



Rewarding Learning

ADVANCED

General Certificate of Education

2019

Centre Number

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Candidate Number

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Life and Health Sciences

Assessment Unit A2 2

assessing

Organic Chemistry



AZ021

[AZ021]

TUESDAY 28 MAY, AFTERNOON

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all six** questions.

Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

Your attention is drawn to the Data leaflet which is used with the question paper.

You may use an electronic calculator.

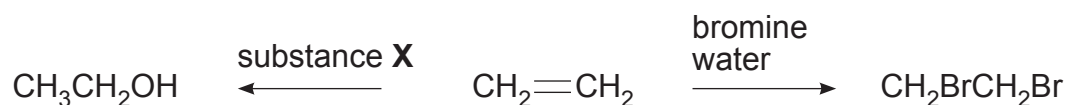
Quality of written communication will be assessed in Question **5(a)**.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	

Total Marks	
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- 1 Alkanes and alkenes react with halogens. Alkenes also react with hydrogen bromide.

(a) Two reactions of ethene are shown below.



- (i) What colour change is observed when ethene reacts with bromine water?

_____ [2]

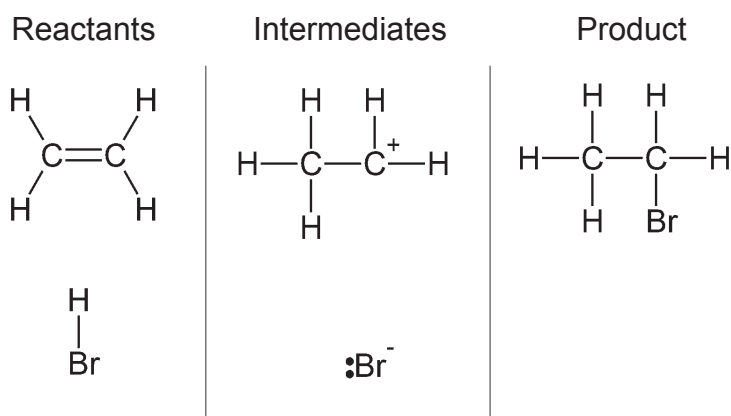
- (ii) State the IUPAC name of $\text{CH}_2\text{BrCH}_2\text{Br}$.

_____ [2]

- (iii) Identify substance X.

_____ [1]

- (b) The diagram below shows some details of the mechanism for the reaction of ethene with hydrogen bromide.



- (i) In the reactants stage, draw two curly arrows to show the formation of the intermediates. [2]

- (ii) What general name is given to the positively charged organic intermediate?

_____ [1]

Examiner Only

Marks Remark

2 (a) Four different alcohols, all with the same formula $C_5H_{11}OH$, were labelled **A**, **B**, **C** and **D**.

(i) Complete the table giving the IUPAC name, structural formula and classification (P = primary, S = secondary, T = tertiary) for each alcohol.

Alcohol	IUPAC name	Structural formula	Classification
A		$ \begin{array}{cccccc} & H & H & H & H & H \\ & & & & & \\ H & -C & -C & -C & -C & -C-OH \\ & & & & & \\ & H & H & H & H & H \end{array} $	P
B	pentan-2-ol		
C		$ \begin{array}{cccccc} & H & H & CH_3 & H \\ & & & & \\ H & -C & -C & -C & -C-OH \\ & & & & \\ & H & H & H & H \end{array} $	P
D		$ \begin{array}{cccccc} & H & CH_3 & H & H \\ & & & & \\ H & -C & -C & -C & -C-H \\ & & & & \\ & H & OH & H & H \end{array} $	

[6]

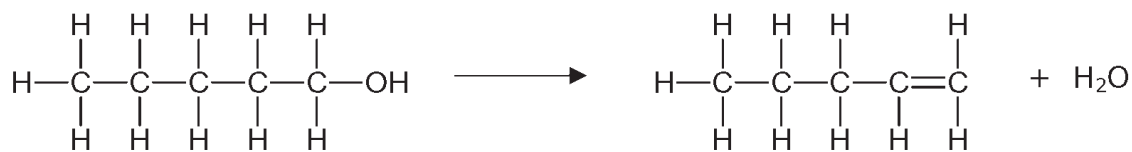
(ii) Which alcohol(s) (**A**, **B**, **C**, **D**) can undergo oxidation to form a ketone?

