Write your name here

Surname	Other names

Edexcel GCE

Centre Number	Candidate Number

Chemistry

Advanced Subsidiary
Unit 1: The Core Principles of Chemistry

Thursday 10 January 2013 – Morning
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 ▶

P41212A

7/6/5/5/4/5/

P 4 1 2 1 2 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 When aqueous solutions of barium chloride and potassium sulfate are mixed, a white precipitate forms. The ionic equation for the reaction is

☒ **A** $K^+(aq) + Cl^-(aq) \rightarrow KCl(s)$

☒ **B** $K^{2+}(aq) + 2Cl^-(aq) \rightarrow KCl_2(s)$

☒ **C** $Ba^+(aq) + SO_4^-(aq) \rightarrow BaSO_4(s)$

☒ **D** $Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

(Total for Question 1 = 1 mark)

2 Which of the following processes has the highest atom economy?

☒ **A** Making poly(ethene) from ethene.

☒ **B** Making ethene from eicosane, $C_{20}H_{42}$.

☒ **C** Making chloromethane from methane.

☒ **D** Making magnesium chloride from magnesium and hydrochloric acid.

(Total for Question 2 = 1 mark)

3 How many molecules are present in 16 g of oxygen gas, $O_2(g)$?

[Avogadro constant = 6×10^{23} mol^{-1}]

☒ **A** 96×10^{23}

☒ **B** 12×10^{23}

☒ **C** 6×10^{23}

☒ **D** 3×10^{23}

(Total for Question 3 = 1 mark)

4 Nickel(II) sulfate is prepared by adding an excess of nickel(II) carbonate to 0.010 mol of dilute sulfuric acid.

$$NiCO_3(s) + H_2SO_4(aq) \rightarrow NiSO_4(aq) + H_2O(l) + CO_2(g)$$

Solid nickel(II) sulfate crystals are produced with a 20% yield. How many moles of nickel(II) sulfate crystals are obtained?

☒ **A** 0.001

☒ **B** 0.002

☒ **C** 0.010

☒ **D** 0.050

(Total for Question 4 = 1 mark)

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5 When 0.635 g of copper (relative atomic mass, RAM = 63.5) is added to an excess of silver nitrate solution, 2.158 g of silver (RAM = 107.9) form. The ionic equation for the reaction is

☒ **A** $Cu(s) + Ag^{2+}(aq) \rightarrow Cu^{2+}(aq) + Ag(s)$

☒ **B** $Cu(s) + Ag^{+}(aq) \rightarrow Cu^{+}(aq) + Ag(s)$

☒ **C** $2Cu(s) + Ag^{2+}(aq) \rightarrow 2Cu^{+}(aq) + Ag(s)$

☒ **D** $Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$

(Total for Question 5 = 1 mark)

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6 In an experiment to measure the enthalpy change of a reaction involving gases, which of the following conditions must always be kept constant?

☒ **A** Pressure

☒ **B** Temperature

☒ **C** Volume

☒ **D** Temperature and pressure

(Total for Question 6 = 1 mark)

---

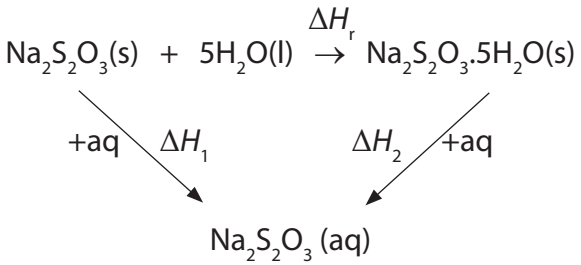
7 In an endothermic reaction in aqueous solution, which of the following is correct?

	Temperature	Sign of enthalpy change
☒ **A**	Increases	Positive
☒ **B**	Increases	Negative
☒ **C**	Decreases	Positive
☒ **D**	Decreases	Negative

(Total for Question 7 = 1 mark)

8 The enthalpy change for the reaction to form hydrated sodium thiosulfate crystals cannot be measured directly.

The following Hess cycle can be used.



