



Please check the examination details below before entering your candidate information

Candidate surname

Other names

**Pearson Edexcel**  
**International**  
**Advanced Level**

Centre Number

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Candidate Number

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**Wednesday 9 January 2019**

Morning (Time: 1 hour 30 minutes)

Paper Reference **WCH11/01**

**Chemistry**

**International Advanced Subsidiary**

**Unit 1: Structure, Bonding and Introduction to  
Organic Chemistry**

**Candidates must have: Scientific calculator  
Ruler**

Total Marks

### Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*

### Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- A Periodic Table is printed on the back cover of this paper.

### Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Check your answers if you have time at the end.

Turn over ►

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## SECTION A

Answer ALL the questions in this section.

You should aim to spend no more than 20 minutes on this section.

For each question, select one answer from A to D and put a cross in the box . If you change your mind, put a line through the box  and then mark your new answer with a cross .

- 1 The hydroxide ion,  $\text{OH}^-$ , has a total of 9 protons.

How many neutrons and electrons are there in this ion?

	Number of neutrons	Number of electrons
<input type="checkbox"/> A	8	8
<input type="checkbox"/> B	8	10
<input type="checkbox"/> C	9	8
<input type="checkbox"/> D	9	9

(Total for Question 1 = 1 mark)

- 2 A sample of silicon contains the following isotopes.

Isotope	Percentage abundance
$^{28}\text{Si}$	81.21
$^{29}\text{Si}$	14.10
$^{30}\text{Si}$	4.69

What is the relative atomic mass of silicon, to one decimal place, in this sample?

- A 28.0  
 B 28.2  
 C 29.0  
 D 29.8

(Total for Question 2 = 1 mark)



3 Which is the electronic configuration of a carbon atom in its ground state?

- |                                       | 1s                   | 2s                   | 2p   |
|---------------------------------------|----------------------|----------------------|--|
| <input checked="" type="checkbox"/> A | $\uparrow$           | $\uparrow$           | $\uparrow\downarrow$ $\uparrow$ $\uparrow$ |
| <input checked="" type="checkbox"/> B | $\uparrow\downarrow$ | $\uparrow$           | $\uparrow$ $\uparrow$ $\uparrow$           |
| <input checked="" type="checkbox"/> C | $\uparrow\downarrow$ | $\uparrow\downarrow$ | $\uparrow\downarrow$ $\square$ $\square$   |
| <input checked="" type="checkbox"/> D | $\uparrow\downarrow$ | $\uparrow\downarrow$ | $\uparrow$ $\uparrow$ $\square$            |

(Total for Question 3 = 1 mark)

4 What is the maximum number of electrons in the 3p subshell, and in the third quantum shell of an atom?

	Maximum number of electrons in the 3p subshell	Maximum number of electrons in the third quantum shell
<input checked="" type="checkbox"/> A	2	8
<input checked="" type="checkbox"/> B	2	18
<input checked="" type="checkbox"/> C	6	8
<input checked="" type="checkbox"/> D	6	18

(Total for Question 4 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.



5 The first six ionisation energies of an element, in  $\text{kJ mol}^{-1}$ , are shown.

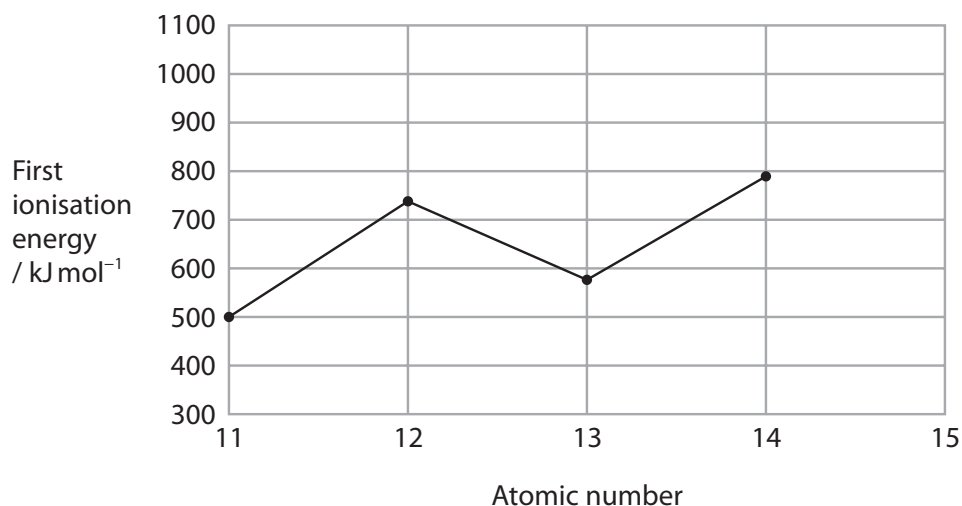
578 1817 2745 11578 14831 18378

Which group of the Periodic Table includes this element?

