The King's School Canterbury

Sixth Form Entrance 2015

CHEMISTRY

1 hour

Name (Capital Letters): .....

Present School: ……

Answer ALL the questions

TOTAL MARK = 70

Answers to Section A should be answered on the question paper.
Answers to Section B should be written on the blank pages at the end of the question paper.
A copy of the Periodic Table is included with the question paper (back page).

If you know the name of the examination board and the title of the chemistry course you are currently studying e.g. AQA Chemistry, Edexcel, OCR Gateway or 21st Century Science, IGCSE write it below. Indicate if you are doing Triple Science (i.e. you will get separate grades in Biology, Chemistry and Physics) or Double Science.

Board_____ Course_____ Triple/Double _____

SECTION A

Q1 Use the Periodic Table to help you with this question.
Complete the table below by putting in the missing symbols or numbers.

Symbol	Number of protons	Number of neutrons	Mass number	Electron arrangement
O	8	8		
	17		37	2.8.7
S^{2-}			32	

[TOTAL = 7]

Q2 (a) You are given the formulae of the following ions. Write the chemical formula of the following substances. The first one is shown as an example.

Ion	Formula	Ion	Formula
Ammonium	NH_4^+	Iodide	I^-
Magnesium	Mg^{2+}	Nitride	N^{3-}
Lithium	Li^+	Hydroxide	OH^-
Potassium	K^+	Hydrogencarbonate	HCO_3^-
Lead(II)	Pb^{2+}	Carbonate	CO_3^{2-}
Iron(III)	Fe^{3+}	Sulfate	SO_4^{2-}
Barium	Ba^{2+}	Nitrate	NO_3^-

Example: barium hydroxide $Ba(OH)_2$

(i) ammonium nitrate.....

(ii) Magnesium nitride.....

(iii) Barium hydrogencarbonate.....

(iv) Iron(III) hydroxide.....

(v) Lead nitride.....

[5]

(b) Put numbers in front of the formulae as necessary to balance the equations below:

(i) .....Cs + ...H_2O → .....CsOH + ...H_2

(ii) .....Fe_2O_3 + ...C → .....Fe + ...CO

(iii) .....C_9H_{20} + ...O_2 → .....CO_2 + ...H_2O

(iv) ..... $Al_2(SO_4)_3$ + ...$Mg(OH)_2$ → .....$Al(OH)_3$ + ...$MgSO_4$

[4]

[TOTAL = 9]

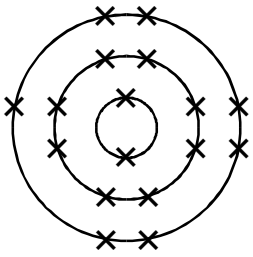
Q3 Atoms are made of electrons, neutrons and protons.

(a) Complete the table to show the relative mass and charge of an electron, neutron and proton.

particle	**relative mass**	**relative charge**
electron		-1
neutron	1	
proton		

[4]

(b) The diagram shows the electronic structure of an atom of an element.



(i) Name the element of which this is an atom.

Explain your answer.

.....

.....

[2]

(ii) What is the atomic number of this element?

.....

[1]

(c) The table below shows some information about the isotopes of neon.

Isotope	**Mass Number**	**Abundance**
Lead - 207	207	90.1%
Lead - 208	208	3.4%
Lead - 210	210	6.5%

(i) What is the definition of an isotope?

…….....

…….....

…….....

…….....

[2]

(ii) Calculate the relative atomic mass of lead.

…….....

…….....

……...…….....

…….....

[2]

[TOTAL = 11]

Q4 The following table gives some information about several substances.

Substance	Melting point / °C	Boiling point / °C	Electrical conductivity when solid	Electrical conductivity when molten	Solubility in water
A	705	1445	poor	good	soluble
B	1635	3350	good	good	insoluble
C	-111	-45	poor	poor	soluble
D	-25	154	poor	poor	insoluble
E	1435	2295	poor	poor	insoluble

For each of the substances, A to E, decided the type of bonding **and** structure present. Circle the correct answers below.

