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CHEMISTRY

9701/33

Paper 3 Advanced Practical Skills 1

February/March 2018

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Give details of the practical session and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
Use of a Data Booklet is unnecessary.

Qualitative Analysis Notes are printed on pages 14 and 15.
A copy of the Periodic Table is printed on page 16.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [] at the end of each question or part question.

Session	
Laboratory	

For Examiner's Use	
1	
2	
Total	

This document consists of **14** printed pages, **2** blank pages and **1** Insert.

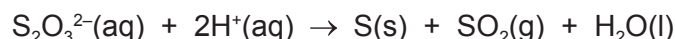
Quantitative Analysis

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

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

- 1 You will investigate how increasing temperature affects the rate of a reaction.

Sodium thiosulfate reacts with acid to form a pale yellow precipitate of sulfur. The ionic equation for the reaction is given.



You will measure the time it takes for the sulfur formed in the reaction to obscure the print on the Insert supplied.

Record your results in a table on page 4. Your table should include the rate of reaction for each experiment.

FA 1 is an 18.1 g dm⁻³ solution of hydrated sodium thiosulfate, Na₂S₂O₃·5H₂O.

FA 2 is a 0.050 mol dm⁻³ solution of a strong monoprotic acid, HZ.

(a) Method

- Approximately half fill the 250 cm³ beaker with tap water and place it on the tripod and gauze over the Bunsen burner.
- Heat the water in the beaker to about 55 °C and then switch off the Bunsen burner. This will be your hot water bath.
- Use the 25 cm³ measuring cylinder to transfer 10 cm³ of **FA 1** into boiling tube **1**. Place boiling tube **1** into your hot water bath.
- Use the 50 cm³ measuring cylinder to transfer 20 cm³ of **FA 2** into boiling tube **2**. Place boiling tube **2** into your hot water bath.
- Leave boiling tubes **1** and **2** in the hot water bath to heat up for use in **Experiment 2**.
- Start **Experiment 1**.

Experiment 1

- Use the 50 cm³ measuring cylinder to transfer 20 cm³ of **FA 2** into the 100 cm³ beaker.
- Measure and record the temperature of **FA 2**.
- Use the 25 cm³ measuring cylinder to transfer 10 cm³ of **FA 1** into the same beaker and start timing **immediately**.
- Swirl the beaker once to mix the solutions and place the beaker on the Insert.
- Look down through the beaker and contents onto the Insert.
- Stop timing as soon as the precipitate of sulfur obscures the print on the Insert.
- Record the reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready for use in **Experiment 2**.

Experiment 2

- Measure and record the temperature of **FA 2** in boiling tube **2**.
- Carefully transfer the hot contents of boiling tube **2** into the 100 cm³ beaker.
- Carefully transfer the hot contents of boiling tube **1** into the same beaker and start timing **immediately**.
- Swirl the beaker once to mix the solutions and place the beaker on the Insert.
- Look down through the beaker and contents onto the Insert.
- Stop timing as soon as the precipitate of sulfur obscures the print on the Insert.
- Record the reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready for use in **Experiment 3**.

Experiment 3

- Use the 25 cm³ measuring cylinder to transfer 10 cm³ of **FA 1** into boiling tube **1**. Place boiling tube **1** into your hot water bath.
- Use the 50 cm³ measuring cylinder to transfer 20 cm³ of **FA 2** into boiling tube **2**. Place boiling tube **2** into your hot water bath.
- Place the thermometer in boiling tube **2**. When the temperature of **FA 2** is about 8 °C lower than that for **Experiment 2** record the temperature. Remove the thermometer and transfer the contents of boiling tube **2** into the 100 cm³ beaker.
- Transfer the contents of boiling tube **1** into the same beaker and start timing **immediately**.
- Swirl the beaker once to mix the solutions and place the beaker on the Insert.
- Look down through the beaker and contents onto the Insert.
- Stop timing as soon as the precipitate of sulfur obscures the print on the Insert.
- Record the reaction time to the nearest second.
- Empty the contents of the beaker into the quenching bath.
- Rinse and dry the beaker so it is ready for use in **Experiments 4 and 5**.

Experiments 4 and 5

- Repeat the method for **Experiment 3** but at **two** different temperatures.
- Keep the temperature of **FA 2** between room temperature and 55 °C. Do **not** exceed 55 °C.

Record all your results in your table on page 4.

Results

The rate of reaction can be calculated as shown.

