Name___________________________

Room number __________

Seat number __________

1. (14 points) Give the appropriate name or formula for the following.

   a. mercury(II) hypobromite
   b. Copper(I) cyanide
   c. iron(III)iodide
   d. NH_3
   e. PCl_3
   f. nitrous acid
   g. tin(II) permanganate
   h. K_3PO_4
   i. sulfur tetrafluoride
   j. NH_4IO_4
   k. ammonium hydrogen phosphate
   l. $Cr(HCO_3)_3$
   m. $KMnO_4$
   n. $HNO_{3(aq)}$

2. (3 points) Three successive reactions: $A \rightarrow B$, $B \rightarrow C$, and $C \rightarrow D$ have yields of 80%, 90% and 68%, respectively. What is the overall percent yield for the conversion of $A \rightarrow D$?

Read this BEFORE you start the test:

- Clear your workspace entirely. You should have only your test, an exam approved calculator, pencils, and erasers; anything else will constitute cheating (this includes but is not exclusive to spare brains, book-bags, purses, coats, and cell phones.) You can use the back of the periodic table, the test, and information page for scratch paper.
- **Put your name on the test—NOT ON THIS SHEET!!!!**

BATHROOM BREAK: I HAD TOO MANY REPORTS OF PARTIES IN THE BATHROOM!

- If you leave the exam without asking, I will assume you are off to consult the internet and I will confiscate your test.
- If you take more than 5 minutes to "restroom", I will assume you are off to consult the internet and I will confiscate your test.
- One at time for the break; wait your turn: **SUGGESTION-go before the test starts.**
- If you need more than one break, I will assume you are off to consult the internet and I will confiscate your test.

THE TEST:

- Please answer the following questions **neatly, clearly, and concisely**. Short answers should be completed in Standard English using complete, sentences. Support your answer with background information. Make your drawings as clear as possible. If you have answers on the scratch paper that you want me to read, make sure they are referenced to the question and attached to the test. As always, use correct significant figures, exponential (scientific) notation, and units on appropriate answers. **Show your work and/or reasoning for full credit.**
- **When there is a question that involves correcting the statement, cross out the word that makes the statement false and adding the information to make it true in a complete sentence.**

Example: Red and yellow make blue.

- ✓ **Good: Red and yellow make orange. This tells me I should hire you to paint my house orange, given samples of the rainbow as a choice for paints.**
- ✓ **Bad: Red and yellow do not make blue. I can't tell from this answer if you know your colors and need to read "Color Kittens".**

- **If you have a question, raise your hand and be patient, I will help you ASAP. Don't walk around trying to find me or ask another student for help—it can be construed as cheating.**
- The test has 17 questions, 1 extra credit question, and is 14 pages long; this includes the ancillary pages. It is your responsibility to check the exam.
- Good luck!

WHEN YOU ARE FINISHED WITH THE EXAM:

- Tear off any cover sheets.
- **Make sure that your name is on everything you turn in that you want graded AND STAPLED TO THE TEST. Put your study sheet in the same envelope as your exam.**
- Pick up relevant papers and hand in your test to a) me, or b) my TA. Any other form of submittal will not be graded. It is your responsibility to turn in the entire test. I grade what you turn in. **You will need to sign out your test! No signature, no grade.**
- **Please pick up your work. I will keep any work until the end of the first week of the semester.**

☞PS: Although I try to make sure that you have all the information you might need, sometimes I forget (mess up); please ask and check the board from time to time. You are responsible for the changes on the board.

Periodic Table of the Elements

Note: all atomic masses are given to four significant figures.

	1 1A																17 7A	18 8A
1	1 H 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	1 H 1.008	2 He 4.003
2	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
3	11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.49	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
6	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)
7	87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Ds (269)	111 Rg (269)	112 Cn (277)	113 Uut	114 Fl (289)	115 Uup	116 Lv (298}	117 Uus	118 Uuo

Lanthanide Series	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
Actinide Series	90 Th 232.0	91 Pa 231.0	92 U 238.0	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 (260)

Equations and Constants

TEMPERATURE

$T_{°F} = \frac{1.8°F}{1°C}(T_{°C}) + 32°F$

$T_K = \frac{1K}{1°C}T_{°C} + 273.15K$

ENERGY, LIGHT, AND HEAT

$\Delta E = q + w$

coffee cup cal $q = C_p m \Delta T$

Bomb cal $-q_{(rxn)} = Cv\Delta T_{(calorimeter)}$;

