Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

Friday 13 January 2012 – Afternoon
Time: 1 hour 30 minutes

Paper Reference
6CH01/01

Candidates may use a calculator.

Total Marks

Instructions

- Use **black** ink or 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.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- A Periodic Table is printed on the back cover of this paper.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

P39295A

7/7/5/3/

P 3 9 2 9 5 A 0 1 2 4

PEARSON

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 A molecule is

☒ **A** a group of atoms bonded by ionic bonds.

☒ **B** a group of atoms bonded by covalent bonds.

☒ **C** a group of ions bonded by covalent bonds.

☒ **D** a group of atoms bonded by metallic bonds.

(Total for Question 1 = 1 mark)

2 The relative atomic mass is defined as

☒ **A** the mass of an atom of an element relative to 1/12 the mass of a carbon-12 atom.

☒ **B** the mass of an atom of an element relative to the mass of a hydrogen atom.

☒ **C** the average mass of an element relative to 1/12 the mass of a carbon atom.

☒ **D** the average mass of an atom of an element relative to 1/12 the mass of a carbon-12 atom.

(Total for Question 2 = 1 mark)

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

3 The definition of the mole is

☒ **A** the amount of any substance which occupies a volume of 24 dm^3 at room temperature and pressure.

☒ **B** the amount of any substance containing the same number of identical entities as there are in exactly 12 g of the carbon-12 isotope.

☒ **C** the number of atoms in exactly 12 g of the carbon-12 isotope.

☒ **D** the number of molecules in exactly 2 g of hydrogen at room temperature and pressure.

(Total for Question 3 = 1 mark)

---

4 The concentration of blood glucose is usually given in millimoles per dm^3 or mmol dm^{-3}. A reading of 5.0 mmol dm^{-3} is within the normal range. Glucose has a molar mass of 180 g mol^{-1}. What mass of glucose dissolved in 1 dm^3 of blood would give this normal reading?

☒ **A** 0.090 g

☒ **B** 0.18 g

☒ **C** 0.90 g

☒ **D** 9.0 g

(Total for Question 4 = 1 mark)

---

5 In an experiment performed to measure the enthalpy change for the reaction

$$Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$$

3.0 g of zinc powder (an excess) was added to 30.0 cm^3 of copper(II) sulfate solution of concentration 1.00 mol dm^{-3}. The temperature rise of the mixture was 47.6 K. Assuming that the heat capacity of the solution is 4.2 J K^{-1} g^{-1}, the enthalpy change for the reaction is given by

☒ **A** $\Delta H = -(30 \times 4.2 \times 47.6) \div 0.03$

☒ **B** $\Delta H = -(33 \times 4.2 \times 47.6) \div 0.03$

☒ **C** $\Delta H = -(30 \times 4.2 \times 47.6) \times 0.03$

☒ **D** $\Delta H = -(33 \times 4.2 \times 47.6) \times 0.03$

(Total for Question 5 = 1 mark)

---

6 The enthalpy change of atomization of iodine is the value of ΔH for the process

☒ **A** $I_2(s) \rightarrow I_2(g)$

☒ **B** $I_2(s) \rightarrow 2I(g)$

☒ **C** $I_2(g) \rightarrow 2I(g)$

☒ **D** $\frac{1}{2}I_2(s) \rightarrow I(g)$

(Total for Question 6 = 1 mark)

7 The enthalpy change for the reaction

$$C(s, \text{graphite}) + \tfrac{1}{2}O_2(g) \rightarrow CO(g)$$

cannot be measured directly since some carbon dioxide is always formed in the reaction. It can be calculated using Hess's Law and the enthalpy changes of combustion of graphite and of carbon monoxide.

$$C(s, \text{graphite}) + O_2(g) \rightarrow CO_2(g) \quad \Delta H = -394 \text{ kJ mol}^{-1}$$

$$CO(g) + \tfrac{1}{2}O_2(g) \rightarrow CO_2(g) \quad \Delta H = -283 \text{ kJ mol}^{-1}$$

