

# Periodic Table of Elements and X-ray Energies

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<b>1</b> H Hydrogen 1.01 0.0007																	<b>2</b> He Helium 4.00 0.0002						
<b>3</b> Li Lithium 6.94 0.53	<b>4</b> Be Beryllium 9.01 1.85 K $\alpha$ 0.108																	<b>5</b> B Boron 10.81 2.34 K $\alpha$ 0.183	<b>6</b> C Carbon 12.01 2.27 K $\alpha$ 0.277	<b>7</b> N Nitrogen 14.01 0.001 K $\alpha$ 0.392	<b>8</b> O Oxygen 16.00 0.001 K $\alpha$ 0.525	<b>9</b> F Fluorine 19.00 0.001 K $\alpha$ 0.677	<b>10</b> Ne Neon 20.18 0.0009 K $\alpha$ 0.849
<b>11</b> Na Sodium 22.99 0.97 K $\alpha$ 1.040	<b>12</b> Mg Magnesium 24.31 1.74 K $\alpha$ 1.254																	<b>13</b> Al Aluminium 26.98 2.70 K $\alpha$ 1.486	<b>14</b> Si Silicon 28.09 2.33 K $\alpha$ 1.740	<b>15</b> P Phosphorus 30.97 1.82 K $\alpha$ 2.010	<b>16</b> S Sulfur 32.07 2.07 K $\alpha$ 2.309	<b>17</b> Cl Chlorine 35.45 0.003 K $\alpha$ 2.622	<b>18</b> Ar Argon 39.95 0.002 K $\alpha$ 2.958
<b>19</b> K Potassium 39.10 0.86 K $\alpha$ 3.314	<b>20</b> Ca Calcium 40.08 1.54 K $\alpha$ 3.692 L $\alpha$ 0.341	<b>21</b> Sc Scandium 44.96 2.99 K $\alpha$ 4.093 L $\alpha$ 0.395	<b>22</b> Ti Titanium 47.87 4.54 K $\alpha$ 4.512 L $\alpha$ 0.452	<b>23</b> V Vanadium 50.94 6.11 K $\alpha$ 4.953 L $\alpha$ 0.510	<b>24</b> Cr Chromium 52.00 7.15 K $\alpha$ 5.415 L $\alpha$ 0.572	<b>25</b> Mn Manganese 54.94 7.44 K $\alpha$ 5.900 L $\alpha$ 0.637	<b>26</b> Fe Iron 55.85 7.87 K $\alpha$ 6.405 L $\alpha$ 0.705	<b>27</b> Co Cobalt 58.93 8.86 K $\alpha$ 6.931 L $\alpha$ 0.775	<b>28</b> Ni Nickel 58.69 8.91 K $\alpha$ 7.480 L $\alpha$ 0.849	<b>29</b> Cu Copper 63.55 8.93 K $\alpha$ 8.046 L $\alpha$ 0.928	<b>30</b> Zn Zinc 65.38 7.13 K $\alpha$ 8.637 L $\alpha$ 1.012	<b>31</b> Ga Gallium 69.72 5.91 K $\alpha$ 9.251 L $\alpha$ 1.098	<b>32</b> Ge Germanium 72.64 5.32 K $\alpha$ 9.886 L $\alpha$ 1.188	<b>33</b> As Arsenic 74.92 5.78 K $\alpha$ 10.543 L $\alpha$ 1.282	<b>34</b> Se Selenium 78.96 4.81 K $\alpha$ 11.224 L $\alpha$ 1.379	<b>35</b> Br Bromine 79.90 3.12 K $\alpha$ 11.924 L $\alpha$ 1.481	<b>36</b> Kr Krypton 83.80 0.004 K $\alpha$ 12.648 L $\alpha$ 1.585						
<b>37</b> Rb Rubidium 85.47 1.53 K $\alpha$ 13.396 L $\alpha$ 1.692	<b>38</b> Sr Strontium 87.62 2.64 K $\alpha$ 14.165 L $\alpha$ 1.806	<b>39</b> Y Yttrium 88.91 4.47 K $\alpha$ 14.958 L $\alpha$ 1.924	<b>40</b> Zr Zirconium 91.22 6.51 K $\alpha$ 15.775 L $\alpha$ 2.044	<b>41</b> Nb Niobium 92.91 8.57 K $\alpha$ 16.615 L $\alpha$ 2.169	<b>42</b> Mo Molybdenum 95.94 10.22 K $\alpha$ 17.480 L $\alpha$ 2.292	<b>43</b> Tc Technetium (98) 11.50 K $\alpha$ 18.367 L $\alpha$ 2.423	<b>44</b> Ru Ruthenium 101.07 12.37 K $\alpha$ 19.279 L $\alpha$ 2.558	<b>45</b> Rh Rhodium 102.91 12.41 K $\alpha$ 20.216 L $\alpha$ 2.697	<b>46</b> Pd Palladium 106.42 12.02 K $\alpha$ 21.177 L $\alpha$ 2.838	<b>47</b> Ag Silver 107.87 10.50 K $\alpha$ 22.163 L $\alpha$ 2.983	<b>48</b> Cd Cadmium 112.41 8.69 K $\alpha$ 23.173 L $\alpha$ 3.133	<b>49</b> In Indium 114.82 7.31 K $\alpha$ 24.210 L $\alpha$ 3.286	<b>50</b> Sn Tin 118.71 7.29 K $\alpha$ 25.271 L $\alpha$ 3.444	<b>51</b> Sb Antimony 121.76 6.69 K $\alpha$ 26.359 L $\alpha$ 3.604	<b>52</b> Te Tellurium 127.60 6.23 K $\alpha$ 27.473 L $\alpha$ 3.768	<b>53</b> I Iodine 126.90 4.93 K $\alpha$ 28.612 L $\alpha$ 3.938	<b>54</b> Xe Xenon 131.29 0.006 K $\alpha$ 29.775 L $\alpha$ 4.110						
<b>55</b> Cs Cesium 132.91 1.87 K $\alpha$ 30.973 L $\alpha$ 4.285	<b>56</b> Ba Barium 137.33 3.59 K $\alpha$ 32.194 L $\alpha$ 4.466	<b>57</b> La Lanthanum 138.91 6.15 K $\alpha$ 33.442 L $\alpha$ 4.647	<b>72</b> Hf Hafnium 178.49 13.31 K $\alpha$ 7.899 M $\alpha$ 1.646	<b>73</b> Ta Tantalum 180.95 16.65 K $\alpha$ 8.146 M $\alpha$ 1.712	<b>74</b> W Tungsten 183.84 19.25 K $\alpha$ 8.398 M $\alpha$ 1.775	<b>75</b> Re Rhenium 186.21 21.02 K $\alpha$ 8.652 M $\alpha$ 1.843	<b>76</b> Os Osmium 190.23 22.61 K $\alpha$ 8.911 M $\alpha$ 1.907	<b>77</b> Ir Iridium 192.22 22.65 K $\alpha$ 9.175 M $\alpha$ 1.980	<b>78</b> Pt Platinum 195.08 21.46 K $\alpha$ 9.442 M $\alpha$ 2.050	<b>79</b> Au Gold 196.97 19.28 K $\alpha$ 9.713 M $\alpha$ 2.123	<b>80</b> Hg Mercury 200.59 13.53 K $\alpha$ 9.989 M $\alpha$ 2.195	<b>81</b> Tl Thallium 204.37 11.85 K $\alpha$ 10.269 M $\alpha$ 2.271	<b>82</b> Pb Lead 207.20 11.34 K $\alpha$ 10.551 M $\alpha$ 2.342	<b>83</b> Bi Bismuth 208.98 9.81 K $\alpha$ 10.839 M $\alpha$ 2.423	<b>84</b> (209) Po Polonium 9.32 K $\alpha$ 11.131 M $\alpha$ 2.499	<b>85</b> (210) At Astatine 7.00 K $\alpha$ 11.427 M $\alpha$ 2.577	<b>86</b> (222) Rn Radon 0.01 K $\alpha$ 11.727 M $\alpha$ 2.654						
<b>87</b> Fr Francium (223) 1.87 L $\alpha$ 12.031 M $\alpha$ 2.732	<b>88</b> Ra Radium (226) 5.50 L $\alpha$ 12.339 M $\alpha$ 2.806	<b>89</b> Ac Actinium (227) 10.07 L $\alpha$ 12.652 M $\alpha$ 2.900																					

