CHM 1045 Dr. Light **FINAL EXAM** **Name _____**
December 12, 2001 **(please print)**
Lecture Section: 8 am 12:20 pm (circle correct one). Recitation Section ____ Meeting Time_____

This exam consists of seven pages. Make sure you have one of each. Print your name at the top of each page now. Pages 8 and 9 contain some thermochemical data, important constants, a table of electronegativities, and a periodic table. You may tear both off and use them for scratch paper. Show your work on calculations, including unit conversions, and give answers in the correct units and appropriate number of significant figures. In problems involving molecular and formula weights, you may use values rounded to the nearest 0.1 amu.

The exam contains a total of 200 points. For the purpose of replacing a low test grade, divide the exam score by 2.

If anything confuses you or is not clear, raise your hand and ask!

Page	Points
1	_____
2	_____
3	_____
4	_____
5	_____
6	_____
7	_____
Total	**_____**

For statistical purposes:

(Question 27 + 28 _____

Questions 1-26_____)

Points

(10) 1. How many L of a 0.12 M solution of $Ba(OH)_2$ is required to neutralize 0.31 L of a solution of 0.47 M HCl? (Write the equation for the reaction, and show your work).

(10) 2. A compound containing C, H, and Cl yields the following analysis:
10.0% Carbon, 0.84% Hydrogen, 89.1% Chlorine by mass.
Determine the empirical formula. (Show your work).

(10) 3. Given the following balanced chemical equation:

$2\ Al(s) + 6\ HCl(aq) \text{ -----> } 2\ AlCl_3(aq) + 3\ H_2(g)$

2.5 Moles of Al are added to a solution containing 9.5 moles of HCl.

(a) Which reagent is limiting? (Show how you determine)

(b) How many moles of the excess reagent will remain after the reaction?

(c) How many moles of H_2 will be produced in the reaction?

(10) 4. Calculate the ÄH for the following reaction in two different ways, using the thermochemical data given at the end of the test:

$C_2H_2(g) + 2\ H_2(g) \rightarrow C_2H_6(g)$

(a) Using heats of formation data.

(b) Using bond energy data.

(16) 5. For each of the following compounds or ions, draw the best Lewis dot structure. Give the electron group geometry, the molecular geometry, and the hybridization about the central atom.

Compound	Lewis Structure	electron group geometry	molecular geometry	hybridization
$AlCl_3$				
ClF_3				

(10) 6. What volume of oxygen, measured at 273 K and 1.00 atm pressure, must be used to completely burn 42.0 g of C_4H_{10}? (Write the balanced equation for the reaction and show your work).

(14) 7. Draw Lewis dot structures for:

(a) **C_2Br_4** (b) **IO_3^{-1}**

(c) Draw all the equivalent resonance structures for **SeO_3** that obey the octet rule, and give the formal charge on each atom for one of the structures.

(10) 8. Given the following oxidation-reduction reaction:

$$VO^{2+}(aq) + Cr_2O_7^{2-}(aq) \rightarrow Cr^{3+}(aq) + VO_2^{+}(aq)$$

(a) Identify: The reagent being oxidized: _____; The reagent being reduced: _____
(b) Balance the equation **in acid solution**.

(10) 9. A helium weather balloon is filled on the ground where the atmospheric pressure is 768 Torr and the temperature is 25 ^{o}C. The volume of the balloon is 8.00 m^3. When the balloon reaches an altitude of 4.5 km, its volume is found to be 12.4 m^3. The temperature at 4.5 km is –14.7 ^{o}C. What is the pressure (in Torr) at 4.5 km?

(10) 10. The National Ignition Facility at Lawrence Livermore National Laboratory has achieved scientific breakeven in laser fusion. The energy of 16 lasers is focused on the target, achieving PW (petawatt) power levels (1 petawatt = 10^{15} watts). How many photons of green light at 530 nm does it take to achieve 1 PW for 1 ns (equal to 1 MJ of energy).?

