



Rewarding Learning

General Certificate of Secondary Education
2016

Centre Number

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Candidate Number

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GCSE Chemistry

Unit 2

Foundation Tier



GCH21

[GCH21]

WEDNESDAY 22 JUNE, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete in blue or black ink only. **Do not write with a gel pen.**

Answer **all six** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 90.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question **4(b)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.



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- 1 (a) The first national report examining the impact of water fluoridation on children was published in 2014. The dental health of five year olds and twelve year olds living in fluoridated water and non-fluoridated water areas was measured.

Data from this report is shown in the table below.

| | In fluoridated water areas | In non-fluoridated water areas |
|--|----------------------------|--------------------------------|
| % of twelve year olds with tooth decay | 22 | 37 |
| % of five year olds with tooth decay | 13 | 42 |
| % of hospital admissions for children aged 1–4 for tooth decay | 2 | 20 |

- (i) Use the data in the table to deduce the effect, if any, of the presence of fluoride in water on the dental health of children.

[2]

- (ii) State one reason why some people are against the fluoridation of drinking water.

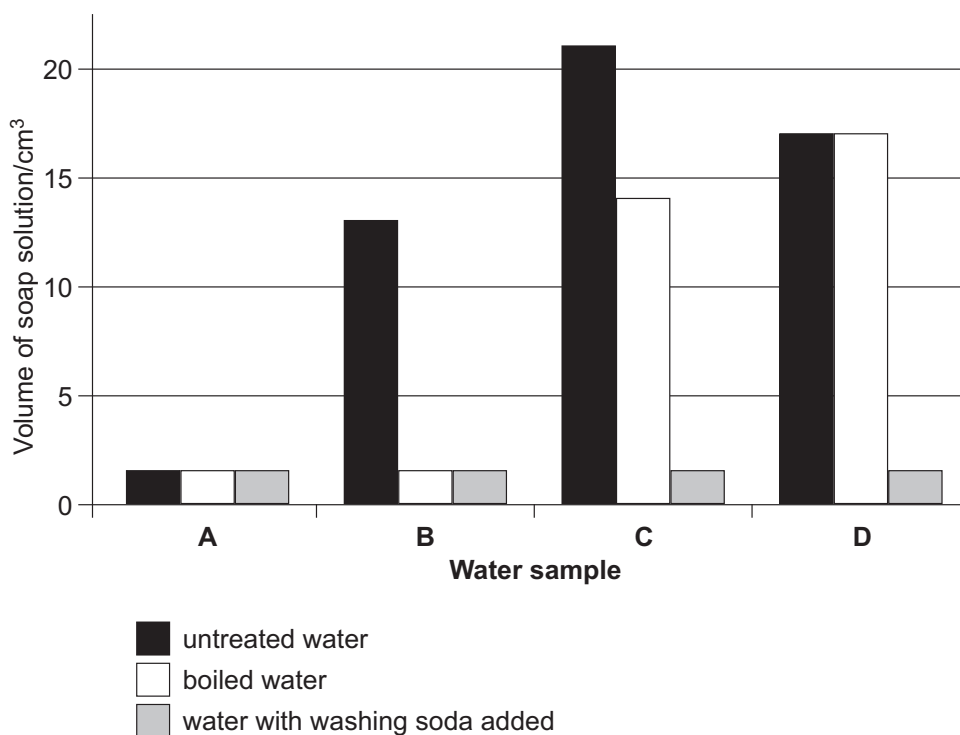
[1]

[Turn over



(b) Four samples of water, A, B, C and D, were tested for hardness. Soap solution was added, with shaking, to each of the four 20.0 cm³ samples of water. The volume of soap solution required to produce 1 cm height of lather was recorded.

The experiment was repeated, with fresh boiled samples of water and then again with fresh samples of water which had been treated with washing soda. The results of the experiment are shown below.



(i) What is meant by the term hard water?

