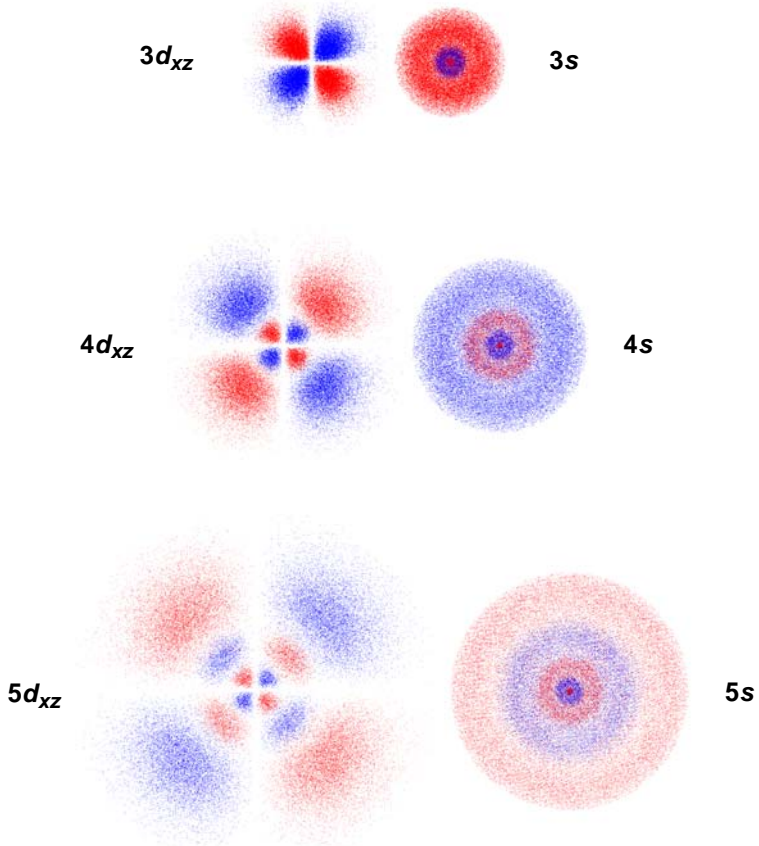
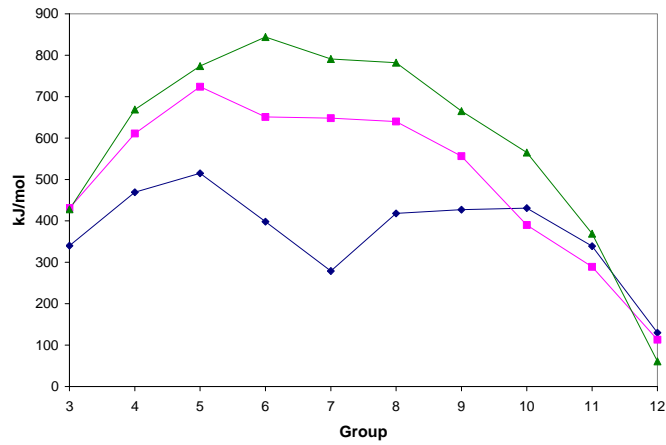