_____ [1]

(iii) Draw the structural formula and state the IUPAC name of **another primary alcohol**, apart from alcohols **A** and **C**, which has the formula $C_5H_{11}OH$.

IUPAC name: _____ [2]

(b) Alcohol **A** from the table in (a)(i) reacts as shown below in the presence of a catalyst.



(i) Name the type of reaction shown above.

_____ [1]

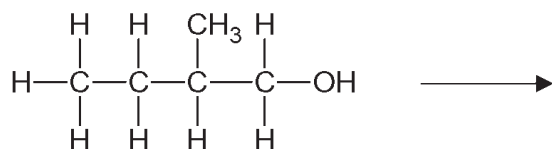
(ii) State the IUPAC name of the organic product of the reaction.

_____ [1]

(iii) Name the catalyst used in this reaction.

_____ [2]

(iv) Alcohol **C** undergoes the same type of reaction. Complete the equation below for this reaction and state the IUPAC name of the organic product.



IUPAC name: _____ [2]

Examiner Only	
Marks	Remark

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(b) The IUPAC names of some hydrocarbons are given below.

ethene	octane	hex-2-ene
pentane	propane	but-1-ene

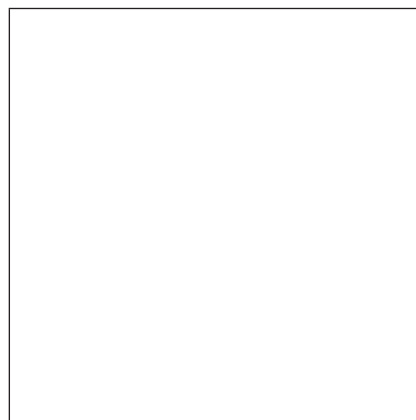
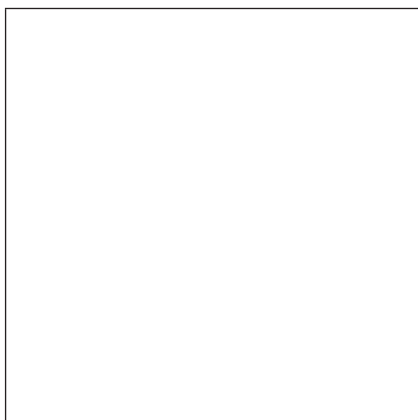
(i) Write the names of all the hydrocarbons from the table which are saturated.

_____ [1]

(ii) Draw the skeletal formula of hex-2-ene.

[1]

(iii) Hex-2-ene forms cis-trans isomers. Draw the two isomers in the boxes below and label them appropriately as cis and trans.



[3]

Examiner Only

Marks Remark

- (iv) Hex-2-ene reacts with hydrogen. State the catalyst used in this reaction and give the name of the organic product formed.

Catalyst: _____

Product: _____ [2]

- (v) Draw the structural formula and state the IUPAC name of one branched chain isomer of pentane.

IUPAC name: _____ [2]

- (vi) Write a balanced symbol equation for the combustion of pentane in a plentiful supply of air.

_____ [2]

- (c) A sample of 1.16 g of a hydrocarbon contains 0.96 g of carbon. The relative molecular mass of the hydrocarbon is 58. The empirical formula and molecular formula of the hydrocarbon may be determined using the data.

- (i) What is meant by the terms empirical formula and molecular formula?