[1]

(ii) Which one of the samples, A, B, C or D is the hardest water? Explain your answer.

Sample: _____

[2]



(iii) What type of hardness is present in the following samples?

Sample B _____

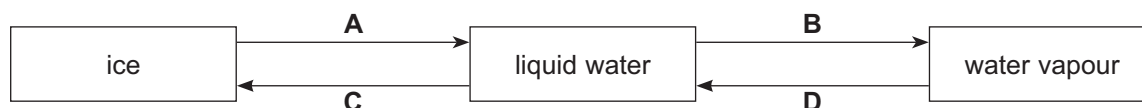
Sample D _____ [2]

(iv) Explain why hard water is considered to be good for your health.

_____ [1]

(c) Water can exist in three different states of matter.

(i) The changes of state are represented by the letters A, B, C and D, in the diagram below.



Complete the table below giving the name of the change of state represented by each letter.

| Change of state | Name of the change of state |
|-----------------|-----------------------------|
| A | |
| B | |
| C | |
| D | |

[4]

(ii) Name a chemical which could be used to test for the presence of water.

_____ [1]

[Turn over



2 Cyclohexane, cyclohexene, ethanol and ethanoic acid are colourless liquids at room temperature. Each one belongs to a different homologous series.

(a) What is meant by the term homologous series?

[3]

(b) Cyclohexane is a colourless liquid alkane.

(i) What is the general formula for the alkanes?

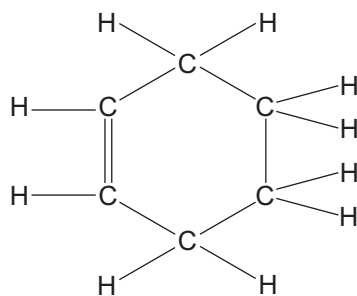
[1]

(ii) Draw the structural formula of ethane.

[1]



- (c) The colourless liquid cyclohexene is a hydrocarbon with the molecular formula C_6H_{10} . The structural formula of cyclohexene is shown below.



- (i) What is the functional group in cyclohexene?

_____ [1]

- (ii) Why is cyclohexene described as a hydrocarbon?

_____ [1]

- (iii) Name the two products formed when cyclohexene is burned in excess oxygen.

1. _____
2. _____ [2]

- (iv) Name the two **compounds** formed when cyclohexene is burned in a limited supply of oxygen.

1. _____
2. _____ [2]

[Turn over



(d) Ethanol is a colourless liquid which can be made by fermentation.

(i) Describe the process of fermentation.

[4]

(ii) State one use of ethanol.

[1]

(e) Ethanoic acid is a colourless liquid with a sharp smell.

(i) State one use of ethanoic acid.

[1]

(ii) Complete the word equation below.

ethanoic acid + sodium carbonate → [1]



3 Hydrogen peroxide decomposes rapidly into water and oxygen in the presence of a catalyst.

(a) (i) Write a balanced symbol equation for the decomposition of hydrogen peroxide.

_____ [3]

(ii) Name the catalyst used for this reaction in the laboratory.