(a) **A**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

(b) **B**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

(c) **C**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

(d) **D**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

(e) **E**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

[TOTAL = 5]

Q5 (a) Draw a dot-cross diagram to show the bonding in an methane molecule. Show the outer shell electrons only. Name the type of bonding.

[3]

(b) Draw one molecule of butane and one molecule of butene, showing all the bonds.

butane	butene

[4]

(c) Define the term isomerism

……

……

[2]

[TOTAL = 9]

Q6 Sodium nitrate decomposes on strong heating as shown:

$$2KNO_3(s) \rightarrow 2KNO_2(s) + O_2(g)$$

If 51.0 g of potassium nitrate was completely decomposed by heating, what mass of solid would remain? Show full working including relevant equations used with appropriate units for each calculation.

[TOTAL = 6]

Q8 Hydrogen peroxide (H_2O_2) decomposes slowly at room temperature to form oxygen and water.

(a) Write a balanced equation for this reaction including the relevant state symbols.

.....

[3]

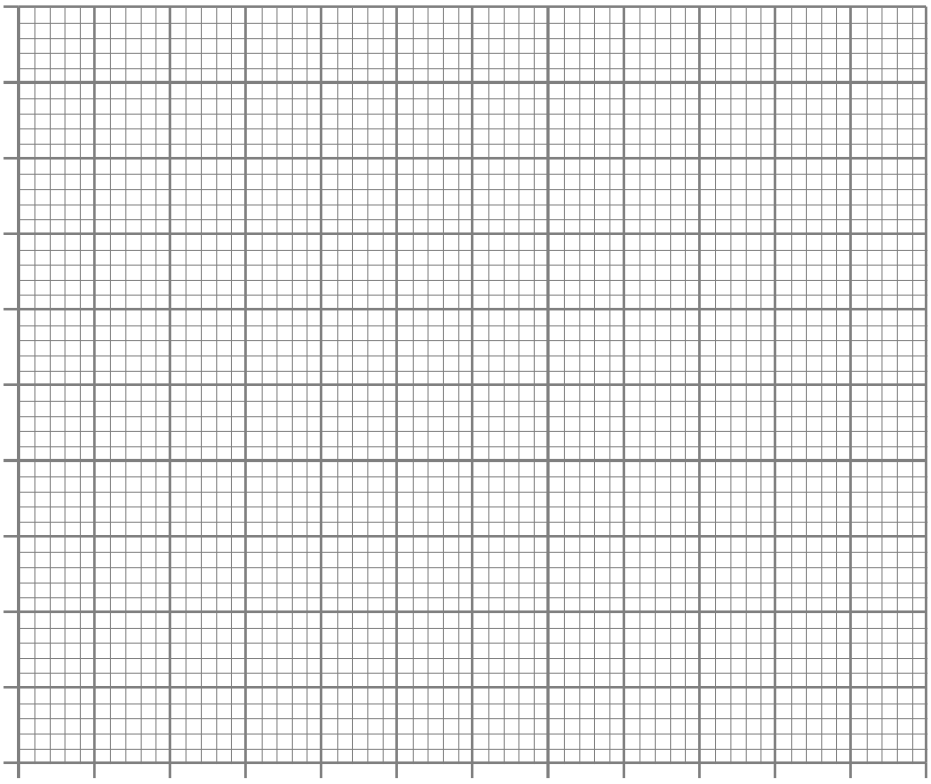
(b) Iron (III) oxide acts as a catalyst for this reaction.

Andy added 1.0 g of Iron (III) oxide to 35 cm^3 of hydrogen peroxide solution at room temperature.
He measured the total volume of oxygen given off at one minute intervals.
His results are shown in the table.

Time (minutes)	0	1	2	3	4	5
Total volume of oxygen (cm^3)	0	62	80	94	96	96

Draw a graph of total volume of oxygen produced against time.

Total volume of oxygen in cm^3



Time in minutes

[3]

(c) At the end of the experiment Andy filtered off the oxide.
What mass of oxide would you expect to be left?

.....

[1]

(d) Define catalyst

.....

.....

