

|   |   |
|---|---|
| 0 | 1 |
|---|---|

A chemist was making some aspirin. She calculated that the maximum yield of aspirin that she could make was 800g.

The chemist carried out the experiment but only made 500g of aspirin.

|   |   |   |   |
|---|---|---|---|
| 0 | 1 | . | 1 |
|---|---|---|---|

Calculate the percentage yield of aspirin for this experiment.

[2 marks]

Show clearly how you work out your answer.

.....

.....

.....

.....

Percentage yield of aspirin = ..... %

|   |   |   |   |
|---|---|---|---|
| 0 | 1 | . | 2 |
|---|---|---|---|

Suggest one possible reason why the percentage yield was not 100%.

[1 mark]

.....

.....

|   |   |
|---|---|
| 0 | 2 |
|---|---|

This question is about atom economy.

|   |   |   |   |
|---|---|---|---|
| 0 | 2 | . | 1 |
|---|---|---|---|

Which reaction has an atom economy of 100%?

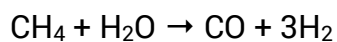
[1 mark]

- $C + H_2O \rightarrow CO_2 + 2H_2$
- $Cu + 2HCl \rightarrow CuCl_2 + H_2$
- $2Cu + O_2 \rightarrow 2CuO$

|   |   |   |   |
|---|---|---|---|
| 0 | 2 | . | 2 |
|---|---|---|---|

Calculate the atom economy for making hydrogen:

[2 marks]



.....

.....

Atom economy = .....%

(Total 6 marks)

