

Wednesday 18 January 2012 – Morning

**GCSE GATEWAY SCIENCE
CHEMISTRY B**

B741/02 Chemistry modules C1, C2, C3 (Higher Tier)

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: 1 hour 15 minutes




| | | | |
|-----------------------|--|----------------------|--|
| Candidate forename | | Candidate surname | |
|-----------------------|--|----------------------|--|

| | | | | | | | | | | |
|---------------|--|--|--|--|--|------------------|--|--|--|--|
| Centre number | | | | | | Candidate number | | | | |
|---------------|--|--|--|--|--|------------------|--|--|--|--|

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

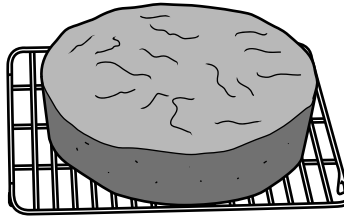
- Your quality of written communication is assessed in questions marked with a pencil (.
- The Periodic Table can be found on the back page.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **75**.
- This document consists of **24** pages. Any blank pages are indicated.

Answer **all** the questions.

Section A – Module C1

1 This question is about chemical changes.

(a) Amir is making a cake.



He adds baking powder to the cake mixture.

Baking powder contains sodium hydrogencarbonate.

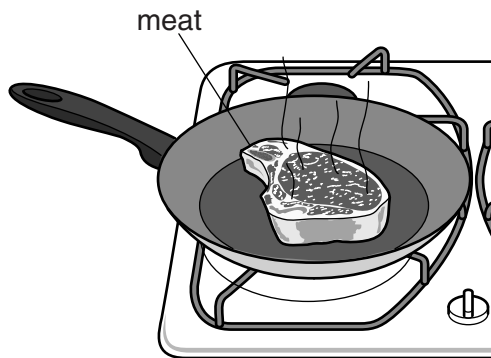
Sodium hydrogencarbonate breaks down when heated in an oven.

Sodium carbonate, water and a gas are the products made.

What gas is made?

..... [1]

(b) Amir cooks some meat.



Meat contains protein.

What happens to the **protein molecules** when the meat is cooked?

.....
..... [1]

[Total: 2]

2 This question is about the atmosphere.

(a) The air we breathe is a mixture of gases.

Look at the table. It shows the percentage of gases in clean air.

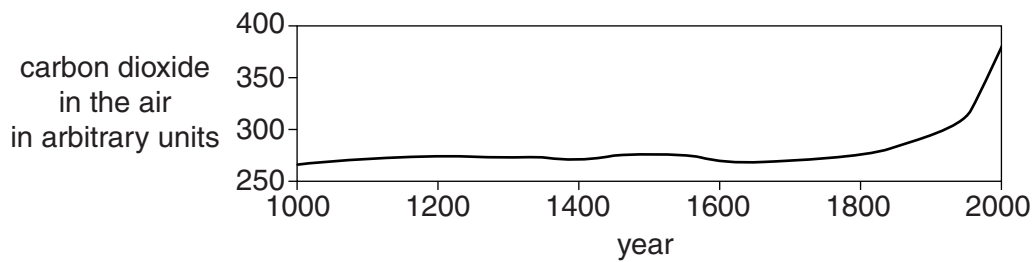
| gas | percentage in clean air |
|----------------|-------------------------|
| nitrogen | |
| oxygen | 21 |
| other gases | 1 |
| carbon dioxide | 0.035 |

Complete the table.

[1]

(b) Look at the graph.

The graph shows the carbon dioxide levels in the air from the year 1000 to the year 2000.



Look at the table.

It shows the population of the world in the year 1000, 1800 and 2000.

| year | 1000 | 1800 | 2000 |
|------------------------------|------|------|------|
| world population in millions | 275 | 1000 | 6000 |

Compare the data for population and carbon dioxide levels.

Does an increase in population **directly** cause an increase in carbon dioxide levels?

Explain your answer.

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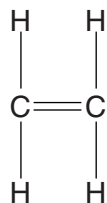
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..... [2]

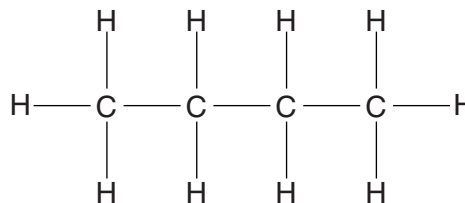
[Total: 3]

3 This question is about carbon compounds.

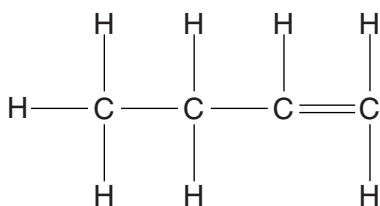
Compounds **A**, **B**, **C** and **D** are hydrocarbons.



