Name Key

Chem 370 - Spring, 2018
Test II - Part 1
April 9, 2018

1. (30 points; 3 points each) Circle the correct answer to each of the following.

a. Which one of the following aqueous solutions would be acidic?

$Be(NO_3)_2(aq)$ $LiNO_3(aq)$ $Sr(NO_3)_2(aq)$ $Ba(NO_3)_2\ (aq)$ $RbNO_3(aq)$

b. Among the following, which is likely to be the strongest Lewis base?

NCl_3 NH_3 **$N(CH_3)_3$** NF_3 NI_3

c. *On the basis of the solvent system concept*, which one of the following reactions would result in an *acidic* solution? The first reactant is the solvent in each case.

$BrF_3 + NaF \rightarrow Na^+ + [BrF_4]^-$

$BrF_3 + SnF_4 \rightarrow [BrF_2]^+ + [SnF_5]^-$

$CH_3OH + Na \rightarrow NaOCH_3 + ½\ H_2$

$ClF_3 + NOF \rightarrow [NO]^+ + [ClF_4]^-$

$ICl + NaCl \rightarrow Na^+ + [ICl_2]^-$

d. Which one of the following acids or bases would be leveled in water?

H_3PO_4 $HOCl$ $HClO_2$ **Na_2O** $NaOH$

e. Which one of the following has the *lowest* bond order?

NO^- O_2 C_2^{2-} N_2 **O_2^{2-}**

f. If z is the internuclear axis, which one of the following combinations of AOs on adjacent atoms would be capable of forming π and π* MOs in a diatomic species?

$p_z \pm p_z$ **$d_{xz} \pm d_{xz}$** $p_x \pm p_y$ $p_z \pm s$ $d_{z^2} \pm d_{xy}$

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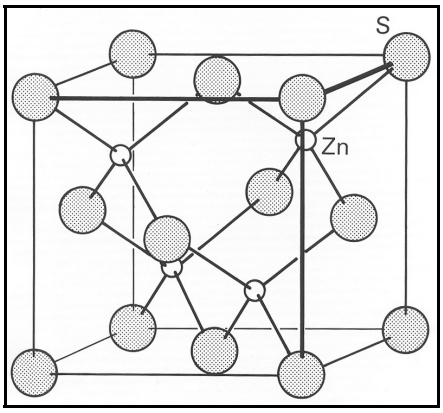
g. A certain crystal structure is found to have $a \neq b \neq c$; $\alpha = \gamma = 90^o$, $\beta \neq 90^o$ and has two lattice points per unit cell. Which one of the Bravais lattices describes this structure?

orthorhombic *P* orthorhombic *C* tetragonal *I*

monoclinic *C* monoclinic *P*

h. The most common zinc ore is zinc blende, a form of ZnS. The zinc blend structure is shown below.



How many ZnS formula units (*Z*) does the zinc blende structure contain?

1 2 3 **4** 8

i. Zinc blend can be described as having inter-penetrating lattices of zinc and sulfide ions, both of the same type. Which one of the following best describes the structure of either lattice?

triclinic simple cubic body-centered cubic **face-centered cubic** rhombahedral

j. Which one of the following ionic compounds has the *smallest* lattice energy?

ScN **CsI** MgO ZnS BaF_2

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2. (16 points; 4 points each lettered part) Fill in the blanks with the correct answers.

a. Give the electronic configuration in the form $t_{2g}^{n}e_{g}^{m}$ for the metal ion in each of the following ML_6 octahedral complexes, where M is a transition-metal ion and L is a unidentate ligand.

d^5 high-spin	d^5 low-spin
$\boldsymbol{t_{2g}^{3}e_{g}^{2}}$	$\boldsymbol{t_{2g}^{5}}$

b. Give the spin-only magnetic moments (B.M.) expected for octahedral complexes with metal ions having the following configurations.

d^5 high-spin	d^5 low-spin
5.92 B.M.	**1.73 B.M.**

c. For the complexes described in parts a and b, give the expressions for the crystal (ligand) field stabilization energies (CFSE) in terms of Δ_o and P.

d^5 high-spin	d^5 low-spin
CFSE = **0**	CFSE = $\boldsymbol{-2.0\,\Delta_o + 2P}$

d. How many unpaired electrons are there in each of the following complexes?