<b>58</b> Ce Cerium 140.12 6.77 L $\alpha$ 4.839 M $\alpha$ 0.884	<b>59</b> Pr Praseodymium 140.91 6.77 L $\alpha$ 5.035 M $\alpha$ 0.927	<b>60</b> Nd Neodymium 144.24 7.01 L $\alpha$ 5.228 M $\alpha$ 0.979	<b>61</b> Pm Promethium (145) 7.26 L $\alpha$ 5.432 M $\alpha$ 1.023	<b>62</b> Sm Samarium 150.36 7.52 L $\alpha$ 5.633 M $\alpha$ 1.078	<b>63</b> Eu Europium 151.96 5.24 L $\alpha$ 5.849 M $\alpha$ 1.131	<b>64</b> Gd Gadolinium 157.25 7.90 L $\alpha$ 6.053 M $\alpha$ 1.181	<b>65</b> Tb Terbium 158.93 8.23 L $\alpha$ 6.273 M $\alpha$ 1.240	<b>66</b> Dy Dysprosium 162.50 8.55 L $\alpha$ 6.498 M $\alpha$ 1.293	<b>67</b> Ho Holmium 164.93 8.80 L $\alpha$ 6.720 M $\alpha$ 1.348	<b>68</b> Er Erbium 167.26 9.07 L $\alpha$ 6.949 M $\alpha$ 1.404	<b>69</b> Tm Thulium 168.93 9.32 L $\alpha$ 7.180 M $\alpha$ 1.462	<b>70</b> Yb Ytterbium 173.04 6.97 L $\alpha$ 7.416 M $\alpha$ 1.526	<b>71</b> Lu Lutetium 174.47 9.84 L $\alpha$ 7.655 M $\alpha$ 1.580
<b>90</b> Th Thorium 232.04 11.72 L $\alpha$ 12.968 M $\alpha$ 2.996	<b>91</b> Pa Protactinium 231.04 15.37 L $\alpha$ 13.291 M $\alpha$ 3.082	<b>92</b> U Uranium 238.03 18.95 L $\alpha$ 13.614 M $\alpha$ 3.171	<b>93</b> Np Neptunium (237) 20.45 L $\alpha$ 13.946 M $\alpha$ 3.250	<b>94</b> Pu Plutonium (244) 19.84 L $\alpha$ 14.282 M $\alpha$ 3.339	<b>95</b> Am Americium (243) 13.69 L $\alpha$ 14.620 M $\alpha$ 3.438	<b>96</b> Cm Curium (247) 13.51 L $\alpha$ 14.79	<b>97</b> Bk Berkelium (247) 14.79	<b>98</b> Cf Californium (251) 15.1 L $\alpha$ 15.1	<b>99</b> Es Einsteinium (252) 13.5	<b>100</b> Fm Fermium (257)	<b>101</b> Md Mendelevium (258)	<b>102</b> No Nobelium (259)	<b>103</b> Lr Lawrencium (262)