_____ [1]

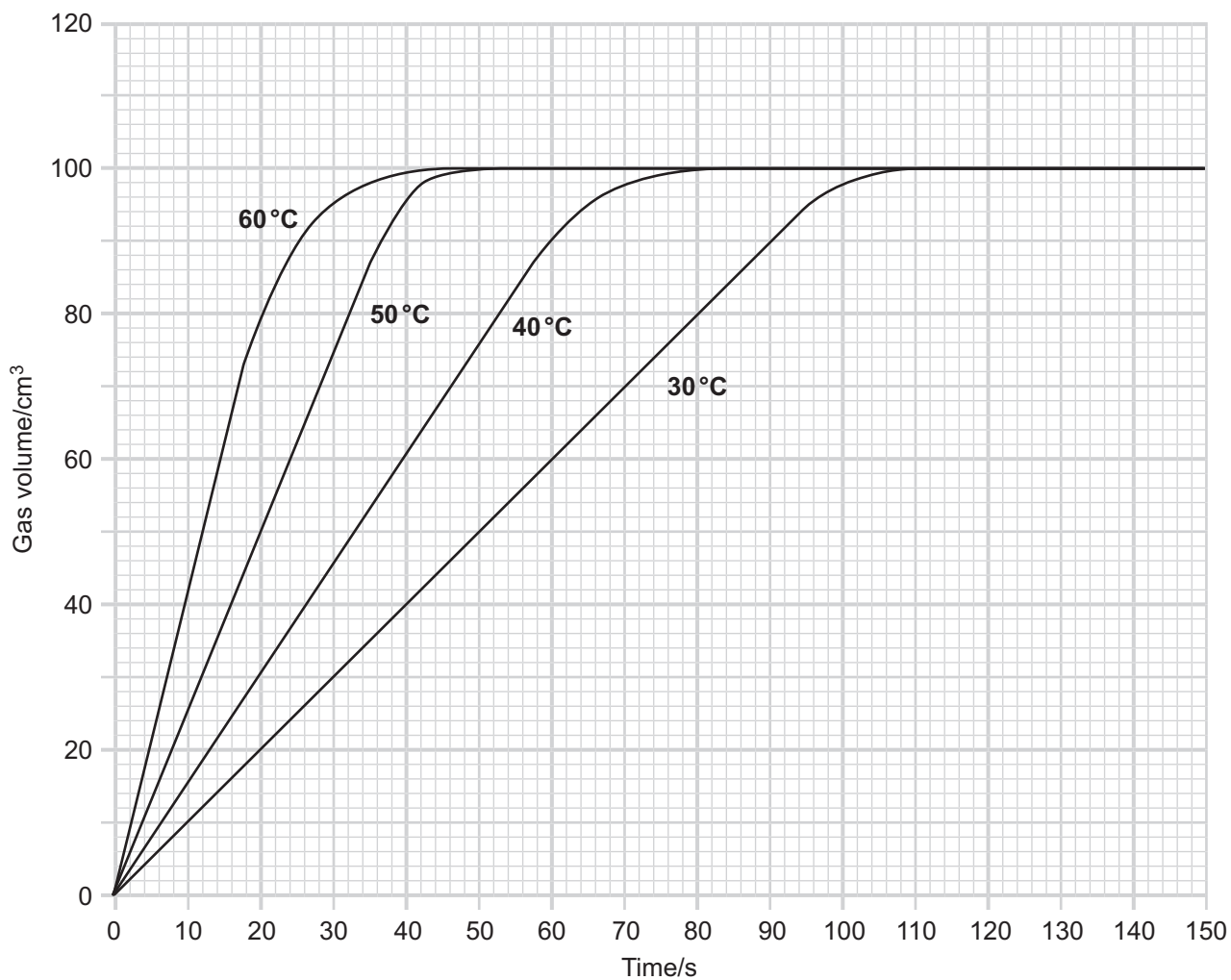
(iii) What is meant by the term catalyst?

_____ [3]

[Turn over



(b) The volume of gas produced by the catalytic decomposition of hydrogen peroxide was measured at four different temperatures. The results were plotted on the graph below.



- (i) What was the gas volume at 40 seconds when the temperature was 30 °C?
State the units.

_____ [2]

- (ii) Complete the table below giving the time taken for the reaction to finish at 60 °C. Calculate the rate based on this time.

| Temperature (°C) | Time taken for reaction to finish (s) | Rate = $\frac{1}{\text{time}}$ (s ⁻¹) |
|------------------|---------------------------------------|---|
| 30 | 108 | 0.00926 |
| 40 | 79 | 0.01266 |
| 50 | 48 | 0.02083 |
| 60 | | |

[2]

- (iii) Using the data from the table above, state how rate changes as temperature increases.