The enthalpy change for the reaction of graphite with oxygen to give carbon monoxide is

☒ **A** -677 kJ mol^{-1}

☒ **B** $+111 \text{ kJ mol}^{-1}$

☒ **C** -111 kJ mol^{-1}

☒ **D** $+677 \text{ kJ mol}^{-1}$

(Total for Question 7 = 1 mark)

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

8 The molar enthalpy change of combustion of some alkanes is given below in kJ mol^{-1}.

C_3H_8	−2219
C_4H_{10}	−2877
C_5H_{12}	−3509
C_6H_{14}	−4163

Another alkane was found to have an enthalpy change of combustion of −6125 kJ mol^{-1}.
The alkane is

☒ **A** C_7H_{16}

☒ **B** C_8H_{18}

☒ **C** C_9H_{20}

☒ **D** $C_{10}H_{22}$

(Total for Question 8 = 1 mark)

---

9 If the mean C—H bond enthalpy is **+*x***, which of the following represents a process with an enthalpy change of **+4*x***?

☒ **A** $C(g) + 4H(g) \rightarrow CH_4(g)$

☒ **B** $CH_4(g) \rightarrow C(g) + 4H(g)$

☒ **C** $CH_4(g) \rightarrow C(s, \text{graphite}) + 2H_2(g)$

☒ **D** $C(s, \text{graphite}) + 2H_2(g) \rightarrow CH_4(g)$

(Total for Question 9 = 1 mark)

---

10 The first eight ionization energies of an element are (in kJ mol^{-1}):

789, 1577, 3232, 4356, 16091, 19785, 23787, 29253.

The element is in

☒ **A** Group 1

☒ **B** Group 2

☒ **C** Group 3

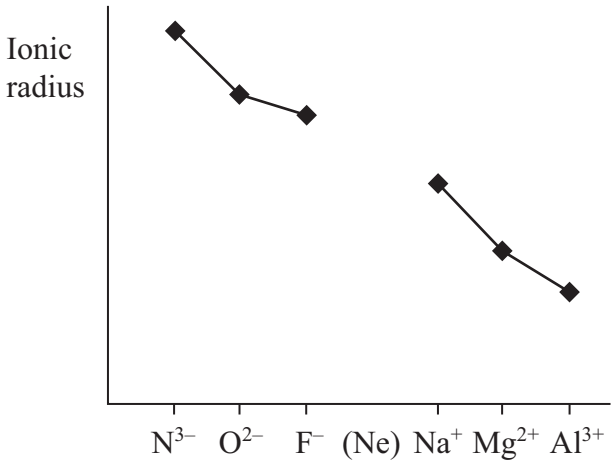
☒ **D** Group 4

(Total for Question 10 = 1 mark)

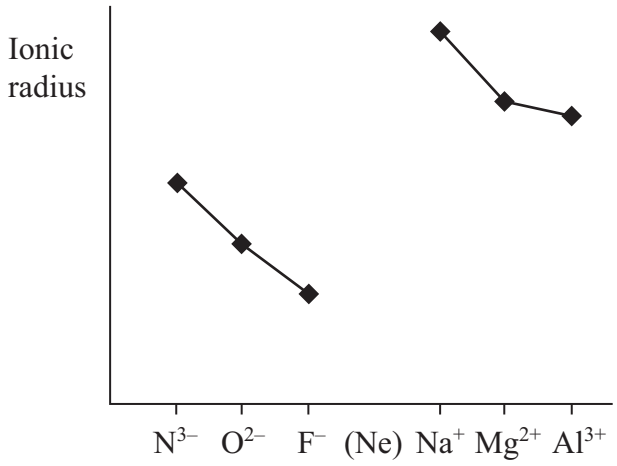
---

11 Which of the graphs shows (from left to right) the trend in the ionic radius of the isoelectronic ions N^{3-}, O^{2-}, F^-, Na^+, Mg^{2+}, Al^{3+}?

