

# Periodic Table of the Elements

1A <b>1</b>																8A <b>18</b>				
<b>1</b> <b>H</b> 1.008											3A <b>13</b>		4A <b>14</b>	5A <b>15</b>	6A <b>16</b>	7A <b>17</b>	<b>2</b> <b>He</b> 4.003			
<b>3</b> <b>Li</b> 6.941	<b>4</b> <b>Be</b> 9.012											<b>5</b> <b>B</b> 10.81	<b>6</b> <b>C</b> 12.01	<b>7</b> <b>N</b> 14.01	<b>8</b> <b>O</b> 16.00	<b>9</b> <b>F</b> 19.00	<b>10</b> <b>Ne</b> 20.18			
<b>11</b> <b>Na</b> 22.99	<b>12</b> <b>Mg</b> 24.31	3B <b>3</b>	4B <b>4</b>	5B <b>5</b>	6B <b>6</b>	7B <b>7</b>	8B <b>8</b>	8B <b>9</b>	8B <b>10</b>	1B <b>11</b>	2B <b>12</b>	<b>13</b> <b>Al</b> 26.98	<b>14</b> <b>Si</b> 28.09	<b>15</b> <b>P</b> 30.97	<b>16</b> <b>S</b> 32.07	<b>17</b> <b>Cl</b> 35.45	<b>18</b> <b>Ar</b> 39.95			
<b>19</b> <b>K</b> 39.10	<b>20</b> <b>Ca</b> 40.08	<b>21</b> <b>Sc</b> 44.96	<b>22</b> <b>Ti</b> 47.87	<b>23</b> <b>V</b> 50.94	<b>24</b> <b>Cr</b> 52.00	<b>25</b> <b>Mn</b> 54.94	<b>26</b> <b>Fe</b> 55.85	<b>27</b> <b>Co</b> 58.93	<b>28</b> <b>Ni</b> 58.69	<b>29</b> <b>Cu</b> 63.55	<b>30</b> <b>Zn</b> 65.41	<b>31</b> <b>Ga</b> 69.72	<b>32</b> <b>Ge</b> 72.64	<b>33</b> <b>As</b> 74.92	<b>34</b> <b>Se</b> 78.96	<b>35</b> <b>Br</b> 79.90	<b>36</b> <b>Kr</b> 83.80			
<b>37</b> <b>Rb</b> 85.47	<b>38</b> <b>Sr</b> 87.62	<b>39</b> <b>Y</b> 88.91	<b>40</b> <b>Zr</b> 91.22	<b>41</b> <b>Nb</b> 92.91	<b>42</b> <b>Mo</b> 95.94	<b>43</b> <b>Tc</b> (98)	<b>44</b> <b>Ru</b> 101.07	<b>45</b> <b>Rh</b> 102.91	<b>46</b> <b>Pd</b> 106.42	<b>47</b> <b>Ag</b> 107.87	<b>48</b> <b>Cd</b> 112.41	<b>49</b> <b>In</b> 114.82	<b>50</b> <b>Sn</b> 118.71	<b>51</b> <b>Sb</b> 121.76	<b>52</b> <b>Te</b> 127.60	<b>53</b> <b>I</b> 126.90	<b>54</b> <b>Xe</b> 131.29			
<b>55</b> <b>Cs</b> 132.91	<b>56</b> <b>Ba</b> 137.33	<b>57</b> <b>La</b> 138.91	<b>72</b> <b>Hf</b> 178.49	<b>73</b> <b>Ta</b> 180.95	<b>74</b> <b>W</b> 183.84	<b>75</b> <b>Re</b> 186.21	<b>76</b> <b>Os</b> 190.23	<b>77</b> <b>Ir</b> 192.22	<b>78</b> <b>Pt</b> 195.08	<b>79</b> <b>Au</b> 196.97	<b>80</b> <b>Hg</b> 200.59	<b>81</b> <b>Tl</b> 204.38	<b>82</b> <b>Pb</b> 207.20	<b>83</b> <b>Bi</b> 208.98	<b>84</b> <b>Po</b> (209)	<b>85</b> <b>At</b> (210)	<b>86</b> <b>Rn</b> (222)			
<b>87</b> <b>Fr</b> (223)	<b>88</b> <b>Ra</b> (226)	<b>89</b> <b>Ac</b> (227)	<b>104</b> <b>Rf</b> (261)	<b>105</b> <b>Db</b> (262)	<b>106</b> <b>Sg</b> (266)	<b>107</b> <b>Bh</b> (264)	<b>108</b> <b>Hs</b> (277)	<b>109</b> <b>Mt</b> (268)	<b>110</b> <b>Ds</b> (281)	<b>111</b> <b>Rg</b> (272)	<b>112</b> <b>Cn</b> (285)									

<b>58</b> <b>Ce</b> 140.12	<b>59</b> <b>Pr</b> 140.91	<b>60</b> <b>Nd</b> 144.24	<b>61</b> <b>Pm</b> (145)	<b>62</b> <b>Sm</b> 150.36	<b>63</b> <b>Eu</b> 151.96	<b>64</b> <b>Gd</b> 157.25	<b>65</b> <b>Tb</b> 158.93	<b>66</b> <b>Dy</b> 162.50	<b>67</b> <b>Ho</b> 164.93	<b>68</b> <b>Er</b> 167.26	<b>69</b> <b>Tm</b> 168.93	<b>70</b> <b>Yb</b> 173.04	<b>71</b> <b>Lu</b> 174.97
<b>90</b> <b>Th</b> 232.04	<b>91</b> <b>Pa</b> 231.04	<b>92</b> <b>U</b> 238.03	<b>93</b> <b>Np</b> (237)	<b>94</b> <b>Pu</b> (244)	<b>95</b> <b>Am</b> (243)	<b>96</b> <b>Cm</b> (247)	<b>97</b> <b>Bk</b> (247)	<b>98</b> <b>Cf</b> (251)	<b>99</b> <b>Es</b> (252)	<b>100</b> <b>Fm</b> (257)	<b>101</b> <b>Md</b> (258)	<b>102</b> <b>No</b> (259)	<b>103</b> <b>Lr</b> (262)

