Paper Reference(s)

## 6251/01

# Edexcel GCE

## Chemistry (Nuffield)

### Advanced Subsidiary

Unit Test 1

Thursday 17 January 2008 – Morning

Time: 1 hour 15 minutes

**Materials required for examination**
Nil

**Items included with question papers**
Nil

**A calculator may be used.**

## Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and your signature.
Answer **ALL** the questions. Write your answers in the spaces provided in this question paper.
One question in Section B must be answered with a cross in a box (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).
Final answers to calculations should be given to an appropriate number of significant figures.

## Information for Candidates

A Periodic Table is printed on the back cover of this paper.
The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
The total mark for this paper is 60. There are 16 pages in this paper. Any blank pages are indicated.

## Advice to Candidates

You are advised to show all steps in any calculations.
You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.

*Turn over*

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**Answer ALL the questions. Write your answers in the spaces provided.**

**SECTION A**

1.  Name the following organic compounds.

    (a)  HCHO

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    **(1)**

    (b)  $CH_3CH_2CHOHCH_2CH_3$

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    **(1)**

    **(Total 2 marks)**

**2.** (a) Draw the displayed formula of a branched chain ketone containing **five** carbon atoms.

**(2)**

(b) Give the systematic name for this ketone.

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**(1)**

(c) What is the **molecular** formula of the alcohol this ketone could be made from?

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**(1)**

(d) An alcohol can be converted into a ketone by oxidation with sodium dichromate(VI) and sulphuric acid.

Explain why refluxing the mixture first, rather than immediately distilling the product over from the beginning, results in a higher yield of the ketone.

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**(1)**

**Q2**

**(Total 5 marks)**

**TOTAL FOR SECTION A: 7 MARKS**

**SECTION B**

3.  This question concerns some aspects of the chemistry of hydrogen.

    (a) A sample of hydrogen contains 97.22% $_1^1H$ and the rest is deuterium, $_1^2H$.

    (i) How many protons, neutrons and electrons are present in one atom of deuterium?
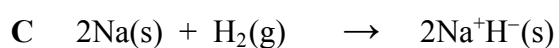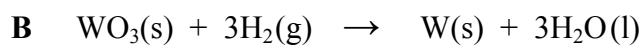
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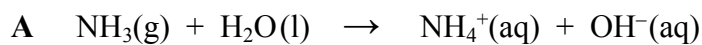    e ...............................

    **(2)**

    (ii) Calculate the average atomic mass of hydrogen in this sample to **4** significant figures.

    **(2)**

    (b) Three reactions involving hydrogen and its compounds are shown below.

    **A**    $NH_3(g) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$

    **B**    $WO_3(s) + 3H_2(g) \rightarrow W(s) + 3H_2O(l)$

    **C**    $2Na(s) + H_2(g) \rightarrow 2Na^+H^-(s)$

    (i) Give the name of the type of reaction in

    **A** ............................................................................................................

    **B** ............................................................................................................

    **(2)**

    (ii) In reaction **C**, are sodium atoms oxidised or reduced?  Justify your answer.

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    **(1)**

(c) Suggest why hydrogen could be placed at the top of either Group 1 or Group 7 in the Periodic Table.

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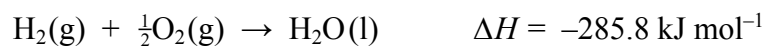..........................................................................................................................

**(2)**

(d) Some data about hydrogen are given below.

Melting point       14 K

Boiling point       20 K

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$        $\Delta H = -285.8 \text{ kJ mol}^{-1}$

(i) What is the boiling point of hydrogen in °C? .......................................................

**(1)**

(ii) Suggest an advantage and a disadvantage of using hydrogen as a fuel for road vehicles.

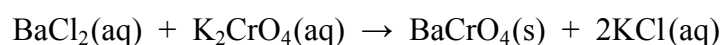Advantage ....................................................................................................

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Disadvantage ..............................................................................................