$J = \frac{kg \bullet m^2}{s^2}$

$\Delta E = h\nu$, $c = \upsilon\lambda$

$\Delta E = KE + PE$, where PE is the work function.Φ

$\Delta E_{el} = \frac{kQ_1Q_2}{d}$

$\frac{1}{\lambda} = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

$\Delta E = -R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

#radial nodes = $n - \ell - 1$

PRESSURE, GASES

PV = nRT and PMM = dRT; P=Ghd

$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$

$\sqrt{\frac{MW_1}{MW_2}} = \frac{rate_2}{rate_1}$

$\mu_{rms} = \sqrt{\frac{3RT}{MW}}$

S of gas = $k_{(\text{Henry's constant})}$ x P

Manometer: $P_{gas} = P_{atm} \pm P_{Hg}$ (operation depends on whether pressure is higher or lower than atmospheric)

CONSTANTS, ETC.

Density of water @4°C = 1.000 g/mL

Ideal gas constant:
R = 0.08206 L-atm/K•mol
R = 8.314 J/mol•K

Specific heat of water:
$C_{p(H_2O)}$ = 4.184 J/g•°C

Avogadro's number is =
6.02214 x 10^{23} "things" = 1 mol of "things"

Planck's constant: h = 6.626 x 10^{-34}Js

Rydberg's constant: R_H
2.179 x 10^{-18} J
1.0968 x 10^{7}m^{-1}

Speed of light, c, = 2.998 x 10^8 m/s

the Debye:
1D =3.335 64 x 10^{-30} C• m

Charge of electron
1*e* =1.602 177 x 10^{-19}C

LENGTH

2.54 cm = 1 in
1 mi = 1.6093 km
12 in = 1 ft
3 ft = 1 yd
5,280 ft = 1 mile
1 Å = 10^{-10}m

MASS

1 lb = 453.59237 g
1 oz = 28.35 g
1 kg = 2.2046 lb
1 amu = 1.660 539 040 x 10^{-24} g
16 oz (dry) = 1 lb
1 t (ton, short) = 2000 lb
1 tonnes or 1 metric ton = 1000 kg

TIME

60 min. = 1 hr
24 hr = 1 day
365 day = 1 yr.

VOLUME

1 L = 1.0567 qt
1 L = 1 dm^3
1 gallon = 3.7854 L
4 qt = 1 gal
1 quart = 32 fl oz

PRESSURE

1 atm = 101.325 kPa
1 atm = 760 mmHg, 760 torr
22.4 L = 1 mol (at STP)

TABLES:

- ◊ Periodic table
- ◊ Electronegativities & bond enthalpies
- ◊ Solubility chart
- ◊ Activity series

THERMOCHEMICAL DATA

$\Delta H°f(CO_{2(g)}) = -393.5$ kJ/mol,
$\Delta H°f(H_2O_{(l)}) = -285.840$kJ/mol
$\Delta H°f(H_2O_{(g)}) = -241.82$kJ/mol

MISCELLANEOUS

$\mu = Qr$

V of a sphere= $\frac{4}{3}\pi r^3$, V of a cubic solid = X^3,
V of a cylinder = $\pi r^2 h$

Solubility Rules for Ionic Compounds at 25°C

Soluble Compounds	Exceptions
Almost all salts of Na^+, K^+, the other alkali metals and NH_4^+	none
All salts of Cl^-, Br^-, and I^-	Halides of Ag^+, Hg_2^{2+}, Pb^{2+}
Compounds containing F^-	Fluorides of Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
Salts of NO_3^-, ClO_3^-, ClO_4^-, HCO_3^-, $C_2H_3O_2^- = H_3CO_2^-$	none
Salts of SO_4^{2-}	Sulfates of Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}
Inorganic acids	none

Insoluble Compounds	Exceptions
All salts of CO_3^{2-}, PO_4^{3-}, $C_2O_4^{2-}$, CrO_4^{2-}	Salts of $NH_4^+$and the alkali metal cations
Compounds containing S^{2-}	Salts of NH_4^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, and the alkali metals
Metal hydroxides and oxides	Hydroxides or oxides Salts of NH_4^+, [Ca^{2+}], Sr^{2+}, $Ba^2$and the alkali metals (Note, NH_4OH does not exist in ionic form; it is actually NH_3 in water.)