Empirical formula _____

Molecular formula _____

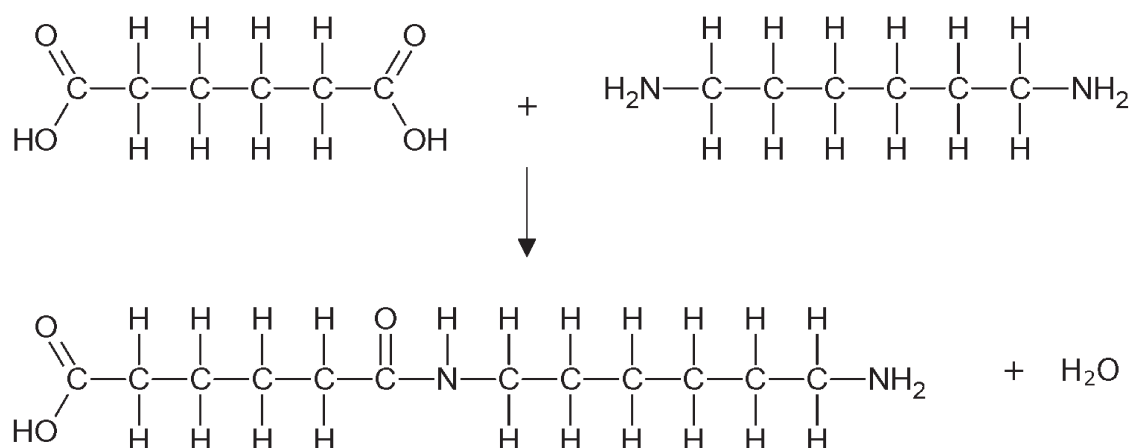
_____ [2]

Examiner Only

Marks

Remark

- (c) The diagram below shows the reaction between hexanedioic acid and hexane-1,6-diamine. Continued reaction would produce the polymer nylon-6,6.



- (i) State the type of polymerisation which occurs to form nylon-6,6.

_____ [1]

- (ii) Suggest why the polymer is known as nylon-6,6.

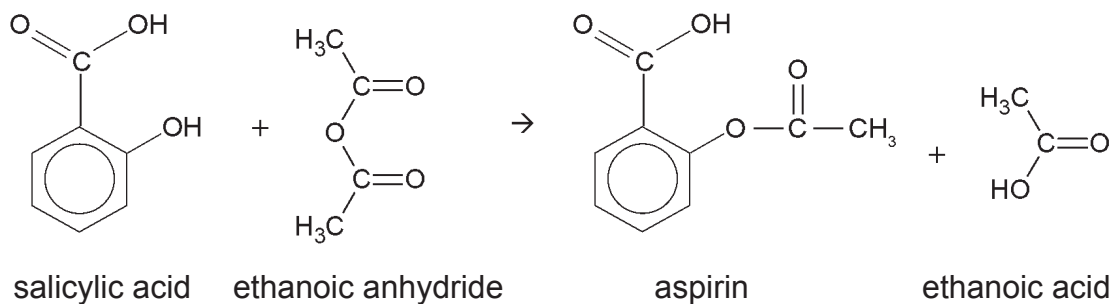
 _____ [2]

- (iii) This type of polymerisation may be reversed when the polymer reacts with water. Suggest the name of this type of reaction.

_____ [1]

Examiner Only	
Marks	Remark

- (b) The reaction below shows the production of aspirin from salicylic acid and ethanoic anhydride. The molecular formula of salicylic acid is $C_7H_6O_3$ and its relative formula mass is 138.



- (i) Write the molecular formula of aspirin.

_____ [1]

- (ii) Calculate the relative formula mass of aspirin.

_____ [1]

- (iii) In a laboratory experiment 2.25 g of aspirin was obtained. Calculate the number of moles of aspirin obtained.

Moles of aspirin = _____ [1]

- (iv) State the number of moles of ethanoic anhydride required to produce this number of moles of aspirin.

Moles of ethanoic anhydride = _____ [1]

Examiner Only

Marks Remark

- (v) During this reaction 0.024 moles of ethanoic anhydride were used. Using your answer to (b)(iv), calculate the percentage of ethanoic anhydride which reacted. Give your answer to 1 decimal place.

Percentage of ethanoic anhydride = _____ % [2]

- (vi) Suggest **one** reason why not all the ethanoic anhydride reacted.

_____ [1]

- (c) An impure sample of aspirin is purified using the following method.

*Dissolve the sample of aspirin in a **minimum volume of hot solvent** to increase yield. Filter the mixture through filter paper. Allow the filtrate to cool and crystallise. Filter off the crystals using suction filtration. Dry the crystals and determine their melting point. A pure laboratory sample of aspirin will melt at 139°C.*

- (i) State a reason why dissolving the sample of aspirin in a minimum volume of hot solvent increases yield.

