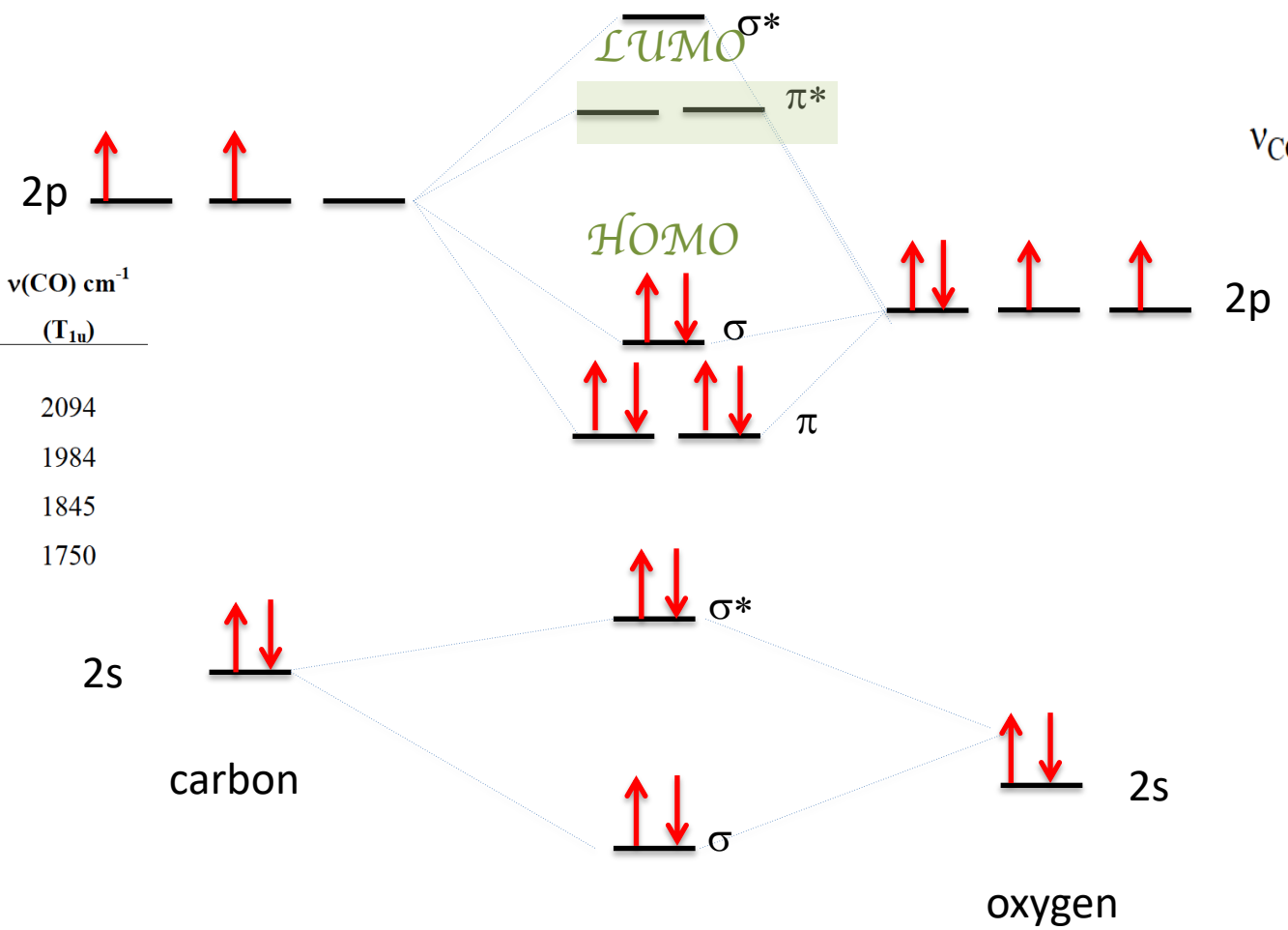
Molecular Orbital Diagram for CO

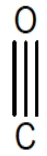


	ν(CO) cm^{-1} (T_{1u})
$Mn(CO)_6^+$	2094
$Cr(CO)_6$	1984
$V(CO)_6^-$	1845
$Ti(CO)_6^{2-}$	1750

Bond Order is = 3.0.