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

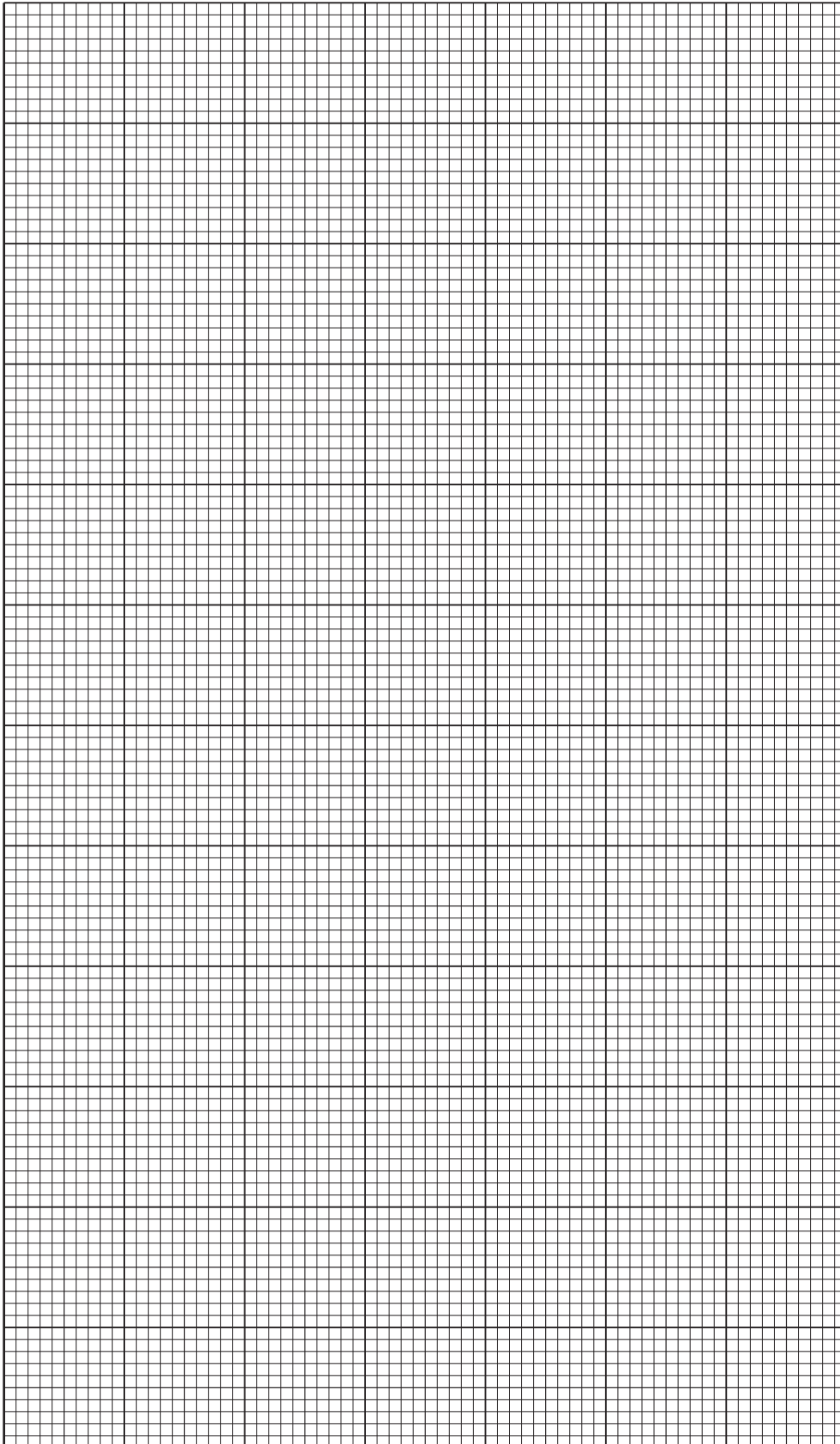
Calculate the rate of reaction for each of your **five** experiments. Record these rates in your table.

I	
II	
III	
IV	
V	
VI	
VII	
VIII	

[8]

- (b) On the grid plot a graph of rate of reaction on the y -axis, starting at zero, against temperature on the x -axis. Select a scale for the x -axis which includes a temperature of 15.0°C . Label your axes and any points you consider anomalous.

Draw a line of best fit and extrapolate it to 15.0°C .



