

## GCE Chemistry Data Sheet

**Table 1**

Infrared absorption data

| Bond           | Wavenumber /cm <sup>-1</sup> |
|----------------|------------------------------|
| N-H (amines)   | 3300 – 3500                  |
| O-H (alcohols) | 3230 – 3550                  |
| C-H            | 2850 – 3300                  |
| O-H (acids)    | 2500 – 3000                  |
| C≡N            | 2220 – 2260                  |
| C=O            | 1680 – 1750                  |
| C=C            | 1620 – 1680                  |
| C-O            | 1000 – 1300                  |
| C-C            | 750 – 1100                   |


**Table 2**

<sup>1</sup>H n.m.r. chemical shift data

| Type of proton                                                                                                    | δ/ppm       |
|-------------------------------------------------------------------------------------------------------------------|-------------|
| ROH                                                                                                               | 0.5 – 5.0   |
| RCH <sub>3</sub>                                                                                                  | 0.7 – 1.2   |
| RNH <sub>2</sub>                                                                                                  | 1.0 – 4.5   |
| R <sub>2</sub> CH <sub>2</sub>                                                                                    | 1.2 – 1.4   |
| R <sub>3</sub> CH                                                                                                 | 1.4 – 1.6   |
| $\begin{array}{c}   \\ \text{R}-\text{C}-\text{C}- \\    \quad   \\ \text{O} \quad \text{H} \end{array}$          | 2.1 – 2.6   |
| $\begin{array}{c}   \\ \text{R}-\text{O}-\text{C}- \\   \\ \text{H} \end{array}$                                  | 3.1 – 3.9   |
| RCH <sub>2</sub> Cl or Br                                                                                         | 3.1 – 4.2   |
| $\begin{array}{c}   \\ \text{R}-\text{C}-\text{O}-\text{C}- \\    \quad   \\ \text{O} \quad \text{H} \end{array}$ | 3.7 – 4.1   |
| $\begin{array}{c} \text{H} \\   \\ \text{R}-\text{C}=\text{C}- \\   \end{array}$                                  | 4.5 – 6.0   |
| $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}-\text{H} \end{array}$                                       | 9.0 – 10.0  |
| $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}-\text{O}-\text{H} \end{array}$                              | 10.0 – 12.0 |

**Table 3**

<sup>13</sup>C n.m.r. chemical shift data

| Type of carbon                                                                            | δ/ppm                                 |
|-------------------------------------------------------------------------------------------|---------------------------------------|
| $\begin{array}{c}   \\ -\text{C}- \\   \end{array}$                                       | 5 – 40                                |
| $\begin{array}{c}   \\ \text{R}-\text{C}-\text{Cl or Br} \\   \end{array}$                | 10 – 70                               |
| $\begin{array}{c}   \\ \text{R}-\text{C}-\text{C}- \\    \quad   \\ \text{O} \end{array}$ | 20 – 50                               |
| $\begin{array}{c}   \\ \text{R}-\text{C}-\text{N}- \\   \end{array}$                      | 25 – 60                               |
| $\begin{array}{c}   \\ -\text{C}-\text{O}- \\   \end{array}$                              | alcohols, ethers or esters<br>50 – 90 |
| $\begin{array}{c} \diagup \\ \text{C}=\text{C} \\ \diagdown \end{array}$                  | 90 – 150                              |
| R-C≡N                                                                                     | 110 – 125                             |
|        | 110 – 160                             |
| $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}- \end{array}$                       | esters or acids<br>160 – 185          |
| $\begin{array}{c} \text{O} \\    \\ \text{R}-\text{C}- \end{array}$                       | aldehydes or ketones<br>190 – 220     |