Activity series of elements

Elements					
Lithium	Li	$\rightarrow$	Li^{+}	+	1e-
Potassium	K	$\rightarrow$	K^{+}	+	1e-
Barium	Ba	$\rightarrow$	Ba^{2+}	+	2e-
Calcium	Ca	$\rightarrow$	Ca^{2+}	+	2e-
Sodium	Na	$\rightarrow$	Na^{+}	+	1e-
Magnesium	Mg	$\rightarrow$	Mg^{2+}	+	2e-
Aluminum	Al	$\rightarrow$	Al^{3+}	+	3e-
Manganese	Mn	$\rightarrow$	Mn^{2+}	+	2e-
Zinc	Zn	$\rightarrow$	Zn^{2+}	+	2e-
Chromium	Cr	$\rightarrow$	Cr^{3+}	+	3e-
Iron	Fe	$\rightarrow$	Fe^{2+}	+	2e-
Cobalt	Co	$\rightarrow$	Co^{2+}	+	2e-
Nickel	Ni	$\rightarrow$	Ni^{2+}	+	2e-
Tin	Sn	$\rightarrow$	Sn^{2+}	+	2e-
Lead	Pb	$\rightarrow$	Pb^{2+}	+	2e-
HYDROGEN	H_2	$\rightarrow$	$2H^{+}$	+	2e-
Copper	Cu	$\rightarrow$	Cu^{2+}	+	2e-
Mercury	2Hg	$\rightarrow$	Hg_2^{2+}	+	2e-
Silver	Ag	$\rightarrow$	Ag^{+}	+	$1e^{-}$
Mercury	Hg	$\rightarrow$	Hg^{2+}	+	2e-
Platinum	Pt	$\rightarrow$	Pt^{2+}	+	2e-
Gold	Au	$\rightarrow$	Au^{3+}	+	3e-

3. (3 points) What is the molarity of a solution made by dissolving 0.75 g of C_4H_8O in enough water to make 125-mL of solution?

4. (5 points) Which compound or compounds in **EACH** of the following groups is(are) expected to be insoluble in water? Circle the compound(s) in each group that are insoluble. This is not a multiple-choice problem. Answer each part.

   a. CuO, $CuCl_2$, and $FeCO_3$

   b. AgI, Ag_3PO_4, and $AgNO_3$

   c. K_2CO_3, NiS, and KCN

5. (6 points) Consider solutions in which 0.10 mol of each of the following compounds is dissolved in 1 L of water: $Ca(NO_3)_2$, $C_6H_{12}OH$, $NaC_2H_3O_2$, HF, $Al_2(SO_4)_3$. Rank the solutions in order of increasing electrical conductivity (which ones will be the worst conductors of electricity to the best conductors of electricity), based on the number of ions in solution. Explain your choices BRIEFLY based on conductivity and electrolyte strength.

6. (6 points) Write the molecular, ionic and net ionic equations for the reaction of a strontium hydroxide solution mixing with propionic acid, $HC_3H_5O_2$. Propionic acid forms the propionate ion ($C_3H_5O_2^{-}$) upon reacting with a base. Ionic salts of propionate are very soluble. Clearly label states and charges if any.

7. When 29.5 g of methane and 45.0 g of chlorine gas undergo a reaction that has a 85.0% yield, what mass of chloromethane (CH_3Cl) forms? (The second product is $HCl_{(g)}$)

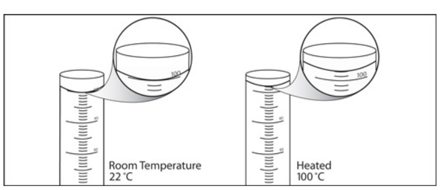
8. (7 points) Acenaphthoquinone is a molecule based on quinone. It is insoluble in water, but soluble in alcohol. It is used in the manufacturing of dyes, pharmaceuticals, and pesticides. Determine the empirical formula of acenaphthoquinone 79.12% C, 3.32 % H, and 17.57% O by mass.