Metallic radii of the *d*-block elements

Atomization enthalpies of the d-block metals



*nd* vs. *ns* orbitals:  
50,000 dots per orbital

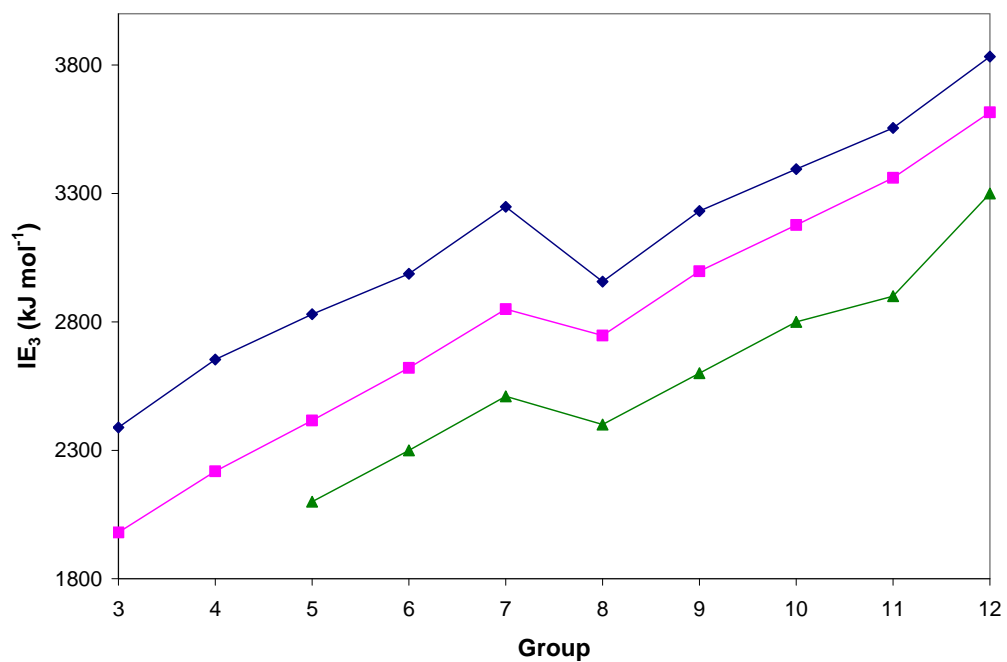
### Simple binary transition metal oxides

3			4		5			6			7			8		9		10		11		12					
Sc	Y	Lu	Ti		V	Nb				Mn		Fe			Co		Ni	Pd		Cu	Ag		Zn	Cd	Hg		
			Ti	Zr	Hf	V	Nb	Ta	Cr	Mo	W	Mn	Tc	Re	Fe	Co	Rh	Ir		Pd	Pt	Cu	Ag				Au
						V	Nb	Ta		Mo				Re													
									Cr	Mo	W		Tc	Re													
												Mn	Tc	Re													
															Ru	Os											

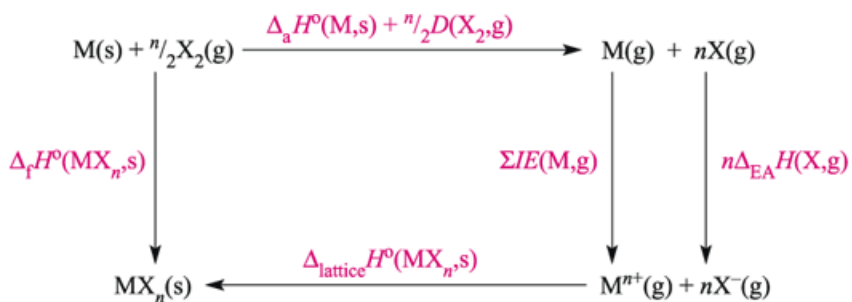
### Simple binary transition metal fluorides

3			4		5			6			7			8		9		10		11		12				
Sc	Y	Lu	Ti	Zr	V	Nb		Cr	Mo		Mn		Fe		Co		Ni	Pd		Cu	Ag		Zn	Cd	Hg	
			Ti	Zr	Hf	V	Nb	Ta	Cr	Mo		Mn		Fe	Ru	Co	Rh	Ir				Cu	Ag			
						V	Nb	Ta	Cr	Mo				Re	Ru	Os										
									Cr	Mo	W		Tc	Re		Os										
													Re													
														Re	Os											

In both tables, the most stable oxidation state is in bold.