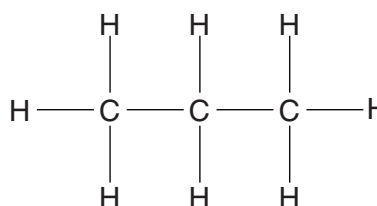
compound **A**



compound **B**



compound **C**



compound **D**

(a) Look at the displayed formulas of these compounds.

Explain why they are all hydrocarbons.

.....

 [2]

(b) Write down the **molecular formula** of compound **B**.

answer [1]

(c) Look at the displayed formulas of compounds **A** and **C**.

Compounds **A** and **C** are **unsaturated**.

Explain why.

.....
 [1]

4 This question is about oil and the products from oil.

(a) Crude oil is transported over long distances by sea and through pipelines.

The UK gets some of its crude oil from politically unstable countries.

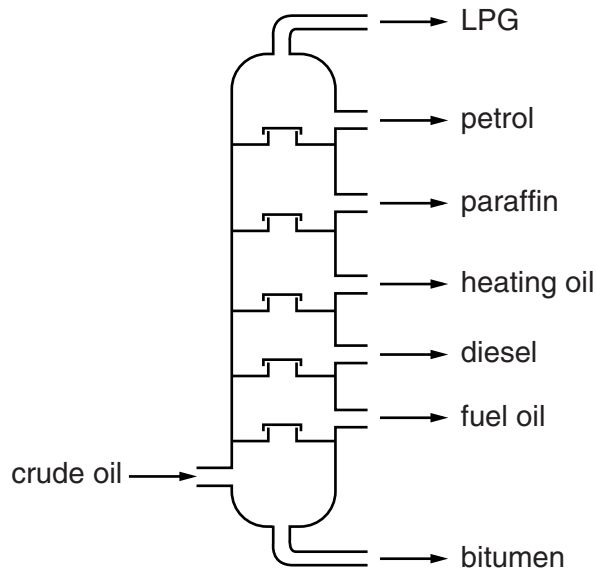
Suggest one argument for, and one argument against, getting oil from such countries.

.....
.....
..... [2]

(b) Crude oil is separated into many fractions by fractional distillation.

Look at the diagram.

It shows a fractionating column.



LPG has a lower boiling point than petrol.

Explain why.

.....
.....
..... [2]

(c) Look at the table.

It shows the percentage of each fraction in crude oil.

It also shows the percentage of each fraction needed for everyday use.

| fraction | % in crude oil | % needed |
|----------------------|-----------------------|-----------------|
| LPG | 4 | 4 |
| petrol | 5 | 22 |
| heating oil | 9 | 5 |
| diesel | 19 | 23 |
| paraffin | 13 | 8 |
| fuel oil and bitumen | 50 | 38 |

The table shows that fractional distillation cannot supply all the petrol that is needed.

Explain how an oil refinery uses **cracking** to make sure that enough petrol is made.

Use information from the table.

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..... [2]

(d) Look at the table.

It gives information about some fuels.

| fuel | energy released by one gram of fuel in kJ | products of burning | availability |
|----------|---|---------------------------------------|------------------|
| ethene | 44.3 | carbon dioxide and water | limited |
| hydrogen | 143.0 | water | limited |
| LPG | 55.6 | carbon dioxide and water | available |
| petrol | 48.3 | carbon dioxide, water and other gases | widely available |

Petrol can be used to power a car.

Recommend one of these fuels as an alternative fuel to petrol.

fuel

Explain your answer using information from the table.

.....

 [2]

(e) Ethene, C_2H_4 , reacts with oxygen, O_2 .

Carbon dioxide and water are made.

Write the **balanced symbol** equation for this reaction.

..... [2]

[Total: 10]

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Question 5 begins on page 10.

PLEASE DO NOT WRITE ON THIS PAGE

Section B – Module C2

- 5 George is researching information about construction materials on the internet.