# The Periodic Table of the Elements

| 1                                                                                                                                                                                                                                                                                                                                                                                                       | 2                                      | 3                                                                                   | 4                                    | 5                                      | 6                                       | 7                                    | 0                                       |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------|----------------------------------------|-----------------------------------------|--------------------------------------|-----------------------------------------|--|
| 6.9<br><b>Li</b><br>lithium<br>3                                                                                                                                                                                                                                                                                                                                                                        | 9.0<br><b>Be</b><br>beryllium<br>4     | 10.8<br><b>B</b><br>boron<br>5                                                      | 12.0<br><b>C</b><br>carbon<br>6      | 14.0<br><b>N</b><br>nitrogen<br>7      | 16.0<br><b>O</b><br>oxygen<br>8         | 19.0<br><b>F</b><br>fluorine<br>9    | 20.2<br><b>Ne</b><br>neon<br>10         |  |
| 23.0<br><b>Na</b><br>sodium<br>11                                                                                                                                                                                                                                                                                                                                                                       | 24.3<br><b>Mg</b><br>magnesium<br>12   | 27.0<br><b>Al</b><br>aluminium<br>13                                                | 28.1<br><b>Si</b><br>silicon<br>14   | 31.0<br><b>P</b><br>phosphorus<br>15   | 32.1<br><b>S</b><br>sulfur<br>16        | 35.5<br><b>Cl</b><br>chlorine<br>17  | 39.9<br><b>Ar</b><br>argon<br>18        |  |
| 39.1<br><b>K</b><br>potassium<br>19                                                                                                                                                                                                                                                                                                                                                                     | 40.1<br><b>Ca</b><br>calcium<br>20     | 69.7<br><b>Ga</b><br>gallium<br>31                                                  | 72.6<br><b>Ge</b><br>germanium<br>32 | 74.9<br><b>As</b><br>arsenic<br>33     | 79.0<br><b>Se</b><br>selenium<br>34     | 79.9<br><b>Br</b><br>bromine<br>35   | 83.8<br><b>Kr</b><br>krypton<br>36      |  |
| 85.5<br><b>Rb</b><br>rubidium<br>37                                                                                                                                                                                                                                                                                                                                                                     | 87.6<br><b>Sr</b><br>strontium<br>38   | 114.8<br><b>In</b><br>indium<br>49                                                  | 118.7<br><b>Sn</b><br>tin<br>50      | 121.8<br><b>Sb</b><br>antimony<br>51   | 127.6<br><b>Te</b><br>tellurium<br>52   | 126.9<br><b>I</b><br>iodine<br>53    | 131.3<br><b>Xe</b><br>xenon<br>54       |  |
| 132.9<br><b>Cs</b><br>caesium<br>55                                                                                                                                                                                                                                                                                                                                                                     | 137.3<br><b>Ba</b><br>barium<br>56     | 204.4<br><b>Tl</b><br>thallium<br>81                                                | 207.2<br><b>Pb</b><br>lead<br>82     | 209.0<br><b>Bi</b><br>bismuth<br>83    | [209]<br><b>Po</b><br>polonium<br>84    | [210]<br><b>At</b><br>astatine<br>85 | [222]<br><b>Rn</b><br>radon<br>86       |  |
| [223]<br><b>Fr</b><br>francium<br>87                                                                                                                                                                                                                                                                                                                                                                    | [226]<br><b>Ra</b><br>radium<br>88     | Elements with atomic numbers 112-116 have been reported but not fully authenticated |                                      |                                        |                                         |                                      | [222]<br><b>Rn</b><br>radon<br>86       |  |
| <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="border: 1px solid black; padding: 5px;">                     1.0<br/><b>H</b><br/>hydrogen<br/>1                 </div> <div style="border: 1px solid black; padding: 5px;">                     relative atomic mass<br/><b>symbol</b><br/>name<br/>atomic (proton) number                 </div> </div> |                                        |                                                                                     |                                      |                                        |                                         |                                      |                                         |  |
| (1)                                                                                                                                                                                                                                                                                                                                                                                                     | (2)                                    | (3)                                                                                 | (4)                                  | (5)                                    | (6)                                     | (7)                                  | (8)                                     |  |
| (13)                                                                                                                                                                                                                                                                                                                                                                                                    | (14)                                   | (15)                                                                                | (16)                                 | (17)                                   | (18)                                    |                                      |                                         |  |
| 162.5<br><b>Dy</b><br>dysprosium<br>66                                                                                                                                                                                                                                                                                                                                                                  | 164.9<br><b>Ho</b><br>holmium<br>67    | 167.3<br><b>Er</b><br>erbium<br>68                                                  | 168.9<br><b>Tm</b><br>thulium<br>69  | 173.1<br><b>Yb</b><br>ytterbium<br>70  | 175.0<br><b>Lu</b><br>lutetium<br>71    |                                      |                                         |  |
| 158.9<br><b>Tb</b><br>terbium<br>65                                                                                                                                                                                                                                                                                                                                                                     | 157.3<br><b>Gd</b><br>gadolinium<br>64 | 152.0<br><b>Eu</b><br>europium<br>63                                                | 150.4<br><b>Sm</b><br>samarium<br>62 | [145]<br><b>Pm</b><br>promethium<br>61 | [251]<br><b>Cf</b><br>californium<br>98 | [257]<br><b>Fm</b><br>fermium<br>100 | [262]<br><b>Lr</b><br>lawrencium<br>103 |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 197.0<br><b>Au</b><br>gold<br>79                                                    | 192.2<br><b>Ir</b><br>iridium<br>77  | 190.2<br><b>Os</b><br>osmium<br>76     | 186.2<br><b>Re</b><br>rhenium<br>75     | 183.8<br><b>W</b><br>tungsten<br>74  | 180.9<br><b>Ta</b><br>tantalum<br>73    |  |
| 157.3<br><b>Gd</b><br>gadolinium<br>64                                                                                                                                                                                                                                                                                                                                                                  | 157.0<br><b>Au</b><br>gold<br>79       | 1                                                                                   |                                      |                                        |                                         |                                      |                                         |  |