B. O. = ((# bonding e-) –(# nonbonding e-))/ 2

Free

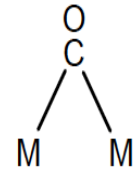


ν_{CO} (cm^{-1}) 2143

Terminal

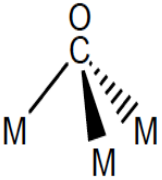
1850-2120

μ_2-CO



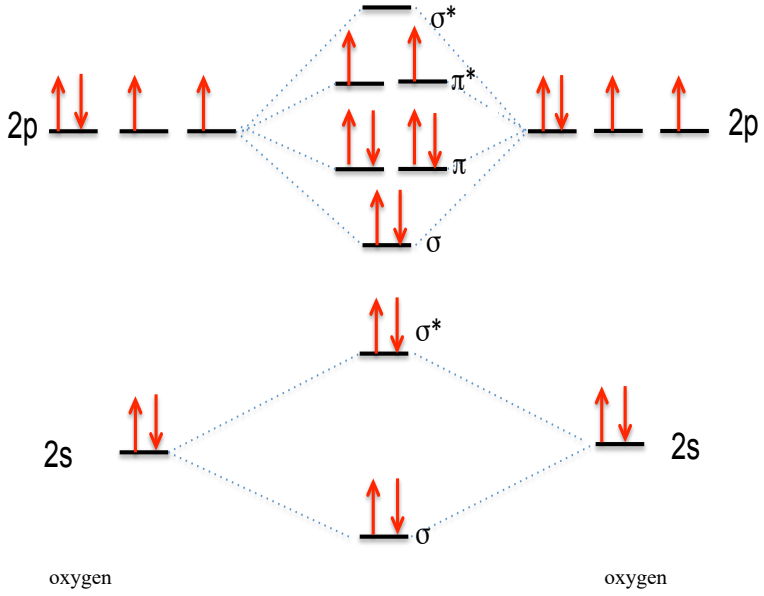
1750-1850

μ_3-CO

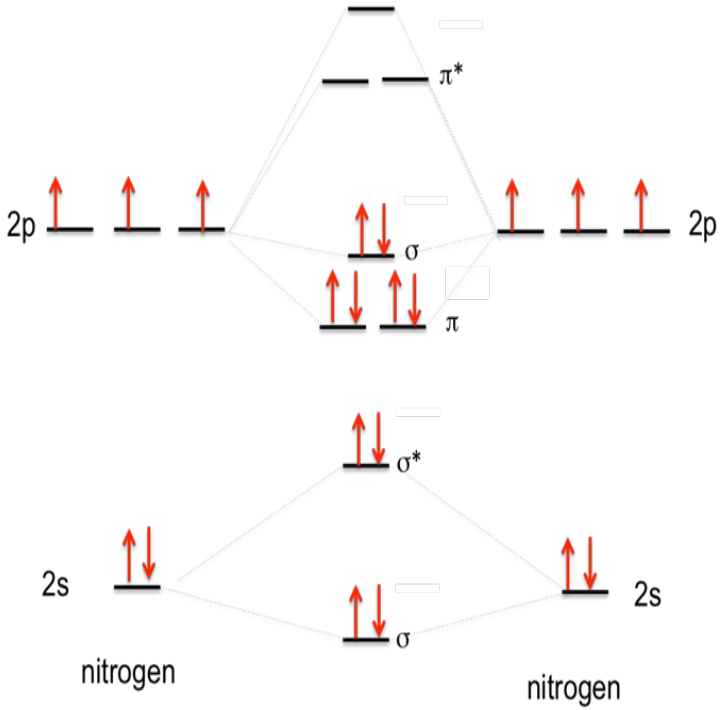


1620-1730

MO diagram of N_2 and O_2



Bond Order is = 2.



Bond Order is = 3.0.