[1]

(e) Andy then added 1.0 g of a different oxide to a fresh 20 cm^3 sample of hydrogen peroxide solution at the same temperature.
Again he measured the volume of oxygen produced at one minute intervals.
From his results he concluded that this different oxide was a better catalyst than manganese(IV) oxide.
Add a line to your graph to show results which would support this conclusion. Label this new line "Oxide".

[2]

(f) Draw a labelled diagram to illustrate the apparatus you would use to investigate this reaction and collect and measure the volume of gas produced.

[3]
[TOTAL = 13]

SECTION B

Write your answers to this section on the blank pages which follow.

Write notes on **TWO** of the following [5 marks each]. Use diagrams and chemical equations where relevant.

(a) Fractional distillation

(b) The industrial manufacture of sulphuric acid

(c) The mole concept

(d) The bonding and structure of sodium and water

(e) The formation of *soluble* salts

(f) The manufacture of iron from its ore (include all relevant equations)

(g) The structures, properties and uses of **TWO** polymers

SECTION B ANSWER

SECTION B ANSWER (continued)

SECTION B ANSWER (continued)

THE PERIODIC TABLE

Key

Atomic Number
Symbol
Name
Molar mass in g mol^{-1}

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

► **Lanthanide elements**

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

►► **Actinide elements**

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

THE KING'S SCHOOL, CANTERBURY

SIXTH FORM ENTRANCE EXAMINATION

2014-2015

CHEMISTRY

1 Hour

Name (Capital Letters): .....

Present School: …….

Answer ALL the questions

TOTAL MARK = 70

Answers to Section A should be answered on the question paper.
Answers to Section B should be written on the blank pages at the end of the question paper.
A copy of the Periodic Table is included with the question paper (back page).

If you know the name of the examination board and the title of the chemistry course you are currently studying e.g. AQA Chemistry, Edexcel, OCR Gateway or 21st Century Science, IGCSE write it below. Indicate if you are doing Triple Science (i.e. you will get separate grades in Biology, Chemistry and Physics) or Double Science.

Board_____ Course_____ Triple/Double _____

SECTION A

Q1 Use the Periodic Table to help you with this question.
Complete the table below by putting in the missing symbols or numbers.

Symbol	Number of protons	Number of neutrons	Mass number	Electron arrangement
Si	14	14		
	13		27	2.8.2
O^{2-}			16	

[TOTAL = 7]

Q2 (a) You are given the formulae of the following ions. Write the chemical formula of the following substances. The first one is shown as an example.

Ion	Formula	Ion	Formula
Ammonium	NH_4^+	Iodide	I^-
Magnesium	Mg^{2+}	Nitride	N^{3-}
Lithium	Li^+	Hydroxide	OH^-
Potassium	K^+	Hydrogencarbonate	HCO_3^-
Lead(II)	Pb^{2+}	Carbonate	CO_3^{2-}
Iron(III)	Fe^{3+}	Sulfate	SO_4^{2-}
Barium	Ba^{2+}	Nitrate	NO_3^-

Example: barium hydroxide $Ba(OH)_2$

(i) lead(II) carbonate.....

(ii) Potassium nitride.....

(iii) ammonium hydroxide.....

(iv) ammonium sulfate.....

(v) iron(III) hydrogencarbonate.....

[5]

(b) Put numbers in front of the formulae as necessary to balance the equations below:

(i) .....Na + ...H_2O → .....NaOH + ...H_2

(ii) .....Fe_2O_3 + ...CO → .....Fe + ...CO_2

(iii) .....C_7H_{16} + ...O_2 → .....CO_2 + ...H_2O

(iv) ..... $Al_2(SO_4)_3$ + ...NaOH → .....$Al(OH)_3$ + ...Na_2SO_4

[4]

[TOTAL = 9]

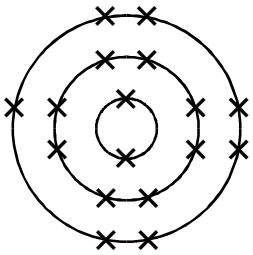
Q3 Atoms are made of electrons, neutrons and protons.

(a) Complete the table to show the relative mass and charge of an electron, neutron and proton.

particle	**relative mass**	**relative charge**
electron	1/1840	
neutron		0
proton		

[4]

(b) The diagram shows the electronic structure of an atom of an element.



