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Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Chemistry

Advanced Subsidiary

Unit 3B: Chemistry Laboratory Skills I Alternative

Monday 7 January 2013 – Morning
Time: 1 hour 15 minutes

Paper Reference
6CH07/01

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 50.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- 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 ▶

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

1 (a) A student carried out a series of tests on solid potassium iodide, KI.
Complete the table below.

(5)

	Test	Observation	Inference
(i)	Carry out a flame test on potassium iodide.	Colour of flame is	Cation is K^+
(ii)	Dissolve potassium iodide in water. Add dilute nitric acid followed by aqueous silver nitrate.	Colour of precipitate formed is	Anion is I^-
(iii)	Test the precipitate formed in (ii) with **concentrated** ammonia solution.	.....	Confirms iodide ions
(iv)	Dissolve potassium iodide in water. Add 10 drops of aqueous chlorine solution.	Colour of solution formed is	Formula of the coloured species is .....

(v) A hydrocarbon solvent, which is less dense than water, was added to the solution formed in test (iv). What would you expect to see in the test tube after the solvent has been added, the contents of the test tube vigorously shaken and left to stand for a few minutes?

(2)

.....

.....

.....

.....

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(b) In an experiment, iodide ions from potassium iodide react with iodate(V) ions and hydrogen ions from hydrochloric acid according to the ionic equation

$$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \rightarrow 3I_2(aq) + 3H_2O(l)$$

The amount of iodine formed can be determined by titration with sodium thiosulfate solution of known concentration. The equation for this reaction is

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

30.0 cm^3 of a solution of hydrochloric acid was added to an excess of potassium iodate(V) and potassium iodide solutions in a conical flask.

The iodine formed in the conical flask was titrated with sodium thiosulfate solution of concentration 0.100 mol dm^{-3}. The mean titre was 45.00 cm^3.

(i) Name the indicator that is used in thiosulfate/iodine titrations.

(1)

.....

(ii) Give the colour change at the end-point of the titration.

(1)

From ..... to .....

(iii) Calculate the number of moles of sodium thiosulfate in the mean titre.

(1)

(iv) Hence deduce the number of moles of iodine, I_2, which reacted with the number of moles of sodium thiosulfate calculated in (b)(iii).

(1)

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(v) How many moles of hydrogen ions, H^+, are required to produce the number of moles of iodine stated in (b)(iv)?

$$IO_3^-(aq) + 5I^-(aq) + 6H^+(aq) \rightarrow 3I_2(aq) + 3H_2O(l)$$

(1)

(vi) Use your answer to (b)(v) to calculate the concentration of the hydrochloric acid in mol dm^{-3}.

(1)

(c) Complete the half-equation showing the reduction of iodate(V) ions in acidic solution.

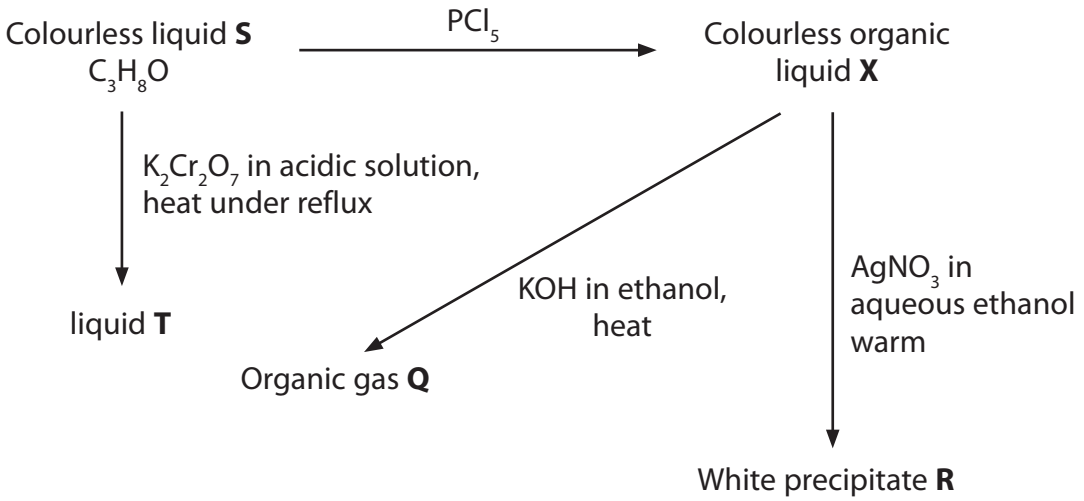
(1)

