Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	C	H	0	2	/	1	Signature	

Paper Reference(s)

6CH02/1

Edexcel GCE

Chemistry

Advanced Subsidiary

Unit 2: Application of Core Principles of Chemistry

Sample Assessment Material

Time: 1 hour 15 minutes

Examiner's use only		

Team Leader's use only		

Question Number	Leave Blank
Section A	
Section B	
Section C	
Total	

Materials required for examination
Nil

Items included with question papers
Nil

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and signature. Check that you have the correct question paper. Answer ALL the questions. Write your answers in the spaces provided in this question paper.
Some questions must be answered with a cross in a box (☒). If you change your mind, put a line through the box (☒) and then mark your new answer with a cross (☒).
Do not use pencil. Use black or blue ink.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
There are 28 questions in this question paper. The total mark for this paper is 80.
There are 28 pages in this question paper. Any blank pages are indicated.
Candidates may use a calculator.

Advice to Candidates

Quality of written communication will be taken into account in the marking of your responses to Questions 26(b)(ii), 27(a)(vi), 27(b), 28(b)(i), 28(b)(iv) and 28(b). These questions are indicated with an asterisk. Quality of written communication includes clarity of expression, the structure and presentation of ideas and grammar, punctuation and spelling.

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SECTION A

Answer ALL the questions in this section. You should aim to spend no more than 30 minutes on this section. 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 (☒).

Each of the questions or incomplete statements is followed by four suggested answers. Select the BEST answer in each case.

1. Which of the following best describes the molecular shape of carbon dioxide, CO_2?

☒ **A** linear

☒ **B** trigonal planar

☒ **C** triangular

☒ **D** v-shaped

Q1

(Total 1 mark)

2. Which of the following species is polar?

☒ **A** NH_3

☒ **B** BF_3

☒ **C** SO_3

☒ **D** CO_3^{2-}

Q2

(Total 1 mark)

3. Polar liquids are affected by electric fields. For which of the following liquids would a jet of the liquid be affected by an electric field?

☒ **A** hexane

☒ **B** cyclohexane

☒ **C** cyclohexene

☒ **D** cyclohexanol

Q3

(Total 1 mark)

Leave blank

4. What are the intermolecular forces in methanal, HCHO?

- ☒ **A** London forces only
- ☒ **B** hydrogen bonds and London forces
- ☒ **C** permanent dipole – permanent dipole only
- ☒ **D** permanent dipole – permanent dipole and London forces

Q4

(Total 1 mark)

5. Which of the following substances is likely to be insoluble in water?

- ☒ **A** methanol, CH_3OH
- ☒ **B** ethanol, CH_3CH_2OH
- ☒ **C** fluoromethane, CH_3F
- ☒ **D** hydrogen fluoride, HF

Q5

(Total 1 mark)

6. The following liquids have a similar number of electrons per molecule. Suggest which is likely to have the highest boiling point?

- ☒ **A** $CH_3CH_2CH_2CH_2CH_3$
- ☒ **B** $(CH_3)_3COH$
- ☒ **C** $CH_3CH_2CH(OH)CH_3$
- ☒ **D** $CH_3CH_2CH_2CH_2OH$

Q6

(Total 1 mark)

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7. Which concentrated acid should be used to dissolve a carbonate of a Group 2 metal to carry out a flame test?

☒ **A** ethanoic acid

☒ **B** hydrochloric acid

☒ **C** nitric acid

☒ **D** sulfuric acid

Q7

(Total 1 mark)

8. What colour does a barium salt give in a flame test?

☒ **A** colourless

☒ **B** green

☒ **C** red

☒ **D** yellow-red

Q8

(Total 1 mark)

9. Separate flame tests are carried out with lithium, sodium, potassium, magnesium, calcium and strontium salts. How many of these metal ions would colour the flame red?

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

Q9

(Total 1 mark)

Leave blank

10. A Group 2 element reacts vigorously with water to produce a soluble hydroxide, which forms a white precipitate when neutralised by sulfuric acid and forms a carbonate which is very stable to heat. The element could be

- ☒ **A** magnesium
- ☒ **B** calcium
- ☒ **C** strontium
- ☒ **D** barium

Q10

(Total 1 mark)

11. The Group 2 metals, considered in order of increasing atomic number, show a **decrease** in

- ☒ **A** first ionisation energy
- ☒ **B** nuclear charge
- ☒ **C** chemical reactivity
- ☒ **D** ionic radius

Q11

(Total 1 mark)

12. When a Group 1 metal nitrate is heated, brown fumes are observed. The metal could be

- ☒ **A** lithium
- ☒ **B** sodium
- ☒ **C** rubidium
- ☒ **D** caesium

Q12

(Total 1 mark)

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13. Methyl orange is red in acidic solutions and yellow in alkaline solutions. What is the colour of the indicator at the end point of a titration of aqueous sodium hydroxide solution with hydrochloric acid?