(i) Name the element of which this is an atom.

Explain your answer.

.....

.....

[2]

(ii) What is the atomic number of this element?

.....

[1]

(c) The table below shows some information about the isotopes of neon.

Isotope	**Mass Number**	**Abundance**
arsenic-74	74	9%
arsenic-75	75	91%

(i) What is the definition of an isotope?

…….....

…….....

…….....

…….....

[2]

(ii) Calculate the relative atomic mass of arsenic.

…….....

…….....

……...…….....

…….....

[2]

[TOTAL = 11]

Q4 The following table gives some information about several substances.

Substance	Melting point / °C	Boiling point / °C	Electrical conductivity when solid	Electrical conductivity when molten	Solubility in water
A	1410	2355	poor	poor	insoluble
B	-25	144	poor	poor	insoluble
C	712	1418	poor	good	soluble
D	-101	-35	poor	poor	soluble
E	1660	3287	good	good	insoluble

For each of the substances, A to E, decided the type of bonding **and** structure present. Circle the correct answers below.

(a) **A**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

(b) **B**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

(c) **C**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

(d) **D**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

(e) **E**: Bonding – Covalent / Ionic / Metallic
Structure – Giant / Simple Molecular

[TOTAL = 5]

Q5 (a) Draw a dot-cross diagram to show the bonding in an ammonia molecule. Show the outer shell electrons only. Name the type of bonding.

[3]

(b) Draw one molecule of ethane and one molecule of ethene, showing all the bonds.

ethane	ethene

[4]
[TOTAL = 7]

Q6 Molten, impure iron is made from iron ore in the blast furnace.

(a) In the blast furnace, reducing agents change iron ore into iron.

Give the name of ONE substance which can act as a reducing agent in the blast furnace.

……

[1]

(b) The main impurity in iron ore is silicon dioxide (SiO_2).

Describe how this is removed.

Give the name of the raw material which must be present to remove this impurity and describe the reactions involved, naming the waste product formed.

You should include equations for the chemical reactions taking place.

……

……

……

……

……

……

……

……

……

[5]
[TOTAL = 6]

Q7 Sodium nitrate decomposes on strong heating as shown:

$$2KNO_3(s) \rightarrow 2KNO_2(s) + O_2(g)$$

If 51.0 g of potassium nitrate was completely decomposed by heating, what mass of solid would remain? Show full working.

[TOTAL = 4]

Q8 Hydrogen peroxide (H_2O_2) decomposes slowly at room temperature to form oxygen and water.

(a) Write a balanced equation for this reaction.

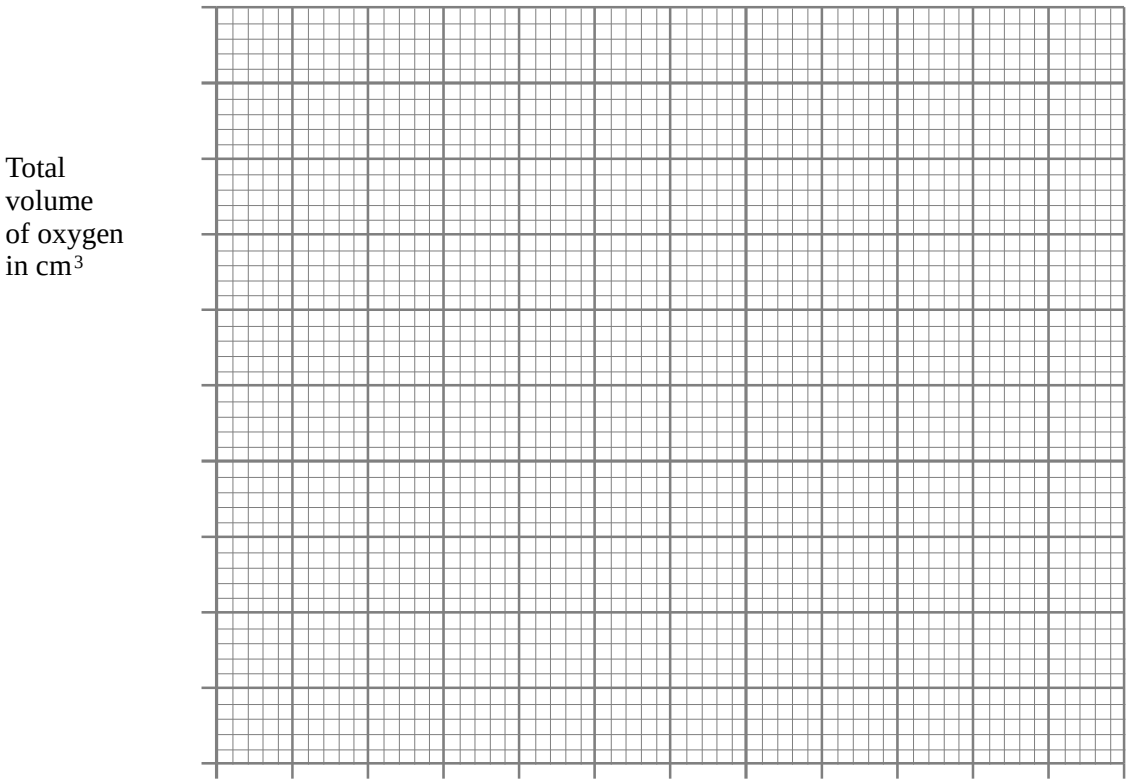
.....