9. (5 points) You know that an unlabeled bottle contains a solution of one of the following ions: Na_3PO_4, $BaCl_2$, Rb_2CO_3, or ~~Na_2SO_4.~~ A friend suggests that you test perform three tests on the unknown solution. TEST 1: An equal volume sample of the unknown solution was mixed with a solution of a silver nitrate. TEST 2: An equal volume of sample of the unknown solution was mixed with a a sodium sulfate solution. TEST 3: An equal volume of sample of the unknown solution was mixed with a copper(II) chloride solution. TEST 4: An equal volume of sample of the unknown solution was mixed with a 6.0M $HCl_{(aq)}$ solution.

i. A reaction occurs when silver nitrate solution is added to a sample of the solution from the bottle.
ii. No reaction occurs when sodium sulfate solution is added to a sample of the solution from the bottle.
iii. A precipitate formed when the copper(II) chloride solution is added to a sample of the solution from the bottle.
iv. A reaction occurs when a 6.0 M $HCl_{(aq)}$ solution is added to sample.

What anion(s) are present in the bottle? Explain your choice(s) using solubility rules.

10. (6 points) The figure shows the meniscus of two identical solutions at two temperatures in identical flasks. Liquid 1 is at 22°C and liquid 2 is at 100°C. The level of the meniscus of Liquid 1 is 100.0-mL, while the level of the meniscus in Liquid 2 is 102.0-mL.
    a. Does the molarity of the solution change with the change in temperature? Explain and support your answer.
    b. Does the molality of the solution change with the change in temperature? Explain and support your answer.



11. (10 Points) In a combustion analysis of 23.2g sample of aspartame containing carbon, hydrogen, and oxygen was burned in excess oxygen and yielded 52.8 g of CO_2 and 21.6 g of water. Determine the empirical formula of the compound. A sample of 0.00829 g aspartame contains 0.000 0357 mole of aspartame. What is the molecular formula?

12. (10 points) Suppose you have 5.00g of powdered magnesium metal, 1.00L of 2.00 M potassium nitrate solution, and 1.00L of 2.00 M silver nitrate solution.
    a. Which one of the solutions will react with the magnesium powder? Explain your choice.
    b. What volume of solution is needed to completely react with the magnesium metal?
    c. What is the net ionic equation that describes this reaction?
    d. What is the molarity of the magnesium ion in the resulting solution.

13. (6 point) A student mixed 200.0 mL of 6.00 M $Al(NO_3)_3$, 400.0 mL of 1.00 M $NaNO_3$, 400.0mL of 0.500M $Ba(NO_3)_2$ and enough water to make 2000.0 mL of solution. What is the molarity of the nitrate ion (NO_3^-) in the final solution?

14. (6 points) A sulfuric acid solution containing 571.6 g of H_2SO_4 per liter of solution has a density of 1.329 g/cm^3. [MW= 98.086 g/mol]
Calculate the:

a. Mass percentage of H_2SO_4 in this solution
b. The mole fraction of H_2SO_4 in this solution
c. The molarity of H_2SO_4 of this solution

15. (5 points) Rust stains can be removed by washing a surface of a piece of steel with a dilute solution of oxalic acid ($H_2C_2O_4$).

The reaction is $Fe_2O_{3(s)} + 6\ H_2C_2O_{4(aq)} \rightarrow 2\ Fe(C_2O_4)_3^{3-}{}_{(aq)} + 3\ H_2O_{(l)} + 6\ H^+{}_{(aq)}$.

What mass of rust can be removed from the surface of steel by 1.0L of a 1.14M solution of oxalic acid?

16. (5 points) You have 0.954 g of an unknown acid H_2A, which reacts with NaOH according to the reaction below.

$$H_2A_{(aq)} + 2\ NaOH_{(aq)} \rightarrow Na_2A_{(aq)} + H_2O_{(l)}$$

If 36.04 mL of 0.509 M NaOH is required to titrate the acid to the equivalence point, what is the molar mass of the acid?

17. (10 points) A precipitate forms when aqueous sodium sulfide is mixed with aqueous copper(II) chloride. Calculate the mass of the precipitate that forms when 75.0 mL of 1.50 M sodium sulfide is mixed with 100.0 mL of 0.500 M copper(II) chloride. Hint: Write the equation for the reaction.

18. EC (5 points) Consider the following data for five hypothetical elements: Q, W, X, Y, and Z.

a. W^{2+} ions are reduced by the metal 'Q', but W^{2+} is not reduced by the metal 'Z'
b. Z^{2+} ions will oxidize the metal 'W', but Z^{2+} ions will not oxidize metal X
c. The metal 'Y' is oxidized by Q^{2+} ions

a. Rank the elements from most reactive to least reactive based on the following reactions

Most reactive | | | | Least reactive
