



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

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**CHEMISTRY****0620/13**

Paper 1 Multiple Choice

**May/June 2010****45 Minutes**

Additional Materials:      Multiple Choice Answer Sheet  
   Soft clean eraser  
   Soft pencil (type B or HB is recommended)



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**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 16.

You may use a calculator.

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This document consists of **15** printed pages and **1** blank page.

- 1 The diagram shows a cup of tea.



Which row describes the water particles in the air above the cup compared with the water particles in the cup?

|          | moving faster | closer together |
|----------|---------------|-----------------|
| <b>A</b> | ✓             | ✓               |
| <b>B</b> | ✓             | x               |
| <b>C</b> | x             | ✓               |
| <b>D</b> | x             | x               |

- 2 Which row shows the change that takes place when element X gains the new particle shown?

|          | particle gained | change  |
|----------|-----------------|---|
| <b>A</b> | electron        | an isotope of element X is formed                                       |
| <b>B</b> | electron        | the element one place to the right of X in the Periodic Table is formed |
| <b>C</b> | proton          | an isotope of element X is formed                                       |
| <b>D</b> | proton          | the element one place to the right of X in the Periodic Table is formed |

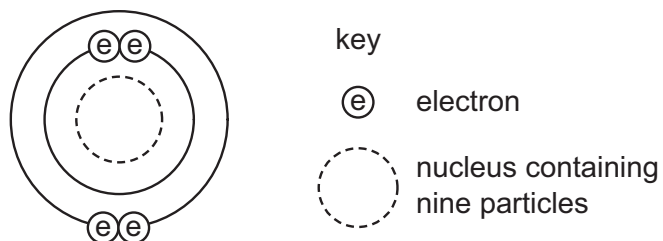
- 3 The symbols of two atoms may be written as shown.



Which statement about these atoms is correct?

- A** They are different elements because they have different numbers of neutrons.
- B** They are different elements because they have different numbers of protons.
- C** They are isotopes of the same element because they have the same nucleon number.
- D** They are isotopes of the same element because they have the same proton number.

- 4 The diagram shows an atom.



What is the proton number and neutron number of the atom?

|          | proton number | neutron number |
|----------|---------------|----------------|
| <b>A</b> | 4             | 5              |
| <b>B</b> | 4             | 9              |
| <b>C</b> | 5             | 4              |
| <b>D</b> | 5             | 9              |

- 5 A fruit drink coloured orange contains a dissolved mixture of red and yellow colouring agents. One of these colouring agents is suspected of being illegal.

Which method could be used to show the presence of this illegal colouring agent?

- A** chromatography
- B** distillation
- C** evaporation
- D** filtration
- 6 A student carries out an experiment to find how fast 3 cm pieces of magnesium ribbon dissolve in 10 cm<sup>3</sup> samples of sulfuric acid at different temperatures.

Which piece of apparatus does the student **not** need?

- A** balance
- B** measuring cylinder
- C** stop-clock
- D** thermometer

7 Three electrolysis cells are set up. Each cell has inert electrodes.

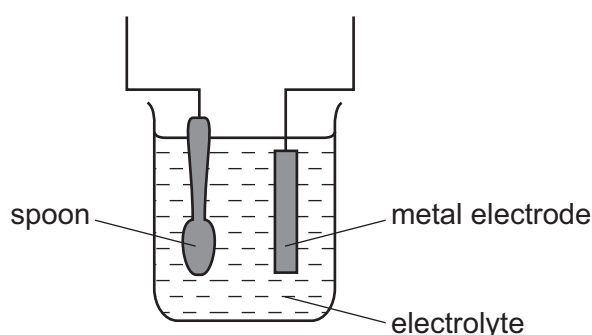
The electrolytes are listed below.

- cell 1     aqueous sodium chloride  
 cell 2     concentrated hydrochloric acid  
 cell 3     molten lead(II) bromide

In which cells is a gas formed at **both** electrodes?

- A** 1 and 2     **B** 1 and 3     **C** 2 only     **D** 3 only

8 The diagram shows apparatus for plating a spoon with silver.



Which statement is **not** correct?

- A** Silver would stick to the spoon because it is a very reactive metal.  
**B** The electrolyte would be a silver salt dissolved in water.  
**C** The metal electrode would be made from silver.  
**D** The spoon would be connected to the negative of the power supply.