- A Group 2
- B Group 3
- C Group 4
- D Group 5

(Total for Question 5 = 1 mark)

6 The diagram shows the first ionisation energy for the elements from sodium to silicon.



What is the approximate first ionisation energy, in  $\text{kJ mol}^{-1}$ , of phosphorus (atomic number 15)?

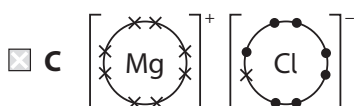
- A 400
- B 500
- C 700
- D 1000

(Total for Question 6 = 1 mark)



7 Which is the dot-and-cross diagram for magnesium chloride?

Only outer shell electrons are shown.



(Total for Question 7 = 1 mark)

8 Metallic bonding is the strong electrostatic attraction between

- A anions and cations
- B atoms and delocalised electrons
- C ions and delocalised electrons
- D two nuclei and a shared pair of electrons

(Total for Question 8 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.



9 The ionic radius of  $\text{Al}^{3+}$  is smaller than that of  $\text{N}^{3-}$ .

This is because  $\text{Al}^{3+}$  has

- A fewer protons but more electrons than  $\text{N}^{3-}$
- B more protons but fewer electrons than  $\text{N}^{3-}$
- C more protons than  $\text{N}^{3-}$  but the same number of electrons as  $\text{N}^{3-}$
- D the same number of protons as  $\text{N}^{3-}$  but fewer electrons

(Total for Question 9 = 1 mark)

10 Which ion has the greatest polarising power?

- A  $\text{Cl}^-$
- B  $\text{Mg}^{2+}$
- C  $\text{Na}^+$
- D  $\text{S}^{2-}$

(Total for Question 10 = 1 mark)

11 Which species is **not** tetrahedral?

- A  $\text{CCl}_4$
- B  $\text{CH}_4$
- C  $\text{ICl}_4^-$
- D  $\text{NH}_4^+$

(Total for Question 11 = 1 mark)

12 Members of the homologous series of alkanes have the same

- A boiling temperature
- B density
- C empirical formula
- D general formula

(Total for Question 12 = 1 mark)

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**13** An electrophile

- A** accepts a pair of electrons
- B** always has a negative charge
- C** always has a positive charge
- D** donates a pair of electrons

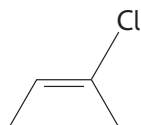
**(Total for Question 13 = 1 mark)**

**14** What is the total number of structural isomers with the molecular formula  $C_6H_{14}$ ?

- A** 4
- B** 5
- C** 6
- D** 7

**(Total for Question 14 = 1 mark)**

**15** What is the systematic name of compound **X**?



Compound **X**

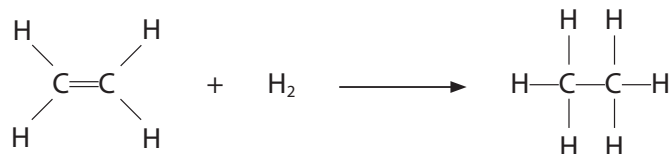
- A** *E*-2-chlorobut-2-ene
- B** *Z*-2-chlorobut-2-ene
- C** *E*-3-chlorobut-2-ene
- D** *Z*-3-chlorobut-2-ene

**(Total for Question 15 = 1 mark)**

**Use this space for any rough working. Anything you write in this space will gain no credit.**



16 Ethene reacts with hydrogen in the presence of a heated nickel catalyst to form ethane.



Which types of bond are broken and formed in this reaction?

	Bonds broken	Bonds formed
<input type="checkbox"/> A	$\sigma$ only	$\pi$ only
<input type="checkbox"/> B	$\pi$ only	$\sigma$ only
<input type="checkbox"/> C	$\sigma$ and $\pi$	$\sigma$ only
<input type="checkbox"/> D	$\sigma$ and $\pi$	$\pi$ only

(Total for Question 16 = 1 mark)

17 Calcium reacts with dilute nitric acid to form calcium nitrate and hydrogen.

Which is the balanced equation for this reaction?