Atomic number	Atomic weight	Density (g/cm <sup>3</sup> )	Symbol	Element name	Energy (keV)	Spectral line
35	79.90	3.12	Br	Bromine	11.924	L $\alpha$ 1.481



Z	Element	$K\alpha_1$	$K\beta_1$	$L\alpha_1$	$L\beta_1$
3	Li Lithium				
4	Be Beryllium	0.108			
5	B Boron	0.183			
6	C Carbon	0.277			
7	N Nitrogen	0.392			
8	O Oxygen	0.525			
9	F Fluorine	0.677			
10	Ne Neon	0.849			
11	Na Sodium	1.040			
12	Mg Magnesium	1.254	1.302		
13	Al Aluminium	1.486	1.557		
14	Si Silicon	1.740	1.837		
15	P Phosphorus	2.010	2.139		
16	S Sulfur	2.309	2.465		
17	Cl Chlorine	2.622	2.812		
18	Ar Argon	2.958	3.190		
19	K Potassium	3.314	3.590		
20	Ca Calcium	3.692	4.013	0.341	0.345
21	Sc Scandium	4.093	4.464	0.395	0.400
22	Ti Titanium	4.512	4.933	0.452	0.458
23	V Vanadium	4.953	5.428	0.510	0.518
24	Cr Chromium	5.415	5.947	0.572	0.582
25	Mn Manganese	5.900	6.492	0.637	0.648
26	Fe Iron	6.405	7.059	0.705	0.718
27	Co Cobalt	6.931	7.649	0.775	0.790
28	Ni Nickel	7.480	8.267	0.849	0.866
29	Cu Copper	8.046	8.904	0.928	0.947
30	Zn Zinc	8.637	9.570	1.012	1.035
31	Ga Gallium	9.251	10.267	1.098	1.125
32	Ge Germanium	9.886	10.982	1.188	1.218
33	As Arsenic	10.543	11.726	1.282	1.317