$$IO_3^-(aq) + 6H^+(aq) + \text{.....}e^- \rightarrow \tfrac{1}{2}\, I_2(aq) + 3H_2O(l)$$

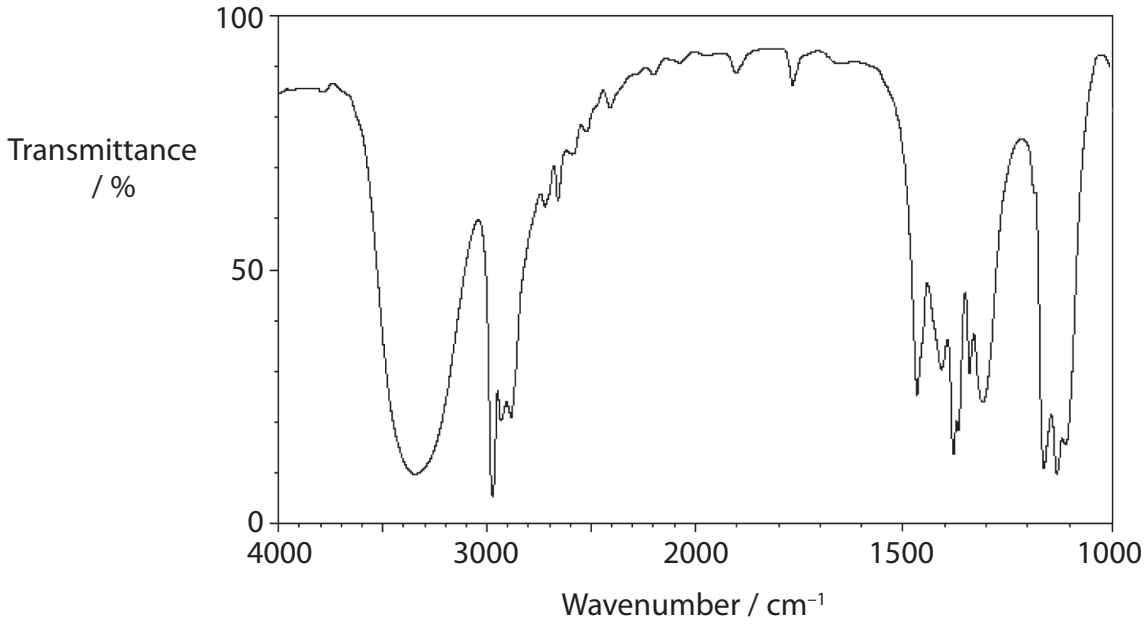
(Total for Question 1 = 14 marks)

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2 Consider the following reaction scheme.



The infrared spectrum of compound **S** is shown below.



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Bond	Group	Wavenumber range / cm^{-1}
C—H	alkane	2962 – 2853
	alkene	3095 – 3010
O—H	alcohol	3750 – 3200
C═C	alkene	1669 – 1645
C═O	aldehyde	1740 –1720
	ketone	1720 – 1680

(a) (i) Give the wavenumber range of the absorption in the infrared spectrum that shows that compound **S** is an alcohol.

(1)

.....

(ii) Identify the type of organic compound formed in the reaction of **S** with phosphorus(V) chloride, PCl_5.

(1)

.....