The enthalpy change for the reaction, ΔH_r, is equal to

☒ **A** $\Delta H_1 + \Delta H_2$

☒ **B** $\Delta H_1 - \Delta H_2$

☒ **C** $-\Delta H_1 - \Delta H_2$

☒ **D** $-\Delta H_1 + \Delta H_2$

(Total for Question 8 = 1 mark)

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

9 When 10 cm^3 of 2 mol dm^{-3} hydrochloric acid is reacted with 10 cm^3 of 2 mol dm^{-3} sodium hydroxide solution, the temperature change is ΔT.

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

When the reaction is repeated with 50 cm^3 of each solution, the temperature change is

☒ **A** ΔT

☒ **B** $5 \times \Delta T$

☒ **C** $\frac{1}{5} \times \Delta T$

☒ **D** $10 \times 2 \times \Delta T$

(Total for Question 9 = 1 mark)

10 An isotope of an element, atomic number z, has mass number 2z + 4. How many neutrons are in the nucleus of the element?

☒ **A** z + 4

☒ **B** z + 2

☒ **C** z

☒ **D** 4

(Total for Question 10 = 1 mark)

11 When an Al^{4+} ion is formed from an Al atom, the fourth electron is lost from the

☒ **A** 1s sub-shell.

☒ **B** 2s sub-shell.

☒ **C** 2p sub-shell.

☒ **D** 3s sub-shell.

(Total for Question 11 = 1 mark)

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

12 Metals are good conductors of electricity because

- ☒ **A** metal atoms are arranged in a regular lattice.
- ☒ **B** metal ions are very close to each other.
- ☒ **C** metal ions are free to move through the lattice.
- ☒ **D** electrons are free to move through the lattice.

(Total for Question 12 = 1 mark)

13 Which of the following statements is evidence for the existence of ions in ionic compounds?

- ☒ **A** Ionic compounds, in the solid state, conduct electricity.
- ☒ **B** When **any** ionic compound in solution is electrolysed, the migration of ions can be seen.
- ☒ **C** In electron density maps for ionic compounds, there is no single line representing electron density that surrounds both cations and anions.
- ☒ **D** In electron density maps for ionic compounds, there are some single lines representing electron density that surround both cations and anions.

(Total for Question 13 = 1 mark)

14 White phosphorus consists of

- ☒ **A** a giant structure of atoms.
- ☒ **B** a giant structure of ions.
- ☒ **C** small molecules.
- ☒ **D** single atoms.

(Total for Question 14 = 1 mark)

15 Isomers have different

- ☒ **A** empirical formulae.
- ☒ **B** molecular formulae.
- ☒ **C** skeletal formulae.
- ☒ **D** molar masses.

(Total for Question 15 = 1 mark)

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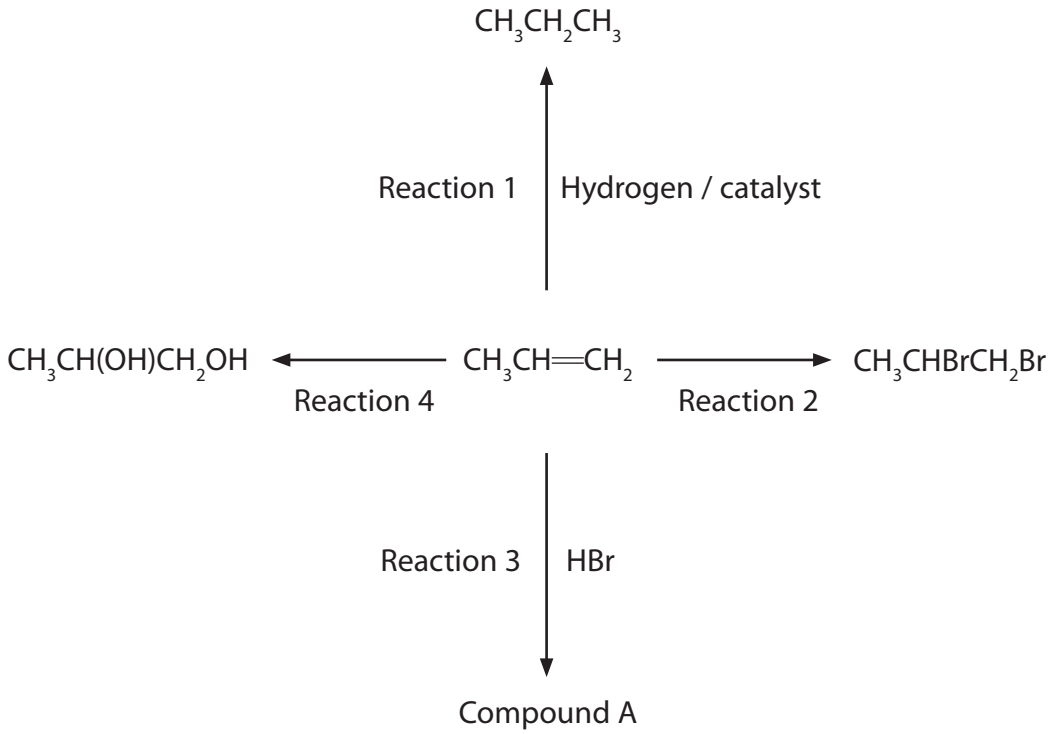
16 Four of the reactions of propene are shown on the diagram below.