Magnetic Properties of Complexes

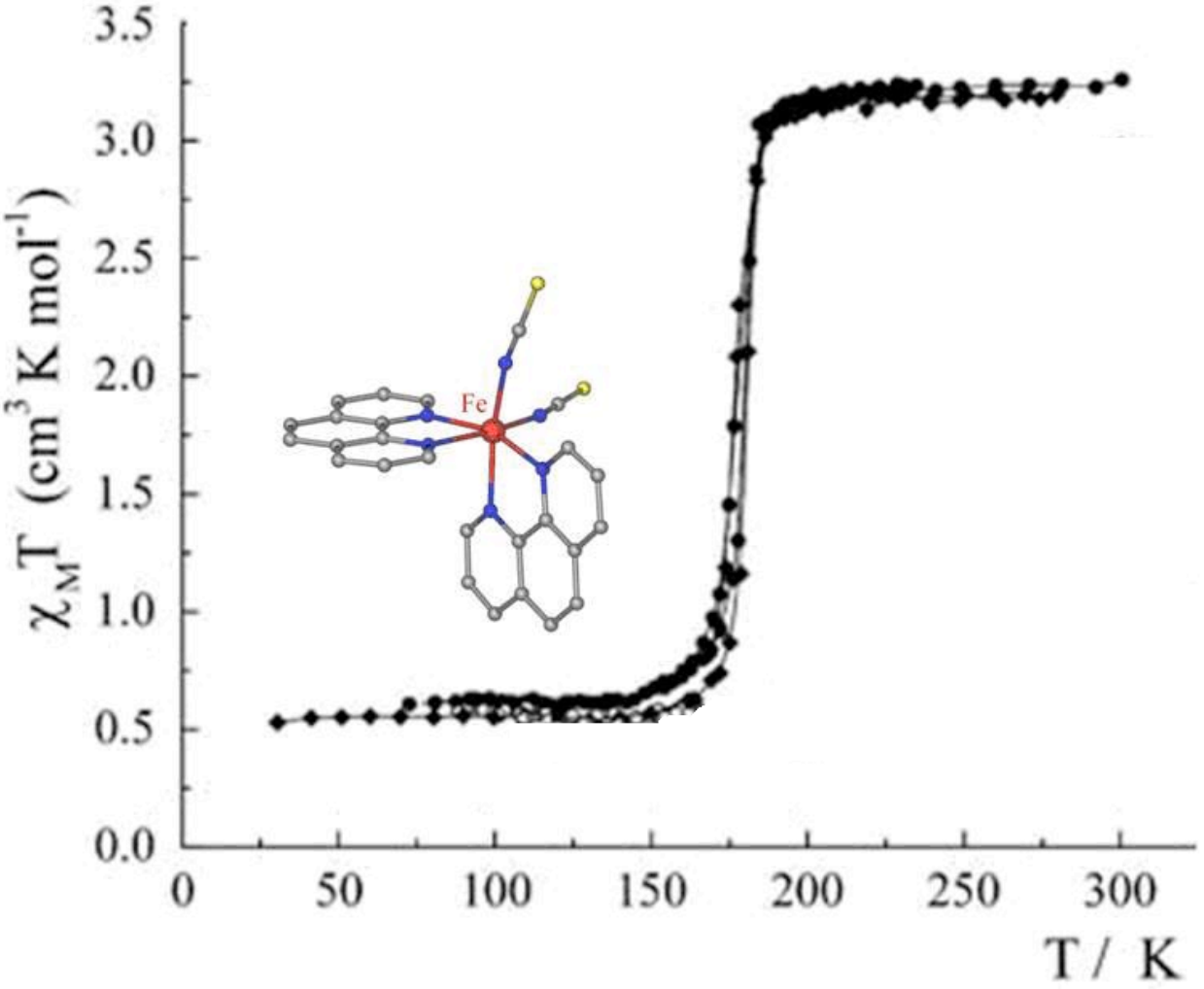
TABLE 10-3
Calculated and Experimental Magnetic Moments

Ion	*n*	*S*	*L*	μ_S	μ_{S+L}	*Observed*
V^{4+}	1	$\frac{1}{2}$	2	1.73	3.00	1.7–1.8
Cu^{2+}	1	$\frac{1}{2}$	2	1.73	3.00	1.7–2.2
V^{3+}	2	1	3	2.83	4.47	2.6–2.8
Ni^{2+}	2	1	3	2.83	4.47	2.8–4.0
Cr^{3+}	3	$\frac{3}{2}$	3	3.87	5.20	~3.8
Co^{2+} HS d^7	3	$\frac{3}{2}$	3	3.87	5.20	4.1–5.2
Fe^{2+} HS d^6	4	2	2	4.90	5.48	5.1–5.5
Co^{3+} HS d^6	4	2	2	4.90	5.48	~5.4
Mn^{2+}	5	$\frac{5}{2}$	0	5.92	5.92	~5.9
Fe^{3+}	5	$\frac{5}{2}$	0	5.92	5.92	~5.9

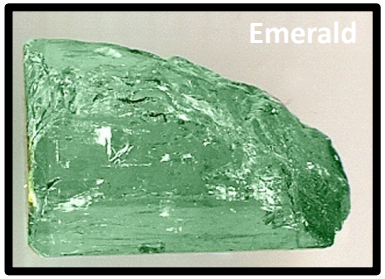
SOURCE: F. A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 4th ed., Wiley, New York, 1980, pp. 627–628.

