

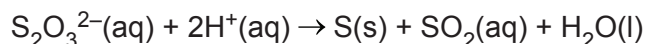
Quantitative analysis

Read through the whole method before starting any practical work. Where appropriate, prepare a table for your results in the space provided.

Show the precision of the apparatus you used in the data you record.

Show your working and appropriate significant figures in the answer to **each** step of your calculations.

1 The ionic equation for the reaction between sodium thiosulfate and hydrochloric acid is:



The solid sulfur formed causes the reaction mixture to become cloudy and opaque.

You will carry out experiments to investigate the relationship between the concentration of sodium thiosulfate and the rate of reaction.

Small amounts of SO₂ gas are released during this reaction. Take care to avoid inhaling this gas. It is important that, as soon as each experiment is complete, the contents of the beaker are emptied into the quenching bath and the beaker is rinsed thoroughly.

FA 1 is 0.10 mol dm⁻³ sodium thiosulfate, Na₂S₂O₃.

FA 2 is 2.00 mol dm⁻³ hydrochloric acid, HCl.
distilled water

(a) Method

Prepare a table for your results in the Results section on page 4. For each experiment the table should include:

- volume of **FA 1** used
- volume of distilled water used
- reaction time
- relative rate.

Relative rate can be calculated using the expression:

$$\text{relative rate} = \frac{1000}{\text{reaction time}}$$

Experiment 1

- Label a burette **FA 1**. Fill the burette with **FA 1**.
- Transfer 25.00 cm^3 of **FA 1** into a 100 cm^3 beaker.
- Place the beaker on the printed insert.
- Use the 25 cm^3 measuring cylinder to measure 10.0 cm^3 of **FA 2**.
- Add the **FA 2** to the **FA 1** in the beaker and immediately start the stop-clock. Stir the mixture once.
- Look vertically down through the solution in the beaker at the print on the insert.
- Stop the stop-clock as soon as the print on the insert is no longer visible.
- Record the reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse the beaker with water. Dry the beaker so that it is ready to be used in **Experiment 2**.

Experiment 2

- Transfer 12.50 cm^3 of **FA 1** into the 100 cm^3 beaker.
- Label a second burette 'water'. Fill this burette with distilled water.
- Transfer 12.50 cm^3 of distilled water into the 100 cm^3 beaker.
- Place the beaker on the printed insert.
- Use the 25 cm^3 measuring cylinder to measure 10.0 cm^3 of **FA 2**.
- Add the **FA 2** to the solution in the beaker and immediately start the stop-clock. Stir the mixture once.
- Look vertically down through the solution in the beaker at the print on the insert.
- Stop the stop-clock as soon as the print on the insert is no longer visible.
- Record the reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse the beaker with water. Dry the beaker so that it is ready to be used in the next experiment.

Experiments 3–5

Carry out three further experiments to investigate how reaction times change with different volumes of **FA 1**. Do **not** use a volume of **FA 1** less than 12.50 cm^3 .

Results



I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

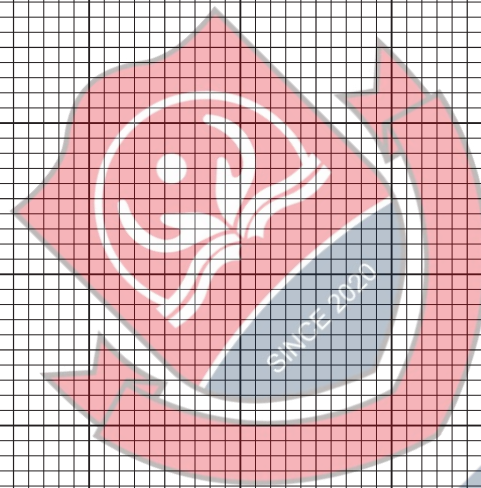
- (b) Plot a graph, on the grid, of relative rate (y-axis) against volume of **FA 1** (x-axis). The graph should **not** include the origin.

Identify any anomalous point.

Draw a line of best fit.

I	
II	
III	
IV	

[4]



- (c) Use your graph to predict the reaction time if an experiment is carried out using 23.50 cm^3 of **FA 1** and distilled water.
Show clearly **on the grid** how you determined the relative rate.

reaction time = s
[2]

- (d) The final instruction for each experiment is to rinse and dry the beaker.

State the effect on the reaction time of **not** drying the beaker before carrying out each of **Experiments 2–5**.
Explain your answer.

.....
.....
..... [1]

- (e) A student repeats **Experiment 1** but uses a 250 cm^3 beaker in place of the 100 cm^3 beaker.
All other conditions remain the same.

State whether each statement below is correct.
Explain your answers.

