P_2 = \frac{5}{2}P_1$

$P_F = \frac{7}{2}P_1$

$50 = \frac{7}{2}P_1$

$P_1 = 14.29$ atm

$P_2 = 35.71$ atm

$PV = nRT$

$n = \frac{PV}{RT}$

$n_{O_2} = \frac{(35.71 \text{ atm})(3.0 \text{ L})}{(0.0821 \frac{\text{L atm}}{\text{mol K}})(300 \text{ K})} = 4.35 \text{ mol } O_2$

$4.35 \text{ mol } O_2 \left| \frac{4 \text{ mol } CO_2}{5 \text{ mol } O_2} \right| \frac{44.0 \text{ g } CO_2}{1 \text{ mol } CO_2} = 150 \text{ g } CO_2$

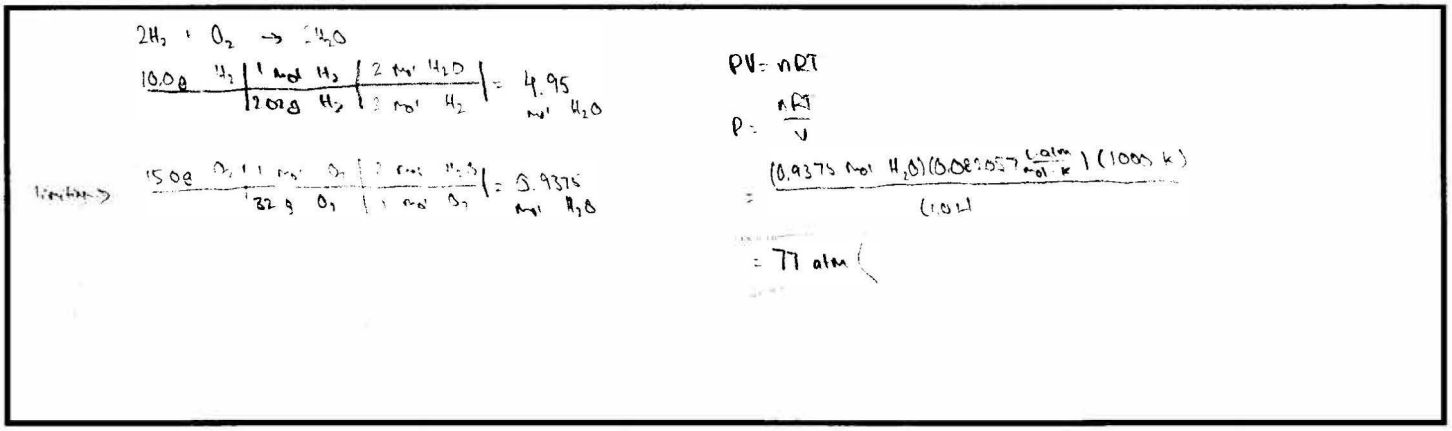
B) Calculate the <u>mass of CO_2</u> produced by complete surface combustion of 0.50 L of a 5.0 M solution of propanol (C_3H_7OH) in water.

$2C_3H_7OH + 9O_2 \rightarrow 8H_2O + 6CO_2$

$0.5 \text{ L } C_3H_7OH \left| \frac{5.0 \text{ mol } C_3H_7OH}{1 \text{ L } C_3H_7OH} \right| \frac{6 \text{ mol } CO_2}{2 \text{ mol } C_3H_7OH} \left| \frac{44.0 \text{ g } CO_2}{1 \text{ mol } CO_2} \right| = 330 \text{ g } CO_2$

Question 2 (20 points)