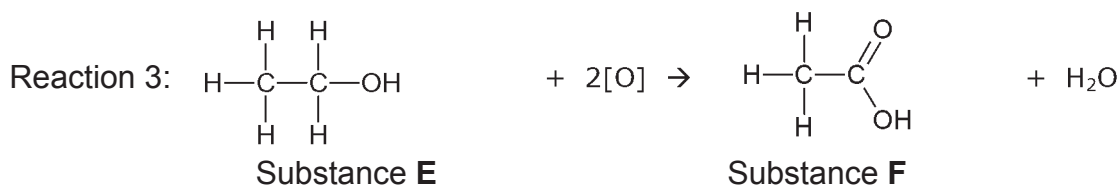
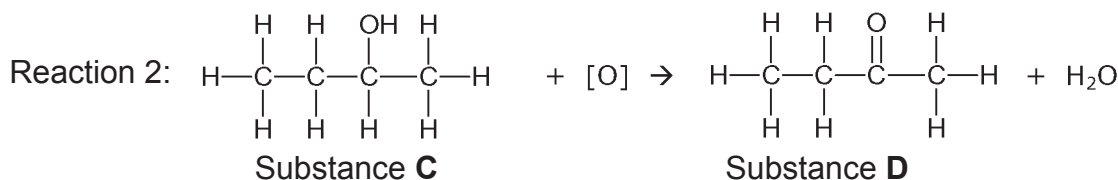
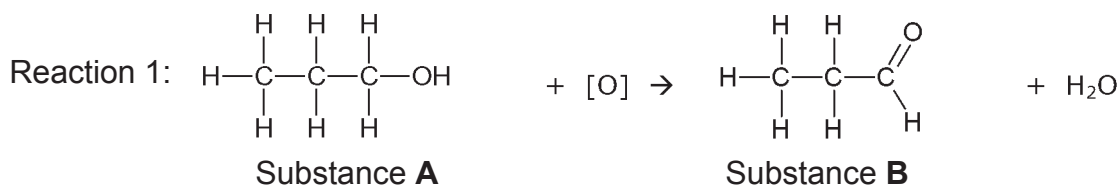
_____ [1]

Examiner Only

Marks Remark

6 Alcohols can be oxidised to aldehydes, ketones and carboxylic acids depending on the alcohol and the conditions used.

(a) Some oxidation reactions of alcohols are shown below where [O] represents a suitable oxidising agent.



(i) Name a suitable oxidising agent to carry out the oxidation reactions of alcohols. State the colour change observed when the reaction occurs.

_____ [3]

(ii) State the IUPAC names of substances **B**, **D** and **F**.

B _____

D _____

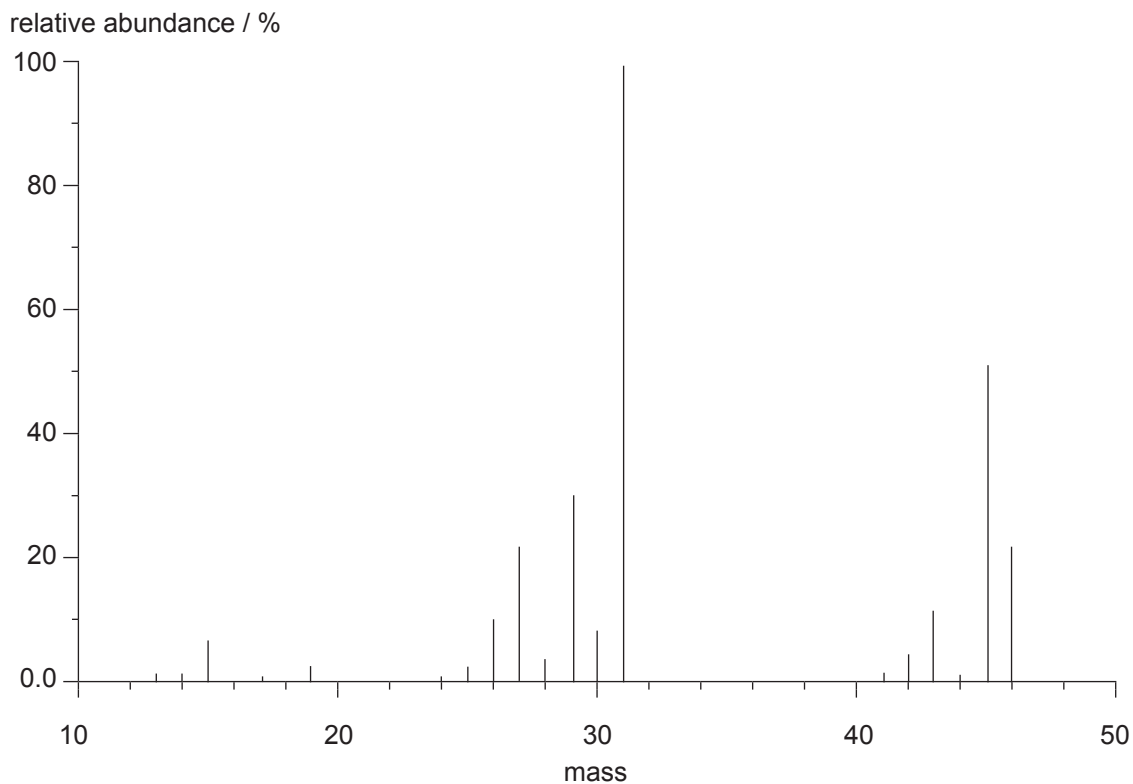
F _____ [3]

