

# PERIODIC TABLE

## Atomic Properties of the Elements

Physical Measurement Laboratory [www.nist.gov/pml](http://www.nist.gov/pml)  
Standard Reference Data [www.nist.gov/srd](http://www.nist.gov/srd)

### FREQUENTLY USED FUNDAMENTAL PHYSICAL CONSTANTS<sup>§</sup>

1 second = 9 192 631 770 periods of radiation corresponding to the transition between the two hyperfine levels of the ground state of <sup>133</sup>Cs

speed of light in vacuum	<i>c</i>	299 792 458 m s <sup>-1</sup>	(exact)
Planck constant	<i>h</i>	6.626 070 15 × 10 <sup>-34</sup> J Hz <sup>-1</sup>	(exact)
elementary charge	<i>e</i>	1.602 176 634 × 10 <sup>-19</sup> C	(exact)
Avogadro constant	<i>N<sub>A</sub></i>	6.022 140 76 × 10 <sup>23</sup> mol <sup>-1</sup>	(exact)
Boltzmann constant	<i>k</i>	1.380 649 × 10 <sup>-23</sup> J K <sup>-1</sup>	(exact)
electron volt	eV	1.602 176 634 × 10 <sup>-19</sup> J	(exact)
electron mass	<i>m<sub>e</sub></i>	9.109 383 70 × 10 <sup>-31</sup> kg	
energy equivalent	<i>m<sub>e</sub>c<sup>2</sup></i>	0.510 998 950 MeV	
proton mass	<i>m<sub>p</sub></i>	1.672 621 924 × 10 <sup>-27</sup> kg	
energy equivalent	<i>m<sub>p</sub>c<sup>2</sup></i>	938.272 088 MeV	
fine-structure constant	<i>α</i>	1/137.035 999	
Rydberg energy	<i>R<sub>∞</sub>hc</i>	13.605 693 1230 eV	
Newtonian constant of gravitation	<i>G</i>	6.674 × 10 <sup>-11</sup> m <sup>3</sup> kg <sup>-1</sup> s <sup>-2</sup>	

<sup>§</sup>For the most accurate values of these and other constants, visit [pml.nist.gov/constants](http://pml.nist.gov/constants).