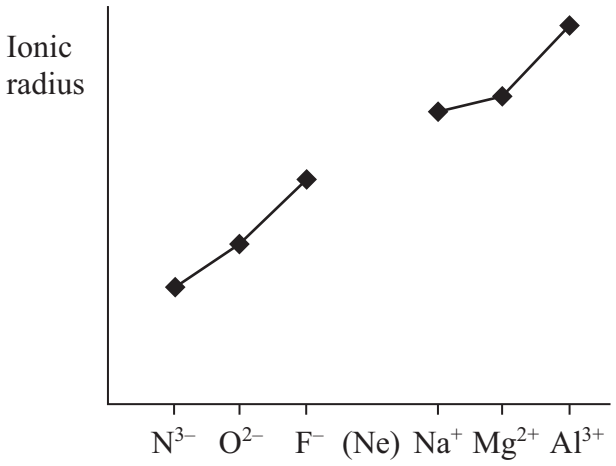
☒ **A**



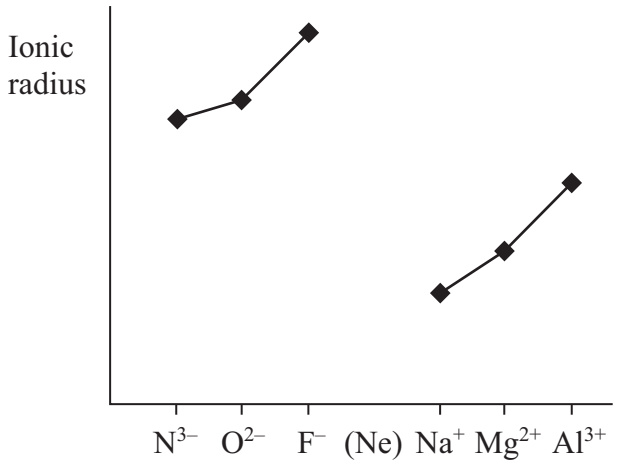
☒ **B**



☒ **C**



☒ **D**



(Total for Question 11 = 1 mark)

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

12 Oxygen can be prepared using several different reactions. Which of those given below has the highest atom economy by mass?

☒ **A** $NaNO_3 \rightarrow NaNO_2 + ½O_2$

☒ **B** $H_2O_2 \rightarrow H_2O + ½O_2$

☒ **C** $Cl_2 + H_2O \rightarrow 2HCl + ½O_2$

☒ **D** $PbO_2 \rightarrow PbO + ½O_2$

(Total for Question 12 = 1 mark)

---

13 The ionic radii in nm of some ions are given below.

Li^+	0.074	F^-	0.133
Ca^{2+}	0.100	Cl^-	0.180
		O^{2-}	0.140
		S^{2-}	0.185

(a) Which of the following compounds has the most exothermic lattice energy? They all have the same crystal structure.

(1)

☒ **A** LiF

☒ **B** LiCl

☒ **C** CaO

☒ **D** CaS

(b) Which of the following compounds will show the greatest difference between the experimental (Born-Haber) lattice energy and that calculated from a purely ionic model?

(1)

☒ **A** LiF

☒ **B** Li_2O

☒ **C** CaO

☒ **D** CaS

(Total for Question 13 = 2 marks)

---

14 Which of the following is the correct order for the processes used to obtain petrol from petroleum (crude oil)?

☒ **A** Petroleum → fractional distillation → reforming → cracking → petrol.

☒ **B** Petroleum → reforming → fractional distillation → cracking → petrol.

☒ **C** Petroleum → cracking → reforming → fractional distillation → petrol.

☒ **D** Petroleum → fractional distillation → cracking → reforming → petrol.

(Total for Question 14 = 1 mark)

15 In the reaction between ethene and bromine, the bromine molecule acts as an electrophile.

$$CH_2{=}CH_2 + Br_2 \rightarrow BrCH_2CH_2Br$$

Which of the following statements is true?