I	
II	
III	
IV	

[4]

- (c) Use your graph to calculate the **time** to the nearest second that the reaction would have taken if you had carried it out at 17.5°C. Show **on the grid** how you obtained your answer.

time = s [2]

- (d) Explain, by referring to your graph or your table of results, how the rate of reaction is affected by increasing temperature.

.....

 [2]

(e) Calculations

- (i) Calculate the concentration of hydrated sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$, in **FA 1** in mol dm^{-3} .

concentration of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ in **FA 1** = mol dm^{-3} [1]

- (ii) Calculate the concentration of the strong monoprotic acid, **HZ**, in the solution immediately **after FA 1** was added to **FA 2** in the beaker.

concentration of **HZ** = mol dm^{-3} [1]

- (iii) Use the equation on page 2 to determine which reagent, **FA 1** or **FA 2**, was in excess.

The reagent in excess was [2]

- (f) (i) Calculate the maximum percentage error in measuring the reaction time you recorded for **Experiment 2**. Assume that the maximum error of the timer is ± 0.5 s.

maximum percentage error in the reaction time = % [1]

- (ii) A student suggested that the error in measuring the reaction time in **Experiment 1** was greater than for **Experiment 2**.

Give **one** reason why the student could be correct.

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

- (g) Suggest **two** ways to improve the accuracy of the results of these experiments.

1
.....
2
..... [2]

[Total: 24]

Qualitative Analysis

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

At each stage of any test you are to record details of the following:

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

You should indicate clearly at what stage in a test a change occurs.

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

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

No additional tests for ions present should be attempted.

- 2 (a) **FA 3** is a more concentrated solution of the strong monoprotic acid, **HZ**, used for **Question 1**.

Select **two** sets of reagents and suitable apparatus to use in **two** separate tests, **Test 1** and **Test 2**, to investigate the identity of the anion, **Z⁻**, present in **FA 3**. The anion is one of those listed in the Qualitative Analysis Notes.

Complete the 'test' boxes in the table **before** starting any practical work by circling whether you would use a test-tube or a boiling tube, and stating which reagents you would use.

Carry out your tests and record your observations. You must carry out both **Test 1** and **Test 2**.

<i>test</i>	<i>observations</i>
<p>Test 1</p> <p>To a 1 cm depth of FA 3 in a <i>test-tube/boiling tube</i></p> <p>add</p> <p>..... <i>(reagent(s))</i></p>	
<p>Test 2</p> <p>To a 1 cm depth of FA 3 in a <i>test-tube/boiling tube</i></p> <p>add</p> <p>..... <i>(reagent(s))</i></p>	

[4]

- (b) Identify the anion present in **HZ** from your observations in (a).

Z⁻ is

[1]

- (c) **FA 4** and **FA 5** both contain one cation and one anion. The ions present in **FA 4** are different from the ions present in **FA 5**. All four ions are listed in the Qualitative Analysis Notes. You are to identify the **four** different ions.

Carry out the following tests and record your observations.

<i>test</i>	<i>observations</i>
To a small spatula measure of FA 4 in a boiling tube, add a 4 cm depth of FA 3 and shake the tube well. Leave the tube to stand for at least five minutes. Label the solution formed FA 6 .	
To a 1 cm depth of FA 5 in a test-tube, add aqueous sodium carbonate.	
To a 1 cm depth of FA 5 in a test-tube, add aqueous sodium hydroxide.	
To a 1 cm depth of FA 5 in a test-tube, add aqueous ammonia.	
To a 1 cm depth of FA 5 in a test-tube, add a few drops of aqueous silver nitrate.	
To a 1 cm depth of FA 5 in a test-tube, add a few drops of aqueous barium chloride or aqueous barium nitrate, then ----- add a 1 cm depth of a suitable acid.	
To a 1 cm depth of FA 6 in a test-tube, add aqueous sodium hydroxide.	
To a 1 cm depth of FA 6 in a test-tube, add aqueous ammonia.	
To a 1 cm depth of FA 6 in a test-tube, add dilute sulfuric acid.	
To a 1 cm depth of FA 6 in a test-tube, add a 1 cm depth of FA 5 .	

[8]

- (d) Give the formula of the acid you added to the mixture of **FA 5** and aqueous barium chloride or aqueous barium nitrate in (c).