Look at his results.

| material | formula | density in g/cm ³ | relative hardness (1=soft, 10=very hard) | relative strength (1=weak, 500=very strong) |
|-----------|-------------------------|---------------------------------|---|--|
| brick | no information | 2.0 | 6 | 3 |
| steel | mainly Fe | 7.7 | 6 | 400 |
| limestone | CaCO ₃ | 2.4 | 3 | 7 |
| granite | mainly SiO ₂ | 2.9 | 7 | 23 |
| lead | Pb | 11.4 | 1 | 12 |
| marble | CaCO ₃ | 2.7 | 5 | 15 |
| copper | Cu | 8.9 | 3 | 200 |
| wood | no information | 0.9 | 0.8 | 1 |

- (a) Which material would be the **most** scratch resistant?

Choose from the table.

Explain your answer.

.....

.....

..... [2]

(b) Look at the picture of a girder bridge.



Which material would be best to use to make the girders of this bridge?

Choose from the table.

Explain your answer.

.....

.....

..... [2]

(c) Marble, granite and wood are materials that can be used to make a kitchen worktop.

Describe the **advantages** and **disadvantages** of marble, granite and wood for making a kitchen worktop.

Use information from the table.

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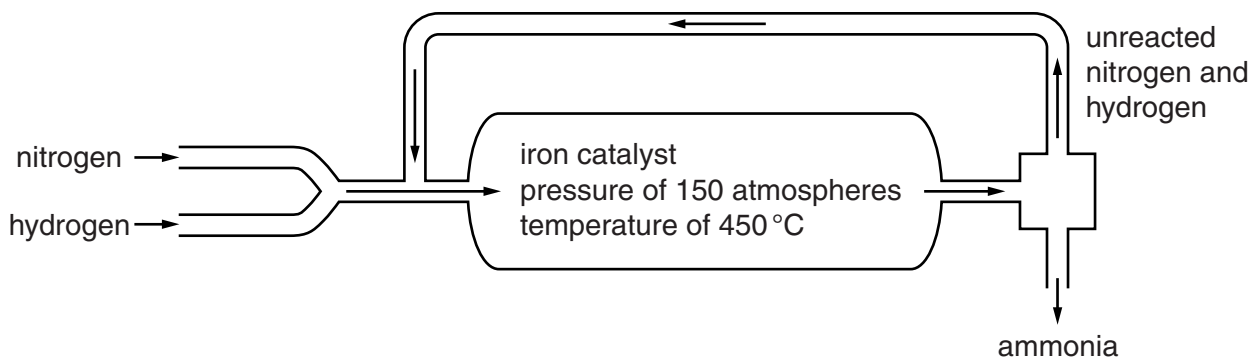
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..... [3]

[Total: 7]

6 Look at the diagram. It shows how ammonia is made in the Haber process.



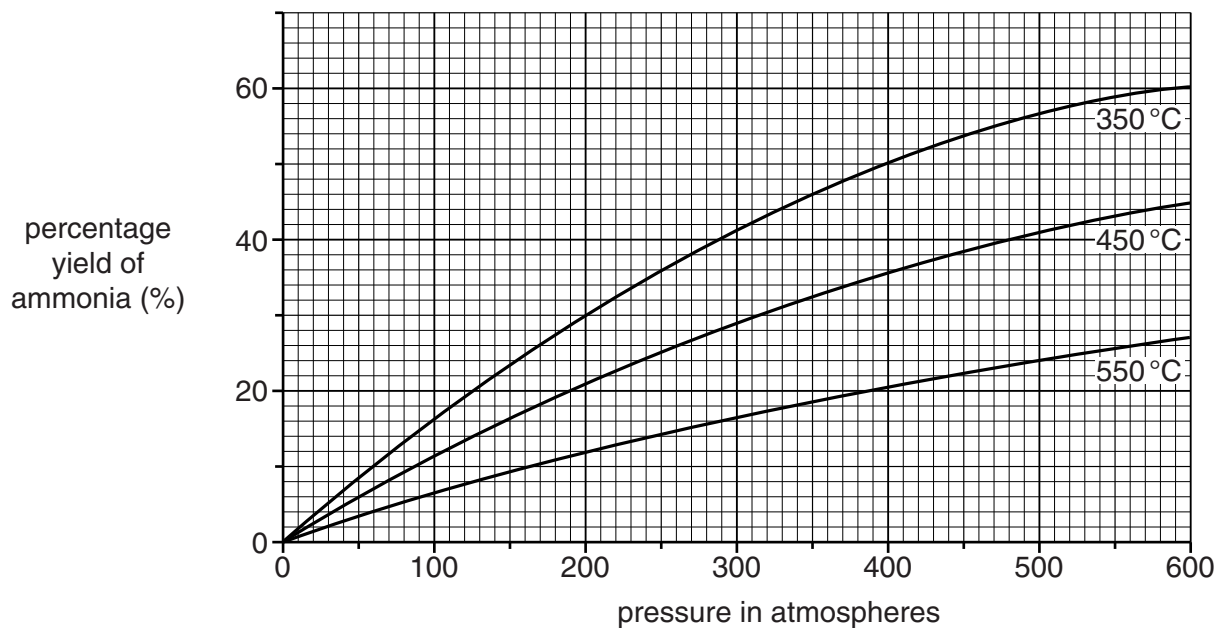
(a) Unreacted nitrogen and hydrogen are recycled.