☒ **A** Ethene acts as a nucleophile because it is polar.

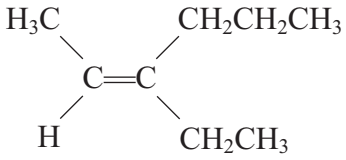
☒ **B** Ethene acts as a nucleophile because it can donate a pair of electrons to bromine.

☒ **C** Ethene is not a nucleophile in this reaction.

☒ **D** Ethene acts as a nucleophile because it donates a single electron to bromine.

(Total for Question 15 = 1 mark)

16 Name the alkene shown below.



☒ **A** *Z*-4-ethylhex-4-ene

☒ **B** *E*-3-ethylhex-2-ene

☒ **C** *Z*-3-ethylhex-2-ene

☒ **D** *E*-3-propylpent-2-ene

(Total for Question 16 = 1 mark)

17 If propene, $CH_3CH{=}CH_2$, is reacted with aqueous acidified potassium manganate(VII) the organic product is

☒ **A** $CH_3CH(OH)CH_2OH$

☒ **B** $CH_3CH(OH)CH_3$

☒ **C** $HOCH_2CH_2CH_2OH$

☒ **D** $CH_3CH_2CH_2OH$

(Total for Question 17 = 1 mark)

18 How many compounds have the formula C_5H_{12}?

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(Total for Question 18 = 1 mark)

19 An organic compound reacts with chlorine in the presence of ultraviolet light. The relative molecular mass of the product has increased by 34.5 compared with the original compound. What is the reaction mechanism?

☒ **A** Free radical substitution

☒ **B** Electrophilic substitution

☒ **C** Nucleophilic substitution

☒ **D** Free radical addition

(Total for Question 19 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

20 (a) An impure sample of sodium hydrogencarbonate, $NaHCO_3$, of mass 0.227 g, was reacted with an excess of hydrochloric acid. The volume of carbon dioxide evolved was measured at room temperature and pressure and found to be 58.4 cm^3.

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

The molar volume of any gas at the temperature and pressure of the experiment is 24 $dm^3\ mol^{-1}$. The molar mass of sodium hydrogencarbonate is 84 $g\ mol^{-1}$.

(i) Calculate the number of moles of carbon dioxide given off.

(1)

(ii) Calculate the mass of sodium hydrogencarbonate present in the impure sample.

(2)

(iii) Calculate the percentage purity of the sodium hydrogencarbonate. Give your answer to two significant figures.

(2)

(b) (i) The total error in reading the gas syringe is ±0.4 cm^3. Calculate the percentage error in measuring the gas volume of 58.4 cm^3.

(1)

(ii) Suggest why the carbon dioxide should not be collected over water in this experiment.

(1)

.....

.....

(Total for Question 20 = 7 marks)

21 (a) On strong heating, calcium carbonate decomposes to calcium oxide and carbon dioxide:

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

Owing to the conditions under which the reaction occurs, it is not possible to measure the enthalpy change directly.

An indirect method employs the enthalpy changes when calcium carbonate and calcium oxide are neutralized with hydrochloric acid.

(i) Write the equation for the reaction of calcium carbonate with hydrochloric acid. State symbols are **not** required.

[$\boldsymbol{\Delta H}_1$ is the enthalpy change for this reaction]

(1)

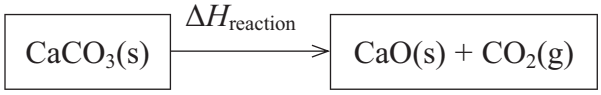
.....$\boldsymbol{\Delta H}_1$

(ii) The reaction of calcium oxide with hydrochloric acid is

$$CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) \qquad \boldsymbol{\Delta H}_2$$

Use the equations in parts (i) and (ii) to complete the Hess's Law cycle below to show how you could calculate the enthalpy change for the decomposition of calcium carbonate, $\Delta H_{reaction}$. Label the arrows in your cycle.