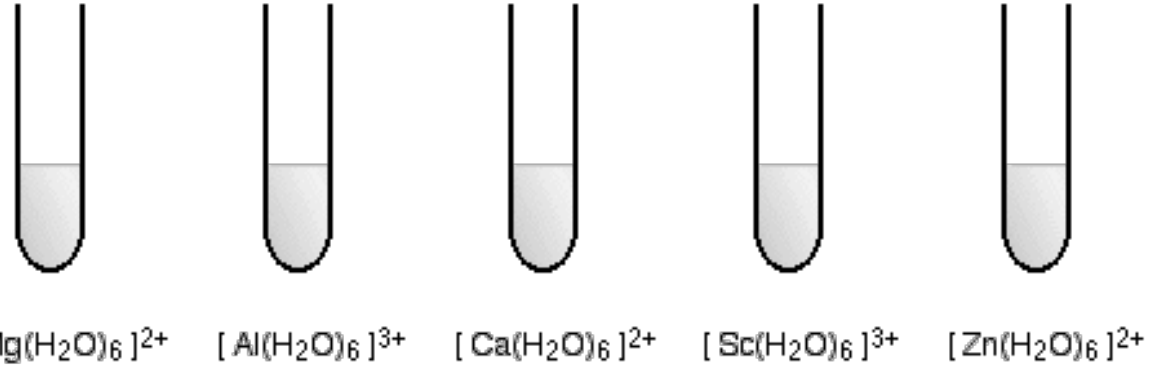
NOTE: All moments are given in Bohr magnetons.

Colors of Complexes

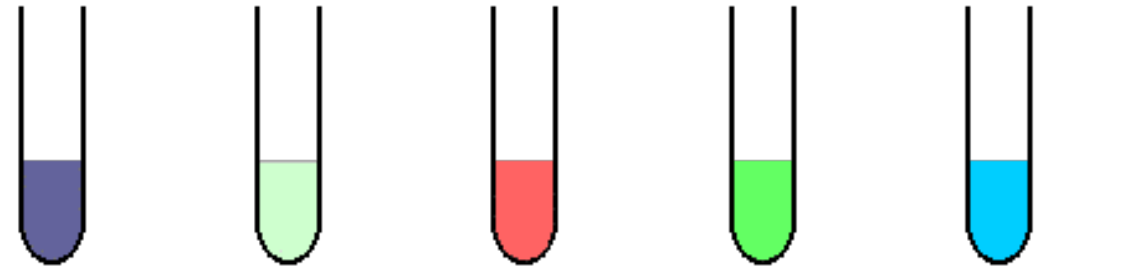


Colors of Complexes

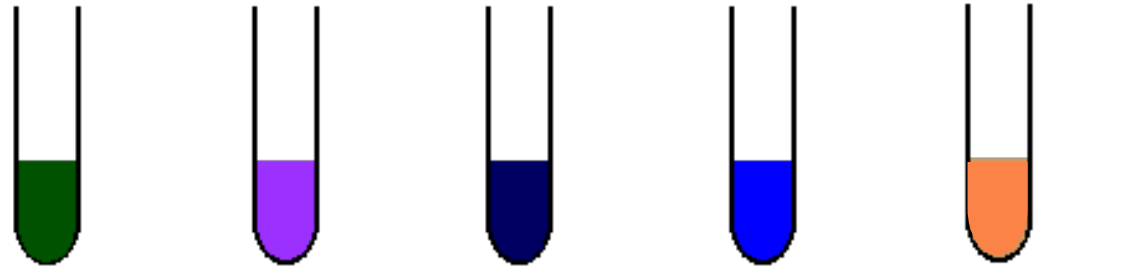




$[Mg(H_2O)_6]^{2+}$ $[Al(H_2O)_6]^{3+}$ $[Ca(H_2O)_6]^{2+}$ $[Sc(H_2O)_6]^{3+}$ $[Zn(H_2O)_6]^{2+}$