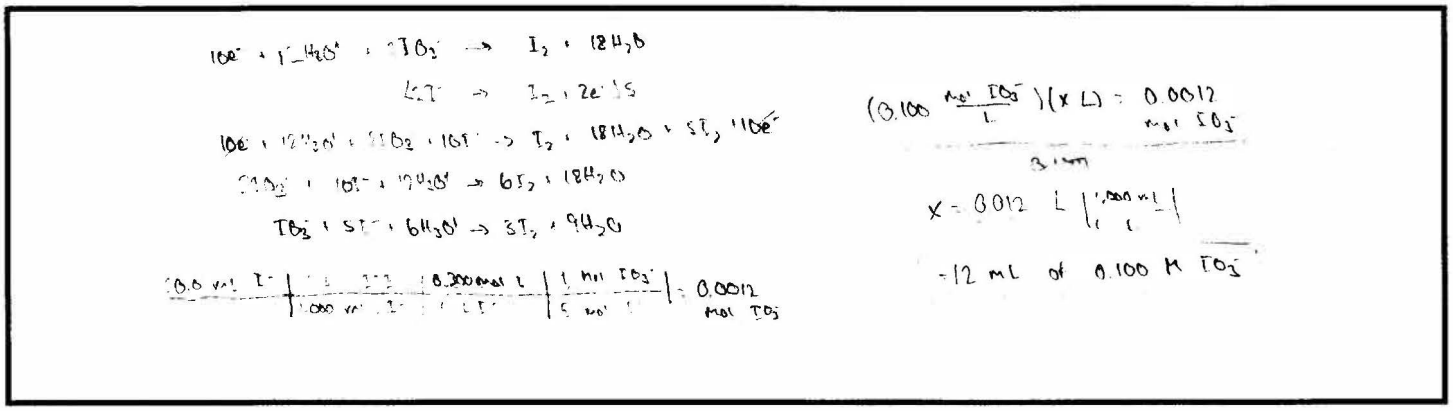
A mixture of 10.0 g of H_2 (*g*) and 15.0 g of O_2 (*g*) is combusted in a 1.0 L vessel. Calculate the partial pressure of the H_2O (*g*) produced assuming it is at 1000 K.



Question 3 (10 points each)

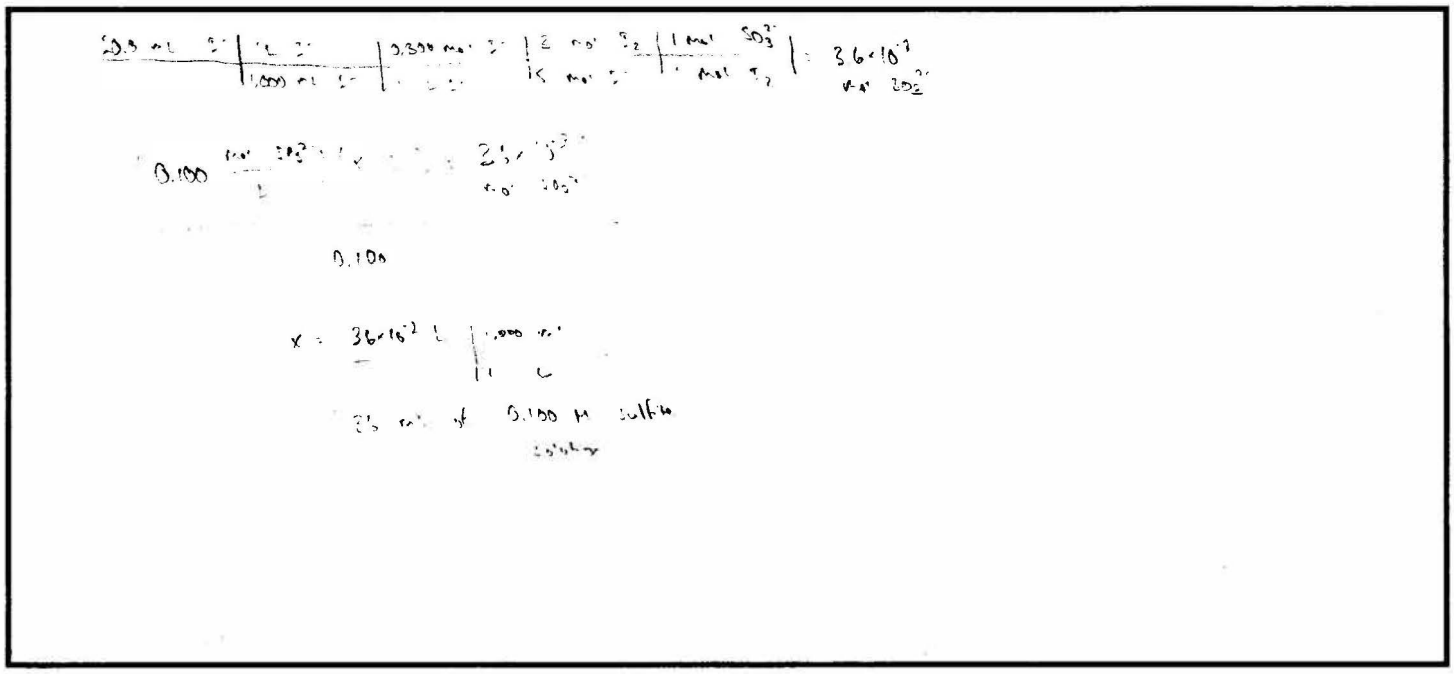
The Iodine Clock Reaction involves the reaction of iodate (IO_3^-) with iodide (I^-) in acidic solution (H^+) to produce iodine (I_2) and water.