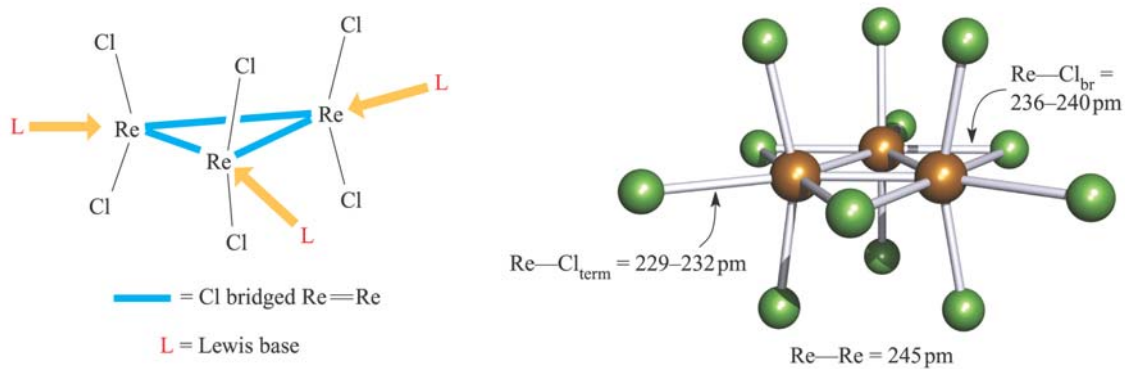


Third ionization energies of the d-block metals

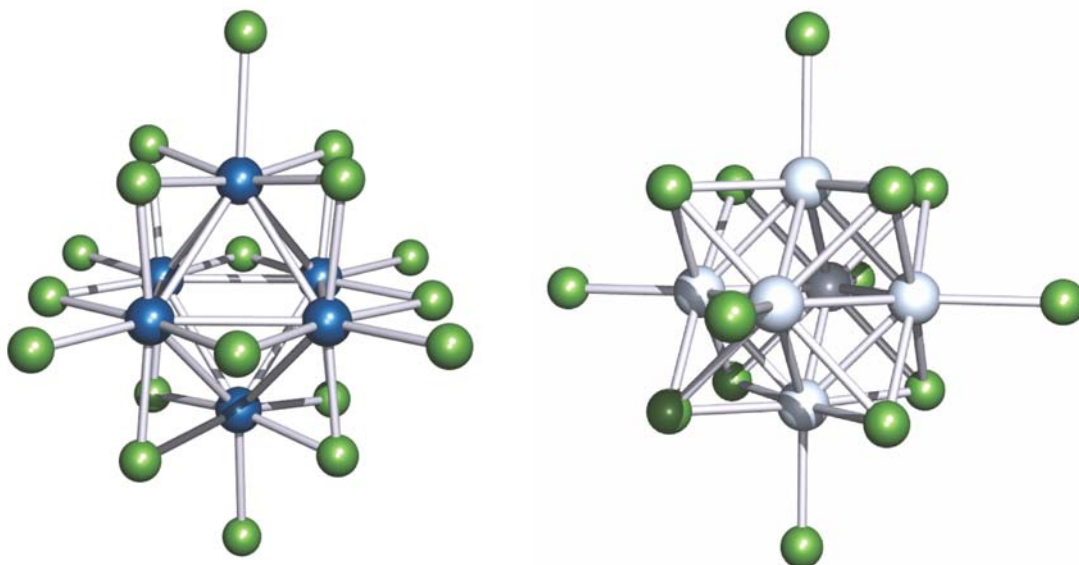


- $\Delta_a H^\circ(\text{M,s})$  = Enthalpy of atomization of metal M  
 $D(\text{X}_2,\text{g})$  = Dissociation enthalpy of  $\text{X}_2 = 2 \times$  Enthalpy of atomization of X  
 $\Sigma IE(\text{M,g})$  = Sum of the ionization energies for the processes  $\text{M(g)} \rightarrow \text{M}^+(\text{g}) \rightarrow \text{M}^{2+}(\text{g}) \dots \rightarrow \text{M}^{n+}(\text{g})$   
 $\Delta_{\text{EA}} H(\text{X,g})$  = Enthalpy change associated with the attachment of an electron  
 $\Delta_f H^\circ(\text{MX}_n,\text{s})$  = Standard enthalpy of formation  
 $\Delta_{\text{lattice}} H^\circ(\text{MX}_n,\text{s})$  = Lattice enthalpy change (see text)