9 Aqueous copper(II) sulfate solution is electrolysed using inert electrodes.

Copper(II) ions ( $\text{Cu}^{2+}$ ), hydrogen ions ( $\text{H}^+$ ), hydroxide ions ( $\text{OH}^-$ ) and sulfate ions ( $\text{SO}_4^{2-}$ ) are present in the solution.

To which electrodes are the ions attracted during this electrolysis?

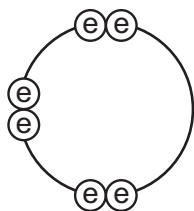
|          | attracted to anode                      | attracted to cathode                    |
|----------|---|---|
| <b>A</b> | $\text{Cu}^{2+}$ and $\text{H}^+$       | $\text{OH}^-$ and $\text{SO}_4^{2-}$    |
| <b>B</b> | $\text{Cu}^{2+}$ and $\text{SO}_4^{2-}$ | $\text{H}^+$ and $\text{OH}^-$          |
| <b>C</b> | $\text{H}^+$ and $\text{OH}^-$          | $\text{Cu}^{2+}$ and $\text{SO}_4^{2-}$ |
| <b>D</b> | $\text{OH}^-$ and $\text{SO}_4^{2-}$    | $\text{Cu}^{2+}$ and $\text{H}^+$       |

10 In which compounds are pairs of electrons shared between atoms?

- 1 sodium chloride
- 2 methane
- 3 lead bromide

**A** 1 only      **B** 2 only      **C** 1 and 3      **D** 1, 2 and 3

11 Element X has six electrons in its outer shell.

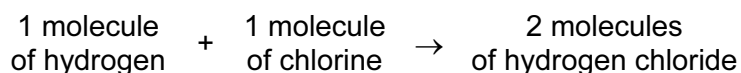


key  
⊕ = electron

How could the element react?

- A** by gaining two electrons to form a positive ion
- B** by losing six electrons to form a negative ion
- C** by sharing two electrons with two electrons from another element to form two covalent bonds
- D** by sharing two electrons with two electrons from another element to form four covalent bonds

12 Hydrogen and chlorine react as shown.



What is the equation for this reaction?

- A**  $2\text{H} + 2\text{Cl} \rightarrow 2\text{HCl}$
- B**  $2\text{H} + 2\text{Cl} \rightarrow \text{H}_2\text{Cl}_2$
- C**  $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$
- D**  $\text{H}_2 + \text{Cl}_2 \rightarrow \text{H}_2\text{Cl}_2$

13 Which name is given to mixtures of metals?

- A** alloys
- B** compounds
- C** ores
- D** salts

- 14 Iron is extracted from iron oxide using carbon monoxide as shown in the equation.

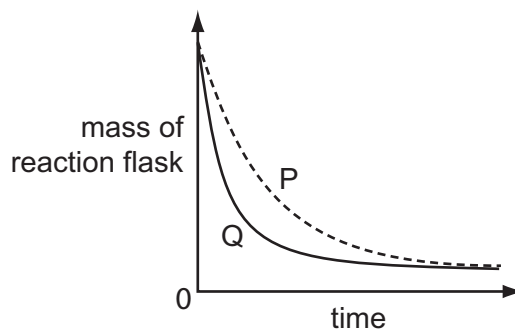


What does the equation show?

- A Carbon monoxide is oxidised to carbon dioxide.
  - B Carbon monoxide is reduced to carbon dioxide.
  - C Iron is oxidised to iron oxide.
  - D Iron oxide is oxidised to iron.
- 15 A student investigates the rate of reaction between marble chips and hydrochloric acid.

The loss in mass of the reaction flask is measured.

