

# Metals with Variable Charge

Most transition metals (3-12) and Group 4A (14) metals form 2 or more positive ions, except  $\text{Zn}^{2+}$ ,  $\text{Ag}^+$ , and  $\text{Cd}^{2+}$ , which form only one ion.

3	4	5	6	7	8	9	10	11	12	14 Group 4A
3B	4B	5B	6B	7B	8B			1B	2B	
			$\text{Cr}^{2+}$ $\text{Cr}^{3+}$	$\text{Mn}^{2+}$ $\text{Mn}^{3+}$	$\text{Fe}^{2+}$ $\text{Fe}^{3+}$	$\text{Co}^{2+}$ $\text{Co}^{3+}$	$\text{Ni}^{2+}$ $\text{Ni}^{3+}$	$\text{Cu}^+$ $\text{Cu}^{2+}$	$\text{Zn}^{2+}$	
								$\text{Ag}^+$	$\text{Cd}^{2+}$	
								$\text{Au}^+$ $\text{Au}^{3+}$	$\text{Hg}_2^{2+}$ $\text{Hg}^{2+}$	
										$\text{Sn}^{2+}$ $\text{Sn}^{4+}$
										$\text{Pb}^{2+}$ $\text{Pb}^{4+}$

Metals  
 Metalloids  
 Nonmetals

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The names of transition metals with two or more positive ions (cations) use a *Roman numeral* after the name of the metal to identify the ion charge.

TABLE 5.5 Some Metals That Form More Than One Positive Ion

Element	Ions	Name of Ion	Element	Ions	Name of Ion
Chromium	$\text{Cr}^{2+}$	Chromium(II)	Lead	$\text{Pb}^{2+}$	Lead(II)
	$\text{Cr}^{3+}$	Chromium(III)		$\text{Pb}^{4+}$	Lead(IV)
Cobalt	$\text{Co}^{2+}$	Cobalt(II)	Manganese	$\text{Mn}^{2+}$	Manganese(II)
	$\text{Co}^{3+}$	Cobalt(III)		$\text{Mn}^{3+}$	Manganese(III)
Copper	$\text{Cu}^+$	Copper(I)	Mercury	$\text{Hg}_2^{2+}$	Mercury(I)*
	$\text{Cu}^{2+}$	Copper(II)		$\text{Hg}^{2+}$	Mercury(II)
Gold	$\text{Au}^+$	Gold(I)	Nickel	$\text{Ni}^{2+}$	Nickel(II)
	$\text{Au}^{3+}$	Gold(III)		$\text{Ni}^{3+}$	Nickel(III)
Iron	$\text{Fe}^{2+}$	Iron(II)	Tin	$\text{Sn}^{2+}$	Tin(II)
	$\text{Fe}^{3+}$	Iron(III)		$\text{Sn}^{4+}$	Tin(IV)

\*Mercury(I) ions form an ion pair with a 2+ charge.