- A  $\text{Ca} + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{H}_2$
- B  $\text{Ca} + \text{H}_2\text{NO}_3 \rightarrow \text{CaNO}_3 + \text{H}_2$
- C  $\text{Ca} + 2\text{H}_2\text{NO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + 2\text{H}_2$
- D  $2\text{Ca} + 2\text{HNO}_3 \rightarrow 2\text{CaNO}_3 + \text{H}_2$

(Total for Question 17 = 1 mark)

18 What mass of anhydrous sodium carbonate is needed to make  $50.0 \text{ cm}^3$  of a  $0.0800 \text{ mol dm}^{-3}$  solution of sodium carbonate,  $\text{Na}_2\text{CO}_3$ ?

[ $A_r$  values: C = 12.0, O = 16.0, Na = 23.0]

- A 0.332 g
- B 0.424 g
- C 5.30 g
- D 8.48 g

(Total for Question 18 = 1 mark)





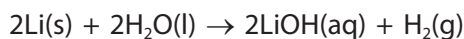
19 A sample of air, with a mass of 5.0 kg, contained carbon monoxide with a concentration of 12 parts per million by mass.

What is the mass of carbon monoxide in this sample of air?

- A  $6.0 \times 10^{-2}$  g
- B  $6.0 \times 10^{-5}$  g
- C  $2.4 \times 10^{-6}$  g
- D  $2.4 \times 10^{-9}$  g

(Total for Question 19 = 1 mark)

20 What is the maximum volume of hydrogen formed, at room temperature and pressure (r.t.p.), when 0.207 g of lithium is added to excess water?



[ $A_r$  Li = 6.9 Molar volume of gas at r.t.p. =  $24.0 \text{ dm}^3 \text{ mol}^{-1}$ ]

- A  $0.36 \text{ dm}^3$
- B  $0.72 \text{ dm}^3$
- C  $1.44 \text{ dm}^3$
- D  $2.48 \text{ dm}^3$

(Total for Question 20 = 1 mark)

**TOTAL FOR SECTION A = 20 MARKS**



## SECTION B

Answer **ALL** the questions.

Write your answers in the spaces provided.

**21** Heptane,  $C_7H_{16}$ , is one of the compounds present in crude oil.

(a) When heptane is reformed, the products include 2,2,3-trimethylbutane and cycloheptane.

(i) Give a reason why petrol should **not** contain a high proportion of heptane.

(1)

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(ii) Draw the **skeletal** formula of 2,2,3-trimethylbutane.

(1)

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(iii) Write the equation for reforming heptane into cycloheptane.  
Use **molecular** formulae.

State symbols are not required.

(1)

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(iv) When petrol is burned in a car engine, oxides of nitrogen are formed.

Explain how these compounds result in damage to trees.

(2)

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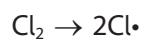
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(b) Heptane reacts with chlorine in sunlight.

(i) Chlorine radicals are formed in the first step in the mechanism.



Name this step in the mechanism.

(1)

(ii) Give the **two** propagation steps for the formation of chloroheptane.  
Use molecular formulae. Curly arrows are **not** required.

(2)

(iii) Give the termination step which forms a hydrocarbon.

(1)

(iv) Explain how some dichloroheptane,  $\text{C}_7\text{H}_{14}\text{Cl}_2$ , also forms during this reaction.  
You may include equation(s) in your answer.

(2)

(Total for Question 21 = 11 marks)



**22** This question is about nitrogen.

(a) The table shows the successive ionisation energies of nitrogen.