(3)



(iii) Complete the expression for $\Delta H_{reaction}$ in terms of $\mathbf{\Delta H_1}$ and $\mathbf{\Delta H_2}$.

(1)

$\Delta H_{reaction}$ =

(b) Suggest **two** reasons why the value obtained by carrying out these two experiments and using the equation gives a value different to the data booklet value for the decomposition reaction of calcium carbonate.

(2)

1 .....

.....

2 .....

.....

(Total for Question 21 = 7 marks)

BLANK PAGE

22 (a) State how the following processes are achieved in a mass spectrometer.

(i) Ionization of the sample.

(1)

(ii) Acceleration of the ions.

(1)

(iii) Deflection of the ions.

(1)

(b) State how you could find the molecular mass of a substance from its mass spectrum.

(1)

(c) Living things take up the radioactive isotope carbon-14 from the atmosphere. In recent years a particular linen cloth was shown, using mass spectrometry, to have been made from flax grown in the early 14th century. Suggest how mass spectrometry can be used to estimate the age of the cloth.

(2)

(Total for Question 22 = 6 marks)

***23** The melting temperatures of the elements of Period 3 are given in the table below. Use these values to answer the questions that follow.

Element	Na	Mg	Al	Si	P (white)	S (monoclinic)	Cl	Ar
Melting temperature / K	371	922	933	1683	317	392	172	84

(a) Explain why the melting temperature of sodium is very much less than that of magnesium.

(3)

(b) Explain why the melting temperature of silicon is very much greater than that of white phosphorus.

(3)

(c) Explain why the melting temperature of argon is the lowest of all the elements of Period 3.

(1)

.....

.....

(d) Explain why magnesium is a good conductor of electricity whereas sulfur is a non-conductor.

(2)

.....

.....

.....

.....

(Total for Question 23 = 9 marks)

24 (a) Briefly describe an experiment, with a diagram of the apparatus you would use, which shows that there are oppositely charged ions in copper(II) chromate(VI), $CuCrO_4$. Describe what you would expect to see.

Formula of ion	Colour
$Cu^{2+}(aq)$	blue
$CrO_4^{2-}(aq)$	yellow

(4)

Diagram

(b) The ions in an ionic lattice are held together by an **overall** force of attraction.

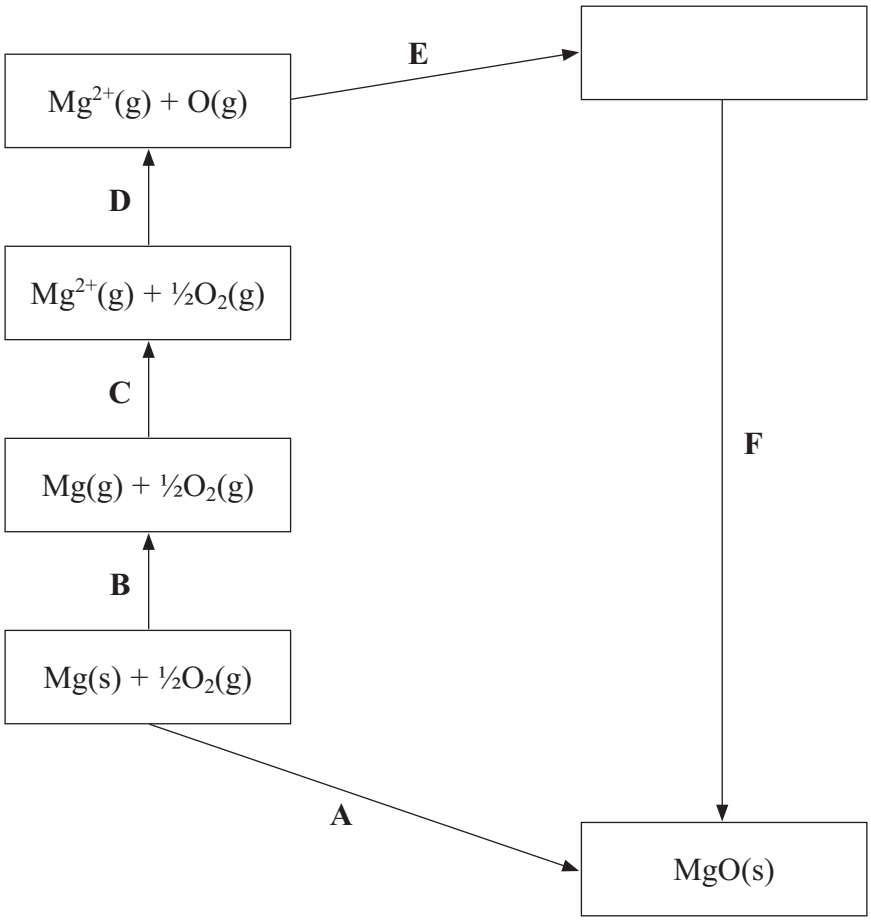
(i) Describe the forces of attraction in an ionic lattice.