Explain why.

.....
 [1]

(b) Look at the graph.

It shows the percentage yield of ammonia at different temperatures and pressures.



What is the percentage yield of ammonia at **450 °C** and **400 atmospheres**?

answer %

[1]

(c) Look at the graph.

(i) What conditions, shown on the graph, give the **highest** yield of ammonia?

pressure = atmospheres

temperature = °C [1]

(ii) Ammonia is manufactured at 450°C and 150 atmospheres using an iron catalyst.

Explain why these conditions are used.

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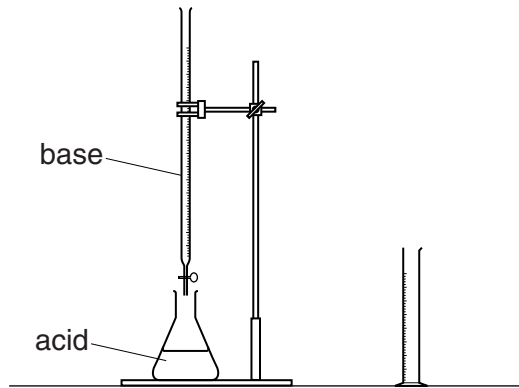
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..... [3]

[Total: 6]

7 Jade and Philip are making fertilisers by neutralisation.



(a) Complete the **word** equation for neutralisation.

acid + base → + water [1]

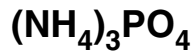
(b) Jade and Philip want to make potassium nitrate.

Which **acid** and which **base** should they use?

.....
 [2]

(c) Jade and Philip also make ammonium phosphate.

The formula of ammonium phosphate is



What is the total number of **atoms** in this formula?

..... [1]

[Total: 4]

8 Scientists accept that the surface of the Earth is made up of **tectonic plates**.

(a) Describe the theory of plate tectonics and use this theory to explain subduction.



The quality of written communication will be assessed in your answer to this question.

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..... [6]

(b) Geologists study the structure of the Earth.

This is not an easy thing to do.

Explain why.

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..... [2]

[Total: 8]

Section C – Module C3

9 Pharmaceutical drugs or medicines are speciality chemicals.



(a) Pharmaceutical drugs are often made by batch processes rather than continuous processes.

Explain why.

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.....
..... [1]

(b) Pharmaceutical drugs often cost a lot of money to make and develop.

One reason is that it takes many years to research and test a new drug.

Explain **two** other reasons why it is expensive to make and develop a new drug.

.....
.....
.....
..... [2]

(c) Pharmaceutical drugs need to be tested to make sure they are safe to use.

The research and testing of pharmaceutical drugs may include

- animal testing
- testing on human volunteers.

The ideas and views of people in society affect the work of scientists.

Suggest how the ideas and views of people in society have changed the way scientists research and test pharmaceutical drugs.

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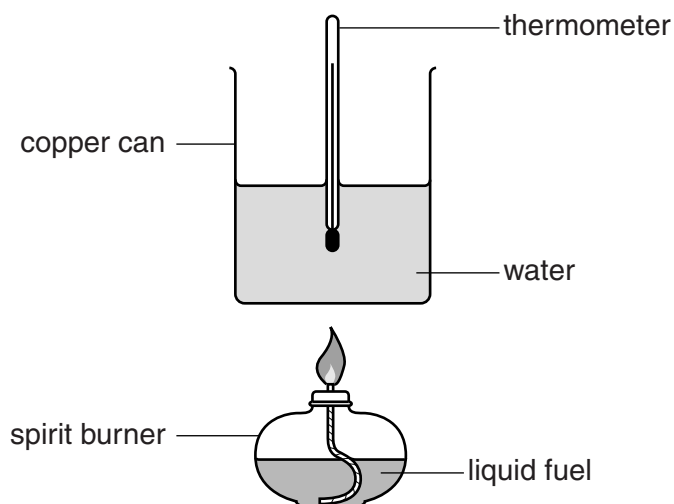
..... [2]

[Total: 5]

10 Petrol is a mixture of hydrocarbons.

David investigates the energy released when five of these hydrocarbons are burned.