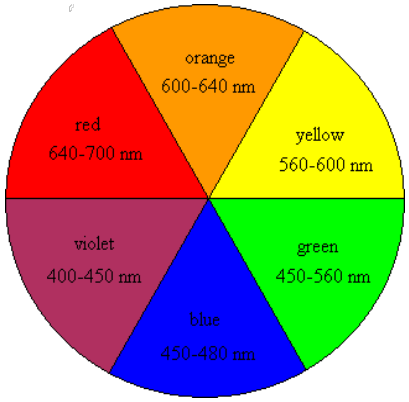


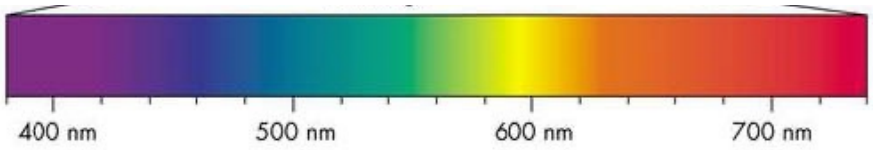
$[Cr(H_2O)_6]^{3+}$ $[Fe(H_2O)_6]^{2+}$ $[Co(H_2O)_6]^{2+}$ $[Ni(H_2O)_6]^{2+}$ $[Cu(H_2O)_6]^{2+}$

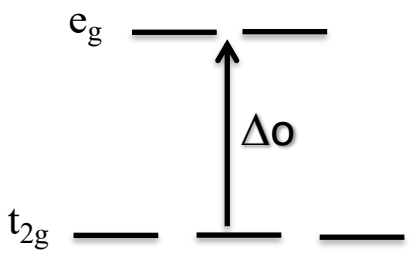


$[Cr(OH)_6]^{3-}$ $[Cr(NH_3)_6]^{3+}$ $[Cu(NH_3)_4(H_2O)_2]^{2+}$ $[CoCl_4]^{2-}$ $[Co(NH_3)_6]^{2+}$