## Some Standard Properties of Water

property	symbol	value
density of water	$\rho_{\text{water}}$	1.000 g cm <sup>-3</sup>
density of ice	$\rho_{\text{ice}}$	0.9167 g cm <sup>-3</sup>
specific heats		
ice	$C_{\text{ice}}$	2.09 J g <sup>-1</sup> K <sup>-1</sup>
water	$C_{\text{water}}$	4.184 J g <sup>-1</sup> K <sup>-1</sup>
steam	$C_{\text{steam}}$	2.03 J g <sup>-1</sup> K <sup>-1</sup>
heat of fusion	$\Delta H_{\text{fus}}$ or $L_f$	334 J g <sup>-1</sup>
heat of vaporization	$\Delta H_{\text{vap}}$ or $L_v$	2260 J g <sup>-1</sup>
index of refraction	$n$	1.33
autoionization	$K_w$	$1.0 \times 10^{-14}$

Pressure	
1 atm	= 760 torr
	= 101325 Pa
	= 14.7 psi
1 bar	= 10 <sup>5</sup> Pa
	= 100 kPa

Energy	
1 cal	= 4.184 J
1 L atm	= 101.325 J
1 Cal	= 1 kcal
1 hp	= 746 W
1 eV	= 1.602 × 10 <sup>-19</sup> J

## Various Physical Constants

property	symbol	value
universal gas constant	$R$	8.314 J mol <sup>-1</sup> K <sup>-1</sup>
		62.36 L torr mol <sup>-1</sup> K <sup>-1</sup>
		0.08206 L atm mol <sup>-1</sup> K <sup>-1</sup>
		1.987 cal mol <sup>-1</sup> K <sup>-1</sup>
Planck's constant	$h$	6.626 × 10 <sup>-34</sup> J s
		4.136 × 10 <sup>-15</sup> eV s
Planck's reduced constant	$h/2\pi$	1.054 × 10 <sup>-34</sup> J s
		6.582 × 10 <sup>-16</sup> eV s
Boltzmann constant	$k_B$	1.38 × 10 <sup>-23</sup> J K <sup>-1</sup>
Stefan-Boltzmann	$\sigma$	5.67 × 10 <sup>-8</sup> W m <sup>-2</sup> K <sup>-4</sup>
speed of light	$c$	3.00 × 10 <sup>8</sup> m s <sup>-1</sup>
speed of sound (at 20°C)	$v_{\text{air}}$	343 m s <sup>-1</sup>
acceleration of gravity	$g$	9.80 m s <sup>-2</sup>
gravitational constant	$G$	6.67 × 10 <sup>-11</sup> N m <sup>2</sup> kg <sup>-2</sup>
Avogadro's number	$N_A$	6.022 × 10 <sup>23</sup> mol <sup>-1</sup>
elementary charge	$e$	1.602 × 10 <sup>-19</sup> C
Faraday	$F$	96485 C mol <sup>-1</sup>
Coulomb's law constant	$k$	8.988 × 10 <sup>9</sup> N m <sup>2</sup> C <sup>-2</sup>
Rydberg constant	$R$	2.178 × 10 <sup>-18</sup> J

### Some Other Conversion Factors

1 in	=	2.54 cm
1 lb	=	453.6 g
1 mi	=	5280 ft = 1.609 km
1 gal	=	4 quarts = 231 in <sup>3</sup> = 3.785 L

property	symbol	value
electron rest mass	$m_e$	9.11 × 10 <sup>-31</sup> kg
		0.000549 u
		0.511 MeV c <sup>-2</sup>
proton mass	$m_p$	1.6726 × 10 <sup>-27</sup> kg
		1.00728 u
		938.3 MeV c <sup>-2</sup>
neutron mass	$m_n$	1.6749 × 10 <sup>-27</sup> kg
		1.008665 u
		939.6 MeV c <sup>-2</sup>
atomic mass unit	$u$	1.6605 × 10 <sup>-27</sup> kg
		931.5 MeV c <sup>-2</sup>
earth mass		5.972 × 10 <sup>24</sup> kg
earth radius		6.371 × 10 <sup>6</sup> m
moon mass		7.348 × 10 <sup>22</sup> kg
sun mass		1.989 × 10 <sup>30</sup> kg
distance earth-moon		3.844 × 10 <sup>8</sup> m
distance earth-sun		1.496 × 10 <sup>11</sup> m
permittivity of free space	$\epsilon_0$	8.85 × 10 <sup>-12</sup> F m <sup>-1</sup>
permeability of free space	$\mu_0$	4π × 10 <sup>-7</sup> T m A <sup>-1</sup>

### Some Average Bond Energies (kJ/mol)

C-H	413	C-C	346	C-Cl	339	C-N	305
O-H	463	C=C	602	C-Br	285	N=N	418
N-H	391	C≡C	835	O=O	498	H-H	436
C-O	358	C=O	799	C≡O	1072	Br-Br	193
H-Cl	432	S-H	347	N≡N	945	Cl-Cl	242
H-Br	366	H-I	299	C≡N	887	I-I	151