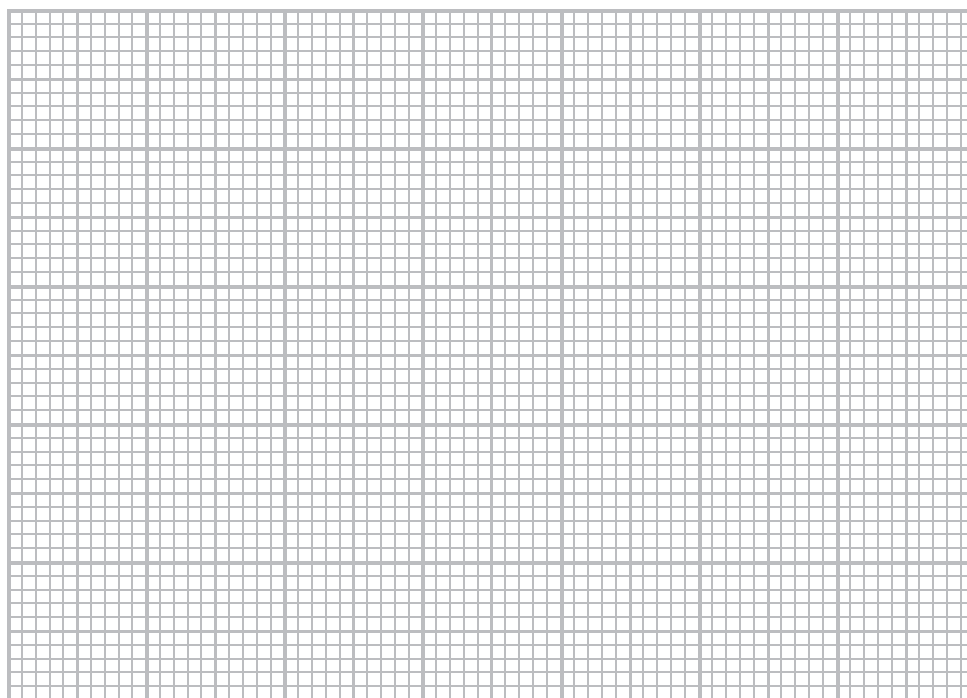
Ionisation number	Ionisation energy / $\text{kJ mol}^{-1}$	log (ionisation energy)
1	1 402	3.15
2	2 856	3.46
3	4 578	3.66
4	7 475	3.87
5	9 445	3.98
6	53 268	
7	64 362	

(i) Complete the table.

(1)

(ii) Plot a graph of log (ionisation energy) against ionisation number.

(3)



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(iii) Give a reason why the logarithm of the ionisation energy, rather than just the ionisation energy, is used to plot this graph.

(1)

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(iv) Explain what can be deduced from the graph about the electronic structure of nitrogen.

(3)

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(v) Explain why the first ionisation energy of oxygen is lower than that of nitrogen.

(3)

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(b) Nitrogen gas consists of nitrogen molecules.

(i) Draw a dot-and-cross diagram to show the bonding in a molecule of nitrogen. (1)

(ii) Calculate the number of nitrogen **atoms** in 5.60 g of nitrogen gas.  
[Avogadro constant =  $6.02 \times 10^{23} \text{ mol}^{-1}$ ] (2)

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- (iii) A sample of nitrogen gas occupied  $108 \text{ cm}^3$  at a temperature of  $25^\circ\text{C}$  and a pressure of  $1.36 \times 10^5 \text{ Pa}$ .

Using the ideal gas equation, calculate the number of moles of nitrogen gas in this sample.

$$[pV = nRT \quad R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}]$$

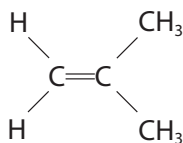
(4)

(Total for Question 22 = 18 marks)

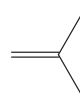


23 This question is about the alkene 2-methylpropene.

The formulae show two different ways of representing a molecule of 2-methylpropene.



formula 1



formula 2

(a) Give the **empirical** formula of 2-methylpropene.

(1)

(b) Give a reason why 2-methylpropene does **not** show geometric isomerism.

(1)

(c) Draw the mechanism for the reaction between 2-methylpropene and bromine, Br<sub>2</sub>.  
Include curly arrows, and relevant lone pairs and dipoles.  
Use formula 1 to represent 2-methylpropene.

(4)

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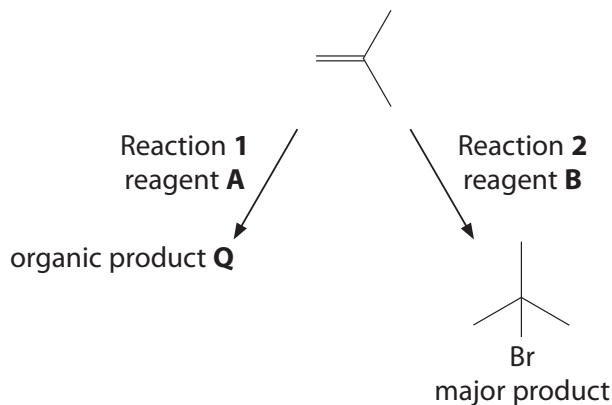
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(d) Two reactions of 2-methylpropene are shown.



