

PROPERTIES OF SOME TRANSITION METALS

	Cr	Fe	Co	Ni	Cu	Zn	Ag	Au	Hg
Melting point (°C)	1857 ± 20	1535	1495	1455	1083	420	962	1064	−38.8
Boiling point (°C)	2672	2750	2870	2732	2567	907	2212	2808 ± 2	356.6
Density (g/cm ³)	7.20	7.86	8.9	8.92	8.96	7.14	10.5	19.3	13.5
Ionization energy (kJ/mol)	653	762	760	737	746	906	731	890	1007
Atomic radius (pm)	128	126	125	124	128	134	144	144	151
Common oxidation numbers	+2, +3, +6	+2, +3	+2, +3	+2	+1, +2	+2	+1	+1, +3	+1, +2

APPLICATION *Geology***Gemstones and Color**

A gemstone is a mineral that can be cut and polished to make gems for an ornament or piece of jewelry. At one time, all gemstones were naturally occurring minerals mined from Earth's crust. Today, however, chemists can duplicate natural processes to produce artificial gemstones. Amethyst, emerald, jade, opal, ruby, sapphire, and topaz occur naturally and can also be produced synthetically.

The color of a gemstone is determined by the presence of small amounts of one or more transition metals. For example, aluminum oxide, Al_2O_3 , often occurs naturally as corundum—a clear, colorless mineral. However, if as few as 1 to 2% of the aluminum ions, Al^{3+} , are replaced by chromium ions, Cr^{3+} , the corundum takes on a reddish color and is known as ruby. If a small fraction of aluminum ions in corundum are replaced by Fe^{3+} and Ti^{3+} , the corundum has

a greenish color and is known as emerald. In another variation, if vanadium ions, V^{3+} , replace a few Al^{3+} ions in corundum, the result is a gemstone known as alexandrite. This gemstone appears green in reflected natural light and red in transmitted or artificial light.

Table 3A lists transition metals that are responsible for the colors of various gemstones. The table provides only a general overview, however, as most naturally occurring gemstones occur in a range of hues, depending on the exact composition of the stone.

Artificial Gemstones

In 1902, the French chemist Auguste Verneuil found a way to melt a mixture of aluminum oxide and chromium salts and then cool the mixture very slowly to produce large crystals of reddish aluminum oxide—rubies.



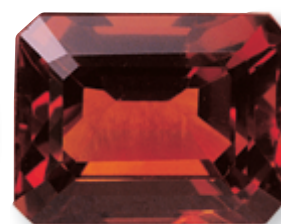
Sapphire



Ruby



Peridot



Garnet