☒ **A** red

☒ **B** pink

☒ **C** orange

☒ **D** yellow

Q13

(Total 1 mark)

14. The volume, in cm^3, of 0.25 mol dm^{-3} hydrochloric acid required to neutralise 100 cm^3 of 0.125 mol dm^{-3} barium hydroxide solution, $Ba(OH)_2(aq)$, is

☒ **A** 25

☒ **B** 50

☒ **C** 100

☒ **D** 200

Q14

(Total 1 mark)

15. What is the oxidation number of **sulfur** in sodium tetrathionate, $Na_2S_4O_6$?

☒ **A** –½

☒ **B** +1½

☒ **C** +2½

☒ **D** +5

Q15

(Total 1 mark)

Leave blank

16. Which of the following statements is FALSE?

☒ **A** iodine is more electronegative than bromine.

☒ **B** fluorine is more electronegative than chlorine.

☒ **C** metallic elements tend to react by loss of electrons.

☒ **D** chlorine is more electronegative than sulfur.

Q16

(Total 1 mark)

17. A commercial production of iodine involves the reduction of a solution of iodate(V) ions, IO_3^-, with hydrogen sulfite ions, HSO_3^-. The equation for the reaction may be written

$$xIO_3^- + yHSO_3^- \longrightarrow zSO_4^{2-} + I_2 + 3H^+ + H_2O$$

What are the balancing numbers x, y and z?

☒ **A** 5,2,2

☒ **B** 2,5,2

☒ **C** 2,5,5

☒ **D** 5,5,2

Q17

(Total 1 mark)

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18. An organic compound is found to react with sodium metal and to react with acidified sodium dichromate(VI), but not to decolourise bromine water, nor to neutralise sodium carbonate solution. The liquid could be

- ☒ **A** ethanol
- ☒ **B** ethane
- ☒ **C** ethanoic acid
- ☒ **D** ethene

Q18

(Total 1 mark)

19. Which of the following is **not** a greenhouse gas?

- ☒ **A** CH_4
- ☒ **B** CO_2
- ☒ **C** H_2O
- ☒ **D** N_2

Q19

(Total 1 mark)

20. Which of the following fuels has the smallest carbon footprint?

- ☒ **A** petrol made from crude oil
- ☒ **B** hydrogen made from methane
- ☒ **C** ethanol made from sugar
- ☒ **D** coal

Q20

(Total 1 mark)

21. Which of the following would **not** lead to a greater sustainability in an industrial process?

- ☒ **A** using a catalyst that improves atom economy
- ☒ **B** running the reaction at a higher temperature
- ☒ **C** using biofuels to run the process
- ☒ **D** recycling waste products

Q21

(Total 1 mark)

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The following questions deal with situations. Each situation is followed by a set of questions. Select the best answer for each question.

22. This question concerns the preparation of 1-bromobutane from butan-1-ol, 50% sulfuric acid and sodium bromide. The mixture was placed in a flask and heated under reflux for ten minutes.

	Boiling temperature / °C
1-bromobutane	100
butan-1-ol	118

(a) The reason that 50% sulfuric acid was used rather than concentrated sulfuric acid is because concentrated sulfuric acid

☒ **A** would oxidise some of the bromide ions to bromine.

☒ **B** would cause the reaction to go too fast.

☒ **C** would react with the bromide ions to produce hydrogen bromide.

☒ **D** is too hazardous a chemical.

(1)

(b) The reaction mixture was distilled. The impure distillate did **not** contain

☒ **A** butan-1-ol

☒ **B** 1-bromobutane

☒ **C** sodium bromide

☒ **D** hydrogen bromide

(1)

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

Leave blank

(c) The impure 1-bromobutane was washed with concentrated hydrochloric acid and shaken in a tap funnel with a base to remove acidic impurities. Which of the following would remove acidic impurities without reacting with the 1-bromobutane.

☒ **A** calcium hydroxide solution

☒ **B** sodium hydroxide solution

☒ **C** calcium chloride solution

☒ **D** sodium hydrogencarbonate solution

(1)

(d) The 1-bromobutane was washed with water, dried and distilled. Which of the following is the correct procedure?

☒ **A** heat the liquid to 118 °C and collect the substance given off

☒ **B** heat the liquid to 100 °C and collect the substance given off

☒ **C** boil the liquid and collect the fraction that boils off between 116 and 120 °C

☒ **D** boil the liquid and collect the fraction that boils off between 98 and 102 °C

(1) **Q22**

(Total 4 marks)

Leave blank

23. Almost two thirds of the world's ethanoic acid is made using the following equilibrium reaction, with the aid of an iridium complex as a catalyst.

$$CH_3OH(l) + CO(g) \rightleftharpoons CH_3COOH(l) \quad \Delta H = -135 \text{ kJ mol}^{-1}$$

Which of the following changes in conditions would increase the equilibrium yield of ethanoic acid?