Solids  
 Liquids  
 Gases  
 Artificially Prepared

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	<b>1</b> <sup>1</sup> S <sub>1/2</sub> <b>H</b> Hydrogen 1.008 1s 13.5984																	<b>2</b> <sup>1</sup> S <sub>0</sub> <b>He</b> Helium 4.0026 1s <sup>2</sup> 24.5874
2	<b>3</b> <sup>2</sup> S <sub>1/2</sub> <b>Li</b> Lithium 6.94 1s <sup>2</sup> 2s 5.3917	<b>4</b> <sup>1</sup> S <sub>0</sub> <b>Be</b> Beryllium 9.0122 1s <sup>2</sup> 2s <sup>2</sup> 9.3227																
3	<b>11</b> <sup>2</sup> S <sub>1/2</sub> <b>Na</b> Sodium 22.990 [Ne]3s	<b>12</b> <sup>1</sup> S <sub>0</sub> <b>Mg</b> Magnesium 24.305 [Ne]3s <sup>2</sup> 7.6462																
4	<b>19</b> <sup>2</sup> S <sub>1/2</sub> <b>K</b> Potassium 39.098 [Ar]4s 4.3407	<b>20</b> <sup>1</sup> S <sub>0</sub> <b>Ca</b> Calcium 40.078 [Ar]3d <sup>4</sup> s <sup>2</sup> 6.1132	<b>21</b> <sup>2</sup> D <sub>3/2</sub> <b>Sc</b> Scandium 44.956 [Ar]3d <sup>4</sup> s <sup>2</sup> 6.5615	<b>22</b> <sup>3</sup> F <sub>2</sub> <b>Ti</b> Titanium 47.867 [Ar]3d <sup>2</sup> 4s <sup>2</sup> 6.8281	<b>23</b> <sup>4</sup> F <sub>3/2</sub> <b>V</b> Vanadium 50.942 [Ar]3d <sup>3</sup> 4s <sup>2</sup> 6.7462	<b>24</b> <sup>5</sup> S <sub>3</sub> <b>Cr</b> Chromium 51.996 [Ar]3d <sup>5</sup> 4s 6.7665	<b>25</b> <sup>6</sup> S <sub>5/2</sub> <b>Mn</b> Manganese 54.938 [Ar]3d <sup>5</sup> 4s <sup>2</sup> 7.4340	<b>26</b> <sup>5</sup> D <sub>4</sub> <b>Fe</b> Iron 55.845 [Ar]3d <sup>6</sup> 4s <sup>2</sup> 7.9025	<b>27</b> <sup>4</sup> F <sub>9/2</sub> <b>Co</b> Cobalt 58.933 [Ar]3d <sup>7</sup> 4s <sup>2</sup> 7.8810	<b>28</b> <sup>3</sup> F <sub>4</sub> <b>Ni</b> Nickel 58.693 [Ar]3d <sup>8</sup> 4s <sup>2</sup> 7.6399	<b>29</b> <sup>2</sup> S <sub>1/2</sub> <b>Cu</b> Copper 63.546 [Ar]3d <sup>10</sup> 4s 7.7264	<b>30</b> <sup>1</sup> S <sub>0</sub> <b>Zn</b> Zinc 65.38 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 9.3942	<b>31</b> <sup>2</sup> P <sub>1/2</sub> <b>Ga</b> Gallium 69.723 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p 5.9993	<b>32</b> <sup>3</sup> P <sub>0</sub> <b>Ge</b> Germanium 72.630 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>2</sup> 7.8994	<b>33</b> <sup>4</sup> S <sub>3/2</sub> <b>As</b> Arsenic 74.922 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>3</sup> 9.7886	<b>34</b> <sup>3</sup> P <sub>2</sub> <b>Se</b> Selenium 78.971 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>4</sup> 9.7524	<b>35</b> <sup>2</sup> P <sub>3/2</sub> <b>Br</b> Bromine 79.904 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>5</sup> 11.8138	<b>36</b> <sup>1</sup> S <sub>0</sub> <b>Kr</b> Krypton 83.798 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p <sup>6</sup> 13.9996