Z	Element	$K\alpha_1$	$K\beta_1$	$L\alpha_1$	$L\beta_1$
34	Se Selenium	11.224	12.497	1.379	1.419
35	Br Bromine	11.924	13.292	1.481	1.526
36	Kr Krypton	12.648	14.112	1.585	1.636
37	Rb Rubidium	13.396	14.961	1.692	1.751
38	Sr Strontium	14.165	15.835	1.806	1.871
39	Y Yttrium	14.958	16.739	1.924	1.998
40	Zr Zirconium	15.775	17.668	2.044	2.126
41	Nb Niobium	16.615	18.625	2.169	2.260
42	Mo Molybdenum	17.480	19.606	2.292	2.394
43	Tc Technetium	18.367	20.626	2.423	2.535
44	Ru Ruthenium	19.279	21.656	2.558	2.683
45	Rh Rhodium	20.216	22.724	2.697	2.834
46	Pd Palladium	21.177	23.818	2.838	2.990
47	Ag Silver	22.163	24.941	2.983	3.150
48	Cd Cadmium	23.173	26.093	3.133	3.315
49	In Indium	24.210	27.275	3.286	3.487
50	Sn Tin	25.271	28.485	3.444	3.663
51	Sb Antimony	26.359	29.725	3.604	3.842
52	Te Tellurium	27.473	30.993	3.768	4.029
53	I Iodine	28.612	32.294	3.938	4.221
54	Xe Xenon	29.775	33.620	4.110	4.418
55	Cs Cesium	30.973	34.982	4.285	4.619
56	Ba Barium	32.194	36.378	4.466	4.828
57	La Lanthanum	33.442	37.797	4.647	5.038
58	Ce Cerium	34.720	39.256	4.839	5.262
59	Pr Praseodymium	36.027	40.749	5.035	5.492
60	Nd Neodymium	37.361	42.272	5.228	5.719
61	Pm Promethium	38.725	43.827	5.432	5.961
62	Sm Samarium	40.118	45.414	5.633	6.201
63	Eu Europium	41.542	47.038	5.849	6.458
64	Gd Gadolinium	42.996	48.695	6.053	6.708

Z	Element	$K\alpha_1$	$K\beta_1$	$L\alpha_1$	$L\beta_1$	$M\alpha_1$	$M\beta_1$
65	Tb Terbium	44.482	50.385	6.273	6.975	1.240	1.269
66	Dy Dysprosium	45.999	52.113	6.498	7.248	1.293	1.325
67	Ho Holmium	47.547	53.877	6.720	7.526	1.348	1.383
68	Er Erbium	49.128	55.674	6.949	7.811	1.404	1.448
69	Tm Thulium	50.742	57.505	7.180	8.102	1.462	1.503
70	Yb Ytterbium	52.388	59.382	7.416	8.402	1.526	1.573
71	Lu Lutetium	54.070	61.290	7.655	8.710	1.580	1.630
72	Hf Hafnium	55.790	63.244	7.899	9.023	1.646	1.700
73	Ta Tantalum	57.535	65.222	8.146	9.343	1.712	1.770
74	W Tungsten	59.318	67.244	8.398	9.672	1.775	1.838
75	Re Rhenium	61.141	69.309	8.652	10.010	1.843	1.906
76	Os Osmium	63.000	71.414	8.911	10.354	1.907	1.978
77	Ir Iridium	64.896	73.560	9.175	10.708	1.980	2.052
78	Pt Platinum	66.831	75.750	9.442	11.071	2.050	2.127
79	Au Gold	68.806	77.982	9.713	11.443	2.123	2.203
80	Hg Mercury	70.818	80.255	9.989	11.824	2.195	2.281
81	Tl Thallium	72.872	82.573	10.269	12.213	2.271	2.363
82	Pb Lead	74.970	84.939	10.551	12.614	2.342	2.444
83	Bi Bismuth	77.107	87.349	10.839	13.023	2.423	2.526
84	Po Polonium	79.291	89.803	11.131	13.446	2.499	2.614
85	At Astatine	81.516	92.304	11.427	13.876	2.577	2.699
86	Rn Radon	83.785	94.866	11.727	14.315	2.654	2.784
87	Fr Francium	86.106	97.474	12.031	14.771	2.732	2.868
88	Ra Radium	88.478	100.130	12.339	15.236	2.806	2.949
89	Ac Actinium	90.884	102.846	12.652	15.713	2.900	3.051
90	Th Thorium	93.351	105.605	12.968	16.202	2.996	3.149
91	Pa Protactinium	95.868	108.427	13.291	16.703	3.082	3.240
92	U Uranium	98.440	111.303	13.614	17.220	3.171	3.336
93	Np Neptunium	101.059	114.234	13.946	17.751	3.250	3.435
94	Pu Plutonium	103.734	117.228	14.282	18.296	3.339	3.534
95	Am Americium	106.472	120.284	14.620	18.856	3.438	3.646

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