**End of Question**  
**See next page for Data Sheet**

|     |                             |     |                              |     |                              |     |                                 |     |                                 |     |                              |     |                               |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                |     |                                   |     |                                |     |                                |     |                                |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |
|-----|-----------------------------|-----|------------------------------|-----|------------------------------|-----|---------------------------------|-----|---------------------------------|-----|------------------------------|-----|-------------------------------|-----|---------------------------------|-----|---------------------------------|-----|---------------------------------|-----|---------------------------------|-----|---------------------------------|-----|---------------------------------|-----|---------------------------------|-----|---------------------------------|-----|--------------------------------|-----|-----------------------------------|-----|--------------------------------|-----|--------------------------------|-----|--------------------------------|-----|-----------------------------------|-----|-----------------------------------|-----|-----------------------------------|-----|-----------------------------------|-----|-----------------------------------|-----|-----------------------------------|-----|-----------------------------------|-----|-----------------------------------|-----|----------------------------------|-----|----------------------------------|-----|----------------------------------|-----|----------------------------------|-----|----------------------------------|-----|----------------------------------|-----|---------------------------------|
| 1   |                             | 2   |                              | 3   |                              | 4   |                                 | 5   |                                 | 6   |                              | 7   |                               | 0   |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                |     |                                   |     |                                |     |                                |     |                                |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |
| 7   | <b>Li</b><br>lithium<br>3   | 9   | <b>Be</b><br>beryllium<br>4  | 11  | <b>Na</b><br>sodium<br>11    | 12  | <b>C</b><br>carbon<br>6         | 13  | <b>Al</b><br>aluminium<br>13    | 14  | <b>N</b><br>nitrogen<br>7    | 15  | <b>P</b><br>phosphorus<br>15  | 16  | <b>O</b><br>oxygen<br>8         | 17  | <b>F</b><br>fluorine<br>9       | 18  | <b>Ne</b><br>neon<br>10         |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                |     |                                   |     |                                |     |                                |     |                                |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |
| 23  | <b>Na</b><br>sodium<br>11   | 24  | <b>Mg</b><br>magnesium<br>12 | 39  | <b>K</b><br>potassium<br>19  | 40  | <b>Ca</b><br>calcium<br>20      | 79  | <b>Br</b><br>bromine<br>35      | 80  | <b>Kr</b><br>krypton<br>36   | 81  | <b>Rb</b><br>rubidium<br>37   | 82  | <b>Sr</b><br>strontium<br>38    | 83  | <b>Y</b><br>yttrium<br>39       | 84  | <b>Zr</b><br>zirconium<br>40    | 85  | <b>Nb</b><br>niobium<br>41      | 86  | <b>Mo</b><br>molybdenum<br>42   | 87  | <b>Tc</b><br>technetium<br>43   | 88  | <b>Ru</b><br>ruthenium<br>44    | 89  | <b>Rh</b><br>rhodium<br>45      | 90  | <b>Pd</b><br>palladium<br>46   | 91  | <b>Ag</b><br>silver<br>47         | 92  | <b>Cd</b><br>cadmium<br>48     | 93  | <b>In</b><br>indium<br>49      | 94  | <b>Sn</b><br>tin<br>50         | 95  | <b>Sb</b><br>antimony<br>51       | 96  | <b>Te</b><br>tellurium<br>52      | 97  | <b>I</b><br>iodine<br>53          | 98  | <b>Xe</b><br>xenon<br>54          |     |                                   |     |                                   |     |                                   |     |                                   |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |
| 103 | <b>Co</b><br>cobalt<br>27   | 104 | <b>Ni</b><br>nickel<br>28    | 105 | <b>Cu</b><br>copper<br>29    | 106 | <b>Zn</b><br>zinc<br>30         | 107 | <b>Ga</b><br>gallium<br>31      | 108 | <b>Ge</b><br>germanium<br>32 | 109 | <b>As</b><br>arsenic<br>33    | 110 | <b>Se</b><br>selenium<br>34     | 111 | <b>Br</b><br>bromine<br>35      | 112 | <b>Kr</b><br>krypton<br>36      | 113 | <b>Rb</b><br>rubidium<br>37     | 114 | <b>Sr</b><br>strontium<br>38    | 115 | <b>Y</b><br>yttrium<br>39       | 116 | <b>Zr</b><br>zirconium<br>40    | 117 | <b>Nb</b><br>niobium<br>41      | 118 | <b>Mo</b><br>molybdenum<br>42  | 119 | <b>Tc</b><br>technetium<br>43     | 120 | <b>Ru</b><br>ruthenium<br>44   | 121 | <b>Rh</b><br>rhodium<br>45     | 122 | <b>Pd</b><br>palladium<br>46   | 123 | <b>Ag</b><br>silver<br>47         | 124 | <b>Cd</b><br>cadmium<br>48        | 125 | <b>In</b><br>indium<br>49         | 126 | <b>Sn</b><br>tin<br>50            | 127 | <b>Sb</b><br>antimony<br>51       | 128 | <b>Te</b><br>tellurium<br>52      | 129 | <b>I</b><br>iodine<br>53          | 130 | <b>Xe</b><br>xenon<br>54          |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |
| 133 | <b>Cs</b><br>caesium<br>55  | 137 | <b>Ba</b><br>barium<br>56    | 138 | <b>La</b><br>lanthanum<br>57 | 139 | <b>Ce</b><br>cerium<br>58       | 140 | <b>Pr</b><br>praseodymium<br>59 | 141 | <b>Nd</b><br>neodymium<br>60 | 142 | <b>Pm</b><br>promethium<br>61 | 143 | <b>Sm</b><br>samarium<br>62     | 144 | <b>Eu</b><br>europium<br>63     | 145 | <b>Gd</b><br>gadolinium<br>64   | 146 | <b>Tb</b><br>terbium<br>65      | 147 | <b>Dy</b><br>dysprosium<br>66   | 148 | <b>Ho</b><br>holmium<br>67      | 149 | <b>Er</b><br>erbium<br>68       | 150 | <b>Tm</b><br>thulium<br>69      | 151 | <b>Yb</b><br>ytterbium<br>70   | 152 | <b>Lu</b><br>lutetium<br>71       | 153 | <b>Hf</b><br>hafnium<br>72     | 154 | <b>Ta</b><br>tantalum<br>73    | 155 | <b>W</b><br>tungsten<br>74     | 156 | <b>Re</b><br>rhenium<br>75        | 157 | <b>Os</b><br>osmium<br>76         | 158 | <b>Ir</b><br>iridium<br>77        | 159 | <b>Pt</b><br>platinum<br>78       | 160 | <b>Au</b><br>gold<br>79           | 161 | <b>Hg</b><br>mercury<br>80        | 162 | <b>Tl</b><br>thallium<br>81       | 163 | <b>Pb</b><br>lead<br>82           | 164 | <b>Bi</b><br>bismuth<br>83       | 165 | <b>Po</b><br>polonium<br>84      | 166 | <b>At</b><br>astatine<br>85      | 167 | <b>Rn</b><br>radon<br>86         |     |                                  |     |                                  |     |                                 |