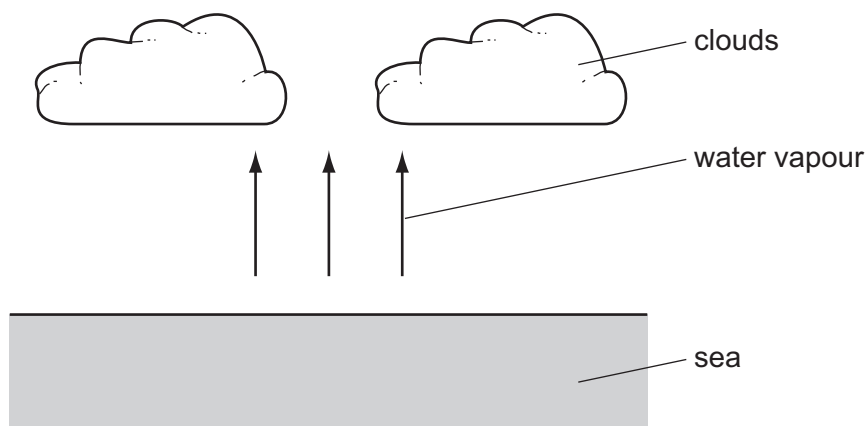
The graph shows the results of two experiments, P and Q.



Which change explains the difference between P and Q?

- A A catalyst is added in P.
- B A higher temperature is used in P.
- C Bigger marble chips are used in Q.
- D Hydrochloric acid is more concentrated in Q.

16 Clouds are formed when water vapour evaporates from the sea.



What is the energy change and what name is given to the type of change when water evaporates?

|          | energy change    | type of change |
|----------|------------------|----------------|
| <b>A</b> | energy given out | endothermic    |
| <b>B</b> | energy given out | exothermic     |
| <b>C</b> | energy taken in  | endothermic    |
| <b>D</b> | energy taken in  | exothermic     |

17 Which process is **not** exothermic?

- A** burning a fossil fuel
- B** obtaining lime from limestone
- C** radioactive decay of  $^{235}\text{U}$
- D** reacting hydrogen with oxygen

18 When pink cobalt(II) sulfate crystals are heated, they form steam and a blue solid.

When water is added to the blue solid, it turns pink and becomes hot.

Which terms describe the pink cobalt(II) sulfate crystals and the reactions?

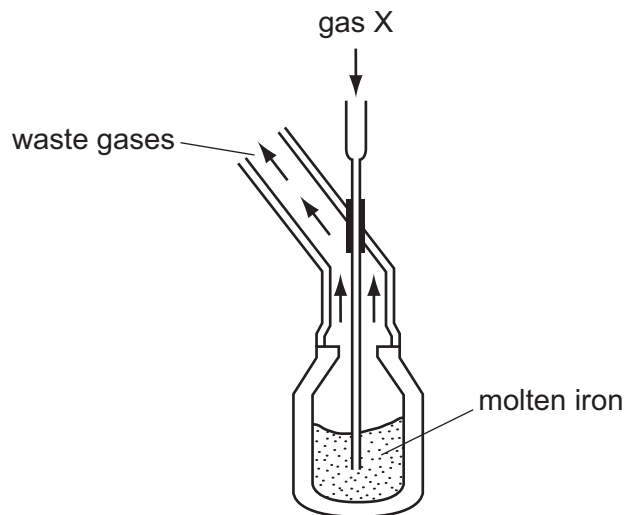
|          | pink cobalt sulfate | reactions    |
|----------|---------------------|--------------|
| <b>A</b> | aqueous             | irreversible |
| <b>B</b> | aqueous             | reversible   |
| <b>C</b> | hydrated            | irreversible |
| <b>D</b> | hydrated            | reversible   |







25 The diagram shows the manufacture of steel.



What is gas X?

- A carbon dioxide
- B chlorine
- C hydrogen
- D oxygen

26 A student added dilute hydrochloric acid to four metals and recorded the results.

Not all of the results are correct.

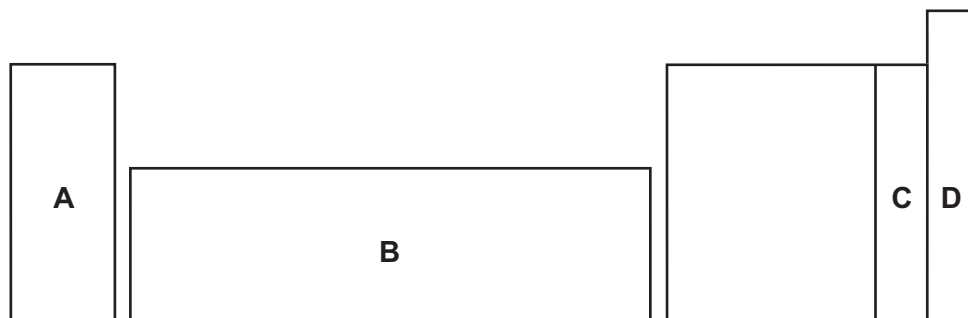
|   | results   |               |
|---|-----------|---------------|
|   | metal     | gas given off |
| 1 | copper    | yes           |
| 2 | iron      | yes           |
| 3 | magnesium | no            |
| 4 | zinc      | yes           |

Which two results are correct?