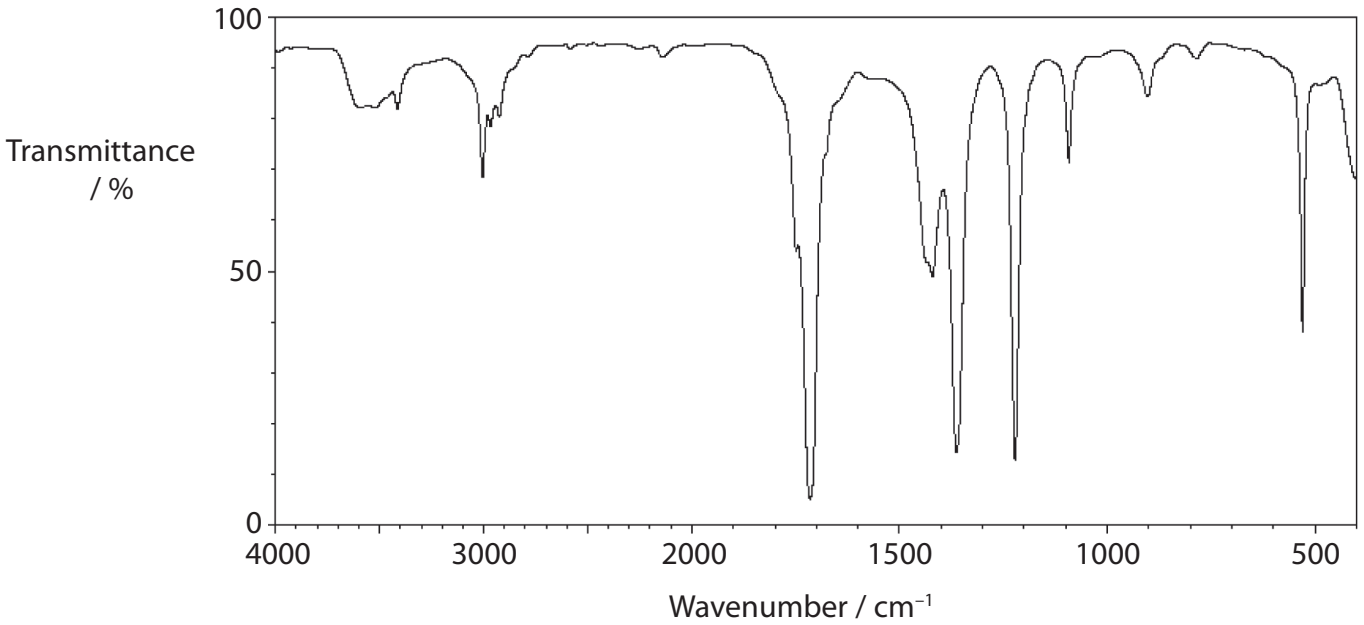
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(b) Compound **T** does not produce carbon dioxide when added to a solution of sodium carbonate.

From this information **alone**, what can you deduce about compound **T**?

(1)

(c) The infrared spectrum of liquid **T** is shown below.



(i) Give the wavenumber range of the absorption in the infrared spectrum that shows that compound **T** is formed from a **secondary** alcohol.

(1)

(ii) Identify the type of organic compound **T**.

(1)

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(iii) Draw the **skeletal** formula for **S**.

(1)

(d) Liquid **X** gives a white precipitate, **R**, on warming with an aqueous ethanolic solution of silver nitrate.

(i) Identify **R** by name or formula.

(1)

(ii) Describe what you would see if precipitate **R** was left in sunlight.

(1)

(iii) Suggest why an aqueous ethanolic solution of silver nitrate gives a better result in this test than would be obtained by aqueous silver nitrate.

(1)

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(e) If **X** is heated with a concentrated ethanolic solution of potassium hydroxide, a gas **Q** is produced.

(i) Describe a test and its expected result to show that this gas is an alkene.

(2)

Test .....

.....

Result .....

.....

(ii) Give the displayed formula of the alkene **Q**.

(1)

(Total for Question 2 = 12 marks)

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3 Weak acids such as ethanoic acid cannot be titrated with weak bases such as ammonia using an indicator since there is never any distinct colour change.