(iii) Draw the skeletal formula for substance **D**.

[1]

Examiner Only	
Marks	Remark

(b) The mass spectrum shown below was obtained for one of the substances **A**, **C** or **E**. The peaks occur at mass values which show the relative formula mass of the molecule and its fragments.



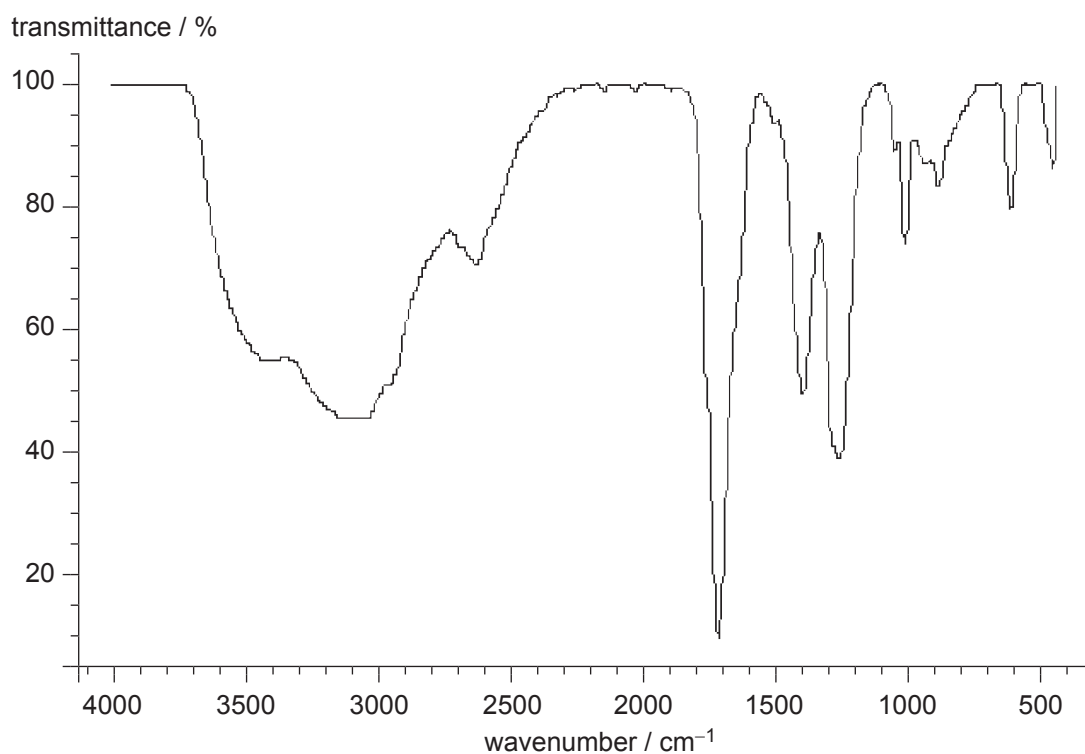
Source: Adapted - Reprinted courtesy of the National Institute of Standards and Technology, U.S. Department of Commerce. Not copyrightable in the United States

Identify which substance **A**, **C** or **E** would produce this spectrum and explain your answer.