(a) Nickel is often used as the catalyst for Reaction 1. Use your Periodic Table to select which of the following metals can be used instead of nickel to catalyse Reaction 1.

(1)

☒ **A** Potassium

☒ **B** Calcium

☒ **C** Gallium

☒ **D** Palladium

(b) The name of the reagent and the product for Reaction 2 are

(1)

	Reagent	Product
☒ **A**	bromine water	dibromopropane
☒ **B**	bromine	dibromopropane
☒ **C**	bromine water	1,2-dibromopropane
☒ **D**	bromine	1,2-dibromopropane

(c) What is formed in Reaction 3?

(1)

☒ **A** Only 1-bromopropane

☒ **B** Only 2-bromopropane

☒ **C** A mixture of bromopropanes containing mainly 2-bromopropane

☒ **D** A mixture of bromopropanes containing mainly 1-bromopropane

(d) A mixture of dilute sulfuric acid and which of the following reagents is needed for Reaction 4?

(1)

☒ **A** KOH

☒ **B** $KMnO_4$

☒ **C** H_2O_2

☒ **D** O_2

(e) The reaction of propene in Reaction 4 can be classified both as

(1)

☒ **A**	addition and reduction.
☒ **B**	addition and oxidation.
☒ **C**	free radical substitution and reduction.
☒ **D**	free radical substitution and oxidation.

(Total for Question 16 = 5 marks)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

17 This question is about the preparation of the alum, potassium aluminium sulfate, $KAl(SO_4)_2 \cdot 12H_2O$. It is a double salt consisting of potassium ions, aluminium ions and sulfate ions, and water of crystallization.

(a) The first step of the preparation involves adding an excess of aluminium foil to 10 cm^3 of 2 mol dm^{-3} potassium hydroxide to form potassium aluminate.

The equation for this reaction is

$$2Al(s) + 2KOH(aq) + 2H_2O(l) \rightarrow 2KAlO_2(aq) + 3H_2(g)$$

(i) Write a balanced **ionic** equation for this reaction.

(1)

(ii) Calculate the number of moles of potassium hydroxide used.

(1)

(iii) Hence state the number of moles of aluminium that react with the potassium hydroxide.

(1)

(iv) Use your answer to (iii) to calculate the mass of aluminium that reacts with the potassium hydroxide. Use the Periodic Table as a source of data.

(1)

(v) Calculate the total mass of aluminium added to the potassium hydroxide if a 10% excess of aluminium is required.

(1)

(vi) Identify **two** hazards in this first step of the preparation.

(2)

Hazard 1 .....

.....

Hazard 2 .....

.....

(b) The second step of the reaction is the addition of a slight excess of 1 mol dm^{-3} sulfuric acid.

