Exam Three **CHM 203 (Dr. Mattson)** **9 November 2011**	***Print your name:*** ***Signature:***	***Circle your section:*** ***8:30 9:30***

Instructions: Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. If you need more space, you may use the back of your periodic table — Write: "See PT" in box and then attach the periodic table. BOX YOUR ANSWERS! Write legibly.

1. (7 pts) Periodic trends. Circle the one member of each set with the largest

atomic radius	N	O	F	Ne
atomic radius	F	Cl	Br	I
Z_{eff}	Na	Mg	Al	Si
first ionization energy	B	C	O	F
first ionization energy	O	S	Se	Te
electron affinity	P	S	Cl	Ar
electronegativity	Li	B	N	Ne

2. (5 pts) Circle the member of each pair with the smallest radius

(a)	F	F^-
(b)	Na	Na^+
(c)	Na^+	Mg^{+2}
(d)	O^{-2}	F^-
(e)	Na^+	F^-

3. (3 pts) Write the electron configuration of

(a) S^{-2}
(b) Mg^{+2}
(c) Co^{+2}

4. (2 pts) Circle the member with the smallest lattice energy and draw a box around the member with the largest lattice energy.

$NiSO_4$ NH_4NO_3 $Ca_3(PO_4)_2$ $PbCl_2$

5. (4 pts) In each case, circle the two ionization energies between which a large jump in energy is expected going from the first to the second. (For example, draw one circle around E_{i2} and E_{i3})

(a) Mg	E_{i1}	E_{i2}	E_{i3}	E_{i4}	E_{i5}
(b) Si	E_{i1}	E_{i2}	E_{i3}	E_{i4}	E_{i5}
(c) Al	E_{i1}	E_{i2}	E_{i3}	E_{i4}	E_{i5}
(d) Na	E_{i1}	E_{i2}	E_{i3}	E_{i4}	E_{i5}

6. (3 pts) Use the periodic trend for electronegativity to predict which atom in each bond could be described as "a little bit negative" (δ^-). Circle one atom from each pair.

(a) C — N (b) S — O (c) P — Cl

7. (1 pt) Which one of the following is true?

(a) $H_2(g) \rightarrow 2\ H(g)$ $\Delta H = +436$ kJ

(b) $H_2(g) \rightarrow 2\ H(g)$ $\Delta H = -436$ kJ

(c) $2\ H(g) \rightarrow H_2(g)$ $\Delta H = +436$ kJ

8a. (6 pts) Draw Lewis dot structures that do not exceed the octet and give the ABE formula for each of these molecules or ions.

(a) NCl_3	(b) NO_3^-
(c) SO_2	(d) CO_2
(e) SO_4^{-2}	(f) HCN Note: Central atom is C

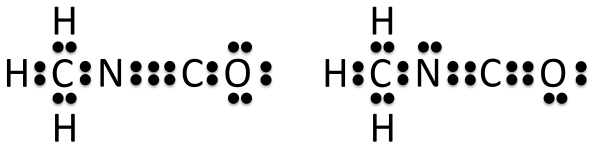
8b. (6 pts) What is the geometric shape, hybridization and estimated angles for each central atom in the previous problem?

	Shape:	Hybridization:	Angle:
(a)			
(b)			
(c)			
(d)			
(e)			
(f)			

8c. (2 pt) Only two of the molecules/ions sketched has resonance. Which are they? (Circle two)

Circle one: (a) (b) (c) (d) (e) (f)

9. Methyl isocyanate[1] is shown below in two arrangements. 9a. (4 pts) Assign formal charges to each central atom (not H) in each arrangement.

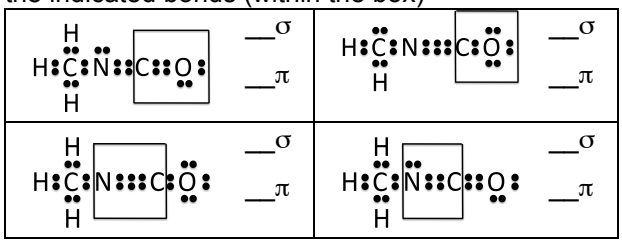


9b (1 pt) Which arrangement is preferred based on formal charges? Circle: LEFT or RIGHT

9c. (4 pts) What is the geometric shape, hybridization and estimated angles for the nitrogen atom in the structure?