$[Ti(H_2O)_6]^{3+}$	**1**
$[Fe(CN)_6]^{4-}$	**0**
$[Ni(CN)_4]^{2-}$	**0**
$[NiCl_4]^{2-}$	**2**

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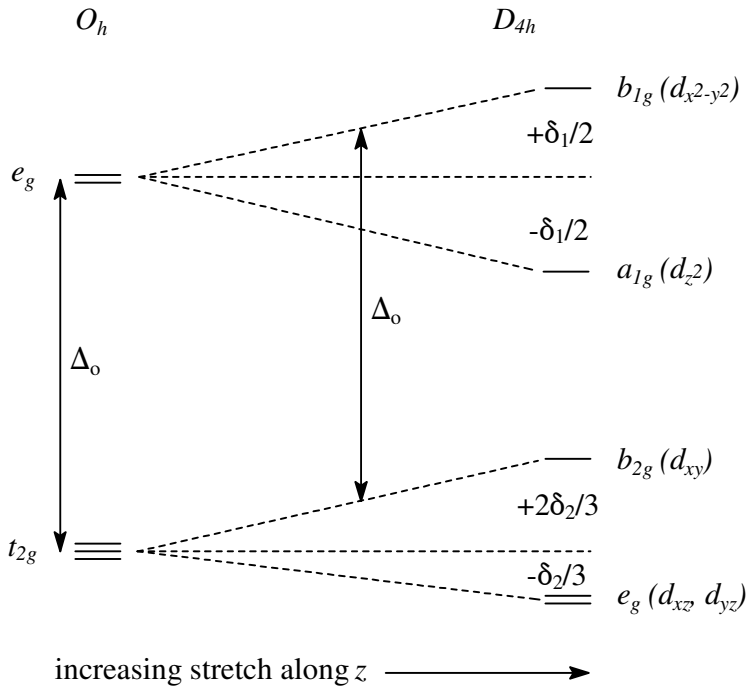
3. (12 points) Using the template below, show the effect on the energies of the *d* orbitals when an octahedral complex is stretched along the *z* axis, a tetragonal distortion resulting in a decent in symmetry from O_h to D_{4h} and a lifting of degeneracies among the t_{2g} and e_g levels. Label your diagram with the specific *d* orbitals and appropriate Mulliken symbols for each level in D_{4h}. Be sure to pay attention to the energy ordering of the new levels and the relative ascent and decent of each as the distortion increases. A D_{4h} character table is shown on the last page for your reference.



D_{4h}	E	$2C_4$	C_2	$2C_2'$	$2C_2''$	i	$2S_4$	σ_h	$2\sigma_v$	$2\sigma_d$		
A_{1g}	1	1	1	1	1	1	1	1	1	1		$x^2 + y^2, z^2$
A_{2g}	1	1	1	−1	−1	1	1	1	−1	−1	R_z	
B_{1g}	1	−1	1	1	−1	1	−1	1	1	−1		$x^2 - y^2$
B_{2g}	1	−1	1	−1	1	1	−1	1	−1	1		xy
E_g	2	0	−2	0	0	2	0	−2	0	0	(R_x, R_y)	(xz, yz)
A_{1u}	1	1	1	1	1	−1	−1	−1	−1	−1		
A_{2u}	1	1	1	−1	−1	−1	−1	−1	1	1	z	
B_{1u}	1	−1	1	1	−1	−1	1	−1	−1	1		
B_{2u}	1	−1	1	−1	1	−1	1	−1	1	−1		
E_u	2	0	−2	0	0	−2	0	2	0	0	(x, y)	