(i) Balance the following equation for the reaction

(1)

$$KAlO_2(aq) + H_2SO_4(aq) \rightarrow KAl(SO_4)_2(aq) + H_2O(l)$$

(ii) Calculate the volume of the 1 mol dm^{-3} sulfuric acid that reacts with the potassium aluminate.

(1)

(iii) State how you would show that the acid had been added in excess.

(2)

.....

.....

.....

.....

*(iv) State and explain the steps necessary to obtain pure, dry crystals from the mixture.

(4)

(v) Suggest the colour of the crystals.

(1)

(vi) Suggest the formula of another metal ion which could form an alum, in combination with potassium and sulfate ions.

(1)

(Total for Question 17 = 17 marks)

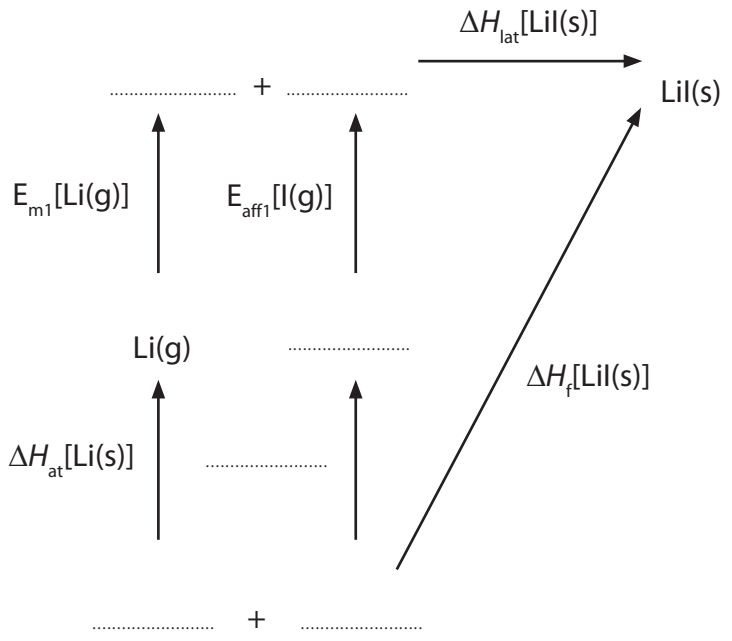
18 This question is about lithium iodide, an ionic salt.

(a) Draw dot and cross diagrams for the lithium and iodide ions. Show all the electrons in the lithium ion but only outer shell electrons in the iodide ion.

(2)

(b) On the Born-Haber cycle below, fill in the missing formulae (including state symbols) and the missing enthalpy change.

(3)



(c) Calculate the electron affinity of iodine, $E_{aff1}[I(g)]$, using the data below.

	ΔH/kJ mol^{-1}
Lattice energy for lithium iodide, ΔH_{lat}	–759
Enthalpy change of atomization of lithium, ΔH_{at}	+159
Enthalpy change of atomization of iodine, ΔH_{at}	+107
First ionization energy of lithium, E_{m1}	+520
Enthalpy change of formation of lithium iodide, ΔH_f	–270

(2)

(d) The experimental lattice energy for lithium iodide is –759 kJ mol^{-1}. The theoretical lattice energy is different from this value.

Will the experimental lattice energy be more negative or less negative than the theoretical lattice energy? Justify your answer.

(3)

(e) State and explain how electron affinity values change as you go down Group 7 from chlorine to iodine.

(2)

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.....

.....

(Total for Question 18 = 12 marks)

19 Hydrogen has three isotopes, ^{1}H, known as protium, ^{2}H, deuterium, and ^{3}H, tritium.

(a) In terms of sub-atomic particles, give the similarities and differences between atoms of these three isotopes of hydrogen.

(3)

.....

.....

.....

(b) When a nitrogen atom collides with a high energy neutron, one atom of tritium and one atom of another element are formed. Complete the equation below.

(1)

$$^{14}_{7}N + {}^{1}_{0}n \rightarrow {}^{3}_{1}H + \text{.....}$$

(c) Tritium-deuterium gas, consisting of molecules each containing one deuterium atom and one tritium atom, is used in some nuclear warheads. Typically, each warhead has about 4.0 g of the gas added.