- A 1 and 3
- B 1 and 4
- C 2 and 3
- D 2 and 4

27 An element does not conduct electricity and exists as diatomic molecules.

In which area of the Periodic Table is the element to be found?



28 Copper, iron and zinc are all used as pure metals.

Which of these three metals are also used in alloys?

|   | copper | iron | zinc |
|---|--------|------|------|
| A | ✓      | ✓    | ✓    |
| B | ✓      | ✓    | x    |
| C | x      | ✓    | ✓    |
| D | x      | x    | ✓    |

29 Solutions of a halogen and a sodium halide are mixed.

Which mixture darkens in colour because a reaction occurs?

- A bromine and sodium chloride
- B bromine and sodium fluoride
- C chlorine and sodium fluoride
- D chlorine and sodium iodide

30 Some properties of four elements are shown in the table.

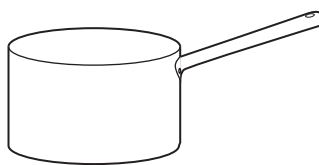
Which element is a metal?

|   | melting point/°C | electrical conductivity when liquid | electrical conductivity when solid |
|---|------------------|-------------------------------------|------------------------------------|
| A | -7               | low                                 | low                                |
| B | 801              | high                                | low                                |
| C | 1535             | high                                | high                               |
| D | 3550             | low                                 | low                                |

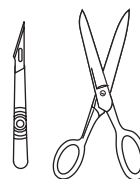
31 The diagram shows three types of item.



cutlery



cooking pan

instruments used  
in hospitals

Which method of rust prevention can be used for all three types of item?

- A coating with plastic
- B covering with grease
- C galvanising
- D using stainless steel

32 Aluminium is an important metal with many uses.

Some of its properties are listed.

- 1 It is a good conductor of heat.
- 2 It is a reactive metal.
- 3 It has a low density.
- 4 It has an oxide layer that prevents corrosion.

Which set of properties help to explain the use of aluminium for cooking and storing food?

- A 1, 2 and 3      B 1, 2 and 4      C 1, 3 and 4      D 2, 3 and 4

33 To grow roses, a fertiliser containing nitrogen, phosphorus and potassium is needed.

For the best flowers, the fertiliser should contain a high proportion of potassium.

Which fertiliser is best for roses?

| fertiliser | proportion by mass |    |    |
|------------|--------------------|----|----|
|            | N                  | P  | K  |
| <b>A</b>   | 9                  | 0  | 25 |
| <b>B</b>   | 13                 | 13 | 20 |
| <b>C</b>   | 29                 | 5  | 0  |
| <b>D</b>   | 29                 | 15 | 5  |

34 Which statements about water are correct?

- 1 Water is treated with chlorine to kill bacteria.
- 2 Household water may contain salts in solution.
- 3 Water is used in industry for cooling.
- 4 Water for household use is filtered to remove soluble impurities.

A 1, 2 and 3      B 1 and 4      C 2, 3 and 4      D 1, 2, 3 and 4

35 Which statement about methane is **not** correct?

- A It is a liquid produced by distilling petroleum.
- B It is produced as vegetation decomposes.
- C It is produced by animals such as cows.
- D It is used as a fuel.

36 Which compound in polluted air can damage stonework and kill trees?

- A carbon dioxide
- B carbon monoxide
- C lead compounds
- D sulfur dioxide

37 Diesel, petrol and bitumen are all

- A fuels.
- B hydrocarbons.
- C lubricants.
- D waxes.