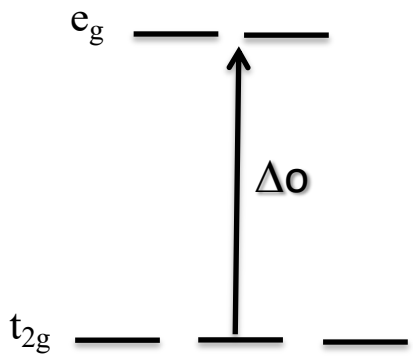
Colors of Complexes



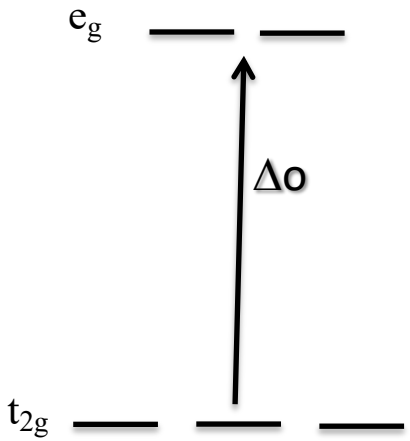




$[CoF_6]^{3-}$
Green
absorbs red



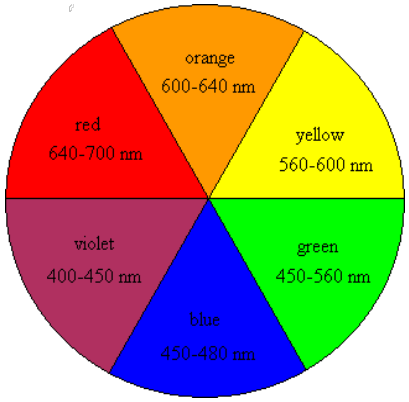
$[Co(NH_3)_6]^{3+}$
Orange
absorbs blue



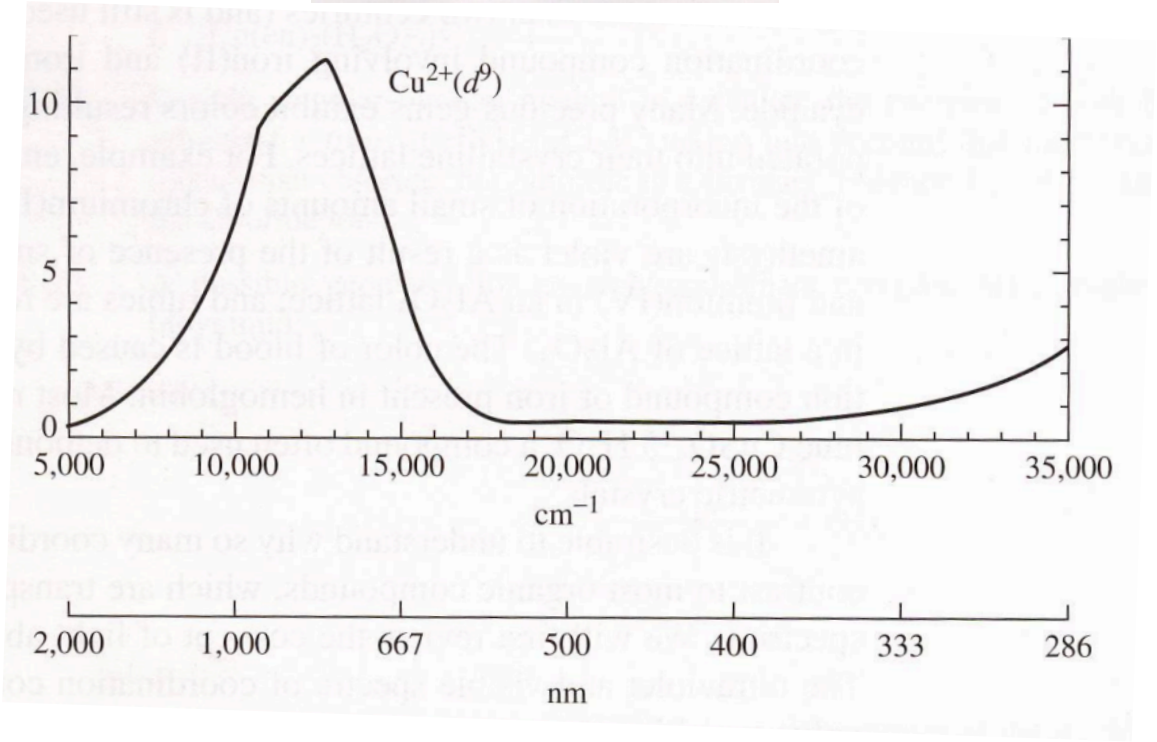
$[Co(CN)_6]^{3-}$
Pale yellow
absorbs
ultraviolet

What properties of complexes affect the color of the resulting materials?