	Shape:	Hybridization:	Angle:
Left			
Right			

9d. (4 pts) How many σ and π bonds are involved in the indicated bonds (within the box)



10. The gas-phase combustion of acetylene is:

$C_2H_2 + {}^5/_2\ O_2 \rightarrow H_2O + 2\ CO_2 \quad \Delta H^o = -1256$ kJ

10a. (1 pts) What is ΔH^o for the reaction:

$2\ C_2H_2 + 5\ O_2 \rightarrow 2\ H_2O + 4\ CO_2 \quad \Delta H^o =$ _____

10b. (4 pts) Calculate q if 35 g $C_2H_2(g)$ is combusted with excess O_2.

11. (4 pts) Calculate ΔH_{rxn}^o for the reaction (see data sheet for necessary information):

$2\ NH_3(g) + 3\ N_2O(g) \rightarrow 4\ N_2(g) + 3\ H_2O(g) \quad \Delta H^o = ?$

[1]The world's worst industrial accident occurred in December of 1984 in Bhopal India at a Union Carbide plant. Methyl isocyanate, a highly toxic substance used to manufacture carbamate insecticides (Furadan, Sevin) escaped into the environment, injuring over half a million people and killing approximately 3000 within weeks of exposure and thousands more from exposure-related diseases.

12. (3 pts) Calculate ΔH_{rxn}^o for the reaction (see data sheet for necessary information):

$NH_3(g) + Cl_2(g) \rightarrow NH_2Cl(g) + HCl(g) \quad \Delta H_{rxn}^o = ?$

13. When 0.80 g calcium metal is added to 200.0 g water in a coffee-cup calorimeter, the temperature increases from 22.5 °C to 39.9 °C. 13a. (3 pts) Calculate q for the calorimeter. [Given: Specific heat for solution is 4.18 J/g deg]

13b. (3 pts) Use q to calculate ΔH_{rxn}^o for:

$2\ Ca(s) + 2\ H_2O(l) \rightarrow 2\ Ca(OH)_2(aq) + H_2(g) \quad \Delta H^o = ?$

14. (10 pts) Nomenclature. Complete the table.
(Skip this question if you are nomenclature certified.)

Formula:	**Name:**
P_4S_6	
$CaCO_3$	
$Co(NO_3)_2$	
$HClO_3$	
$HC_2H_3O_2$	
	iron(III) chlorate
	nitrous acid
	potassium sulfite
	sodium hypochlorite
	nitrogen trifluoride

Subtotal from exam: _____

Homework: (20 max) _____

Total: _____

Thermodynamic Values:

Substance	MM (g/mol)	$\Delta H°_f$ (kJ/mol)	$\Delta G°_f$ (kJ/mol)	S° (J/K mol)
C(s) graphite	12	0	0	6
$CO_2(g)$	44	-393.5	-394	214
$C_2H_6(g)$	30	-84.7	-32.9	229.5
$CH_4(g)$	16	-75	-51	186
$CCl_4(l)$	154	-135	-65	216
$Cl_2(g)$	71	0	0	223
$H_2(g)$	2	0	0	131
HCl(g)	36.5	-92	-95	187
$H_2O(l)$	18	-286	-237	70
$H_2O(g)$	18	-242	-229	189
Fe(s)	56	0	0	27
$Fe_2O_3(s)$	160	-826	-740	90
$N_2(g)$	28	0	0	192
$NH_3(g)$	17	-46	-16	192
NO(g)	30	90	87	211
$N_2O(g)$	44	82	104	220
$O_2(g)$	32	0	0	205

Table of Single Bond Energies (kJ/mol)