☒ **A** increase pressure

☒ **B** decrease pressure

☒ **C** increase temperature

☒ **D** add a catalyst

Q23

(Total 1 mark)

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24. Some absorptions by chemical bonds in the infrared spectrum are given below.

A O—H stretching in alcohols at 3750–3200 cm^{-1}

B C—H stretching in alkanes at 2962–2853 cm^{-1}

C C═O stretching in aldehydes at 1740–1725 cm^{-1}

D C═O stretching in ketones at 1700–1680 cm^{-1}

From A–D above, select which feature of the infrared spectrum would enable you to distinguish between the following compounds:

propanone, CH_3COCH_3, propanal, CH_3CH_2CHO

propan-1-ol, $CH_3CH_2CH_2OH$

(a) propanone from propanal and propan-1-ol

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(1)

(b) propanal from propanone and propan-1-ol

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(1)

Leave blank

(c) propan-1-ol from propanal and propanone

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(1) **Q24**

(Total 3 marks)

TOTAL FOR SECTION A: 29 MARKS

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SECTION B

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

25. This question is about organic compounds with the molecular formula C_3H_8O.

(a) Draw the structural formulae of the two isomers with molecular formula C_3H_8O which are alcohols. Give the names of these alcohols.

	Alcohol 1	**Alcohol 2**
Structural formula		
Name	…….	…….

(4)

(b) Primary alcohols can be oxidised to carboxylic acids.

(i) Give the name and structural formula of the carboxylic acid formed when the primary alcohol C_3H_8O is fully oxidised.

Name .....

Structural formula

(2)

(ii) State the reagents used for this oxidation.

Reagent 1 .....

Reagent 2 .....

(2) **Q25**

(Total 8 marks)

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26. (a) (i) Name the type of bonding that exists between water molecules.

.....

(1)

(ii) Draw a diagram to show this bonding. Use displayed formulae of two water molecules. Clearly mark and label the bond angle **between** the water molecules.

(2)

(b) (i) Draw the boron trichloride molecule, BCl_3, making its shape clear. Mark the bond angle on your diagram.

(2)

*(ii) Explain why boron trichloride has this shape.

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(3)

Leave blank

(iii) Explain why a B–Cl bond is polar.

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(1)

(iv) Explain why a BCl_3 molecule is non-polar.

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(1)

(v) Name the strongest intermolecular force between boron trichloride molecules.

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(1)

Q26

(Total 11 marks)

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27. (a) This part of the question is about the hydrolysis of halogenoalkanes.

$2\ cm^3$ of ethanol is added to each of three separate test-tubes.

Three drops of 1-chlorobutane are added to the first, three drops of 1-bromobutane to the second, and three drops of 1-iodobutane are added to the third test-tube.

$2\ cm^3$ portions of hot aqueous silver nitrate solution are added to each test-tube.

A precipitate forms immediately in the third test-tube, slowly in the second test-tube and extremely slowly in the first test-tube. In each reaction the precipitate is formed by silver ions, $Ag^+(aq)$, reacting with halide ions formed by hydrolysis of the halogenoalkane.

(i) Why was ethanol added to each test-tube?

.....

(1)

(ii) The mechanism of this reaction is similar to that of the reaction between halogenoalkanes and aqueous hydroxide ions.

What feature of a water molecule enables it to act as a nucleophile in this reaction? Suggest the mechanism for the reaction between water and 1-iodobutane. (You may represent 1-iodobutane as RCH_2I).

Feature of water molecule

.....

.....

Mechanism

(4)

Leave blank

(iii) What is the colour of the precipitate in the third test-tube?

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(1)

(iv) Name the precipitate which forms slowly in the **first** test-tube.

.....

(1)

(v) Ammonia solution is added to the precipitate in the **first** test-tube. Describe what you would observe.

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(1)

*(vi) Suggest, why the rates of hydrolysis of the three halogenoalkanes are different, in terms of bonding and kinetics.

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(3)

Leave blank

*(b) One method of the manufacture of alcohols is to react steam with an alkene. For example

$$C_2H_4(g) + H_2O(g) \longrightarrow C_2H_5OH(l)$$

Suggest TWO reasons why this method is preferred to the hydrolysis of halogenoalkanes.