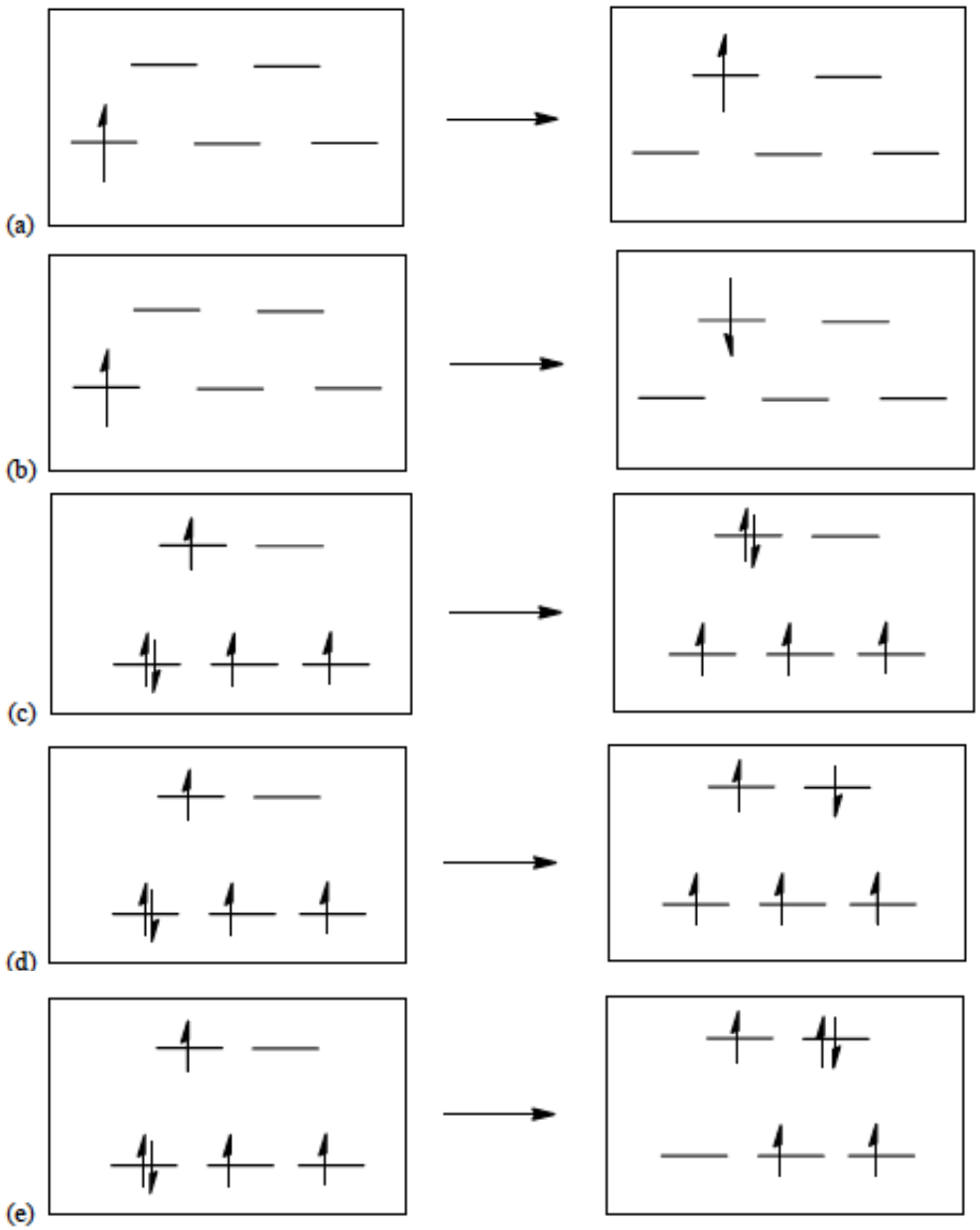
Colors of Complexes

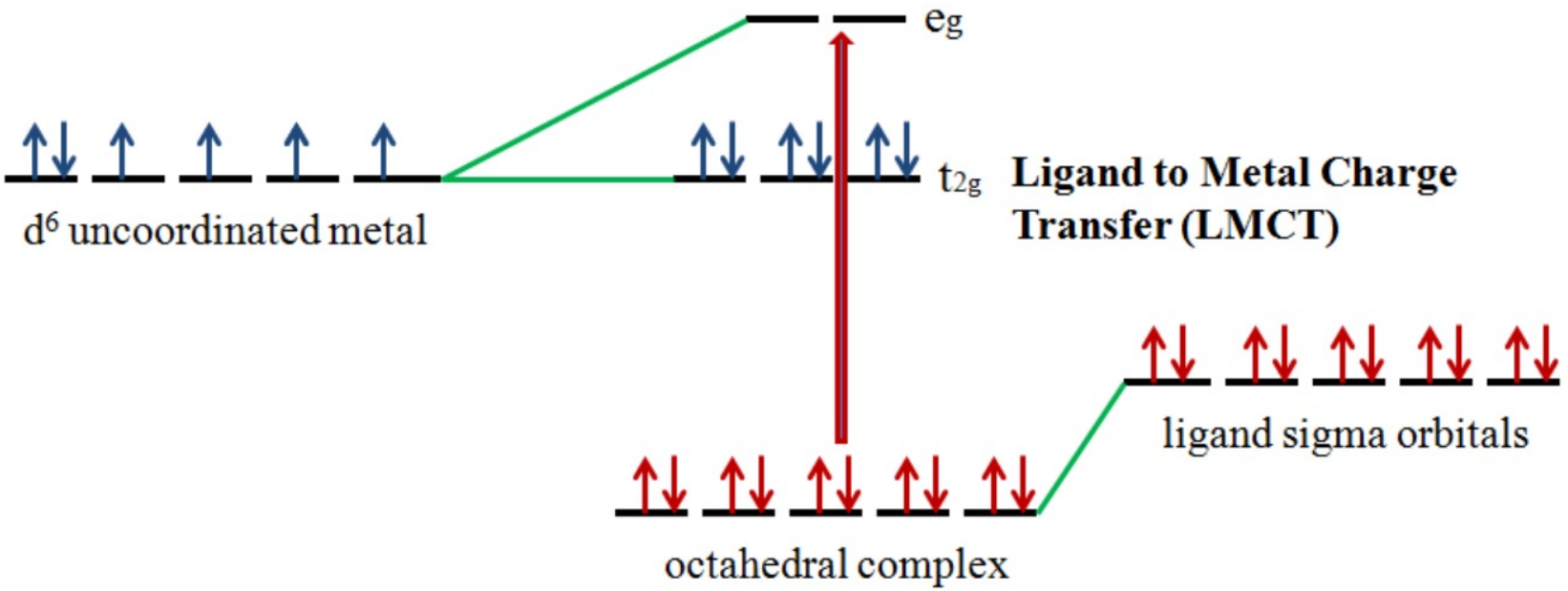


$[Cu(H_2O)_6]^{2+}$ absorbs orange-red, emits blue.