| 171 | <b>Fr</b><br>francium<br>87 | 173 | <b>Ac</b><br>actinium<br>89  | 174 | <b>Th</b><br>thorium<br>90   | 175 | <b>Pa</b><br>protactinium<br>91 | 176 | <b>U</b><br>uranium<br>92       | 177 | <b>Np</b><br>neptunium<br>93 | 178 | <b>Pu</b><br>plutonium<br>94  | 179 | <b>Am</b><br>americium<br>95    | 180 | <b>Cm</b><br>curium<br>96       | 181 | <b>Bk</b><br>berkelium<br>97    | 182 | <b>Cf</b><br>californium<br>98  | 183 | <b>Es</b><br>einsteinium<br>99  | 184 | <b>Fm</b><br>fermium<br>100     | 185 | <b>Mendelevium</b><br>101       | 186 | <b>Nobelium</b><br>102          | 187 | <b>Lr</b><br>lawrencium<br>103 | 188 | <b>Rf</b><br>rutherfordium<br>104 | 189 | <b>Db</b><br>dubnium<br>105    | 190 | <b>Sg</b><br>seaborgium<br>106 | 191 | <b>Bh</b><br>bohrium<br>107    | 192 | <b>Hs</b><br>hassium<br>108       | 193 | <b>Mt</b><br>meitnerium<br>109    | 194 | <b>Ds</b><br>darmstadtium<br>110  | 195 | <b>Rg</b><br>roentgenium<br>111   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |
| 209 | <b>Bi</b><br>bismuth<br>83  | 210 | <b>Po</b><br>polonium<br>84  | 211 | <b>At</b><br>astatine<br>85  | 212 | <b>Rn</b><br>radon<br>86        | 213 | <b>Fr</b><br>francium<br>87     | 214 | <b>Ac</b><br>actinium<br>89  | 215 | <b>Th</b><br>thorium<br>90    | 216 | <b>Pa</b><br>protactinium<br>91 | 217 | <b>U</b><br>uranium<br>92       | 218 | <b>Np</b><br>neptunium<br>93    | 219 | <b>Pu</b><br>plutonium<br>94    | 220 | <b>Am</b><br>americium<br>95    | 221 | <b>Cm</b><br>curium<br>96       | 222 | <b>Bk</b><br>berkelium<br>97    | 223 | <b>Cf</b><br>californium<br>98  | 224 | <b>Es</b><br>einsteinium<br>99 | 225 | <b>Fm</b><br>fermium<br>100       | 226 | <b>Mendelevium</b><br>101      | 227 | <b>Nobelium</b><br>102         | 228 | <b>Lr</b><br>lawrencium<br>103 | 229 | <b>Rf</b><br>rutherfordium<br>104 | 230 | <b>Db</b><br>dubnium<br>105       | 231 | <b>Sg</b><br>seaborgium<br>106    | 232 | <b>Bh</b><br>bohrium<br>107       | 233 | <b>Hs</b><br>hassium<br>108       | 234 | <b>Mt</b><br>meitnerium<br>109    | 235 | <b>Ds</b><br>darmstadtium<br>110  | 236 | <b>Rg</b><br>roentgenium<br>111   |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |
| 207 | <b>Pb</b><br>lead<br>82     | 208 | <b>Bi</b><br>bismuth<br>83   | 209 | <b>Po</b><br>polonium<br>84  | 210 | <b>At</b><br>astatine<br>85     | 211 | <b>Rn</b><br>radon<br>86        | 212 | <b>Fr</b><br>francium<br>87  | 213 | <b>Ac</b><br>actinium<br>89   | 214 | <b>Th</b><br>thorium<br>90      | 215 | <b>Pa</b><br>protactinium<br>91 | 216 | <b>U</b><br>uranium<br>92       | 217 | <b>Np</b><br>neptunium<br>93    | 218 | <b>Pu</b><br>plutonium<br>94    | 219 | <b>Am</b><br>americium<br>95    | 220 | <b>Cm</b><br>curium<br>96       | 221 | <b>Bk</b><br>berkelium<br>97    | 222 | <b>Cf</b><br>californium<br>98 | 223 | <b>Es</b><br>einsteinium<br>99    | 224 | <b>Fm</b><br>fermium<br>100    | 225 | <b>Mendelevium</b><br>101      | 226 | <b>Nobelium</b><br>102         | 227 | <b>Lr</b><br>lawrencium<br>103    | 228 | <b>Rf</b><br>rutherfordium<br>104 | 229 | <b>Db</b><br>dubnium<br>105       | 230 | <b>Sg</b><br>seaborgium<br>106    | 231 | <b>Bh</b><br>bohrium<br>107       | 232 | <b>Hs</b><br>hassium<br>108       | 233 | <b>Mt</b><br>meitnerium<br>109    | 234 | <b>Ds</b><br>darmstadtium<br>110  | 235 | <b>Rg</b><br>roentgenium<br>111  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |
| 204 | <b>Tl</b><br>thallium<br>81 | 205 | <b>Pb</b><br>lead<br>82      | 206 | <b>Bi</b><br>bismuth<br>83   | 207 | <b>Po</b><br>polonium<br>84     | 208 | <b>At</b><br>astatine<br>85     | 209 | <b>Rn</b><br>radon<br>86     | 210 | <b>Fr</b><br>francium<br>87   | 211 | <b>Ac</b><br>actinium<br>89     | 212 | <b>Th</b><br>thorium<br>90      | 213 | <b>Pa</b><br>protactinium<br>91 | 214 | <b>U</b><br>uranium<br>92       | 215 | <b>Np</b><br>neptunium<br>93    | 216 | <b>Pu</b><br>plutonium<br>94    | 217 | <b>Am</b><br>americium<br>95    | 218 | <b>Cm</b><br>curium<br>96       | 219 | <b>Bk</b><br>berkelium<br>97   | 220 | <b>Cf</b><br>californium<br>98    | 221 | <b>Es</b><br>einsteinium<br>99 | 222 | <b>Fm</b><br>fermium<br>100    | 223 | <b>Mendelevium</b><br>101      | 224 | <b>Nobelium</b><br>102            | 225 | <b>Lr</b><br>lawrencium<br>103    | 226 | <b>Rf</b><br>rutherfordium<br>104 | 227 | <b>Db</b><br>dubnium<br>105       | 228 | <b>Sg</b><br>seaborgium<br>106    | 229 | <b>Bh</b><br>bohrium<br>107       | 230 | <b>Hs</b><br>hassium<br>108       | 231 | <b>Mt</b><br>meitnerium<br>109    | 232 | <b>Ds</b><br>darmstadtium<br>110 | 233 | <b>Rg</b><br>roentgenium<br>111  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |
| 201 | <b>Hg</b><br>mercury<br>80  | 202 | <b>Tl</b><br>thallium<br>81  | 203 | <b>Pb</b><br>lead<br>82      | 204 | <b>Bi</b><br>bismuth<br>83      | 205 | <b>Po</b><br>polonium<br>84     | 206 | <b>At</b><br>astatine<br>85  | 207 | <b>Rn</b><br>radon<br>86      | 208 | <b>Fr</b><br>francium<br>87     | 209 | <b>Ac</b><br>actinium<br>89     | 210 | <b>Th</b><br>thorium<br>90      | 211 | <b>Pa</b><br>protactinium<br>91 | 212 | <b>U</b><br>uranium<br>92       | 213 | <b>Np</b><br>neptunium<br>93    | 214 | <b>Pu</b><br>plutonium<br>94    | 215 | <b>Am</b><br>americium<br>95    | 216 | <b>Cm</b><br>curium<br>96      | 217 | <b>Bk</b><br>berkelium<br>97      | 218 | <b>Cf</b><br>californium<br>98 | 219 | <b>Es</b><br>einsteinium<br>99 | 220 | <b>Fm</b><br>fermium<br>100    | 221 | <b>Mendelevium</b><br>101         | 222 | <b>Nobelium</b><br>102            | 223 | <b>Lr</b><br>lawrencium<br>103    | 224 | <b>Rf</b><br>rutherfordium<br>104 | 225 | <b>Db</b><br>dubnium<br>105       | 226 | <b>Sg</b><br>seaborgium<br>106    | 227 | <b>Bh</b><br>bohrium<br>107       | 228 | <b>Hs</b><br>hassium<br>108       | 229 | <b>Mt</b><br>meitnerium<br>109   | 230 | <b>Ds</b><br>darmstadtium<br>110 | 231 | <b>Rg</b><br>roentgenium<br>111  |     |                                  |     |                                  |     |                                  |     |                                 |
| 197 | <b>Au</b><br>gold<br>79     | 198 | <b>Hg</b><br>mercury<br>80   | 199 | <b>Tl</b><br>thallium<br>81  | 200 | <b>Pb</b><br>lead<br>82         | 201 | <b>Bi</b><br>bismuth<br>83      | 202 | <b>Po</b><br>polonium<br>84  | 203 | <b>At</b><br>astatine<br>85   | 204 | <b>Rn</b><br>radon<br>86        | 205 | <b>Fr</b><br>francium<br>87     | 206 | <b>Ac</b><br>actinium<br>89     | 207 | <b>Th</b><br>thorium<br>90      | 208 | <b>Pa</b><br>protactinium<br>91 | 209 | <b>U</b><br>uranium<br>92       | 210 | <b>Np</b><br>neptunium<br>93    | 211 | <b>Pu</b><br>plutonium<br>94    | 212 | <b>Am</b><br>americium<br>95   | 213 | <b>Cm</b><br>curium<br>96         | 214 | <b>Bk</b><br>berkelium<br>97   | 215 | <b>Cf</b><br>californium<br>98 | 216 | <b>Es</b><br>einsteinium<br>99 | 217 | <b>Fm</b><br>fermium<br>100       | 218 | <b>Mendelevium</b><br>101         | 219 | <b>Nobelium</b><br>102            | 220 | <b>Lr</b><br>lawrencium<br>103    | 221 | <b>Rf</b><br>rutherfordium<br>104 | 222 | <b>Db</b><br>dubnium<br>105       | 223 | <b>Sg</b><br>seaborgium<br>106    | 224 | <b>Bh</b><br>bohrium<br>107       | 225 | <b>Hs</b><br>hassium<br>108      | 226 | <b>Mt</b><br>meitnerium<br>109   | 227 | <b>Ds</b><br>darmstadtium<br>110 | 228 | <b>Rg</b><br>roentgenium<br>111  |     |                                  |     |                                  |     |                                 |
| 195 | <b>Pt</b><br>platinum<br>78 | 196 | <b>Au</b><br>gold<br>79      | 197 | <b>Hg</b><br>mercury<br>80   | 198 | <b>Tl</b><br>thallium<br>81     | 199 | <b>Pb</b><br>lead<br>82         | 200 | <b>Bi</b><br>bismuth<br>83   | 201 | <b>Po</b><br>polonium<br>84   | 202 | <b>At</b><br>astatine<br>85     | 203 | <b>Rn</b><br>radon<br>86        | 204 | <b>Fr</b><br>francium<br>87     | 205 | <b>Ac</b><br>actinium<br>89     | 206 | <b>Th</b><br>thorium<br>90      | 207 | <b>Pa</b><br>protactinium<br>91 | 208 | <b>U</b><br>uranium<br>92       | 209 | <b>Np</b><br>neptunium<br>93    | 210 | <b>Pu</b><br>plutonium<br>94   | 211 | <b>Am</b><br>americium<br>95      | 212 | <b>Cm</b><br>curium<br>96      | 213 | <b>Bk</b><br>berkelium<br>97   | 214 | <b>Cf</b><br>californium<br>98 | 215 | <b>Es</b><br>einsteinium<br>99    | 216 | <b>Fm</b><br>fermium<br>100       | 217 | <b>Mendelevium</b><br>101         | 218 | <b>Nobelium</b><br>102            | 219 | <b>Lr</b><br>lawrencium<br>103    | 220 | <b>Rf</b><br>rutherfordium<br>104 | 221 | <b>Db</b><br>dubnium<br>105       | 222 | <b>Sg</b><br>seaborgium<br>106    | 223 | <b>Bh</b><br>bohrium<br>107      | 224 | <b>Hs</b><br>hassium<br>108      | 225 | <b>Mt</b><br>meitnerium<br>109   | 226 | <b>Ds</b><br>darmstadtium<br>110 | 227 | <b>Rg</b><br>roentgenium<br>111  |     |                                  |     |                                 |
| 192 | <b>Ir</b><br>iridium<br>77  | 193 | <b>Pt</b><br>platinum<br>78  | 194 | <b>Au</b><br>gold<br>79      | 195 | <b>Hg</b><br>mercury<br>80      | 196 | <b>Tl</b><br>thallium<br>81     | 197 | <b>Pb</b><br>lead<br>82      | 198 | <b>Bi</b><br>bismuth<br>83    | 199 | <b>Po</b><br>polonium<br>84     | 200 | <b>At</b><br>astatine<br>85     | 201 | <b>Rn</b><br>radon<br>86        | 202 | <b>Fr</b><br>francium<br>87     | 203 | <b>Ac</b><br>actinium<br>89     | 204 | <b>Th</b><br>thorium<br>90      | 205 | <b>Pa</b><br>protactinium<br>91 | 206 | <b>U</b><br>uranium<br>92       | 207 | <b>Np</b><br>neptunium<br>93   | 208 | <b>Pu</b><br>plutonium<br>94      | 209 | <b>Am</b><br>americium<br>95   | 210 | <b>Cm</b><br>curium<br>96      | 211 | <b>Bk</b><br>berkelium<br>97   | 212 | <b>Cf</b><br>californium<br>98    | 213 | <b>Es</b><br>einsteinium<br>99    | 214 | <b>Fm</b><br>fermium<br>100       | 215 | <b>Mendelevium</b><br>101         | 216 | <b>Nobelium</b><br>102            | 217 | <b>Lr</b><br>lawrencium<br>103    | 218 | <b>Rf</b><br>rutherfordium<br>104 | 219 | <b>Db</b><br>dubnium<br>105       | 220 | <b>Sg</b><br>seaborgium<br>106   | 221 | <b>Bh</b><br>bohrium<br>107      | 222 | <b>Hs</b><br>hassium<br>108      | 223 | <b>Mt</b><br>meitnerium<br>109   | 224 | <b>Ds</b><br>darmstadtium<br>110 | 225 | <b>Rg</b><br>roentgenium<br>111  |     |                                 |