_____ [1]

[Turn over



4 (a) The element carbon is found in all living things.

(i) Write a balanced symbol equation for carbon burning in air to form carbon dioxide gas.

_____ [2]

(ii) Describe a chemical test for carbon dioxide gas and state the result for a positive test.

_____ [3]

(b) Acid rain has been a major environmental problem for decades. Sulfur impurities in fossil fuels contribute to acid rain.

Describe in detail how these sulfur impurities lead to the formation of acid rain. Describe the effects of acid rain and methods used to prevent it.

Your answer should include:

- A description of how sulfur impurities lead to acid rain. (Include balanced symbol equations)
- At least two detrimental effects of acid rain on the environment
- At least two methods used to prevent acid rain.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.



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5 Chemical reactions involve reactants being converted into products.

(a) Some signs of a chemical reaction occurring are given in the box below.

| | |
|----------------------------|--------------|
| colour change | gas produced |
| formation of a precipitate | |

For each of the chemical reactions in the table below, choose a sign from the box above which would indicate that a chemical reaction is occurring.

| Chemical reaction | Sign |
|--------------------------------------|------|
| magnesium + hydrochloric acid | |
| copper(II) oxide + hydrochloric acid | |

[2]

(b) Chemical reactions may be classified as exothermic or endothermic reactions.

(i) Explain the meaning of the term endothermic.

[1]

(ii) Complete the following table by placing a tick (✓) in the appropriate column.

| Chemical Reaction | Exothermic | Endothermic |
|-----------------------|------------|-------------|
| Neutralisation | | |
| Thermal decomposition | | |

[2]



(iii) Fill in the missing words to complete the passage below.

During a chemical reaction, bonds in the reactants are broken and this process _____ energy. New bonds are formed in the products and this process _____ energy. [2]

(c) Rusting of iron is a major problem costing millions of pounds every year.

(i) Name the two substances that react with iron to form rust.

1. _____

2. _____ [2]

(ii) Describe the appearance of rust.

_____ [2]

(iii) State a method used to prevent iron from rusting and explain how it works.

Method _____

Explanation _____

_____ [2]

[Turn over



(d) Iron is extracted from its ore, haematite, in a Blast Furnace. Haematite is mainly iron(III) oxide which is reduced by carbon monoxide to produce iron and carbon dioxide.

(i) Write a balanced symbol equation for the reaction between iron(III) oxide and carbon monoxide.

_____ [3]

(ii) Explain why iron(III) oxide is said to be reduced in this reaction.

_____ [2]





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- 6 (a) The reactivity of metals can be studied using displacement reactions. If a displacement reaction occurs there is a temperature rise.

In an experiment the following method was used:

- Pour some copper(II) sulfate solution into a polystyrene cup and record the temperature of the solution.
- Add a known mass of metal and stir.
- Record the maximum temperature of the mixture.
- Repeat the experiment.

The results of this experiment are shown in the table below.

| Metal | Temperature increase (°C) | | Average temperature rise (°C) |
|-----------|---------------------------|--------------|-------------------------------|
| | Experiment 1 | Experiment 2 | |
| magnesium | 11.5 | 16.5 | 14.0 |
| silver | 0.0 | 0.0 | 0.0 |
| iron | 3.0 | 4.0 | 3.5 |
| gold | 0.0 | 0.0 | 0.0 |
| zinc | 7.0 | 8.0 | 7.5 |

- (i) State two factors which should be kept the same in this experiment to make it a fair test.

1. _____

2. _____ [2]

- (ii) State and explain which of the metals gave the least reliable temperature rise.

_____ [1]



(iii) State and explain which of the metals used in the experiment is the most reactive.

_____ [2]

(iv) Explain why there is no temperature rise when silver is added to copper(II) sulfate solution.

_____ [1]

(v) Why do the results make it impossible to decide which of the metals is the least reactive?