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**(2)**    **Q3**

**(Total 12 marks)**

**4.** Potassium chromate(VI) and barium chloride solutions react as shown in the equation below.

$$BaCl_2(aq) + K_2CrO_4(aq) \rightarrow BaCrO_4(s) + 2KCl(aq)$$

(a) Which element is responsible for the colour in both the reactants and the products?

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**(1)**

(b) In which Group of the Periodic Table is barium?  Use this information to state the charge on the barium ion.

Group .......................................................................................................................

Charge on ion ........................................................................................................

**(1)**

(c) Rewrite the equation as an ionic one, including state symbols but omitting the spectator ions.

**(1)**

(d) (i) What volume of $0.10 \text{ mol dm}^{-3}$ $BaCl_2$ solution would react exactly with $20 \text{ cm}^3$ of $0.25 \text{ mol dm}^{-3}$ $K_2CrO_4$ solution?

**(2)**

(ii) Describe in detail how you would obtain pure, dry potassium chloride, KCl(s), from the resulting mixture. Explain the purpose of each step in your method.

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**(4)**

**Q4**

**(Total 9 marks)**

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**5.** Part of the emission spectrum of sodium is shown below.

Frequency/$10^{14}$ Hz

8.0    7.5    7.0    6.5    6.0    5.5    5.0    4.5
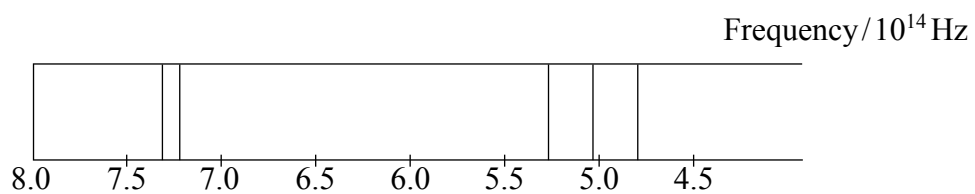
The most intense line in the spectrum has a frequency of $5.1 \times 10^{14}$ Hz.

(a) (i) Suggest the colour of the line at $5.1 \times 10^{14}$ Hz.

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**(1)**

(ii) What is the name of the unit with the symbol Hz?

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**(1)**

(iii) Which line in the spectrum corresponds to the electron transition with the greatest energy?

Put a cross (☒) in the box of the correct answer. If you change your mind about the answer, put a line through the box (☒) and then mark your new answer with a cross (☒).
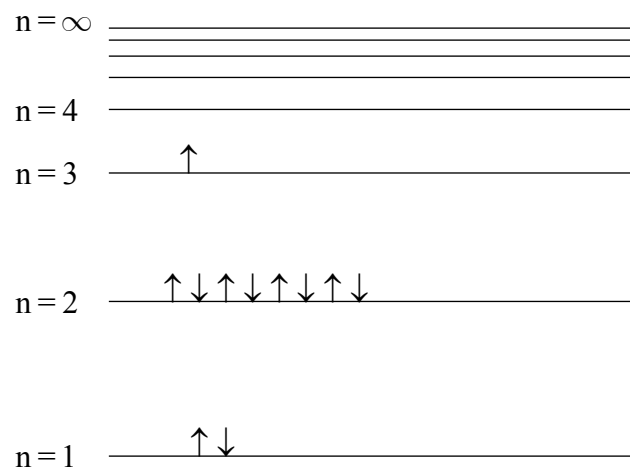
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|---|---|
| $4.8 \times 10^{14}$ Hz | ☒ |
| $5.1 \times 10^{14}$ Hz | ☒ |
| $5.3 \times 10^{14}$ Hz | ☒ |
| $7.2 \times 10^{14}$ Hz | ☒ |
| $7.3 \times 10^{14}$ Hz | ☒ |

**(1)**

(b) The diagram below shows the arrangement of electrons in the energy levels of a sodium atom.