[2]

Examiner Only	
Marks	Remark

(c) The following infrared (IR) spectrum was obtained from one of the substances **A, B, C, D, E** or **F**.



Graph – Spectrum 1 from © Inspirational chemistry – resources for modern curricula by Vicky Wong. Chapter 7, Analysis, 7.5 Spectroscopy, page 185. Published by the Royal Society of Chemistry, 2006. <https://pubs.rsc.org/en/content/ebook/978-0-85404-399-6>

Using the table below identify which substance (**A, B, C, D, E** or **F**) would produce this spectrum and explain your answer.

Wavenumber (cm ⁻¹)	Bond
750 – 1100	C—C (alkanes, alkyl groups)
1000 – 1300	C—O (alcohols, carboxylic acids)
1650 – 1800	C=O (carboxylic acids, aldehydes, ketones)
2500 – 3200	O—H (carboxylic acids)
2750 – 2850	C—H (aldehydes)
2850 – 3000	C—H (alkanes, alkyl groups, alkenes)
3200 – 3600	O—H (alcohols)

[2]

Examiner Only

Marks Remark

THIS IS THE END OF THE QUESTION PAPER

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AS 3 and A2 2 Periodic Table of the Elements

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Advanced Subsidiary and
Advanced Level Examinations

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kind. No other type of data booklet or information
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gce a/as examinations life & health sciences

For first teaching from September 2016
For first award of AS Level in Summer 2017
For first award of A Level in Summer 2018
Subject Code: 0008

THE PERIODIC TABLE OF ELEMENTS

Group

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

1	H Hydrogen 1															4	He Helium 2																			
7	Li Lithium 3	9	Be Beryllium 4															20	Ne Neon 10																	
23	Na Sodium 11	24	Mg Magnesium 12															40	Ar Argon 18																	
39	K Potassium 19	40	Ca Calcium 20	45	Sc Scandium 21	48	Ti Titanium 22	51	V Vanadium 23	52	Cr Chromium 24	55	Mn Manganese 25	56	Fe Iron 26	59	Co Cobalt 27	59	Ni Nickel 28	64	Cu Copper 29	65	Zn Zinc 30	70	Ga Gallium 31	73	Ge Germanium 32	75	As Arsenic 33	79	Se Selenium 34	80	Br Bromine 35	84	Kr Krypton 36	
85	Rb Rubidium 37	88	Sr Strontium 38	89	Y Yttrium 39	91	Zr Zirconium 40	93	Nb Niobium 41	96	Mo Molybdenum 42	98	Tc Technetium 43	101	Ru Ruthenium 44	103	Rh Rhodium 45	106	Pd Palladium 46	108	Ag Silver 47	112	Cd Cadmium 48	115	In Indium 49	119	Sn Tin 50	122	Sb Antimony 51	127	I Iodine 53	131	Xe Xenon 54			
133	Cs Caesium 55	137	Ba Barium 56	139	La Lanthanum 57	178	Hf Hafnium 72	181	Ta Tantalum 73	184	W Tungsten 74	186	Re Rhenium 75	190	Os Osmium 76	192	Ir Iridium 77	195	Pt Platinum 78	197	Au Gold 79	201	Hg Mercury 80	204	Tl Thallium 81	207	Pb Lead 82	209	Bi Bismuth 83	210	Po Polonium 84	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	285	Cn Copernicium 112													
				* 58–71 Lanthanum series				140		Ce Cerium 58	141	Pr Praseodymium 59	144	Nd Neodymium 60	145	Pm Promethium 61	150	Sm Samarium 62	152	Eu Europium 63	157	Gd Gadolinium 64	159	Tb Terbium 65	162	Dy Dysprosium 66	165	Ho Holmium 67	167	Er Erbium 68	169	Tm Thulium 69	173	Yb Ytterbium 70	175	Lu Lutetium 71
				† 90–103 Actinium 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

* 58–71 Lanthanum series
† 90–103 Actinium series

$\begin{matrix} a & x \\ & b \end{matrix}$

a = relative atomic mass (approx)
x = atomic symbol
b = atomic number