_____ [1]

(vi) Write a balanced symbol equation for the displacement reaction between zinc and copper(II) sulfate solution.

_____ [2]

[Turn over



(b) Aluminium is extracted from its ore by electrolysis.

(i) Explain what is meant by the term electrolysis.

_____ [2]

(ii) Name the ore from which aluminium is extracted.

_____ [1]

(iii) The ore of aluminium contains aluminium ions and oxide ions. State the formulae of these ions.

aluminium ion _____

oxide ion _____ [2]

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| For Examiner's use only | |
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| Question Number | Marks |
| 1 | |
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| Total Marks | |
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Examiner Number

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SYMBOLS OF SELECTED IONS

Positive ions

| Name | Symbol |
|---------------|------------------|
| Ammonium | NH_4^+ |
| Chromium(III) | Cr^{3+} |
| Copper(II) | Cu^{2+} |
| Iron(II) | Fe^{2+} |
| Iron(III) | Fe^{3+} |
| Lead(II) | Pb^{2+} |
| Silver | Ag^+ |
| Zinc | Zn^{2+} |

Negative ions

| Name | Symbol |
|--------------------|------------------------------|
| Carbonate | CO_3^{2-} |
| Dichromate | $\text{Cr}_2\text{O}_7^{2-}$ |
| Ethanoate | CH_3COO^- |
| Hydrogen carbonate | HCO_3^- |
| Hydroxide | OH^- |
| Methanoate | HCOO^- |
| Nitrate | NO_3^- |
| Sulfate | SO_4^{2-} |
| Sulfite | SO_3^{2-} |

DATA LEAFLET

For the use of candidates taking
Science: Chemistry,
Science: Double Award
or Science: Single Award

Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations.

SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

| Soluble |
|---|
| All sodium, potassium and ammonium salts |
| All nitrates |
| Most chlorides, bromides and iodides EXCEPT silver and lead chlorides, bromides and iodides |
| Most sulfates EXCEPT lead and barium sulfates Calcium sulfate is slightly soluble |

| Insoluble |
|--|
| Most carbonates EXCEPT sodium, potassium and ammonium carbonates |
| Most hydroxides EXCEPT sodium, potassium and ammonium hydroxides |
| Most oxides EXCEPT sodium, potassium and calcium oxides which react with water |

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| Periodic Table of the Elements | 2–3 |
| Symbols of Selected Ions | 4 |
| Solubility of Common Salts | 4 |

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chemistry
double award
single award