$n = \infty$ ————————

$n = 4$ ————————

$n = 3$ —— ↑ ————

$n = 2$ —— ↑↓↑↓↑↓↑↓ ——

$n = 1$ —— ↑↓ ——

(i) Why are the two electrons shown in the $n = 1$ energy level represented by arrows pointing in opposite directions?

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**(1)**

(ii) Draw an arrow on the diagram to represent the energy change when a sodium atom ionises by losing an electron.

**(2)**

(iii) Do all of the electrons in the $n = 2$ energy level have the same energy? Explain your answer.

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**(2)**

(iv) How would the arrangement of electrons in a potassium atom differ from this arrangement of electrons in sodium?

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**(1)**

(c) Describe an experiment you could carry out to distinguish between samples of sodium chloride and potassium chloride. Give the results of your experiment.

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**(3)**

(d) State TWO different ways in which you could make potassium chloride conduct electricity.

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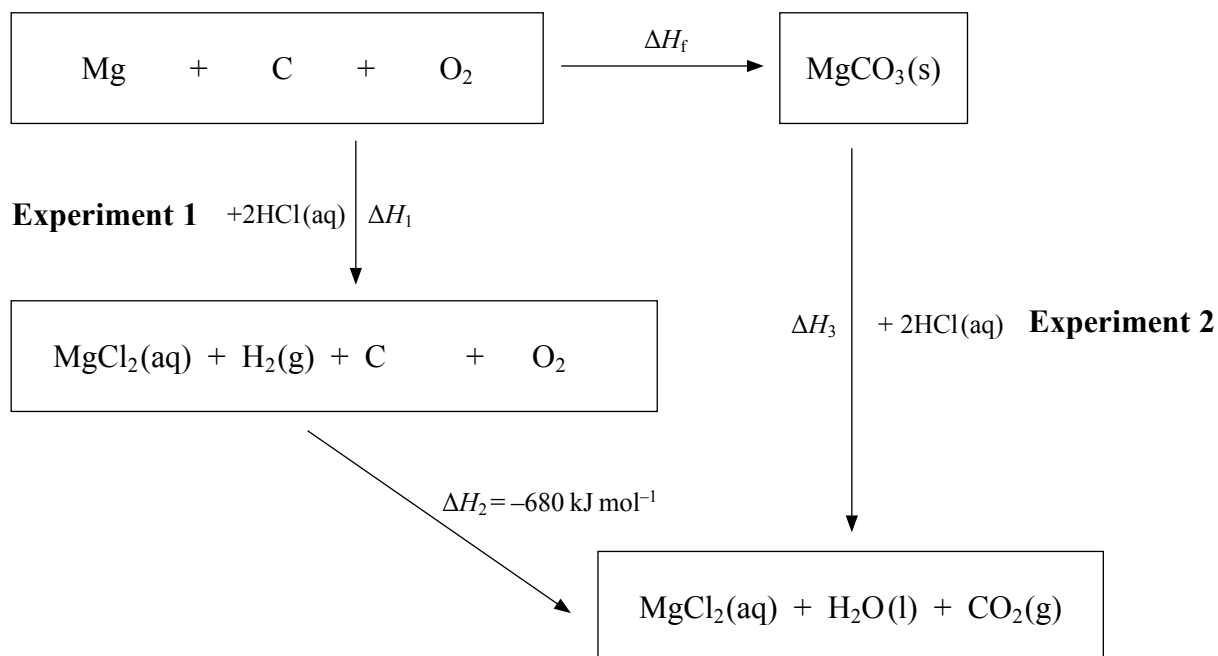
**(2)**

**(Total 14 marks)**

**Q5**

**6.** Two experiments were carried out in order to calculate the enthalpy change of formation of magnesium carbonate, $MgCO_3$.