[2]

(b) Manganese(IV) oxide acts as a catalyst for this reaction.
Andy added 1.0 g of manganese(IV) oxide to 20 cm^3 of hydrogen peroxide solution at room temperature.
He measured the total volume of oxygen given off at one minute intervals.
His results are shown in the table.

Time (minutes)	0	1	2	3	4	5
Total volume of oxygen (cm^3)	0	31	41	46	48	48

Draw a graph of total volume of oxygen produced against time.



[3]

(c) At the end of the experiment Andy filtered off the oxide.
What mass of oxide would you expect to be left?

.....

[1]

(d) Andy then added 1.0 g of a different oxide to a fresh 20 cm^3 sample of hydrogen peroxide solution at the same temperature.
Again he measured the volume of oxygen produced at one minute intervals.
From his results he concluded that this different oxide was a better catalyst than manganese(IV) oxide.
Add a line to your graph to show results which would support this conclusion. Label this new line "Oxide".

[2]

(e) Draw a labelled diagram to illustrate the apparatus you would use to investigate this reaction and collect and measure the volume of gas produced.

[3]
[TOTAL = 11]

SECTION B

Write your answers to this section on the blank pages which follow.

Write notes on **TWO** of the following [5 marks each]. Use diagrams and chemical equations where relevant.

(a) Cracking

(b) The structures, properties and uses of **TWO** polymers

(c) The mole concept

(d) Catalysts

(e) The bonding and structure of graphite and diamond

(f) The formation of *insoluble* salts

(g) The manufacture of aluminium from its ore

(h) The industrial manufacture of ammonia

SECTION B ANSWER

SECTION B ANSWER (continued)

THE PERIODIC TABLE

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

Key

Atomic Number
Symbol
Name
Molar mass in g mol^{-1}

► **Lanthanide elements**	58 **Ce** Cerium 140	59 **Pr** Praseodymium 141	60 **Nd** Neodimium 144	61 **Pm** Promethium (147)	62 **Sm** Samarium 150	63 **Eu** Europium 152	64 **Gd** Gadolinium 157	65 **Tb** Terbium 159	66 **Dy** Dysprosium 163	67 **Ho** Holmium 165	68 **Er** Erbium 167	69 **Tm** Thulium 169	70 **Yb** Ytterbium 173	71 **Lu** Lutetium 175
►► **Actinide elements**	90 **Th** Thorium 232	91 **Pa** Protactinium (231)	92 **U** Uranium 238	93 **Np** Neptunium (237)	94 **Pu** Plutonium (242)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (245)	98 **Cf** Californium (251)	99 **Es** Einsteinium (254)	100 **Fm** Fermium (253)	101 **Md** Mendelevium (256)	102 **No** Nobelium (254)	103 **Lr** Lawrencium (257)