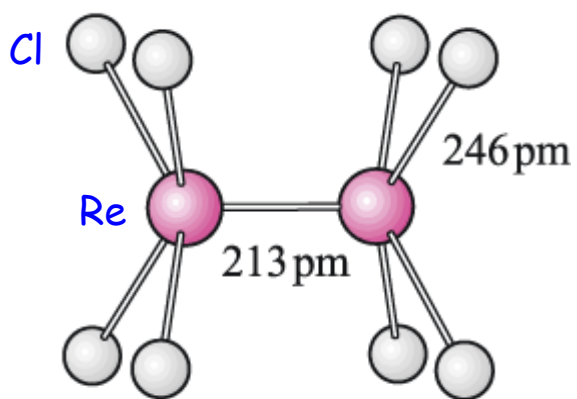
Born-Haber thermochemical cycle for the formation of a salt  $\text{MX}_n$ .



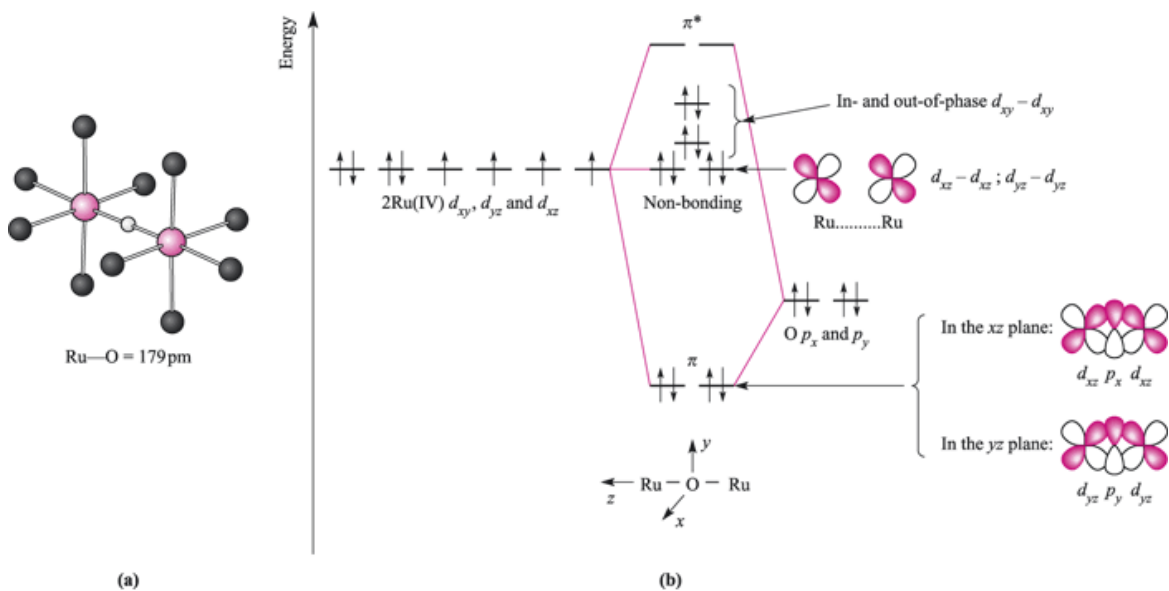
Sites of addition of Lewis bases to  $\text{Re}_3\text{Cl}_9$  and the structure of  $[\text{Re}_3\text{Cl}_{12}]^{3-}$ .