A Hess cycle for these reactions is shown below.

$$\boxed{\text{Mg} \quad + \quad \text{C} \quad + \quad O_2} \xrightarrow{\quad \Delta H_f \quad} \boxed{MgCO_3(s)}$$

**Experiment 1** $+2HCl(aq) \mid \Delta H_1$

$$\boxed{MgCl_2(aq) + H_2(g) + C \quad + \quad O_2}$$

$\Delta H_3 \mid + 2HCl(aq)$ **Experiment 2**

$\Delta H_2 = -680 \text{ kJ mol}^{-1}$

$$\boxed{MgCl_2(aq) + H_2O(l) + CO_2(g)}$$

(a) Complete the Hess cycle above for the formation of magnesium carbonate from its elements by balancing the equations and adding state symbols.

**(2)**

(b) In **Experiment 1** the temperature of $100 \text{ cm}^3$ of hydrochloric acid was measured. After one minute, $0.100 \text{ g}$ of magnesium was added to the excess acid and the temperature measured every minute. The following results were obtained:

| Time/min | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|----------|------|------|------|------|------|------|------|
| Temp/°C | 21.0 | 21.0 | 25.3 | 25.1 | 24.9 | 24.8 | 24.7 |

(i) How many moles of magnesium were used in this experiment?

Use the Periodic Table as a source of data.

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**(1)**

(ii) The initial concentration of the hydrochloric acid was $2.00\ \text{mol dm}^{-3}$.

Calculate the number of moles of hydrochloric acid at the start and hence the number remaining at the end of the experiment.

**(3)**

(iii) Plot the graph of temperature against time.
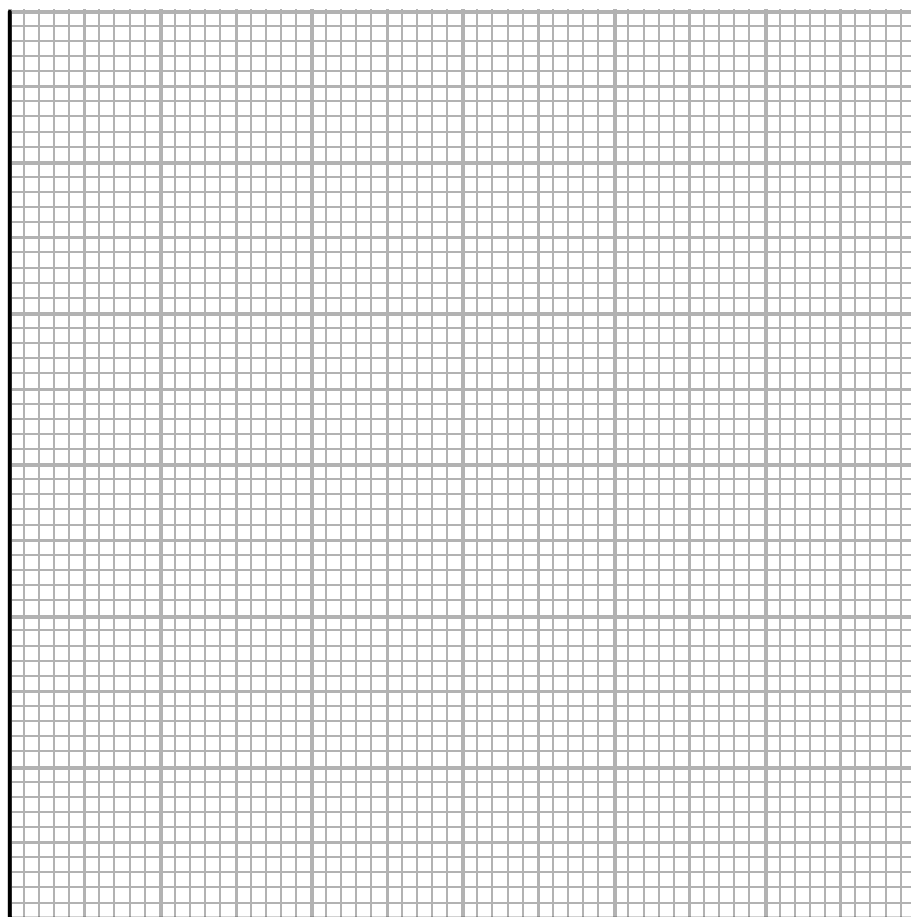
**(2)**