The acid added was [1]

- (e) Identify the ions present in **FA 4** and **FA 5** from your observations in (c).

	cation	anion
FA 4		
FA 5		

[2]

[Total: 16]

Qualitative Analysis Notes

1 Reactions of aqueous cations

ion	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 heating	–
barium, Ba ²⁺ (aq)	faint white ppt. is nearly always observed unless reagents are pure	no ppt.
calcium, Ca ²⁺ (aq)	white ppt. with high [Ca ²⁺ (aq)]	no ppt.
chromium(III), Cr ³⁺ (aq)	grey-green ppt. soluble in excess	grey-green ppt. insoluble in excess
copper(II), Cu ²⁺ (aq)	pale blue ppt. insoluble in excess	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

<i>ion</i>	<i>reaction</i>
carbonate, CO_3^{2-}	CO_2 liberated by dilute acids
chloride, $\text{Cl}^-(\text{aq})$	gives white ppt. with $\text{Ag}^+(\text{aq})$ (soluble in $\text{NH}_3(\text{aq})$)
bromide, $\text{Br}^-(\text{aq})$	gives cream ppt. with $\text{Ag}^+(\text{aq})$ (partially soluble in $\text{NH}_3(\text{aq})$)
iodide, $\text{I}^-(\text{aq})$	gives yellow ppt. with $\text{Ag}^+(\text{aq})$ (insoluble in $\text{NH}_3(\text{aq})$)
nitrate, $\text{NO}_3^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and <i>Al</i> foil
nitrite, $\text{NO}_2^-(\text{aq})$	NH_3 liberated on heating with $\text{OH}^-(\text{aq})$ and <i>Al</i> foil
sulfate, $\text{SO}_4^{2-}(\text{aq})$	gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ (insoluble in excess dilute strong acids)
sulfite, $\text{SO}_3^{2-}(\text{aq})$	gives white ppt. with $\text{Ba}^{2+}(\text{aq})$ (soluble in excess dilute strong acids)

3 Tests for gases

<i>gas</i>	<i>test and test result</i>
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	gives a white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	'pops' with a lighted splint
oxygen, O_2	relights a glowing splint