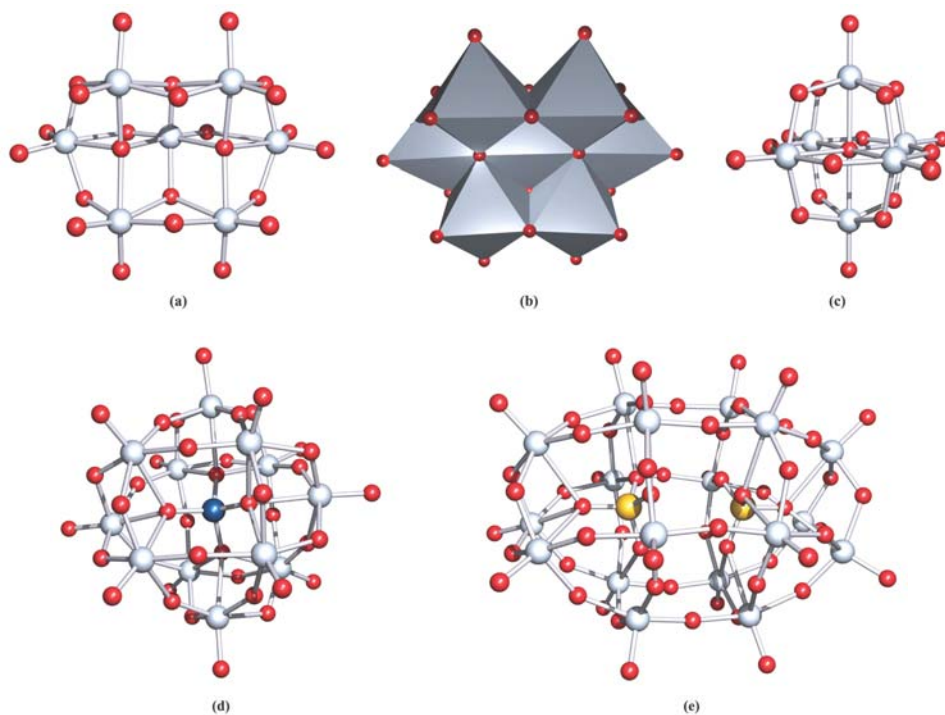
X-ray crystal structure of [Mo<sub>6</sub>Cl<sub>14</sub>]<sup>2-</sup> (left);  
X-ray crystal structure of [Nb<sub>6</sub>Cl<sub>18</sub>]<sup>3-</sup> (right).



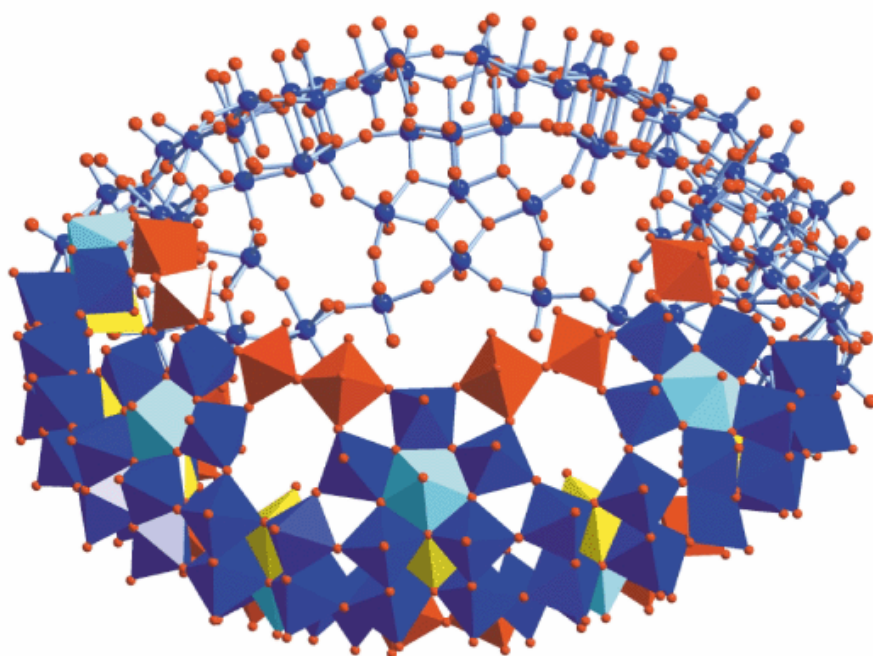
The structure of [Re<sub>2</sub>Cl<sub>8</sub>]<sup>2-</sup>