THE PERIODIC TABLE OF ELEMENTS

Group

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------------------------|------------------------------------|---|--|------------------------------------|---------------------------------------|-------------------------------------|-------------------------------------|---------------------------------------|---|--|--|------------------------------------|------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|----------------------------------|---|--|--|--|--|--|--|--|--|
| | | | | | | | | | | | | | | | | | | 0 | | | | | | | | |
| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | | | | | | | | | | |
| | | <div style="display: flex; justify-content: center; align-items: center; height: 80px;"> <div style="border: 1px solid black; padding: 5px; text-align: left; margin-right: 20px;"> 1 H Hydrogen 1 </div> </div> | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 Li Lithium 3 | 9 Be Beryllium 4 | | | | | | | | | | | 11 B Boron 5 | 12 C Carbon 6 | 14 N Nitrogen 7 | 16 O Oxygen 8 | 19 F Fluorine 9 | 20 Ne Neon 10 | | | | | | | | | |
| 23 Na Sodium 11 | 24 Mg Magnesium 12 | | | | | | | | | | | 27 Al Aluminium 13 | 28 Si Silicon 14 | 31 P Phosphorus 15 | 32 S Sulfur 16 | 35.5 Cl Chlorine 17 | 40 Ar Argon 18 | | | | | | | | | |
| 39 K Potassium 19 | 40 Ca Calcium 20 | 45 Sc Scandium 21 | 48 Ti Titanium 22 | 51 V Vanadium 23 | 52 Cr Chromium 24 | 55 Mn Manganese 25 | 56 Fe Iron 26 | 59 Co Cobalt 27 | 59 Ni Nickel 28 | 64 Cu Copper 29 | 65 Zn Zinc 30 | 70 Ga Gallium 31 | 73 Ge Germanium 32 | 75 As Arsenic 33 | 79 Se Selenium 34 | 80 Br Bromine 35 | 84 Kr Krypton 36 | | | | | | | | | |
| 85 Rb Rubidium 37 | 88 Sr Strontium 38 | 89 Y Yttrium 39 | 91 Zr Zirconium 40 | 93 Nb Niobium 41 | 96 Mo Molybdenum 42 | 99 Tc Technetium 43 | 101 Ru Ruthenium 44 | 103 Rh Rhodium 45 | 106 Pd Palladium 46 | 108 Ag Silver 47 | 112 Cd Cadmium 48 | 115 In Indium 49 | 119 Sn Tin 50 | 122 Sb Antimony 51 | 128 Te Tellurium 52 | 127 I Iodine 53 | 131 Xe Xenon 54 | | | | | | | | | |
| 133 Cs Caesium 55 | 137 Ba Barium 56 | 139 La * Lanthanum 57 | 178 Hf Hafnium 72 | 181 Ta Tantalum 73 | 184 W Tungsten 74 | 186 Re Rhenium 75 | 190 Os Osmium 76 | 192 Ir Iridium 77 | 195 Pt Platinum 78 | 197 Au Gold 79 | 201 Hg Mercury 80 | 204 Tl Thallium 81 | 207 Pb Lead 82 | 209 Bi Bismuth 83 | 210 Po Polonium 84 | 210 At Astatine 85 | 222 Rn Radon 86 | | | | | | | | | |
| 223 Fr Francium 87 | 226 Ra Radium 88 | 227 Ac † Actinium 89 | 261 Rf Rutherfordium 104 | 262 Db Dubnium 105 | 263 Sg Seaborgium 106 | 262 Bh Bohrium 107 | 265 Hs Hassium 108 | 266 Mt Meitnerium 109 | 269 Ds Darmstadtium 110 | 272 Rg Roentgenium 111 | 285 Cn Copernicium 112 | | | | | | | | | | | | | | | |

* 58 – 71 Lanthanum series
† 90 – 103 Actinium series

| | |
|---|--|
| <div style="display: flex; align-items: center; justify-content: center;"> a x </div> <div style="display: flex; align-items: center; justify-content: center;"> b </div> | <p>a = relative atomic mass (approx)</p> <p>x = atomic symbol</p> <p>b = atomic number</p> |
|---|--|

| | | | | | | | | | | | | | |
|-----------------------------------|--|-------------------------------------|--------------------------------------|-------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|--|-------------------------------------|---------------------------------------|
| 140 Ce Cerium 58 | 141 Pr Praseodymium 59 | 144 Nd Neodymium 60 | 147 Pm Promethium 61 | 150 Sm Samarium 62 | 152 Eu Europium 63 | 157 Gd Gadolinium 64 | 159 Tb Terbium 65 | 162 Dy Dysprosium 66 | 165 Ho Holmium 67 | 167 Er Erbium 68 | 169 Tm Thulium 69 | 173 Yb Ytterbium 70 | 175 Lu Lutetium 71 |
| 232 Th Thorium 90 | 231 Pa Protactinium 91 | 238 U Uranium 92 | 237 Np Neptunium 93 | 242 Pu Plutonium 94 | 243 Am Americium 95 | 247 Cm Curium 96 | 245 Bk Berkelium 97 | 251 Cf Californium 98 | 254 Es Einsteinium 99 | 253 Fm Fermium 100 | 256 Md Mendelevium 101 | 254 No Nobelium 102 | 257 Lr Lawrencium 103 |