	H	B	C	N	O	F	Si	P	S	Cl	Br	I
H	432	389	413	391	467	565	323	322	347	427	363	295
B	389	293	372		536	613				456	377	
C	413	372	347	305	358	485	301		259	339	276	240
N	391		305	160	201	272				200	243	
O	467	536	358	201	146	190	452	335	347	203	201	234
F	565	613	485	272	190	154	565	490	327	253	237	277
Si	323		301		452	565	226		393	381	310	234
P	322				335	490		201		326	264	184
S	347		259		347	327	293		266	253	218	
Cl	427	456	339	200	203	253	381	326	253	239	218	208
Br	363	377	276	243	201	237	310	264	218	218	193	175
I	295		240		234	277	234	184		208	175	149

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.01																1 H 1.01	2 He 4.00
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											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 97	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 131.30
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 195.09	79 Au 196.97	80 Hg 200.59	81 Ti 204.37	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															

Answers:

1. N, I, Si, F, O, Cl, N

2. (a) F; (b) Na^{+}; (c) Mg^{+2}; (d) F^{-}; (e) Na^{+}

3. (a) S^{-2} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ or [Ar] or [Ne] $3s^2\ 3p^6$
   (b) Mg^{+2} $1s^2\ 2s^2\ 2p^6$ or [Ne]
   (c) Co^{+2} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^7$ or [Ar] $4s^0\ 3d^7$

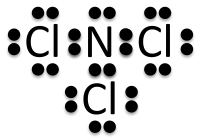
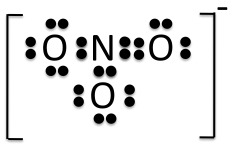
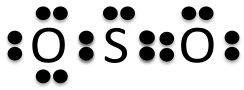
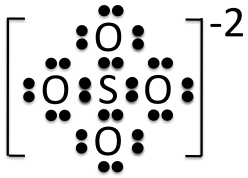
4. smallest lattice energy: NH_4NO_3; largest lattice energy: $Ca_3(PO_4)_2$

5. (a) E_{i2} and E_{i3}; (b) E_{i4} and E_{i5}; (c) E_{i3} and E_{i4}; (d) E_{i1} and E_{i2}

6. (a) N; (b) O; (c) Cl

7. (a)

8a.

(a) NCl_3  AB_3E	(b) NO_3^-  AB_3
(c) SO_2  AB_2E	(d) CO_2  AB_2
(e) SO_4^{-2}  AB_4	(f) HCN  AB_2

8b.

	Shape:	Hybridization:	Angle:
(a)	trigonal pyramid	sp^3	< 109 ^{o}
(b)	trigonal plane	sp^2	120 ^{o}
(c)	bent	sp^2	< 120 ^{o}
(d)	linear	sp	180 ^{o}
(e)	tetrahedral	sp^3	109 ^{o}
(f)	linear	sp	180 ^{o}

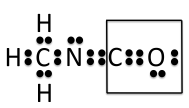
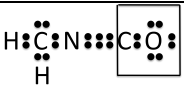
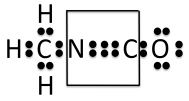
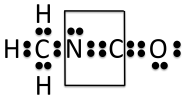
8c. (b) and (c)

9. Left: C: 0; N: +1; C: 0; O: -1; Right: all zero; 9b RIGHT

9c.

	Shape:	Hybridization:	Angle:
Left	Linear	sp	180 ^{o}
Right	bent	sp^2	< 120 ^{o}

9d.

 1 σ 1 π	 1 σ 0 π
 1 σ 2 π	 1 σ 1 π

10a. ΔH^{o} = -2512 kJ; 10b. q = -1700 kJ

11. ΔH^{o} = -880 kJ

12. ΔH_{rxn}^{o} = +3 kJ

13. q = 14.6 kJ; 13b. ΔH^{o} = -1460 kJ

14.

Formula:	**Name:**
P_4S_6	tetraphosphorus hexasulfide
$CaCO_3$	calcium carbonate
$Co(NO_3)_2$	cobalt(II) nitrate
$HClO_3$	chloric acid
$HC_2H_3O_2$	acetic acid
$Fe(ClO_3)_3$	iron(III) chlorate
HNO_2	nitrous acid
K_2SO_3	potassium sulfite
HOCl	sodium hypochlorite
NCl_3	nitrogen trifluoride