An alternative technique is to use thermometric titration as follows.

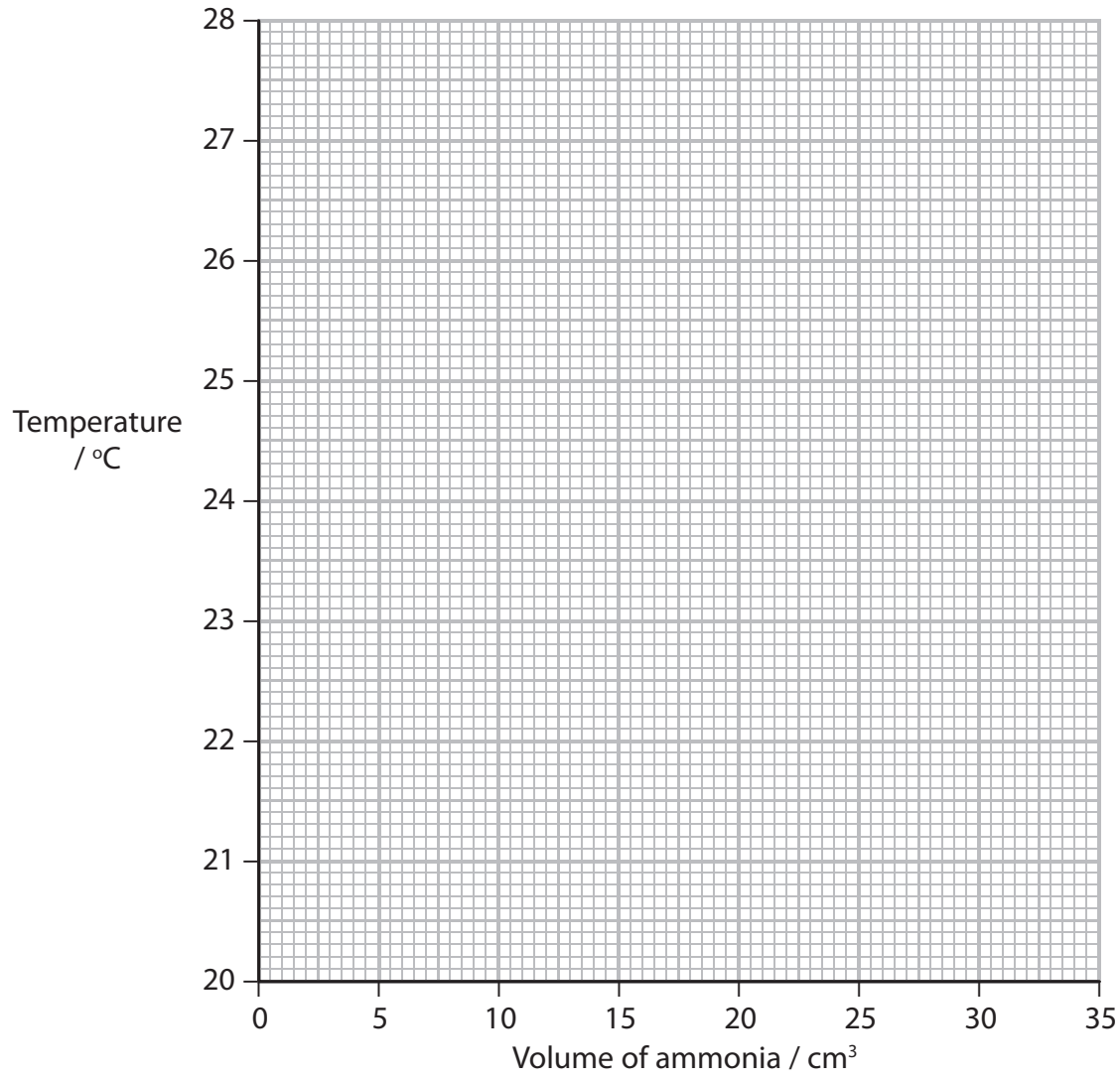
1. 30.0 cm^3 of dilute ethanoic acid is placed in a polystyrene cup and its temperature measured.
2. 5.00 cm^3 of ammonia solution of concentration 1.05 mol dm^{-3} is then added to the acid, the mixture stirred and the temperature measured again.
3. Further 5.00 cm^3 portions of ammonia are added, followed by measurement of the temperature, until a total of 35.0 cm^3 has been added.

