

Periodic Table of the Elements

sb Specialty Metals

1 IA 11A 1 H Hydrogen 1.008	2 IIA 2A 3 Li Lithium 6.941	4 IIA 2A 4 Be Beryllium 9.012																	5 III A 3A 5 B Boron 10.811	6 IV A 4A 6 C Carbon 12.011	7 VA 5A 7 N Nitrogen 14.007	8 VIA 6A 8 O Oxygen 15.999	9 VII A 7A 9 F Fluorine 18.998	10 VIII A 8A 10 Ne Neon 20.180				
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B 21 Sc Scandium 44.956	4 IVB 4B 22 Ti Titanium 47.88	5 VB 5B 23 V Vanadium 50.942	6 VIB 6B 24 Cr Chromium 51.996	7 VIIB 7B 25 Mn Manganese 54.938	8 VIII 8 26 Fe Iron 55.933	9 VIII 8 27 Co Cobalt 58.933	10 VIII 8 28 Ni Nickel 58.693	11 IB 1B 29 Cu Copper 63.546	12 IIB 2B 30 Zn Zinc 65.39	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948											
19 K Potassium 39.099	20 Ca Calcium 40.078	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29											
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanide Series 57 La Lanthanum 138.906	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [209, 282]	85 At Astatine 209.987	86 Rn Radon 222.018											
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series 89 Ac Actinium 227.028	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [271]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [293]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown											
		59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]
		Alkali Metal	Alkaline Earth	Transition Metal	Semimetal	Nonmetal	Basic Metal	Halogen	Noble Gas	Lanthanide	Actinide																	

Tool Steel Alloying Elements and Their Effect

Carbon (C):

The most influential and important alloying element in steel.

Increasing the carbon content increases the steels attainable hardness and strength.

Increasing the carbon content decreases the steels ductility, weldability and machinability

Chromium (Cr):

Chromium additions increase hardenability and corrosion resistance.

Chromium is a carbide former and will increase wear resistance in combination with carbon

Molybdenum (Mo):

Molybdenum promotes fine grain formation and secondary hardening during tempering.

Molybdenum is a carbide former and will increase wear resistance in combination with carbon.

Tungsten (W):

Tungsten increases temper resistance and restricts grain growth.

Tungsten is a strong carbide former and will increase wear resistance in combination with carbon.

Vanadium (V):

Vanadium increases temper resistance and promotes fine grain formation.

Vanadium is a strong carbide former and will increase wear resistance in combination with carbon.

Nickel (Ni):

Nickel increases hardenability and corrosion resistance

Nickel is not a carbide former

Cobalt (Co):

Cobalt increases red hardness and high temperature strength.

Cobalt it not a carbide former.

Manganese (Mn):

Manganese increases hardenability and is used as a de-oxidizer in steelmaking.

Silicon (Si):

Silicon promotes hardenability and scale resistance and is a main de-oxidizer in steelmaking.

Sulfur (S):

Sulfur typically has a maximum level to control inclusion content.

Sulfur will combine with manganese to form sulfides that aid in machinability but decrease toughness.