For the following questions, put a check in the blank next to the **best** answer. Each question is worth five points.

11. What is the change in internal energy of a system that absorbs 635 J of heat and does 249 J of work?

____a) 635 J
____b) 884 J
____c) -635 J
____d) -386 J
____e) 386 J

12. Which set of elements is not in the correct order of increasing first ionization energy (lowest value first, etc)?

____a) Mg, Si, Cl
____b) Te, S, O
____c) Li, Na, K
____d) Al, B, C
____e) I, Br, Cl

13. Determine the number of unpaired electrons in the ground state atoms of P and Cl, respectively.

____a) 5, 3
____b) 5, 1
____c) 3, 1
____d) 3, 2
____e) 3, 5

14. What is the ground state electron configuration of Zn^{2+}?

____a) $[Ar]4s^2 3d^{10}$
____b) $[Ar]4s^2 3d^8$
____c) $[Ar]3s^2 4d^{10}$
____d) $[Ar]3d^{10}$
____e) $[Ne]3s^2 3d^8$

15. Which of the following molecules would be polar?

____a) SF_4
____b) CO_2
____c) BCl_3
____d) CCl_4
____e) PCl_5

16. The density of gold is 19.3 g/cm^3. A 3.4 mg piece of gold is hammered into a square that is 86 nm thick. What is the length of a side of the square?

____a) 0.020 cm
____b) 87 cm
____c) 4.5 cm
____d) 143 cm
____e) 14.3 cm

17. Consider four identical 1.0-L flasks containing the following gases each at 25^o C and 1 atm pressure. For which gas do the molecules have the greatest average kinetic energy?

____a) H_2
____b) O_2
____c) NH_3
____d) SO_2
____e) same for all gases

18. What is the oxidation number of chlorine in $HClO_2$?

____a) -1
____b) +1
____c) +3
____d) +7
____e) -3

19. In the compound, Na_2HPO_4, which element is present in the largest percent by mass?

____a) Na
____b) H
____c) P
____d) O
____e) not enough information given

20. Use the solubility rules to predict which of the following substances is insoluble in water.

____a) Cs_2SO_4
____b) $(NH_4)_2CO_3$
____c) $Pb(NO_3)_2$
____d) Hg_2Cl_2
____e) LiBr

21. The specific heat of aluminum is 0.902 $Jg^{-1o}C^{-1}$ at 25^o C. How much heat does it take to raise the temperature of a 12.0-g chunk of aluminum from 15.5^o C to 35.5^o C?

____a) 0.216 kJ
____b) 0.0108 kJ
____c) 0.0180 kJ
____d) 240 kJ
____e) 216 kJ

22. Which of the following sets is an acceptable set of quantum numbers?

	n	l	m_l	m_s
____a)	1	1	0	-1/2
____b)	2	0	0	1
____c)	3	1	-1	-1/2
____d)	0	0	0	+1/2
____e)	2	1	2	-1/2

23. An atom containing 34 protons, 43 neutrons, and 34 electrons would have the symbol:

____a) ^{77}Se
____b) ^{77}Ir
____c) ^{77}Tc
____d) ^{43}Se
____e) ^{43}Tc

24. Name the following hydrocarbons shown below in the order given:
C_4H_{10}, C_5H_{12}, C_2H_4

____a) propane, pentane, butane
____b) propane, hexane, ethene
____c) butane, pentane, propane
____d) propane, butane, ethane
____e) butane, pentane, ethene

25. Which is incorrectly named?

____a) BBr_3 boron tribromide
____b) CO_2 carbon dioxide
____c) Na_2S disodium sulfide
____d) PCl_5 phosphorus pentachloride
____e) KCl potassium chloride

26. A British thermal unit (Btu) is commonly used to measure the energy capacity of heating and air conditioning systems. A B.t.u is equal to 777.6 ft-lbs and a cal = 3.086 ft-lbs. What is a Btu in SI units of energy?