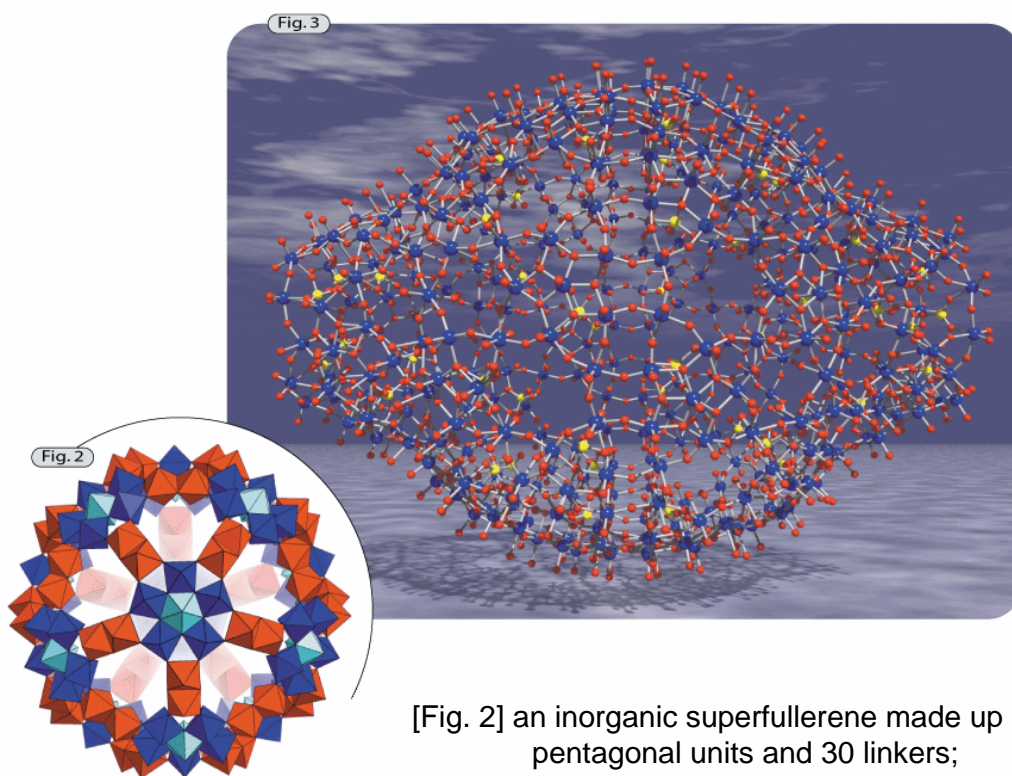
(a) the structure of  $[\text{Ru}_2(\mu\text{-O})\text{Cl}_{10}]^{4-}$ ; (b) a partial MO diagram for the interaction between the Ru  $d_{xy}$ ,  $d_{xz}$  and  $d_{yz}$  orbitals of the  $\text{Ru}^{\text{IV}}$  centers with the  $p_x$  and  $p_y$  orbitals of the O atom to give two bonding, two antibonding and four non-bonding orbitals.



(a)  $[\text{Mo}_7\text{O}_{24}]^{6-}$ ; (b) the same structure drawn as octahedral building blocks; (c)  $[\text{W}_6\text{O}_{19}]^{2-}$ ; (d) the  $\alpha$ -Keggin ion  $[\text{SiMo}_{12}\text{O}_{40}]^{4-}$ ; (e)  $[\text{H}_3\text{S}_2\text{Mo}_{18}\text{O}_{62}]^{5-}$ .



Mo<sub>154</sub> "big wheel", shown half in polyhedra, half in ball-and-stick representations.



[Fig. 2] an inorganic superfullerene made up of 12 pentagonal units and 30 linkers;  
 [Fig. 3] Mo<sub>368</sub> "nanohedgehog"