(iv) Calculate the energy change in this experiment assuming the temperature rise is 4.5 °C. Use the expression

$$\text{Energy change (J)} = 4.2 \times \text{mass of solution} \times \text{temperature change}$$

[Assume that 1 cm$^3$ of solution has a mass of 1 g]

**(1)**

(v) Use your answer to (iv) to calculate $\Delta H_1$ for one mole of magnesium reacting with hydrochloric acid. Include a sign and units in your answer.

**(2)**

(vi) Suggest why a temperature rise of 4.5 °C was used in the calculation in (iv).

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**(1)**

(c) 2.2 g of magnesium carbonate was added to 100 cm³ of the same acid in **Experiment 2**.

The temperature changed from 21.0 °C to 23.5 °C resulting in an energy change of 1.05 kJ.

(i) Calculate the mass of one mole of magnesium carbonate, $MgCO_3$ and hence the number of moles of magnesium carbonate used in this experiment.
Use the Periodic Table as a source of data.

**(2)**

(ii) Using the method in part (b)(v), calculate $\Delta H_3$.

**(1)**

(d) Using your answers to (b)(v) and (c)(ii), calculate the enthalpy change of formation, $\Delta H_f$, of magnesium carbonate, $MgCO_3$.
Include a sign and units in your answer.

**(2)**

(e) Why is it impossible to measure $\Delta H_f$ of $MgCO_3(s)$ directly?