- (i) The student records a longer time for this experiment because the 250 cm^3 beaker is used.

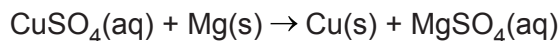
.....
.....
..... [1]

- (ii) A longer time is recorded because the rate of production of sulfur is slower.

.....
.....
..... [1]

[Total: 17]

- 2 In this experiment you will determine the enthalpy change, ΔH , for the reaction between aqueous copper(II) sulfate and magnesium.



FA 3 is 1.0 mol dm^{-3} copper(II) sulfate, CuSO_4 .

FA 4 is magnesium powder, Mg .

(a) Method

- Support the cup in the 250 cm^3 beaker.
- Use the 50 cm^3 measuring cylinder to transfer 50.0 cm^3 of **FA 3** into the cup.
- Weigh the stoppered container of **FA 4**. Record the mass.
- Measure the temperature of **FA 3** in the cup. Record the temperature.
- Add the **FA 4** to the **FA 3** in the cup and stir the mixture constantly.
- Measure and record the maximum temperature reached.
- Reweigh the stoppered container and any residual **FA 4**. Record the mass.
- Calculate and record the mass of **FA 4** used.
- Calculate and record the maximum temperature change that occurs during the reaction.



[3]

(b) Calculations

- (i) Calculate the heat energy produced in the reaction.

heat energy produced = J [1]

- (ii) Determine which reactant, **FA 3** or **FA 4**, is in excess for the reaction.
Show your working.

[1]

(iii) Calculate the enthalpy change, ΔH , in kJ mol^{-1} , for the reaction.

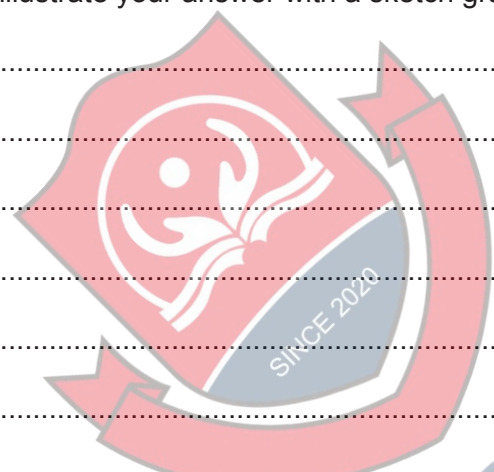
$$\Delta H = \begin{array}{c} \text{.....} \\ \text{(sign)} \end{array} \begin{array}{c} \text{.....} \\ \text{(value)} \end{array} \text{ kJ mol}^{-1}$$

[2]

- (c) A student suggests that the slow rate of the reaction using the method described in (a) means that heat energy is lost from the solution so the temperature change is inaccurate.

Describe how you would change the method and processing of the results to improve the accuracy of the enthalpy change for this reaction. You should **not** change the quantities of **FA 3** or **FA 4** used.

You may wish to illustrate your answer with a sketch graph.



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.....

.....



[3]

[Total: 10]

Qualitative analysis

For each test you should record all your observations in the spaces provided.

Examples of observations include:

- colour changes seen
- the formation of any precipitate and its solubility (where appropriate) in an excess of the reagent added
- the formation of any gas and its identification (where appropriate) by a suitable test.

You should record clearly at what stage in a test an observation is made.

Where no change is observed, you should write 'no change'.

Where reagents are selected for use in a test, the name or correct formula of the element or compound must be given.

If any solution is warmed, a boiling tube must be used.

Rinse and reuse test-tubes and boiling tubes where possible.

No additional tests should be attempted.

- 3 (a)** Each of the solutions **FA 5**, **FA 6** and **FA 7** has an anion containing sulfur. All the anions are listed in the Qualitative analysis notes. None of the anions is present in more than one compound.
None of the solutions contain a cation listed in the Qualitative analysis notes.
Use 1 cm depth of each solution in a test-tube for each test. Record your observations in Table 3.1.

Table 3.1

test	observations		
	FA 5	FA 6	FA 7
Test 1 Add a few drops of aqueous acidified potassium manganate(VII) then ----- leave it to stand for 2 minutes.			
Test 2 Add a piece of magnesium ribbon.			
Test 3 Add aqueous barium chloride or aqueous barium nitrate.			

[5]

- (b) (i) Use your observations from (a) to identify the formula of each of the anions present in **FA 5**, **FA 6** and **FA 7**.

FA 5		FA 6		FA 7	
-------------	--	-------------	--	-------------	--

[2]

- (ii) Use your observations from (a), to suggest the identity of the cation present in **FA 6**.

The cation in **FA 6** is

Carry out a further test to check whether your suggestion is correct.

Record your test and observations.

State the identity of the cation in **FA 6**.