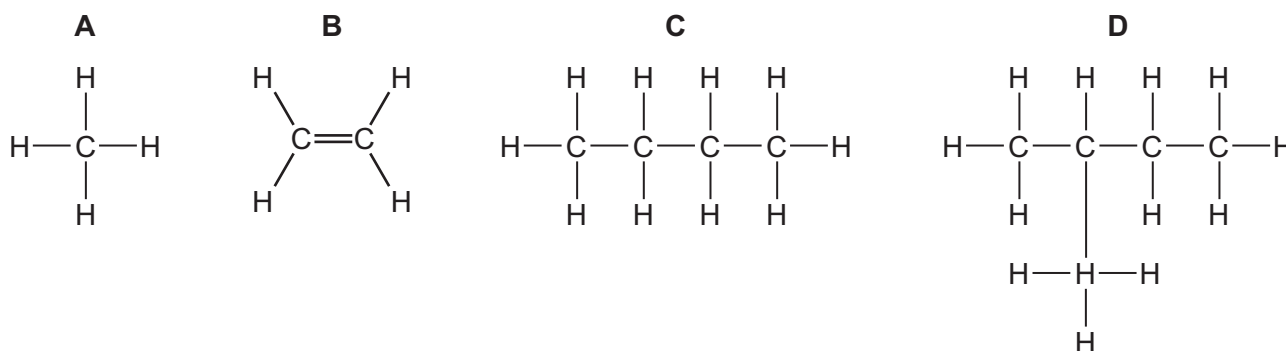
38 A macromolecule is a very large molecule.

Macromolecules can be made by joining smaller molecules together. This is called polymerisation.

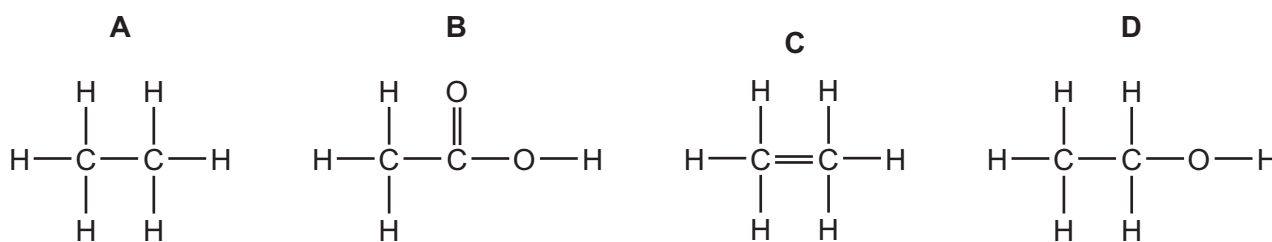
Which row in the table describes the formation of a polymer?

|          | monomer | polymer      |
|----------|---------|--------------|
| <b>A</b> | ethane  | poly(ethane) |
| <b>B</b> | ethene  | poly(ethene) |
| <b>C</b> | ethane  | poly(ethene) |
| <b>D</b> | ethene  | poly(ethane) |