Look at the apparatus he uses.



Each time, he burns 0.5 g of hydrocarbon and heats 100 g of water.

David measures the temperature of the water before heating.

He measures the temperature again when the hydrocarbon has finished burning.

These are his results.

| hydrocarbon | molecular formula | temperature of water in °C | |
|-------------|-------------------|----------------------------|--------|
| | | at start | at end |
| hexane | C_6H_{14} | 20 | 40 |
| heptane | C_7H_{16} | 19 | 41 |
| octane | C_8H_{18} | 15 | 39 |
| nonane | C_9H_{20} | 18 | 45 |
| decane | $C_{10}H_{22}$ | 20 | 46 |

- (a) Calculate the energy released per gram by **hexane**.

Use the equation

$$\text{energy} = \text{mass} \times \text{specific heat capacity} \times \text{temperature change}$$

The specific heat capacity of water is 4.2 J/g°C.

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energy released per gram = J/g [2]

- (b) David knows that the bigger the hydrocarbon molecule, the more carbon atoms it has.

David concludes that the bigger the hydrocarbon molecule, the more energy per gram is released.

Explain whether David's results fully support this conclusion.

.....

.....

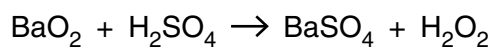
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..... [2]

[Total: 4]

- 11 Hydrogen peroxide has the molecular formula H_2O_2 .

Hydrogen peroxide can be manufactured by reacting barium peroxide, BaO_2 , with sulfuric acid, H_2SO_4 .



Barium sulfate, BaSO_4 , is a waste product.

Look at the table of relative formula masses, M_r .

| formula | relative formula mass, M_r |
|-------------------------|------------------------------|
| BaO_2 | 169 |
| H_2SO_4 | 98 |
| BaSO_4 | 233 |
| H_2O_2 | 34 |

- (a) Show that the **atom economy** for the reaction is 12.7%.

.....

 [1]

- (b) A factory makes 18 tonnes of hydrogen peroxide.

Phil predicts the factory should make 20 tonnes of hydrogen peroxide.

Calculate the **percentage yield** of hydrogen peroxide.

.....

 percentage yield = % [2]

- (c) The manufacture of hydrogen peroxide from barium peroxide is **not sustainable**.

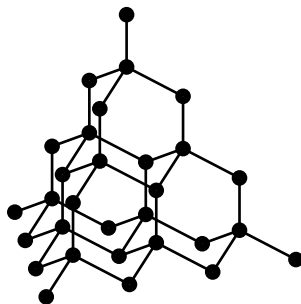
Explain why.

.....
 [1]

[Total: 4]

12 Diamond is a form of carbon.

Look at the structure of diamond.



Scientists use the structure **and** bonding of a substance to explain its properties.

(a) Diamond has a very high melting point.

Explain why.

.....

.....

.....

..... [2]

(b) Diamond does not conduct electricity.

Explain why.

.....

..... [1]

[Total: 3]

13 Magnesium reacts with dilute hydrochloric acid, HCl .

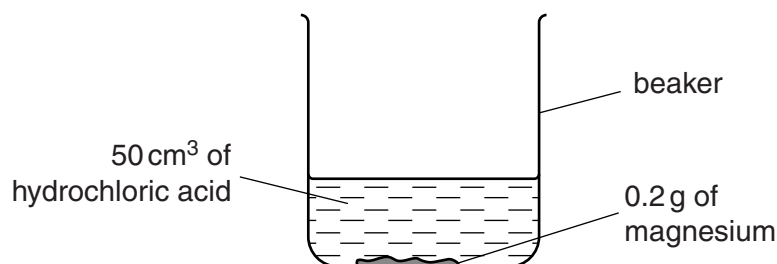
Magnesium chloride and hydrogen, H_2 , are made.

(a) Write down the **balanced symbol** equation for this reaction.

..... [2]

(b) Peter and Rachel investigate the reaction between magnesium and hydrochloric acid.

Look at the apparatus they use.