The cation in **FA 6** is

[2]

- (c) Write an ionic equation for one of the reactions in either **Test 2** or **Test 3** in (a). Include state symbols.

..... [1]

- (d) **FA 8** is a solid compound.

- (i) Gently warm (do **not** boil) a 4 cm depth of **FA 6** in a boiling tube. Stop warming the **FA 6**, add all the **FA 8** and shake the boiling tube. Filter the mixture into a second boiling tube. The filtrate will be used in (d)(ii). Describe the appearance of the residue and the filtrate.

residue

filtrate

[1]

- (ii) To a 2 cm depth of the filtrate from (d)(i) in a test-tube, add an equal volume of aqueous potassium iodide. Record your observations. Filter the mixture into a test-tube for use in (d)(iii).

.....

..... [1]

- (iii) To a 1 cm depth of the filtrate from (d)(ii), add aqueous sodium hydroxide. Record your observations.

.....

..... [1]

[Total: 13]







Qualitative analysis notes

1 Reactions of cations

cation	reaction with	
	NaOH(aq)	NH ₃ (aq)
aluminium, Al ³⁺ (aq)	white ppt. soluble in excess	white ppt. insoluble in excess
ammonium, NH ₄ ⁺ (aq)	no ppt. ammonia produced on warming	–
barium, Ba ²⁺ (aq)	faint white ppt. is observed unless [Ba ²⁺ (aq)] is very low	no ppt.
calcium, Ca ²⁺ (aq)	white ppt. unless [Ca ²⁺ (aq)] is very low	no ppt.
chromium(III), Cr ³⁺ (aq)	grey-green ppt. soluble in excess giving dark green solution	grey-green ppt. insoluble in excess
copper(II), Cu ²⁺ (aq)	pale blue ppt. insoluble in excess	pale blue ppt. soluble in excess giving dark blue solution
iron(II), Fe ²⁺ (aq)	green ppt. turning brown on contact with air insoluble in excess	green ppt. turning brown on contact with air insoluble in excess
iron(III), Fe ³⁺ (aq)	red-brown ppt. insoluble in excess	red-brown ppt. insoluble in excess
magnesium, Mg ²⁺ (aq)	white ppt. insoluble in excess	white ppt. insoluble in excess
manganese(II), Mn ²⁺ (aq)	off-white ppt. rapidly turning brown on contact with air insoluble in excess	off-white ppt. rapidly turning brown on contact with air insoluble in excess
zinc, Zn ²⁺ (aq)	white ppt. soluble in excess	white ppt. soluble in excess

2 Reactions of anions

anion	reaction
carbonate, CO ₃ ²⁻	CO ₂ liberated by dilute acids
chloride, Cl ⁻ (aq)	gives white ppt. with Ag ⁺ (aq) (soluble in NH ₃ (aq))
bromide, Br ⁻ (aq)	gives cream / off-white ppt. with Ag ⁺ (aq) (partially soluble in NH ₃ (aq))
iodide, I ⁻ (aq)	gives pale yellow ppt. with Ag ⁺ (aq) (insoluble in NH ₃ (aq))
nitrate, NO ₃ ⁻ (aq)	NH ₃ liberated on heating with OH ⁻ (aq) and Al foil
nitrite, NO ₂ ⁻ (aq)	NH ₃ liberated on heating with OH ⁻ (aq) and Al foil; decolourises acidified aqueous KMnO ₄
sulfate, SO ₄ ²⁻ (aq)	gives white ppt. with Ba ²⁺ (aq) (insoluble in excess dilute strong acids); gives white ppt. with high [Ca ²⁺ (aq)]
sulfite, SO ₃ ²⁻ (aq)	gives white ppt. with Ba ²⁺ (aq) (soluble in excess dilute strong acids); decolourises acidified aqueous KMnO ₄
thiosulfate, S ₂ O ₃ ²⁻ (aq)	gives off-white/pale yellow ppt. slowly with H ⁺

3 Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint

4 Tests for elements

element	test and test result
iodine, I_2	gives blue-black colour on addition of starch solution

Important values, constants and standards

molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Faraday constant	$F = 9.65 \times 10^4 \text{ C mol}^{-1}$
Avogadro constant	$L = 6.022 \times 10^{23} \text{ mol}^{-1}$
electronic charge	$e = -1.60 \times 10^{-19} \text{ C}$
molar volume of gas	$V_m = 22.4 \text{ dm}^3 \text{ mol}^{-1}$ at s.t.p. (101 kPa and 273 K) $V_m = 24.0 \text{ dm}^3 \text{ mol}^{-1}$ at room conditions
ionic product of water	$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ (at 298 K (25 °C))
specific heat capacity of water	$c = 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ (4.18 $\text{J g}^{-1} \text{ K}^{-1}$)