- (i) In Reaction 1 the reagent **A** is acidified potassium manganate(VII).  
Give the **skeletal** formula of organic product **Q**.

(1)

- (ii) Give the colour change seen during Reaction 1.

(1)

From ..... to .....

- (iii) Identify, by name or formula, reagent **B** in Reaction 2.

(1)

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(iv) Explain why 2-bromo-2-methylpropane is the major organic product in Reaction 2. (2)

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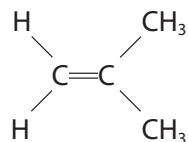
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(e) Draw **two** repeat units of poly(2-methylpropene).



2-methylpropene

(2)

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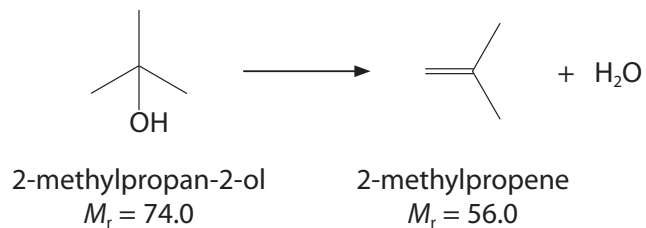
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(f) A sample of 2-methylpropene was prepared from 2-methylpropan-2-ol.



The yield of this reaction was 58.2%.

Calculate the mass of 2-methylpropene formed from 6.85 g of 2-methylpropan-2-ol.  
Give your answer to an appropriate number of significant figures.

(4)

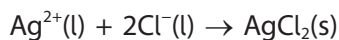
(Total for Question 23 = 17 marks)



**24** This question is about compounds containing chlorine.

- (a) A precipitate of silver chloride is formed when silver nitrate solution reacts with sodium chloride solution.

A student wrote an ionic equation for the reaction.



Explain why this equation is incorrect, even though it is balanced.

(2)

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- (b) A sample of a compound is analysed and found to contain **only** 3.09g carbon, 0.26g hydrogen and 9.15g chlorine.  
The molar mass of the compound is  $97.0 \text{ g mol}^{-1}$ .

Calculate the molecular formula of this compound.  
You **must** show your working.

(3)

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(c) Nitrogen trichloride has the formula  $\text{NCl}_3$ .

- (i) A sample of nitrogen trichloride contained only nitrogen atoms with mass number 14, and chlorine atoms with mass numbers 35 and 37.

Give the formula and mass/charge ratio for each of the **four** ions responsible for the molecular ion peaks in the mass spectrum of nitrogen trichloride.

(2)

- (ii) Complete the table to predict the shape and Cl—N—Cl bond angle in nitrogen trichloride.

(3)

Number of bonding pairs of electrons on nitrogen	
Number of lone pairs of electrons on nitrogen	
Shape of molecule	
Cl—N—Cl bond angle	



(d) Aluminium chloride exists as an ionic lattice in the solid state and as a covalent dimer,  $\text{Al}_2\text{Cl}_6$ , in the gas phase, just above its boiling temperature.

(i) Explain why aluminium chloride in the solid state has significant covalent character. (2)

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(ii) Describe how two  $\text{AlCl}_3$  molecules are joined together in the dimer. Include a diagram in your answer. (2)

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**(Total for Question 24 = 14 marks)**

**TOTAL FOR SECTION B = 60 MARKS**  
**TOTAL FOR PAPER = 80 MARKS**

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# The Periodic Table of Elements