5	<b>37</b> <sup>2</sup> S <sub>1/2</sub> <b>Rb</b> Rubidium 85.468 [Kr]5s 4.1771	<b>38</b> <sup>1</sup> S <sub>0</sub> <b>Sr</b> Strontium 87.62 [Kr]5s <sup>2</sup> 5.6949	<b>39</b> <sup>2</sup> D <sub>3/2</sub> <b>Y</b> Yttrium 88.906 [Kr]4d <sup>5</sup> s <sup>2</sup> 6.2173	<b>40</b> <sup>3</sup> F <sub>2</sub> <b>Zr</b> Zirconium 91.224 [Kr]4d <sup>5</sup> s <sup>2</sup> 6.6341	<b>41</b> <sup>4</sup> D <sub>1/2</sub> <b>Nb</b> Niobium 92.906 [Kr]4d <sup>4</sup> 5s 6.7589	<b>42</b> <sup>5</sup> S <sub>3</sub> <b>Mo</b> Molybdenum 95.95 [Kr]4d <sup>5</sup> 5s 7.0924	<b>43</b> <sup>6</sup> S <sub>5/2</sub> <b>Tc</b> Technetium (97) [Kr]4d <sup>5</sup> 5s <sup>2</sup> 7.1194	<b>44</b> <sup>5</sup> F <sub>5</sub> <b>Ru</b> Ruthenium 101.07 [Kr]4d <sup>6</sup> 5s 7.3605	<b>45</b> <sup>4</sup> F <sub>9/2</sub> <b>Rh</b> Rhodium 102.91 [Kr]4d <sup>7</sup> 5s 8.3369	<b>46</b> <sup>1</sup> S <sub>0</sub> <b>Pd</b> Palladium 106.42 [Kr]4d <sup>10</sup> 8.3369	<b>47</b> <sup>2</sup> S <sub>1/2</sub> <b>Ag</b> Silver 107.87 [Kr]4d <sup>10</sup> 5s 8.9938	<b>48</b> <sup>1</sup> S <sub>0</sub> <b>Cd</b> Cadmium 112.41 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 8.9938	<b>49</b> <sup>2</sup> P <sub>1/2</sub> <b>In</b> Indium 114.82 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p 5.7864	<b>50</b> <sup>3</sup> P <sub>0</sub> <b>Sn</b> Tin 118.71 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>2</sup> 7.3439	<b>51</b> <sup>4</sup> S <sub>3/2</sub> <b>Sb</b> Antimony 121.76 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>3</sup> 8.6084	<b>52</b> <sup>3</sup> P <sub>2</sub> <b>Te</b> Tellurium 127.60 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>4</sup> 9.0097	<b>53</b> <sup>2</sup> P <sub>3/2</sub> <b>I</b> Iodine 126.90 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>5</sup> 10.4513	<b>54</b> <sup>1</sup> S <sub>0</sub> <b>Xe</b> Xenon 131.29 [Kr]4d <sup>10</sup> 5s <sup>2</sup> 5p <sup>6</sup> 12.1298
6	<b>55</b> <sup>2</sup> S <sub>1/2</sub> <b>Cs</b> Cesium 132.91 [Xe]6s 3.8939	<b>56</b> <sup>1</sup> S <sub>0</sub> <b>Ba</b> Barium 137.33 [Xe]6s <sup>2</sup> 5.2117		<b>72</b> <sup>3</sup> F <sub>2</sub> <b>Hf</b> Hafnium 178.49 [Xe]4f <sup>14</sup> 5d <sup>2</sup> 6s <sup>2</sup> 6.8251	<b>73</b> <sup>4</sup> F <sub>3/2</sub> <b>Ta</b> Tantalum 180.95 [Xe]4f <sup>14</sup> 5d <sup>3</sup> 6s <sup>2</sup> 7.5496	<b>74</b> <sup>5</sup> D <sub>0</sub> <b>W</b> Tungsten 183.84 [Xe]4f <sup>14</sup> 5d <sup>4</sup> 6s <sup>2</sup> 7.8640	<b>75</b> <sup>6</sup> S <sub>5/2</sub> <b>Re</b> Rhenium 186.21 [Xe]4f <sup>14</sup> 5d <sup>5</sup> 6s <sup>2</sup> 7.8335	<b>76</b> <sup>5</sup> D <sub>4</sub> <b>Os</b> Osmium 190.23 [Xe]4f <sup>14</sup> 5d <sup>6</sup> 6s <sup>2</sup> 8.4382	<b>77</b> <sup>4</sup> F <sub>9/2</sub> <b>Ir</b> Iridium 192.22 [Xe]4f <sup>14</sup> 5d <sup>7</sup> 6s <sup>2</sup> 8.9670	<b>78</b> <sup>3</sup> D <sub>3</sub> <b>Pt</b> Platinum 195.08 [Xe]4f <sup>14</sup> 5d <sup>9</sup> 6s 8.9588	<b>79</b> <sup>2</sup> S <sub>1/2</sub> <b>Au</b> Gold 196.97 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s 9.2256	<b>80</b> <sup>1</sup> S <sub>0</sub> <b>Hg</b> Mercury 200.59 [Xe]4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 10.4375	<b>81</b> <sup>2</sup> P <sub>1/2</sub> <b>Tl</b> Thallium 204.38 [Hg]6p 6.1083	<b>82</b> <sup>3</sup> P <sub>0</sub> <b>Pb</b> Lead 207.2 [Hg]6p <sup>2</sup> 7.4167	<b>83</b> <sup>4</sup> S <sub>3/2</sub> <b>Bi</b> Bismuth 208.98 [Hg]6p <sup>3</sup> 7.2855	<b>84</b> <sup>3</sup> P <sub>2</sub> <b>Po</b> Polonium (209) [Hg]6p <sup>4</sup> 8.414	<b>85</b> <sup>2</sup> P <sub>3/2</sub> <b>At</b> Astatine (210) [Hg]6p <sup>5</sup> 9.3175	<b>86</b> <sup>1</sup> S <sub>0</sub> <b>Rn</b> Radon (222) [Hg]6p <sup>6</sup> 10.7485