| 190 | <b>Os</b><br>osmium<br>76   | 191 | <b>Pt</b><br>platinum<br>78  | 192 | <b>Au</b><br>gold<br>79      | 193 | <b>Hg</b><br>mercury<br>80      | 194 | <b>Tl</b><br>thallium<br>81     | 195 | <b>Pb</b><br>lead<br>82      | 196 | <b>Bi</b><br>bismuth<br>83    | 197 | <b>Po</b><br>polonium<br>84     | 198 | <b>At</b><br>astatine<br>85     | 199 | <b>Rn</b><br>radon<br>86        | 200 | <b>Fr</b><br>francium<br>87     | 201 | <b>Ac</b><br>actinium<br>89     | 202 | <b>Th</b><br>thorium<br>90      | 203 | <b>Pa</b><br>protactinium<br>91 | 204 | <b>U</b><br>uranium<br>92       | 205 | <b>Np</b><br>neptunium<br>93   | 206 | <b>Pu</b><br>plutonium<br>94      | 207 | <b>Am</b><br>americium<br>95   | 208 | <b>Cm</b><br>curium<br>96      | 209 | <b>Bk</b><br>berkelium<br>97   | 210 | <b>Cf</b><br>californium<br>98    | 211 | <b>Es</b><br>einsteinium<br>99    | 212 | <b>Fm</b><br>fermium<br>100       | 213 | <b>Mendelevium</b><br>101         | 214 | <b>Nobelium</b><br>102            | 215 | <b>Lr</b><br>lawrencium<br>103    | 216 | <b>Rf</b><br>rutherfordium<br>104 | 217 | <b>Db</b><br>dubnium<br>105       | 218 | <b>Sg</b><br>seaborgium<br>106   | 219 | <b>Bh</b><br>bohrium<br>107      | 220 | <b>Hs</b><br>hassium<br>108      | 221 | <b>Mt</b><br>meitnerium<br>109   | 222 | <b>Ds</b><br>darmstadtium<br>110 | 223 | <b>Rg</b><br>roentgenium<br>111  |     |                                 |
| 186 | <b>Re</b><br>rhenium<br>75  | 187 | <b>Os</b><br>osmium<br>76    | 188 | <b>Pt</b><br>platinum<br>78  | 189 | <b>Au</b><br>gold<br>79         | 190 | <b>Hg</b><br>mercury<br>80      | 191 | <b>Tl</b><br>thallium<br>81  | 192 | <b>Pb</b><br>lead<br>82       | 193 | <b>Bi</b><br>bismuth<br>83      | 194 | <b>Po</b><br>polonium<br>84     | 195 | <b>At</b><br>astatine<br>85     | 196 | <b>Rn</b><br>radon<br>86        | 197 | <b>Fr</b><br>francium<br>87     | 198 | <b>Ac</b><br>actinium<br>89     | 199 | <b>Th</b><br>thorium<br>90      | 200 | <b>Pa</b><br>protactinium<br>91 | 201 | <b>U</b><br>uranium<br>92      | 202 | <b>Np</b><br>neptunium<br>93      | 203 | <b>Pu</b><br>plutonium<br>94   | 204 | <b>Am</b><br>americium<br>95   | 205 | <b>Cm</b><br>curium<br>96      | 206 | <b>Bk</b><br>berkelium<br>97      | 207 | <b>Cf</b><br>californium<br>98    | 208 | <b>Es</b><br>einsteinium<br>99    | 209 | <b>Fm</b><br>fermium<br>100       | 210 | <b>Mendelevium</b><br>101         | 211 | <b>Nobelium</b><br>102            | 212 | <b>Lr</b><br>lawrencium<br>103    | 213 | <b>Rf</b><br>rutherfordium<br>104 | 214 | <b>Db</b><br>dubnium<br>105      | 215 | <b>Sg</b><br>seaborgium<br>106   | 216 | <b>Bh</b><br>bohrium<br>107      | 217 | <b>Hs</b><br>hassium<br>108      | 218 | <b>Mt</b><br>meitnerium<br>109   | 219 | <b>Ds</b><br>darmstadtium<br>110 | 220 | <b>Rg</b><br>roentgenium<br>111 |
| 186 | <b>Re</b><br>rhenium<br>75  | 187 | <b>Os</b><br>osmium<br>76    | 188 | <b>Pt</b><br>platinum<br>78  | 189 | <b>Au</b><br>gold<br>79         | 190 | <b>Hg</b><br>mercury            |     |                              |     |                               |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                 |     |                                |     |                                   |     |                                |     |                                |     |                                |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                   |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                  |     |                                 |