The Periodic Table of Elements

Group																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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3 Li lithium 6.9	4 Be beryllium 9.0	11 Na sodium 23.0	12 Mg magnesium 24.3	19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8	37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium —	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3	55 Cs caesium 132.9	56 Ba barium 137.3	57 Fr francium —	58 Ra radium —	59 Pr praseodymium 140.9	60 Nd neodymium 144.4	61 Pm promethium —	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0	72 La lanthanum 138.9	73 Ce cerium 140.1	74 Th thorium 232.0	75 Ac actinium —	76 Pa protactinium 231.0	77 U uranium 238.0	78 Np neptunium —	79 Pu plutonium —	80 Am americium —	81 Cm curium —	82 Bk berkelium —	83 Cf californium —	84 Es einsteinium —	85 Fm fermium —	86 Md mendelevium —	87 No nobelium —	88 Lr lawrencium —	89 La lanthanoids —	90 Ce actinoids —	91 Pr actinoids —	92 Nd actinoids —	93 Pm actinoids —	94 Pu actinoids —	95 Am actinoids —	96 Cm actinoids —	97 Bk actinoids —	98 Cf actinoids —	99 Es actinoids —	100 Fm actinoids —	101 Md actinoids —	102 No actinoids —	103 Lr actinoids —	104 Rn actinoids —	105 Fr actinoids —	106 Ra actinoids —	107 Ac actinoids —	108 Th actinoids —	109 Pa actinoids —	110 U actinoids —	111 Np actinoids —	112 Pu actinoids —	113 Am actinoids —	114 Cm actinoids —	115 Bk actinoids —	116 Cf actinoids —	117 Es actinoids —	118 Fm actinoids —	119 Md actinoids —	120 No actinoids —	121 Lr actinoids —	122 Rn actinoids —	123 Fr actinoids —	124 Ra actinoids —	125 Ac actinoids —	126 Th actinoids —	127 Pa actinoids —	128 U actinoids —	129 Np actinoids —	130 Pu actinoids —	131 Am actinoids —	132 Cm actinoids —	133 Bk actinoids —	134 Cf actinoids —	135 Es actinoids —	136 Fm actinoids —	137 Md actinoids —	138 No actinoids —	139 Lr actinoids —	140 Rn actinoids —	141 Fr actinoids —	142 Ra actinoids —	143 Ac actinoids —	144 Th actinoids —	145 Pa actinoids —	146 U actinoids —	147 Np actinoids —	148 Pu actinoids —	149 Am actinoids —	150 Cm actinoids —	151 Bk actinoids —	152 Cf actinoids —	153 Es actinoids —	154 Fm actinoids —	155 Md actinoids —	156 No actinoids —	157 Lr actinoids —	158 Rn actinoids —	159 Fr actinoids —	160 Ra actinoids —	161 Ac actinoids —	162 Th actinoids —	163 Pa actinoids —	164 U actinoids —	165 Np actinoids —	166 Pu actinoids —	167 Am actinoids —	168 Cm actinoids —	169 Bk actinoids —	170 Cf actinoids —	171 Es 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Cf actinoids —	225 Es actinoids —	226 Fm actinoids —	227 Md actinoids —	228 No actinoids —	229 Lr actinoids —	230 Rn actinoids —	231 Fr actinoids —	232 Ra actinoids —	233 Ac actinoids —	234 Th actinoids —	235 Pa actinoids —	236 U actinoids —	237 Np actinoids —	238 Pu actinoids —	239 Am actinoids —	240 Cm actinoids —	241 Bk actinoids —	242 Cf actinoids —	243 Es actinoids —	244 Fm actinoids —	245 Md actinoids —	246 No actinoids —	247 Lr actinoids —	248 Rn actinoids —	249 Fr actinoids —	250 Ra actinoids —	251 Ac actinoids —	252 Th actinoids —	253 Pa actinoids —	254 U actinoids —	255 Np actinoids —	256 Pu actinoids —	257 Am actinoids —	258 Cm actinoids —	259 Bk actinoids —	260 Cf actinoids —	261 Es actinoids —	262 Fm actinoids —	263 Md actinoids —	264 No actinoids —	265 Lr actinoids —	266 Rn actinoids —	267 Fr actinoids —	268 Ra actinoids —	269 Ac actinoids —	270 Th actinoids —	271 Pa actinoids —	272 U actinoids —	273 Np actinoids —	274 Pu actinoids —	275 Am actinoids —	276 Cm actinoids —	277 Bk actinoids —	278 Cf actinoids —	279 Es actinoids —	280 Fm actinoids —	281 Md actinoids —	282 No actinoids —	283 Lr actinoids —	284 Rn actinoids —	285 Fr actinoids —	286 Ra actinoids —	287 Ac actinoids —	288 Th actinoids —	289 Pa actinoids —	290 U actinoids —	291 Np actinoids —	292 Pu actinoids —	293 Am actinoids —	294 Cm actinoids —	295 Bk actinoids —	296 Cf actinoids —	297 Es actinoids —	298 Fm actinoids —	299 Md actinoids —	300 No actinoids —	301 Lr actinoids —	302 Rn actinoids —	303 Fr actinoids —	304 Ra actinoids —	305 Ac actinoids —	306 Th actinoids —	307 Pa actinoids —	308 U actinoids —	309 Np actinoids —	310 Pu actinoids —	311 Am actinoids —	312 Cm actinoids —	313 Bk actinoids —	314 Cf actinoids —	315 Es actinoids —	316 Fm actinoids —	317 Md actinoids —	318 No actinoids —	319 Lr actinoids —	320 Rn actinoids —	321 Fr actinoids —	322 Ra actinoids —	323 Ac actinoids —	324 Th actinoids —	325 Pa actinoids —	326 U actinoids —	327 Np actinoids —	328 Pu actinoids —	329 Am 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Pu actinoids —	383 Am actinoids —	384 Cm actinoids —	385 Bk actinoids —	386 Cf actinoids —	387 Es actinoids —	388 Fm actinoids —	389 Md actinoids —	390 No actinoids —	391 Lr actinoids —	392 Rn actinoids —	393 Fr actinoids —	394 Ra actinoids —	395 Ac actinoids —	396 Th actinoids —	397 Pa actinoids —	398 U actinoids —	399 Np actinoids —	400 Pu actinoids —	401 Am actinoids —	402 Cm actinoids —	403 Bk actinoids —	404 Cf actinoids —	405 Es actinoids —	406 Fm actinoids —	407 Md actinoids —	408 No actinoids —	409 Lr actinoids —	410 Rn actinoids —	411 Fr actinoids —	412 Ra actinoids —	413 Ac actinoids —	414 Th actinoids —	415 Pa actinoids —	416 U actinoids —	417 Np actinoids —	418 Pu actinoids —	419 Am actinoids —	420 Cm actinoids —	421 Bk actinoids —	422 Cf actinoids —	423 Es actinoids —	424 Fm actinoids —	425 Md actinoids —	426 No actinoids —	427 Lr actinoids —	428 Rn actinoids —	429 Fr actinoids —	430 Ra actinoids —	431 Ac actinoids —	432 Th actinoids —	433 Pa actinoids —	434 U actinoids —	435 Np actinoids —	436 Pu actinoids —	437 Am actinoids —	438 Cm actinoids —	439 Bk actinoids —	440 Cf actinoids —	441 Es actinoids —	442 Fm actinoids —	443 Md actinoids —	444 No actinoids —	445 Lr actinoids —	446 Rn actinoids —	447 Fr actinoids —	448 Ra actinoids —	449 Ac actinoids —	450 Th actinoids —	451 Pa actinoids —	452 U actinoids —	453 Np actinoids —	454 Pu actinoids —	455 Am actinoids —	456 Cm actinoids —	457 Bk actinoids —	458 Cf actinoids —	459 Es actinoids —	460 Fm actinoids —	461 Md actinoids —	462 No actinoids —	463 Lr actinoids —	464 Rn actinoids —	465 Fr actinoids —	466 Ra actinoids —	467 Ac actinoids —	468 Th actinoids —	469 Pa actinoids —	470 U actinoids —	471 Np actinoids —	472 Pu actinoids —	473 Am actinoids —	474 Cm actinoids —	475 Bk actinoids —	476 Cf actinoids —	477 Es actinoids —	478 Fm actinoids —	479 Md actinoids —	480 No actinoids —	481 Lr actinoids —	482 Rn actinoids —	483 Fr actinoids —	484 Ra actinoids —	485 Ac actinoids —	486 Th actinoids —	487 Pa actinoids —	488 U actinoids —	489 Np actinoids —	490 Pu actinoids —	491 Am actinoids —	492 Cm actinoids —	493 Bk actinoids —	494 Cf actinoids —	495 Es actinoids —	496 Fm actinoids —	497 Md actinoids —	498 No actinoids —	499 Lr actinoids —	500 Rn actinoids —	501 Fr actinoids —	502 Ra actinoids —	503 Ac actinoids —	504 Th actinoids —	505 Pa actinoids —	506 U actinoids —	507 Np actinoids —	508 Pu actinoids —	509 Am actinoids —	510 Cm actinoids —	511 Bk actinoids —	512 Cf actinoids —	513 Es actinoids —	514 Fm actinoids —	515 Md actinoids —	516 No actinoids —	517 Lr actinoids —	518 Rn actinoids —	519 Fr actinoids —	520 Ra actinoids —	521 Ac actinoids —	522 Th actinoids —	523 Pa actinoids —	524 U actinoids —	525 Np actinoids —	526 Pu actinoids —	527 Am actinoids —	528 Cm actinoids —	529 Bk actinoids —	530 Cf actinoids —	531 Es actinoids —	532 Fm actinoids —	533 Md actinoids —	534 No actinoids —	535 Lr actinoids —	536 Rn actinoids —	537 Fr actinoids —	538 Ra actinoids —	539 Ac actinoids —	540 Th actinoids —	541 Pa actinoids —	542 U actinoids —	543 Np actinoids —	544 Pu actinoids —	545 Am actinoids —	546 Cm actinoids —	547 Bk actinoids —	548 Cf actinoids —	549 Es actinoids —	550 Fm actinoids —	551 Md actinoids —	552 No actinoids —	553 Lr actinoids —	554 Rn actinoids —	555 Fr actinoids —	556 Ra actinoids —	557 Ac actinoids —	558 Th actinoids —	559 Pa actinoids —	560 U actinoids —	561 Np actinoids —	562 Pu actinoids —	563 Am actinoids —	564 Cm actinoids —	565 Bk actinoids —	566 Cf actinoids —	567 Es actinoids —	568 Fm actinoids —	569 Md actinoids —	570 No actinoids —	571 Lr actinoids —	572 Rn actinoids —	573 Fr actinoids —	574 Ra actinoids —	575 Ac actinoids —	576 Th actinoids —	577 Pa actinoids —	578 U actinoids —	579 Np actinoids —	580 Pu actinoids —	581 Am actinoids —	582 Cm actinoids —	583 Bk actinoids —	584 Cf actinoids —	585 Es actinoids —	586 Fm actinoids —	587 Md actinoids —	588 No actinoids —	589 Lr actinoids —	590 Rn actinoids —	591 Fr actinoids —	592 Ra actinoids —	593 Ac actinoids —	594 Th actinoids —	595 Pa actinoids —	596 U actinoids —