7	<b>87</b> <sup>2</sup> S <sub>1/2</sub> <b>Fr</b> Francium (223) [Rn]7s 4.0727	<b>88</b> <sup>1</sup> S <sub>0</sub> <b>Ra</b> Radium (226) [Rn]7s <sup>2</sup> 5.2784		<b>104</b> <sup>3</sup> F <sub>2</sub> <b>Rf</b> Rutherfordium (261) [Rn]5f <sup>14</sup> 6d <sup>2</sup> 7s <sup>2</sup> 6.02	<b>105</b> <sup>4</sup> F <sub>3/2</sub> <b>Db</b> Dubnium (268) [Rn]5f <sup>14</sup> 6d <sup>3</sup> 7s <sup>2</sup> 6.8	<b>106</b> <sup>5</sup> D <sub>0</sub> <b>Sg</b> Seaborgium (269) [Rn]5f <sup>14</sup> 6d <sup>4</sup> 7s <sup>2</sup> 7.8	<b>107</b> <sup>5</sup> S <sub>2</sub> <b>Bh</b> Bohrium (270) [Rn]5f <sup>14</sup> 6d <sup>5</sup> 7s <sup>2</sup> 7.7	<b>108</b> <sup>4</sup> D <sub>4</sub> <b>Hs</b> Hassium (277) [Rn]5f <sup>14</sup> 6d <sup>6</sup> 7s <sup>2</sup> 7.6	<b>109</b> <sup>3</sup> F <sub>9/2</sub> <b>Mt</b> Meitnerium (278) [Rn]5f <sup>14</sup> 6d <sup>7</sup> 7s <sup>2</sup> 7.6	<b>110</b> <sup>3</sup> D <sub>3</sub> <b>Ds</b> Darmstadtium (281) [Rn]5f <sup>14</sup> 6d <sup>8</sup> 7s <sup>2</sup> 7.6	<b>111</b> <sup>2</sup> S <sub>1/2</sub> <b>Rg</b> Roentgenium (282) [Rn]5f <sup>14</sup> 6d <sup>9</sup> 7s <sup>2</sup> 7.6	<b>112</b> <sup>1</sup> S <sub>0</sub> <b>Cn</b> Copernicium (285) [Rn]5f <sup>14</sup> 6d <sup>10</sup> 7s <sup>2</sup> 7.6	<b>113</b> <sup>2</sup> P <sub>1/2</sub> <b>Nh</b> Nihonium (286) [Rn]5f <sup>14</sup> 6d <sup>10</sup> 7s <sup>2</sup> 7.6	<b>114</b> <sup>3</sup> P <sub>0</sub> <b>Fl</b> Flerovium (289) [Rn]5f <sup>14</sup> 6d <sup>10</sup> 7s <sup>2</sup> 7.6	<b>115</b> <sup>4</sup> S <sub>3/2</sub> <b>Mc</b> Moscovium (289) [Rn]5f <sup>14</sup> 6d <sup>10</sup> 7s <sup>2</sup> 7.6	<b>116</b> <sup>3</sup> P <sub>2</sub> <b>Lv</b> Livermorium (293) [Rn]5f <sup>14</sup> 6d <sup>10</sup> 7s <sup>2</sup> 7.6	<b>117</b> <sup>2</sup> P <sub>3/2</sub> <b>Ts</b> Tennesine (294) [Rn]5f <sup>14</sup> 6d <sup>10</sup> 7s <sup>2</sup> 7.6	<b>118</b> <sup>1</sup> S <sub>0</sub> <b>Og</b> Oganesson (294) [Rn]5f <sup>14</sup> 6d <sup>10</sup> 7s <sup>2</sup> 7.6
			<b>Lanthanides</b>	<b>57</b> <sup>2</sup> D <sub>3/2</sub> <b>La</b> Lanthanum 138.91 [Xe]5d <sup>1</sup> 6s <sup>2</sup> 5.5769	<b>58</b> <sup>1</sup> G <sub>4</sub> <b>Ce</b> Cerium 140.12 [Xe]4f <sup>1</sup> 5d <sup>1</sup> 6s <sup>2</sup> 5.5386	<b>59</b> <sup>4</sup> I <sub>9/2</sub> <b>Pr</b> Praseodymium 140.91 [Xe]4f <sup>3</sup> 6s <sup>2</sup> 5.4702	<b>60</b> <sup>5</sup> I <sub>4</sub> <b>Nd</b> Neodymium 144.24 [Xe]4f <sup>4</sup> 6s <sup>2</sup> 5.5250	<b>61</b> <sup>6</sup> H <sub>5/2</sub> <b>Pm</b> Promethium (145) [Xe]4f <sup>5</sup> 6s <sup>2</sup> 5.577	<b>62</b> <sup>7</sup> F <sub>0</sub> <b>Sm</b> Samarium 150.36 [Xe]4f <sup>6</sup> 6s <sup>2</sup> 