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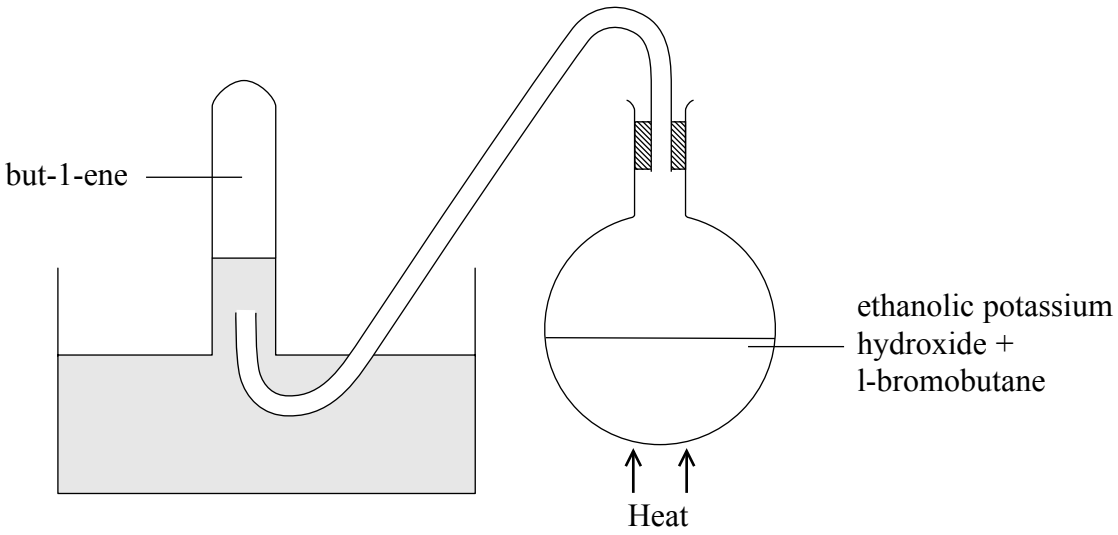
(2)

(c) 1-bromobutane reacts with an ethanolic solution of potassium hydroxide on heating to form but-1-ene. A diagram of the apparatus that could be used to carry out this reaction and to collect the gaseous but-1-ene is shown below.



(i) State the hazard when the heating is stopped.

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(1)

(ii) How would you minimise the risk associated with this hazard?

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(1)

Q27

(Total 15 marks)

TOTAL FOR SECTION B: 34 MARKS

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SECTION C

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

28. Chlorine was used in swimming pools as a bactericide.

The amount of chlorine present can be determined by adding excess potassium iodide solution to a known volume of swimming pool water. This reacts to form iodine:

$$Cl_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Cl^-(aq)$$

The amount of iodine formed is then found by titration with sodium thiosulfate solution of known concentration.

The ionic equation for the reaction between iodine and sodium thiosulfate in aqueous solution is

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

A student carried out the determination of chlorine in a sample of swimming pool water. A record of the measurements obtained is given below:

Volume of water sample tested = 1000 cm^3

Final reading of burette = 16.3 cm^3

Initial reading of burette = 7 cm^3

Volume added from burette = 9.3 cm^3

Concentration of sodium thiosulfate solution = 0.00500 mol dm^{-1}

(a) (i) The record of measurements reveals faults both in the procedure and the recording of measurements. State **one** fault in each of these.

Procedure .....

Recording of measurements .....

.....

(2)

(ii) Calculate the number of moles of sodium thiosulfate used in the titration.

(1)

Leave blank

(iii) Use your answer to (ii) to calculate the number of moles of iodine which reacted.

(1)

(iv) Deduce the concentration of chlorine, in mol dm^{-3}, in the swimming pool water.

(1)

(b) The disinfecting action of chlorine in swimming pools is due to the presence of chloric(I) acid, HClO, formed by the reaction of chlorine with water.

In many swimming pools, chemicals other than chlorine are used to form chloric(I) acid. This is partly because the use of chlorine gas causes much more corrosion of metal parts in swimming pools than does chloric(I) acid.

Compounds used to chlorinate swimming pool water in this way include calcium chlorate(I) and chlorine dioxide.

*(i) State and explain the type of reaction that occurs when chlorine attacks a metal, using the example of iron.

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.....

(2)

(ii) Suggest **one** other reason why the use of chlorine is undesirable in swimming pools.

.....

(1)

(iii) Give the formula for calcium chlorate(I).

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(1)

Leave blank

*(iv) Chlorine dioxide, ClO_2, undergoes a disproportionation reaction when it reacts with water.

$$4ClO_2 + 2H_2O \rightarrow HClO + 3HClO_3$$

Explain, in terms of oxidation numbers, why this is a disproportionation reaction.

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(2)

*(c) Discuss and explain the science community's advice that CFCs should no longer be used in aerosols, foams and refrigerants. Support your answer with one or more equations.

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(6) **Q28**

(Total 17 marks)

TOTAL FOR SECTION C: 17 MARKS
TOTAL FOR PAPER: 80 MARKS

END

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 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* lathanum 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

* Lanthanide series	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
* Actinide series	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