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**(1)**    **Q6**

**(Total 18 marks)**

**TOTAL FOR SECTION B: 53 MARKS**
**TOTAL FOR PAPER: 60 MARKS**

**END**

# THE PERIODIC TABLE

**Group**

**Key**

| Atomic Number |
| Symbol |
| Name |
| Molar mass in g mol⁻¹ |

| Period | 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1<br>H<br>Hydrogen<br>1 | | | | | | | | | | | | | | | | | 2<br>He<br>Helium<br>4 |
| 2 | 3<br>Li<br>Lithium<br>7 | 4<br>Be<br>Beryllium<br>9 | | | | | | | | | | | 5<br>B<br>Boron<br>11 | 6<br>C<br>Carbon<br>12 | 7<br>N<br>Nitrogen<br>14 | 8<br>O<br>Oxygen<br>16 | 9<br>F<br>Fluorine<br>19 | 10<br>Ne<br>Neon<br>20 |
| 3 | 11<br>Na<br>Sodium<br>23 | 12<br>Mg<br>Magnesium<br>24 | | | | | | | | | | | 13<br>Al<br>Aluminium<br>27 | 14<br>Si<br>Silicon<br>28 | 15<br>P<br>Phosphorus<br>31 | 16<br>S<br>Sulphur<br>32 | 17<br>Cl<br>Chlorine<br>35.5 | 18<br>Ar<br>Argon<br>40 |
| 4 | 19<br>K<br>Potassium<br>39 | 20<br>Ca<br>Calcium<br>40 | 21<br>Sc<br>Scandium<br>45 | 22<br>Ti<br>Titanium<br>48 | 23<br>V<br>Vanadium<br>51 | 24<br>Cr<br>Chromium<br>52 | 25<br>Mn<br>Manganese<br>55 | 26<br>Fe<br>Iron<br>56 | 27<br>Co<br>Cobalt<br>59 | 28<br>Ni<br>Nickel<br>59 | 29<br>Cu<br>Copper<br>63.5 | 30<br>Zn<br>Zinc<br>65.4 | 31<br>Ga<br>Gallium<br>70 | 32<br>Ge<br>Germanium<br>73 | 33<br>As<br>Arsenic<br>75 | 34<br>Se<br>Selenium<br>79 | 35<br>Br<br>Bromine<br>80 | 36<br>Kr<br>Krypton<br>84 |
| 5 | 37<br>Rb<br>Rubidium<br>85 | 38<br>Sr<br>Strontium<br>88 | 39<br>Y<br>Yttrium<br>89 | 40<br>Zr<br>Zirconium<br>91 | 41<br>Nb<br>Niobium<br>93 | 42<br>Mo<br>Molybdenum<br>96 | 43<br>Tc<br>Technetium<br>(99) | 44<br>Ru<br>Ruthenium<br>101 | 45<br>Rh<br>Rhodium<br>103 | 46<br>Pd<br>Palladium<br>106 | 47<br>Ag<br>Silver<br>108 | 48<br>Cd<br>Cadmium<br>112 | 49<br>In<br>Indium<br>115 | 50<br>Sn<br>Tin<br>119 | 51<br>Sb<br>Antimony<br>122 | 52<br>Te<br>Tellurium<br>128 | 53<br>I<br>Iodine<br>127 | 54<br>Xe<br>Xenon<br>131 |
| 6 | 55<br>Cs<br>Caesium<br>133 | 56<br>Ba<br>Barium<br>137 | 57<br>La ▲<br>Lanthanum<br>139 | 72<br>Hf<br>Hafnium<br>178 | 73<br>Ta<br>Tantalum<br>181 | 74<br>W<br>Tungsten<br>184 | 75<br>Re<br>Rhenium<br>186 | 76<br>Os<br>Osmium<br>190 | 77<br>Ir<br>Iridium<br>192 | 78<br>Pt<br>Platinum<br>195 | 79<br>Au<br>Gold<br>197 | 80<br>Hg<br>Mercury<br>201 | 81<br>Tl<br>Thallium<br>204 | 82<br>Pb<br>Lead<br>207 | 83<br>Bi<br>Bismuth<br>209 | 84<br>Po<br>Polonium<br>(210) | 85<br>At<br>Astatine<br>(210) | 86<br>Rn<br>Radon<br>(222) |
| 7 | 87<br>Fr<br>Francium<br>(223) | 88<br>Ra<br>Radium<br>(226) | 89<br>Ac ▲▲<br>Actinium<br>(227) | 104<br>Unq<br>Unnil-quadium<br>(261) | 105<br>Unp<br>Unnil-pentium<br>(262) | 106<br>Unh<br>Unnil-hexium<br>(263) | | | | | | | | | | | | |

▲ **Lanthanide elements**

| 58<br>Ce<br>Cerium<br>140 | 59<br>Pr<br>Praseo-dymium<br>141 | 60<br>Nd<br>Neodymium<br>144 | 61<br>Pm<br>Promethium<br>(147) | 62<br>Sm<br>Samarium<br>150 | 63<br>Eu<br>Europium<br>152 | 64<br>Gd<br>Gadolinium<br>157 | 65<br>Tb<br>Terbium<br>159 | 66<br>Dy<br>Dysprosium<br>163 | 67<br>Ho<br>Holmium<br>165 | 68<br>Er<br>Erbium<br>167 | 69<br>Tm<br>Thulium<br>169 | 70<br>Yb<br>Ytterbium<br>173 | 71<br>Lu<br>Lutetium<br>175 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

▲▲ **Actinide elements**

| 90<br>Th<br>Thorium<br>232 | 91<br>Pa<br>Protactinium<br>(231) | 92<br>U<br>Uranium<br>238 | 93<br>Np<br>Neptunium<br>(237) | 94<br>Pu<br>Plutonium<br>(242) | 95<br>Am<br>Americium<br>(243) | 96<br>Cm<br>Curium<br>(247) | 97<br>Bk<br>Berkelium<br>(245) | 98<br>Cf<br>Californium<br>(251) | 99<br>Es<br>Einsteinium<br>(254) | 100<br>Fm<br>Fermium<br>(253) | 101<br>Md<br>Mendelevium<br>(256) | 102<br>No<br>Nobelium<br>(254) | 103<br>Lr<br>Lawrencium<br>(257) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|