39 Which structure shows a compound that belongs to a **different** homologous series to propane?



40 Which structure is **incorrect**?





**DATA SHEET**  
**The Periodic Table of the Elements**

|                                    |                                   | Group                              |                                      |  |                                     |                                    |                                      |                                      |                                      |                                      |  |
|------------------------------------|-----------------------------------|------------------------------------|--------------------------------------|--|-------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--|
|                                    | I                                 | II                                 | III                                  | IV                                     | V                                   | VI                                 | VII                                  | 0                                    |                                      |                                      |  |
|                                    | 1<br><b>H</b><br>Hydrogen<br>1    |                                    |                                      |  |                                     |                                    |                                      |                                      |                                      |                                      |  |
| 9<br><b>Be</b><br>Beryllium<br>4   | 3<br><b>Li</b><br>Lithium<br>3    | 4<br><b>B</b><br>Boron<br>5        | 11<br><b>B</b><br>Boron<br>5         | 12<br><b>C</b><br>Carbon<br>6          | 14<br><b>N</b><br>Nitrogen<br>7     | 16<br><b>O</b><br>Oxygen<br>8      | 19<br><b>F</b><br>Fluorine<br>9      | 20<br><b>Ne</b><br>Neon<br>10        |                                      |                                      |  |
| 12<br><b>Mg</b><br>Magnesium<br>12 | 11<br><b>Na</b><br>Sodium<br>11   | 13<br><b>Al</b><br>Aluminium<br>13 | 27<br><b>Al</b><br>Aluminium<br>13   | 28<br><b>Si</b><br>Silicon<br>14       | 31<br><b>P</b><br>Phosphorus<br>15  | 32<br><b>S</b><br>Sulfur<br>16     | 35.5<br><b>Cl</b><br>Chlorine<br>17  | 40<br><b>Ar</b><br>Argon<br>18       |                                      |                                      |  |
| 20<br><b>Ca</b><br>Calcium<br>20   | 19<br><b>K</b><br>Potassium<br>19 | 21<br><b>Sc</b><br>Scandium<br>21  | 26<br><b>Fe</b><br>Iron<br>26        | 24<br><b>Cr</b><br>Chromium<br>24      | 25<br><b>Mn</b><br>Manganese<br>25  | 27<br><b>Co</b><br>Cobalt<br>27    | 28<br><b>Ni</b><br>Nickel<br>28      | 30<br><b>Zn</b><br>Zinc<br>30        | 33<br><b>As</b><br>Arsenic<br>33     | 34<br><b>Se</b><br>Selenium<br>34    |  |
| 38<br><b>Sr</b><br>Strontium<br>38 | 37<br><b>Rb</b><br>Rubidium<br>37 | 39<br><b>Y</b><br>Yttrium<br>39    | 44<br><b>Ru</b><br>Ruthenium<br>44   | 42<br><b>Mo</b><br>Molybdenum<br>42    | 43<br><b>Tc</b><br>Technetium<br>43 | 45<br><b>Rh</b><br>Rhodium<br>45   | 46<br><b>Pd</b><br>Palladium<br>46   | 48<br><b>Cd</b><br>Cadmium<br>48     | 51<br><b>Sb</b><br>Antimony<br>51    | 52<br><b>Te</b><br>Tellurium<br>52   |  |
| 56<br><b>Ba</b><br>Barium<br>56    | 55<br><b>Cs</b><br>Caesium<br>55  | 57<br><b>La</b><br>Lanthanum<br>57 | 76<br><b>Os</b><br>Osmium<br>76      | 74<br><b>W</b><br>Tungsten<br>74       | 75<br><b>Re</b><br>Rhenium<br>75    | 77<br><b>Ir</b><br>Iridium<br>77   | 78<br><b>Pt</b><br>Platinum<br>78    | 80<br><b>Hg</b><br>Mercury<br>80     | 83<br><b>Bi</b><br>Bismuth<br>83     | 84<br><b>Po</b><br>Polonium<br>84    |  |
| 88<br><b>Ra</b><br>Radium<br>88    | 87<br><b>Fr</b><br>Francium<br>87 | 89<br><b>Ac</b><br>Actinium<br>89  | 101<br><b>Ru</b><br>Ruthenium<br>101 | 100<br><b>Ni</b><br>Nickel<br>100      | 101<br><b>Rh</b><br>Rhodium<br>101  | 103<br><b>Rh</b><br>Rhodium<br>103 | 106<br><b>Pd</b><br>Palladium<br>106 | 112<br><b>Cd</b><br>Cadmium<br>112   | 122<br><b>Sb</b><br>Antimony<br>122  | 128<br><b>Te</b><br>Tellurium<br>128 |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 232<br><b>Th</b><br>Thorium<br>90    | 238<br><b>U</b><br>Uranium<br>92       | 238<br><b>U</b><br>Uranium<br>92    | 238<br><b>U</b><br>Uranium<br>92   | 238<br><b>U</b><br>Uranium<br>92     | 238<br><b>U</b><br>Uranium<br>92     | 238<br><b>U</b><br>Uranium<br>92     | 238<br><b>U</b><br>Uranium<br>92     |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    | 140<br><b>Ce</b><br>Cerium<br>58     | 141<br><b>Pr</b><br>Praseodymium<br>59 | 144<br><b>Nd</b><br>Neodymium<br>60 | 150<br><b>Sm</b><br>Samarium<br>62 | 152<br><b>Eu</b><br>Europium<br>63   | 157<br><b>Gd</b><br>Gadolinium<br>64 | 162<br><b>Dy</b><br>Dysprosium<br>66 | 165<br><b>Ho</b><br>Holmium<br>67    |  |
|                                    |                                   |                                    |                                      |  |                                     |                                    |                                      |                                      |                                      |                                      |  |