CHEMISTRY 4A
Professor Richard Mathies

September 17, 1993

FIRST MIDTERM

Name: _____

TA: _____

Begin by writing your name on all pages. You must **show all your work** in the space provided for each question. Do the problems that you know first and then go back to work on the more difficult ones in the time remaining. **A list of physical constants, some equations, and a periodic table will be found on the last page.**

Good Luck!

(1) _____ / 25

(2) _____ / 28

(3) _____ / 20

(4) _____ / 5

/ 78

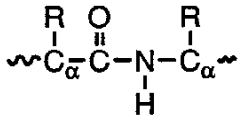
1. a. For each compound indicate whether the bond(s) formed are covalent or ionic. (5)

NaCl I_2 H_2S CN^- NaCN

b. For each compound given below draw the best Lewis electron dot structure. You should clearly indicate any possible resonance structures as well as the formal charges of the various atoms. (15)

O_3 CH_3CN XeO_2F_2

c. The peptide bond is a critical structural element in the formation of proteins. The structure of this bond is sketched below, where R indicates the various amino acid side chains. It is found in practice that rotation about the C-N bond is very difficult so that the O, C, N and H atoms are always found in a plane. Explain this observation based on your knowledge of chemical bonding and Lewis dot structures. (5)



2. a. A standard test for aqueous bromide ion involves oxidation to bromine with permanganate ion and acid. Bromine then dissolves in methylene chloride to give an orange color. Complete and balance the equation for this reaction: (7)

$Br^-(aq) + MnO_4^-(aq) \text{ ----------> } Br_2(aq) + Mn^{2+}(aq)$

b. Manganate (VI) ions (MnO_4^{2-}) are unstable in acidic aqueous solutions. What is the balanced reaction for this disproportionation of manganate ion into permanganate and Mn (II)? (7)

c. The reusable booster rockets of the U.S. space shuttle use a mixture of aluminum and ammonium perchlorate for fuel. The unbalanced reaction between the substances is: (10)

$Al(s) + NH_4ClO_4(s) \text{ -----> } Al_2O_3(s) + AlCl_3(s) + NO(g) + H_2O(g)$

What mass of ammonium perchlorate should be used in the fuel mixture for each kg of Al in order to achieve complete combustion?

d. Identify the Lewis acid and the Lewis base in the following reaction: (4)

$$3Xe + XeF^+ \rightarrow 2Xe_2^+ + F^-$$

3. You are given a vial containing an unknown soluble metal sulfate. A 0.5000 g sample of this unknown is passed through the procedure of Experiment 2 producing 0.6700 g of $BaSO_4$ precipitate.

   a. Assuming that the formula of the salt is MSO_4 what is the atomic weight and identity of the metal? (5)

   b. Assuming that the formula of the salt is M_2SO_4 what is the atomic weight and identity of the metal? (5)

   c. Which of the above results for the identity of the metal is most reasonable. Give a complete explanation of the chemical logic that leads you to this conclusion. (5)

   d. Suppose this experiment was repeated 9 times, yielding a more precise average of 0.6695 g of $BaSO_4$ with a relative standard deviation of 0.15%. Calculate the 90% confidence interval, given that t = 1.86 for 8 degrees of freedom. Explain what this means. (5)

 Name _____

4. Figure 1 shows data for old pennies, recorded in 1968. What is the probability that by randomly picking one of these pennies from a box containing all 100, you will get one with a weight exceeding 3.133 grams? (5)

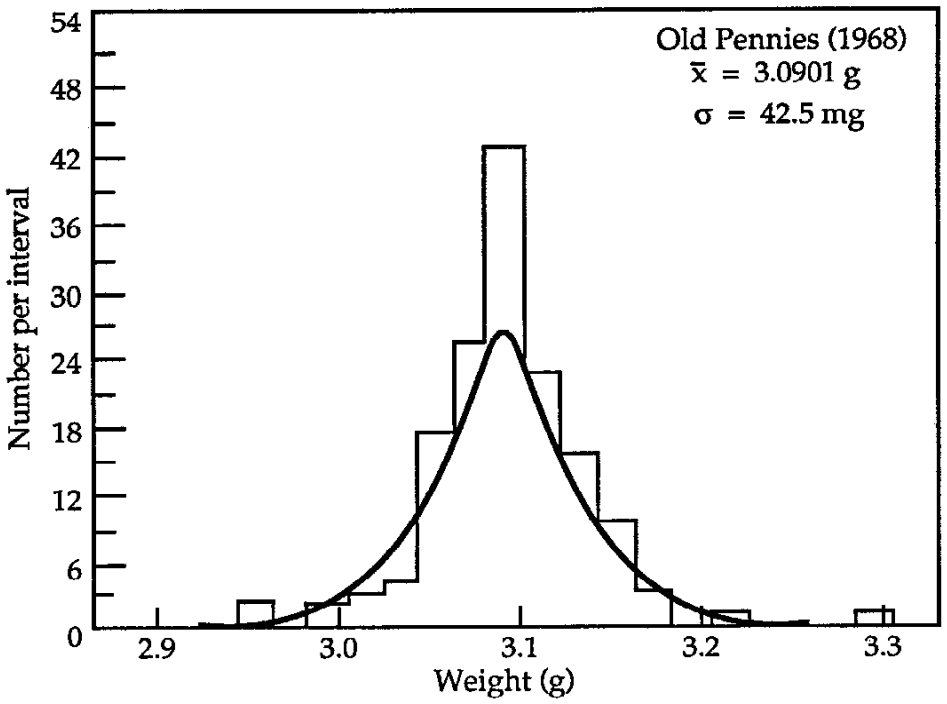


Figure 1

Name_____

Values of physical constants:

Speed of light: $c = 3.00 \times 10^{8}$ m s^{-1}

Planck's constant: $h = 6.626 \times 10^{-34}$ J s

Boltzman's constant: $k_B = 1.381 \times 10^{-23}$ J K^{-1}

Gas constant: $R = 0.08206$ L atm mol^{-1} K^{-1} = 8.315 J mol^{-1} K^{-1}

Avogadro's number: $N_o = 6.023 \times 10^{23}$

Mass of the electron: $m_e = 9.11 \times 10^{-31}$ kg

Rydberg's constant: $R_H = 3.29 \times 10^{15}$ s^{-1}

Gravitational constant: g = 9.807 m s^{-2}

Equations

$$\mu = \bar{x} \pm \frac{ts}{\sqrt{n}}$$

Periodic Table:

1A												3A	4A	5A	6A	7A	Noble gases 8A
1 H 1.008	Alkaline earth metals 2A															Halogens 7A	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	Transition metals										13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226.0)	89 Ac† (227)	104 Rf	105 Ha	106 Unh	107 Uns	108	109 Une									

Alkali metals

*Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
†Actinides	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (244)	94 Pu (242)	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 (260)

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