A) Calculate the volume of 0.100 M IO_3^- solution that will exactly react with 20.0 mL of 0.300 M I^- solution.



B) What volume of 0.100 M sulfite (SO_3^{2-}) solution would be required to exactly react with the iodine (I_2) produced in Part A above?

The balanced reaction is: $SO_3^{2-} + I_2 + H_2O \rightarrow SO_4^{2-} + 2I^- + 2H^+$



Question 4 **(20 points total)**

A) A mixture of aluminum and iron weighing 10.00 g reacts with hydrogen chloride in aqueous solution according to the parallel reactions

$$\mathbf{2\,Al + 6\,HCl \rightarrow 2\,AlCl_3 + 3\,H_2}$$
$$\mathbf{Fe + 2\,HCl \rightarrow FeCl_2 + H_2}$$

A 0.620 g quantity of hydrogen is evolved when the metals react completely. Calculate the mass of iron in the original mixture. **(15 points)**

x g Fe

10.00 − x g Al

x g Fe | 1 mol Fe / 55.85 g Fe | 1 mol H_2 / 1 mol Fe | 2.02 g H_2 / 1 mol H_2 | = 0.0361x g H_2

10.00 − x g Al | 1 mol Al / 26.98 g Al | 3 mol H_2 / 2 mol Al | 2.02 g H_2 / 1 mol H_2 | = [illegible] − 0.225x g H_2

0.0361x + [illegible] − 0.225x g H_2 = 0.620 g H_2

0.188x = 1.626

x = 8.6 g Fe

B) ~~Three~~ Four trials yield the following results for the mass of H_2 produced in the above reactions:

0.738 g 0.516 g 0.815 g 0.920 g

Calculate the standard deviation of the mean for these results. **(5 points)**

$\bar{x} = \frac{0.738 + 0.516 + 0.815 + 0.920}{4} = 0.75\ g\ H_2$

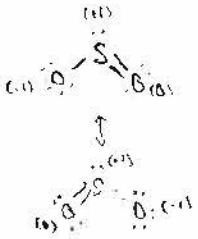
$s_x = \sqrt{\frac{(0.738 - 0.752)^2 + (0.738 - 0.516)^2 + (0.738 - 0.815)^2 + (0.738 - 0.920)^2}{4 - 1}}$

$= 0.17\ g\ H_2$

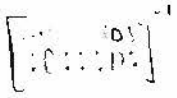
Question 5 (10 Points each)

For the following compounds:
A. Draw the Lewis Structure, explicitly showing the formal charges and molecular geometry
B. Indicate the Electron Pair Geometry
C. Indicate the Molecular Geometry

I. Sulfur Dioxide (SO_2)

A.	B.	C.
	Trigonal Planar	Bent

II. Cyanide (CN^-) ion

A.	B.	C.
	Linear	Linear