(i) Calculate the number of moles of tritium-deuterium in 4.0 g.

(2)

(ii) Calculate the volume, in cm^3, of 4.0 g of tritium-deuterium gas.

[Molar volume of a gas under these conditions = 24 000 $cm^3\ mol^{-1}$]

(1)

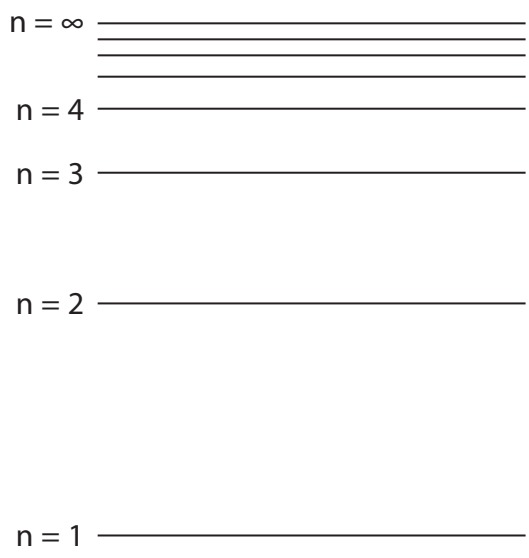
(d) Tritium is not usually included in calculations of the relative atomic mass of hydrogen, because it is radioactive and has a relatively short half-life.

Calculate the relative atomic mass of hydrogen with the following isotopic composition. Give your answer to four decimal places.

(2)

Isotope	Mass number	Relative abundance
^{1}H	1.0078	99.9850
^{2}H	2.0141	0.0150

(e) The electronic energy levels in hydrogen are shown below.



(i) Mark on the energy level diagram, with an arrow, the transition that represents the ionization energy of hydrogen.

(1)

(ii) In some versions of the Periodic Table, hydrogen is placed in the same group as sodium. Give the electronic configurations for both a hydrogen atom and a sodium atom, using the *s* and *p* notation.

Use these electronic configurations to suggest why this is a reasonable grouping.

(2)

H .....

Na .....

.....

.....

*(f) Which element in the Periodic Table has the highest first ionization energy? Justify your answer.

(3)

.....

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.....

(Total for Question 19 = 15 marks)

20 This question is about the gas ethane, C_2H_6, and its reactions.

(a) Write the equation, including state symbols, which represents the reaction taking place when the standard enthalpy change of combustion of ethane is measured.

(2)

(b) Ethane can react with chlorine to form chloroethane and hydrogen chloride.

$$C_2H_6(g) + Cl_2(g) \rightarrow C_2H_5Cl(g) + HCl(g)$$

Bond	Bond enthalpy/kJ mol^{-1}
C—H	413
C—C	347
C—Cl	346
H—Cl	432
Cl—Cl	243

Rewrite this equation using displayed formulae.

Use the equation you have written, together with the bond enthalpy data, to calculate the enthalpy change for the reaction.

(4)

(c) This reaction takes place in a number of steps, some of which are shown below.

Step 1 $Cl_2 \rightarrow 2Cl\bullet$

Step 2 $CH_3CH_3 + Cl\bullet \rightarrow HCl + CH_3CH_2\bullet$

(i) State the type of reaction occurring in step 1 and the conditions needed for this step.

(2)

Type .....

Conditions .....

(ii) Complete the equation below for the third step of the reaction, and show the movement of electrons using the appropriate arrows.

(3)

$CH_3CH_2\bullet + Cl—Cl \rightarrow$

(iii) Write equations for **two** termination steps in this reaction.

(2)

(d) Ethane can be cracked in industry. Write an equation for the cracking of ethane.

(1)

(e) Suggest **two** reasons why cracking of larger alkane molecules is important in industry.

(2)

Reason 1: .....

.....

Reason 2: .....

.....

(Total for Question 20 = 16 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) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass **atomic symbol** name atomic (proton) number									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							

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