5.6437	<b>63</b> <sup>8</sup> S <sub>7/2</sub> <b>Eu</b> Europium 151.96 [Xe]4f <sup>7</sup> 6s <sup>2</sup> 5.6704	<b>64</b> <sup>9</sup> D <sub>2</sub> <b>Gd</b> Gadolinium 157.25 [Xe]4f <sup>7</sup> 5d <sup>1</sup> 6s <sup>2</sup> 6.1498	<b>65</b> <sup>6</sup> H <sub>15/2</sub> <b>Tb</b> Terbium 158.93 [Xe]4f <sup>9</sup> 6s <sup>2</sup> 5.8638	<b>66</b> <sup>5</sup> I <sub>8</sub> <b>Dy</b> Dysprosium 162.50 [Xe]4f <sup>10</sup> 6s <sup>2</sup> 5.9391	<b>67</b> <sup>4</sup> I <sub>15/2</sub> <b>Ho</b> Holmium 164.93 [Xe]4f <sup>11</sup> 6s <sup>2</sup> 6.0215	<b>68</b> <sup>3</sup> H <sub>6</sub> <b>Er</b> Erbium 167.26 [Xe]4f <sup>12</sup> 6s <sup>2</sup> 6.1077	<b>69</b> <sup>2</sup> F <sub>7/2</sub> <b>Tm</b> Thulium 168.93 [Xe]4f <sup>13</sup> 6s <sup>2</sup> 6.1843	<b>70</b> <sup>1</sup> S <sub>0</sub> <b>Yb</b> Ytterbium 173.05 [Xe]4f <sup>14</sup> 6s <sup>2</sup> 6.2542	<b>71</b> <sup>2</sup> D <sub>3/2</sub> <b>Lu</b> Lutetium 174.97 [Xe]4f <sup>14</sup> 5d <sup>1</sup> 6s <sup>2</sup> 5.4259
			<b>Actinides</b>	<b>89</b> <sup>2</sup> D <sub>3/2</sub> <b>Ac</b> Actinium (227) [Rn]6d <sup>1</sup> 7s <sup>2</sup> 5.3802	<b>90</b> <sup>3</sup> F <sub>2</sub> <b>Th</b> Thorium 232.04 [Rn]6d <sup>2</sup> 7s <sup>2</sup> 6.3067	<b>91</b> <sup>4</sup> K <sub>11/2</sub> <b>Pa</b> Protactinium 231.04 [Rn]5f <sup>2</sup> 6d <sup>1</sup> 7s <sup>2</sup> 5.89	<b>92</b> <sup>5</sup> L <sub>6</sub> <b>U</b> Uranium 238.03 [Rn]5f <sup>3</sup> 6d <sup>1</sup> 7s <sup>2</sup> 6.1941	<b>93</b> <sup>6</sup> L <sub>11/2</sub> <b>Np</b> Neptunium (237) [Rn]5f <sup>4</sup> 6d <sup>1</sup> 7s <sup>2</sup> 6.2655	<b>94</b> <sup>7</sup> F <sub>0</sub> <b>Pu</b> Plutonium (244) [Rn]5f <sup>6</sup> 7s <sup>2</sup> 6.0258	<b>95</b> <sup>8</sup> S <sub>7/2</sub> <b>Am</b> Americium (243) [Rn]5f <sup>7</sup> 7s <sup>2</sup> 5.9738	<b>96</b> <sup>9</sup> D <sub>2</sub> <b>Cm</b> Curium (247) [Rn]5f <sup>8</sup> 7s <sup>2</sup> 5.9914	<b>97</b> <sup>6</sup> H <sub>15/2</sub> <b>Bk</b> Berkelium (247) [Rn]5f <sup>9</sup> 7s <sup>2</sup> 6.1978	<b>98</b> <sup>5</sup> I <sub>8</sub> <b>Cf</b> Californium (251) [Rn]5f <sup>10</sup> 7s <sup>2</sup> 6.2817	<b>99</b> <sup>4</sup> I <sub>15/2</sub> <b>Es</b> Einsteinium (252) [Rn]5f <sup>11</sup> 7s <sup>2</sup> 6.3676	<b>100</b> <sup>3</sup> H <sub>6</sub> <b>Fm</b> Fermium (257) [Rn]5f <sup>12</sup> 7s <sup>2</sup> 6.50	<b>101</b> <sup>2</sup> F <sub>7/2</sub> <b>Md</b> Mendelevium (268) [Rn]5f <sup>13</sup> 7s <sup>2</sup> 6.58	<b>102</b> <sup>1</sup> S <sub>0</sub> <b>No</b> Nobelium (259) [Rn]5f <sup>14</sup> 7s <sup>2</sup> 6.66	<b>103</b> <sup>2</sup> P <sub>1/2</sub> <b>Lr</b> Lawrencium (260) [Rn]5f <sup>14</sup> 7s <sup>2</sup> 7p 4.96

Atomic Number

Ground State

Symbol

Name

Standard Atomic Weight<sup>(u)</sup>

Ground-state Configuration

Ionization Energy (eV)

**58** <sup>1</sup>G<sub>4</sub>  
**Ce**  
Cerium  
140.12  
[Xe]4f<sup>1</sup>5d<sup>1</sup>6s<sup>2</sup>  
5.5386

<sup>†</sup>Based upon <sup>12</sup>C. () indicates the mass number of the longest-lived isotope.