The Periodic Table of Elements

Group																																	
1	2													13	14	15	16	17	18														
1 H hydrogen 1.0																																2	
Key atomic number atomic symbol name relative atomic mass																																	
3	4													5	6	7	8	9	10	11	12	13	14	15	16	17	18						
Li lithium 6.9	Be beryllium 9.0													B boron 10.8	C carbon 12.0			N nitrogen 14.0	O oxygen 16.0	F fluorine 19.0													
11	12													13	14	15	16	17	18														
Na sodium 23.0	Mg magnesium 24.3													Al aluminium 27.0	Si silicon 28.1	P phosphorus 31.0	S sulfur 32.1	Cl chlorine 35.5	Ar argon 39.9														
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36																
K potassium 39.1	Ca calcium 40.1	Sc scandium 45.0	Ti titanium 47.9	V vanadium 50.9	Cr chromium 52.0	Mn manganese 54.9	Fe iron 55.8	Co cobalt 58.9	Ni nickel 58.7	Cu copper 63.5	Zn zinc 65.4	Ga gallium 69.7	Ge germanium 72.6	As arsenic 74.9	Se selenium 79.0	Br bromine 79.9	Kr krypton 83.8																
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54																
Rb rubidium 85.5	Sr strontium 87.6	Y yttrium 88.9	Zr zirconium 91.2	Nb niobium 92.9	Mo molybdenum 95.9	Tc technetium —	Ru ruthenium 101.1	Rh rhodium 102.9	Pd palladium 106.4	Ag silver 107.9	Cd cadmium 112.4	In indium 114.8	Sn tin 118.7	Sb antimony 121.8	Te tellurium 127.6	I iodine 126.9	Xe xenon 131.3																
55	56	57–71 lanthanoids	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86																
Cs caesium 132.9	Ba barium 137.3		Hf hafnium 178.5	Ta tantalum 180.9	W tungsten 183.8	Re rhenium 186.2	Os osmium 190.2	Ir iridium 192.2	Pt platinum 195.1	Au gold 197.0	Hg mercury 200.6	Tl thallium 204.4	Pb lead 207.2	Bi bismuth 209.0	Po polonium —	At astatine —	Rn radon —																
87	88	89–103 actinoids	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118																
Fr francium —	Ra radium —		Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —	Nh nihonium —	Fl flerovium —	Moscovium —	Lv livermorium —	Ts tennessine —	Og oganesson —																
																		67	68	69	70	71											
																		Ho holmium 164.9	Er erbium 167.3	Tm thulium 168.9	Yb ytterbium 173.1	Lu lutetium 175.0											
																		Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —											
																		97	98	99	100	101	102	103									
																		Bk berkelium —	Cf californium —	Am americium —	Cm curium —	Bk berkelium —	No nobelium —	Lr lawrencium —									
																		107	108	109	110	111	112	113									
																		Bo bohrium —	Cn copernicium —	Nh nihonium —	Fl flerovium —	Lv livermorium —	Ts tennessine —	Og oganesson —									
																		119	120	121	122	123	124	125									
																		Uu ununennium —	Uub unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		151	152	153	154	155	156	157									
																		Mc moscovium —	Lv livermorium —	Ts tennessine —	Og oganesson —	Ug unvigintium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		167	168	169	170	171	172	173									
																		Uyt ununyttrium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		183	184	185	186	187	188	189									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		195	196	197	198	199	200	201									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		209	210	211	212	213	214	215									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		261	262	263	264	265	266	267									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		271	272	273	274	275	276	277									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		283	284	285	286	287	288	289									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		303	304	305	306	307	308	309									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		327	328	329	330	331	332	333									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		403	404	405	406	407	408	409									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		447	448	449	450	451	452	453									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		471	472	473	474	475	476	477									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
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																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		495	496	497	498	499	500	501									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		503	504	505	506	507	508	509									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		515	516	517	518	519	520	521									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		527	528	529	530	531	532	533									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		539	540	541	542	543	544	545									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		551	552	553	554	555	556	557									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		563	564	565	566	567	568	569									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		571	572	573	574	575	576	577									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		583	584	585	586	587	588	589									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		595	596	597	598	599	600	601									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		603	604	605	606	607	608	609									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		615	616	617	618	619	620	621									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		627	628	629	630	631	632	633									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		639	640	641	642	643	644	645									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								
																		651	652	653	654	655	656	657									
																		Uyp ununpentium —	Uyb unbibium —	Uut untrium —	Uuq unquadium —	Uup unpentium —	Uuh unhexium —	Uus unseptium —	Uuo unoktium —								

lanthanoids

actinoids