1	2	3	4	5	6	7	0 (8)													
(1) 6.9 <b>Li</b> lithium 3	(2) 9.0 <b>Be</b> beryllium 4	(3) 45.0 <b>Sc</b> scandium 21	(4) 47.9 <b>Ti</b> titanium 22	(5) 50.9 <b>V</b> vanadium 23	(6) 52.0 <b>Cr</b> chromium 24	(7) 54.9 <b>Mn</b> manganese 25	(8) 55.8 <b>Fe</b> iron 26	(9) 58.9 <b>Co</b> cobalt 27	(10) 58.7 <b>Ni</b> nickel 28	(11) 63.5 <b>Cu</b> copper 29	(12) 65.4 <b>Zn</b> zinc 30	(13) 10.8 <b>B</b> boron 5	(14) 12.0 <b>C</b> carbon 6	(15) 14.0 <b>N</b> nitrogen 7	(16) 16.0 <b>O</b> oxygen 8	(17) 19.0 <b>F</b> fluorine 9	(18) 4.0 <b>He</b> helium 2			
23.0 <b>Na</b> sodium 11	24.3 <b>Mg</b> magnesium 12	39.1 <b>K</b> potassium 19	87.6 <b>Sr</b> strontium 37	88.9 <b>Y</b> yttrium 39	91.2 <b>Zr</b> zirconium 40	92.9 <b>Nb</b> niobium 41	95.9 <b>Mo</b> molybdenum 42	101.1 <b>Ru</b> ruthenium 44	102.9 <b>Rh</b> rhodium 45	106.4 <b>Pd</b> palladium 46	107.9 <b>Ag</b> silver 47	114.8 <b>In</b> indium 49	118.7 <b>Sn</b> tin 50	121.8 <b>Sb</b> antimony 51	127.6 <b>Te</b> tellurium 52	126.9 <b>I</b> iodine 53	131.3 <b>Xe</b> xenon 54	[222] <b>Rn</b> radon 86		
132.9 <b>Cs</b> caesium 55	137.3 <b>Ba</b> barium 56	138.9 <b>La*</b> lanthanum 57	178.5 <b>Hf</b> hafnium 72	180.9 <b>Ta</b> tantalum 73	183.8 <b>W</b> tungsten 74	186.2 <b>Re</b> rhenium 75	190.2 <b>Os</b> osmium 76	192.2 <b>Ir</b> iridium 77	195.1 <b>Pt</b> platinum 78	197.0 <b>Au</b> gold 79	200.6 <b>Hg</b> mercury 80	204.4 <b>Tl</b> thallium 81	207.2 <b>Pb</b> lead 82	209.0 <b>Bi</b> bismuth 83	[209] <b>Po</b> polonium 84	[210] <b>At</b> astatine 85	[222] <b>Rn</b> radon 86	[222] <b>Rn</b> radon 86		
[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[277] <b>Hs</b> hassium 108	[268] <b>Mt</b> meitnerium 109	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated									
140 <b>Ce</b> cerium 58	141 <b>Pr</b> praseodymium 59	144 <b>Nd</b> neodymium 60	147 <b>Pm</b> promethium 61	150 <b>Eu</b> europium 63	152 <b>Gd</b> gadolinium 64	157 <b>Tb</b> terbium 65	159 <b>Dy</b> dysprosium 66	163 <b>Ho</b> holmium 67	165 <b>Er</b> erbium 68	167 <b>Tm</b> thulium 69	173 <b>Yb</b> ytterbium 70	175 <b>Lu</b> lutetium 71	175 <b>Lu</b> lutetium 71	175 <b>Lu</b> lutetium 71	175 <b>Lu</b> lutetium 71	175 <b>Lu</b> lutetium 71	175 <b>Lu</b> lutetium 71	175 <b>Lu</b> lutetium 71	175 <b>Lu</b> lutetium 71	
232 <b>Th</b> thorium 90	[231] <b>Pa</b> protactinium 91	238 <b>U</b> uranium 92	[237] <b>Np</b> neptunium 93	[242] <b>Pu</b> plutonium 94	[243] <b>Am</b> americium 95	[245] <b>Bk</b> berkelium 97	[251] <b>Cf</b> californium 98	[254] <b>Es</b> einsteinium 99	[254] <b>Fm</b> fermium 100	[256] <b>Md</b> mendelevium 101	[254] <b>No</b> nobelium 102	[254] <b>Lr</b> lawrencium 103	[254] <b>Lr</b> lawrencium 103	[254] <b>Lr</b> lawrencium 103	[254] <b>Lr</b> lawrencium 103	[254] <b>Lr</b> lawrencium 103	[254] <b>Lr</b> lawrencium 103	[254] <b>Lr</b> lawrencium 103	[254] <b>Lr</b> lawrencium 103	[254] <b>Lr</b> lawrencium 103

\* Lanthanide series  
\* Actinide series

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