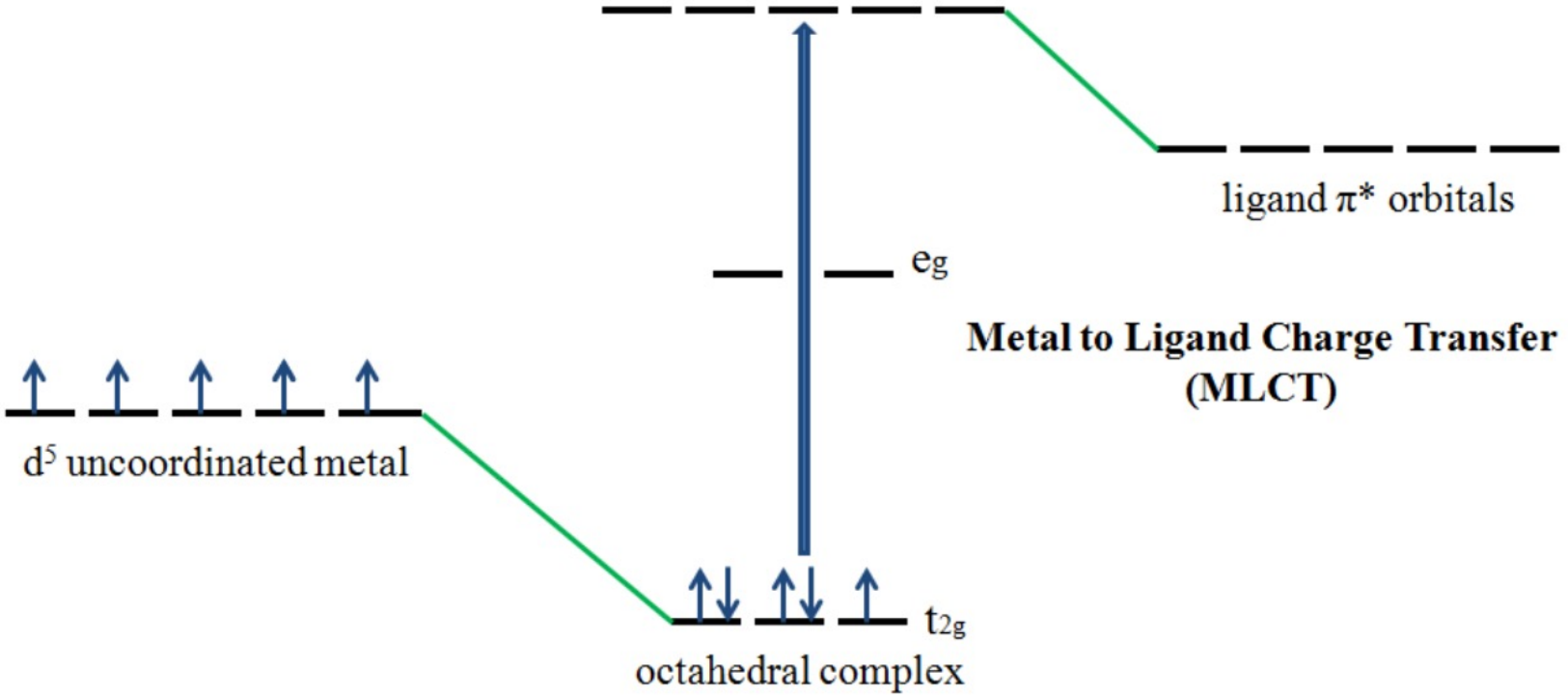
Exercise: Are the following spin allowed?





Ligand to Metal Charge Transfer (LMCT) involving an octahedral d^6 complex.

Or CCTM charge transfer to metal



Metal to Ligand Charge Transfer (MLCT) involving an octahedral d^5 complex.

Or CCTL charge transfer to ligand