They time how long it takes for all of the magnesium to react (the reaction time).

Look at their results.

| experiment | temperature of acid | concentration of acid | magnesium ribbon or powder | reaction time in seconds | mean rate of reaction in g/s |
|------------|---------------------|-----------------------|----------------------------|--------------------------|------------------------------|
| A | cold | dilute | ribbon | 240 | 8.33×10^{-4} |
| B | cold | concentrated | ribbon | 120 | |
| C | warm | dilute | ribbon | 100 | 2.00×10^{-3} |
| D | cold | dilute | powder | 50 | 4.00×10^{-3} |

(i) Look at the results for experiment B.

Calculate the mean rate of reaction in experiment B.

Give your answer to **three** significant figures.

.....

rate of reaction = g/s

[1]

The Periodic Table of the Elements

| | | | | | | | | |
|---|---|---------------------------------------|---------------------------------------|--|---------------------------------------|--|---------------------------------------|---------------------------------------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | |
| 7 Li lithium 3 | 9 Be beryllium 4 | 11 Na sodium 11 | 12 C carbon 6 | 13 Al aluminium 13 | 14 N nitrogen 7 | 15 O oxygen 8 | 16 F fluorine 9 | 17 Ne neon 10 |
| 19 K potassium 19 | 20 Ca calcium 20 | 21 Sc scandium 21 | 22 Ti titanium 22 | 23 V vanadium 23 | 24 Cr chromium 24 | 25 Mn manganese 25 | 26 Fe iron 26 | 27 Co cobalt 27 |
| 37 Rb rubidium 37 | 38 Sr strontium 38 | 39 Y yttrium 39 | 40 Zr zirconium 40 | 41 Nb niobium 41 | 42 Mo molybdenum 42 | 43 Tc technetium [98] | 44 Ru ruthenium 44 | 45 Rh rhodium 45 |
| 55 Cs caesium 55 | 56 Ba barium 56 | 57 La* lanthanum 57 | 58 Ce cerium 58 | 59 Pr praseodymium 59 | 60 Nd neodymium 60 | 61 Pm promethium [61] | 62 Sm samarium 62 | 63 Eu europium 63 |
| 87 Fr francium 87 | 88 Ra radium 88 | 89 Ac* actinium 89 | 90 Th thorium 90 | 91 Pa protactinium 91 | 92 U uranium 92 | 93 Np neptunium [93] | 94 Pu plutonium 94 | 95 Am americium 95 |
| 133 Cs caesium 55 | 137 Ba barium 56 | 138 La* lanthanum 57 | 139 Ce cerium 58 | 140 Pr praseodymium 59 | 141 Nd neodymium 60 | 142 Pm promethium [61] | 143 Sm samarium 62 | 144 Eu europium 63 |
| 209 Tl thallium 81 | 210 Pb lead 82 | 211 Bi bismuth 83 | 212 Po polonium [212] | 213 At astatine [213] | 214 Rn radon [222] | 215 Fr francium [223] | 216 Ra radium [226] | 217 Ac actinium [227] |
| 65 Zn zinc 30 | 66 Ga gallium 31 | 67 Ge germanium 32 | 68 As arsenic 33 | 69 Se selenium 34 | 70 Br bromine 35 | 71 Kr krypton 36 | 72 Xe xenon 54 | 73 Rn radon 86 |
| 112 Cd cadmium 48 | 113 In indium 49 | 114 Sn tin 50 | 115 Sb antimony 51 | 116 Te tellurium 52 | 117 I iodine 53 | 118 Xe xenon 54 | 119 At astatine [210] | 120 Rn radon [222] |
| 197 Au gold 79 | 198 Hg mercury 80 | 199 Tl thallium 81 | 200 Pb lead 82 | 201 Bi bismuth 83 | 202 Po polonium [209] | 203 At astatine [210] | 204 Rn radon [222] | 205 Fr francium [223] |
| 272 Rg roentgenium 111 | 271 Ds darmstadtium 110 | 268 Mt meitnerium 109 | 267 Hs hassium 108 | 264 Bh bohrium 107 | 262 Sg seaborgium 106 | 261 Rf rutherfordium 104 | 257 Lr lawrencium 103 | 256 Yb ytterbium 80 |
| Elements with atomic numbers 112-116 have been reported but not fully authenticated | | | | | | | | |

1
H
hydrogen
1

Key
relative atomic mass
atomic symbol
name
atomic (proton) number

* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.