____a) 0.252 kcal
____b) 777.6 cal
____c) 4.184 cal
____d) 2.399 kJ
____e) 1.054 kJ

27. Which is incorrectly named?

____a) NaOH sodium hydroxide
____b) H_2CO_3 carbonic acid
____c) H_2SO_3 sulfurous acid
____d) H_3PO_4 phosphoric acid
____e) HIO hypoiodic acid

28. The formaldehyde molecule (CH_2O) contains:

____a) 2 sigma and 1 pi bond
____b) 2 sigma and 2 pi bonds
____c) 3 sigma and 1 pi bond
____d) 3 pi and 1 sigma bond
____e) 2 pi and 1 sigma bond

The following tables of data may be useful to you.

Physical constants:

c = 3.00 x 10^{8} ms^{-1}
h = 6.63 x 10^{-34} J-s
$\mathbf{R_H}$ = 2.18 x 10^{-18} J

ÄH of fusion of ice = 6.008 kJ/mol;

Specific heat of ice = 2.092 J/g-K
Specific heat of water = 4.184 J/g-K;

Heats of Formation:

Substance	ΔH_f^o kJ/mol	Substance	ΔH_f^o kJ/mol
CO(g)	-110.5	CaO(s)	-635.1
CO_2(g)	-393.5	$CaCO_3$(s)	-1207.1
CH_3OH(l)	-238.6	$Ca(OH)_2$(s)	-986.1
C_2H_5OH(l)	-277.7	Mg(g)	147.1
H_2O(l)	-285.8	Mg^{2+}(g)	2335.1
H_2O(g)	-241.8	Mg^{+}(g)	885.1
C_2H_6(g)	-84.7	MgO(s)	-601.7
C_2H_4(g)	52.3	Li(g)	159.3
C_2H_2(g)	226.7	Cl(g)	121.7
C_6H_6(l)	49.0	F(g)	80.0
C_4H_{10}(g)	-124.7	LiCl(s)	-408.3
CH_2O(g)	-117.0	Li^{+}(g)	685.7
CH_3COOH(l)	-484.1	Cl^{-}(g)	-227
$C_6H_{12}O_6$(s)	-1273.3	F^{-}(g)	-252

Average Bond Energies (kJ/mol)

Single Bonds:

C-H	413	N-H	391	O-H	463	F-F	155
C-C	348	N-N	163	O-O	146		
C-N	293	N-O	201	O-F	190	Cl-F	253
C-O	358	N-F	272	O-Cl	203	Cl-Cl	242
C-F	485	N-Cl	200	O-I	234		
C-Cl	328	N-Br	243			Br-F	237
C-Br	276			S-H	339	Br-Cl	218
C-I	240	H-H	436	S-F	327	Br-Br	193
C-S	259	H-F	567	S-Cl	253		
		H-Cl	431	S-Br	218	I-Cl	208
Si-H	323	H-Br	366	S-S	266	I-Br	175
Si-Si	226	H-I	299			I-I	151
Si-C	301						
Si-O	368						

Multiple Bonds:

C=C	614	N=N	418	O_2	495
C≡C	839	N≡N	941		
C=N	615			S=O	523
C≡N	891			S=S	418
C=O	799				
C≡O	1072				

Some Electronegativities

H 2.1	(2A)	(3A)	(4A)	(5A)	(6A)	(7A)
Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8	Ca 1.0	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
	[Transition Metals 1.0-2.4]					
Rb 0.8					Te 2.1	I 2.5
Cs 0.7					Po 2.0	At 2.2

1A												3A	4A	5A	6A	7A	8A
1 H 1.008	2A																2 He 4.003
3 Li 6.94	4 Be 9.01											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	3B	4B	5B	6B	7B	|------	8B	------|	1B	2B	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 47.88	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 65.38	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 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La* 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.03	89 Ac** 227.03	104 Rf (263)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 Uun (272)	111 Uuu	112 Uub	113	114 Uuq	115	116 Uuh	117	118 Uuo

*Lanthanides	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
** Actinides	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)