(1)

(ii) Suggest **two** forces of repulsion which exist in an ionic lattice.

(2)

(c) Part of the Born-Haber cycle for magnesium oxide, MgO, is shown below.



(i) Complete the empty box with the appropriate formulae and state symbols.

(2)

(ii) Identify the enthalpy changes represented by the letters **A** and **C**.

(2)

A .....

C .....

(iii) Give the expression for the enthalpy change **F** in terms of the other enthalpy changes **A** to **E**.

(1)

F =

(d) The lattice composed of the ions Mg^{2+} and O^{2-} is stronger than a lattice composed of the ions Mg^{+} and O^{-}.

(i) Explain, in terms of the charges on the ions and the size of the cations, why this is so.

(2)

.....

.....

.....

.....

(ii) Suggest how the lattice energy of $Mg^{2+}O^{2-}$ would differ from that of $Mg^{+}O^{-}$.

(1)

.....

.....

(Total for Question 24 = 15 marks)

25 Chloroethane can be made from ethane and chlorine in the gas phase in the presence of ultraviolet light. The equation for the reaction is

$$CH_3CH_3 + Cl_2 \rightarrow CH_3CH_2Cl + HCl$$

(a) Complete the mechanism for the reaction. Two of the steps have been given for you.

(4)

Initiation: $Cl_2 \rightarrow 2Cl\cdot$

Propagation (two steps)

(i)

(ii)

Termination (three steps)

$2Cl\cdot \rightarrow Cl_2$

(iii)

(iv)

(b) This reaction gives a poor yield of chloroethane. Give the structural formula and name of another organic product, not included in your mechanism for part (a), which could be produced in the reaction.

(2)

Formula

Name .....

(c) Chlorine gas is extremely toxic and is therefore a significant hazard. The preparation must be performed so as to minimise the risk to the experimenter.

(i) Explain the difference between **hazard** and **risk**.

(2)

.....

.....

.....

.....

(ii) Give one precaution that you would use in this experiment to minimise the risk, other than the use of a laboratory coat and safety goggles.

(1)

.....

.....

(Total for Question 25 = 9 marks)

26 (a) The alkenes have the general formula C_nH_{2n}. However, a compound with this general formula is not necessarily an alkene. Suggest why this is so.

(1)

.....

.....

.....

(b) Give the equation, using skeletal formulae, for the reaction of propene with each of the following.

(i) Hydrogen:

(1)

(ii) Hydrogen bromide to form the major product:

(2)

(c) Give the mechanism for the reaction of propene with hydrogen bromide, HBr, to form the major product.

(3)

(Total for Question 26 = 7 marks)

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

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)											(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] 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	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

Elements with atomic numbers 112-116 have been reported but not fully authenticated

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	163 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

* Lanthanide series

* Actinide series