The results of this experiment are tabulated below.

Volume of $NH_3(aq)$ added /cm^3	0.00	5.00	10.0	15.0	20.0	25.0	30.0	35.0
Temperature /°C	20.7	22.4	24.0	25.7	26.4	25.3	24.0	22.7

(a) (i) Plot these data on the axes below. Draw **two straight** lines through the points on your graph. Extrapolate the lines until they intersect, to enable you to determine the end-point volume.

(2)



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(ii) State the volume of the ammonia solution at the end-point.

(2)

.....

(iii) Explain why the temperature rises until the end-point is reached.

(1)

.....

.....

(iv) Explain why the temperature falls when more ammonia solution is added after the end-point.

(2)

.....

.....

.....

.....

(b) In a similar experiment, 25.0 cm^3 of ethanoic acid of concentration 2.00 mol dm^{-3} was reacted with 25.0 cm^3 of 2.00 mol dm^{-3} aqueous ammonia. The initial temperature was 20.6 °C and the temperature at the end-point was 29.8 °C.

(i) Use the expression below to calculate the heat energy evolved in this reaction. (Assume that the density of the reaction mixture is 1.00 g cm^{-3} and that the specific heat capacity of the mixture is 4.18 J g^{-1} $°C^{-1}$.)

energy transferred = mass × specific heat capacity × temperature change
in joules

(2)

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(ii) Calculate the number of moles of ethanoic acid used in this reaction.

(1)

(iii) The reaction that occurs is

$$CH_3COOH(aq) + NH_3(aq) \rightarrow CH_3COONH_4(aq)$$

Use your values from (b)(i) and (ii) to calculate the enthalpy change per mole for this reaction. Include a sign and units in your answer. Give your answer to **three** significant figures.

(3)

(Total for Question 3 = 13 marks)

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4 The procedure below can be used to make 1-bromobutane.

1. Place a mixture of water, sodium bromide and butan-1-ol in a round-bottomed flask.
2. Slowly add a suitable volume of concentrated sulfuric acid to this mixture whilst it is also shaken and cooled.
3. When this addition is complete, heat the mixture under reflux for about 45 minutes.
4. Rearrange the apparatus for distillation and distil off the crude 1-bromobutane, collecting the distillate between 95 ° and 105 °C.
5. Shake the 1-bromobutane first with water, then with dilute sodium carbonate solution.
6. Separate the 1-bromobutane from the aqueous layer, add some anhydrous calcium chloride and leave the mixture to stand.
7. Decant the 1-bromobutane from the calcium chloride.

(a) (i) Explain why sodium bromide and sulfuric acid are required in **step 2**.

(1)

.....

.....

(ii) What would be the effect on this preparation if concentrated sulfuric acid was added in **step 2 without** water having been added in **step 1**? Justify your answer.

(2)

.....

.....

.....

.....

(b) Explain why the acid must be added slowly and with cooling in **step 2**.

(1)

.....

.....

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(c) Draw a labelled diagram of the apparatus that could be used to carry out the distillation in **step 4**.

(4)

(d) Explain why the 1-bromobutane is shaken with sodium carbonate solution in **step 5**.

(1)

(e) What is the purpose of the calcium chloride in **step 6**?

(1)

(f) Suggest how you would obtain pure 1-bromobutane after **step 7**.

(1)

(Total for Question 4 = 11 marks)

TOTAL FOR PAPER = 50 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

P 4 1 2 1 6 A 0 1 6 1 6

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