



福建中學
FUKIEN SECONDARY SCHOOL

S6 Mock Examination (2021-2022)

Chemistry

Paper 2

(1 hour)

Date : 24th January 2022
Time : 11:30a.m. - 12:30p.m.

Name : _____

Class : _____ No. : _____

INSTRUCTIONS

1. Read carefully the instructions. Write your name, class and class number in the spaces provided.
2. This paper consists of **THREE** sections, Section A, Section B and Section C. Attempt **ALL** questions in any **TWO** sections.
3. Write your answers in the Answer Book provided. Start each question (not part of a question) on a new page.
4. A Periodic Table is printed on the back of this Question Book. Atomic numbers and relative atomic masses of elements can be obtained from the Periodic Table.

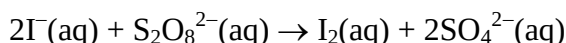
Section A Industrial Chemistry

Answer **ALL** parts of the question.

1. (a) Answer the following short questions:

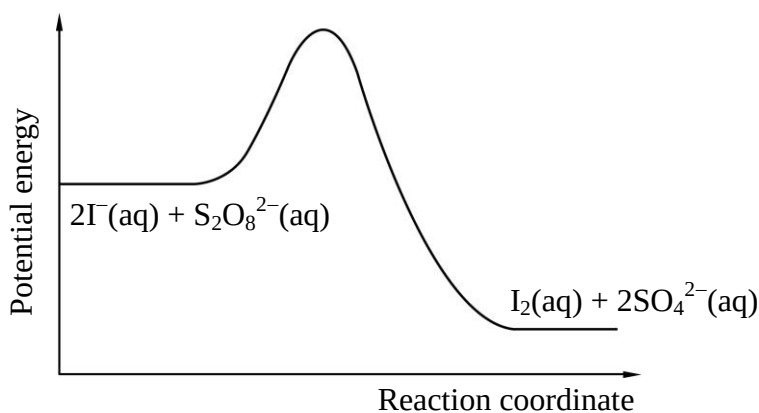
- (i) Write TWO equations for the synthesis of methanol from natural gas. (2 marks)
- (ii) Explain why the operating pressure of Haber process is about 200 atm instead of 1000 atm. (2 marks)
- (iii) The activation energy for the formation of HI(g) from H₂(g) and I₂(g) is +160 kJ mol⁻¹ under certain conditions.
- $$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g}) \quad \Delta H = -9 \text{ kJ mol}^{-1}$$
- What is the activation energy for the decomposition of HI under the same conditions? (1 mark)

(b) Consider the reaction between peroxodisulphate ions and iodide ions:



Without any catalyst, the reaction proceeds very slowly. The reaction can be speeded up by adding a small amount of Fe²⁺(aq) ions or Fe³⁺(aq) ions as catalysts.

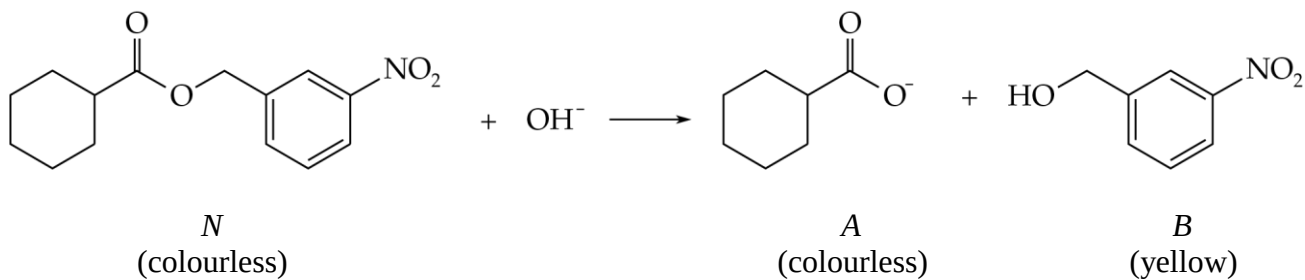
- (i) Explain why the reaction between peroxodisulphate ions and iodide ions proceeds very slowly without any catalyst. (1 mark)
- (ii) Write TWO chemical equations to show how Fe³⁺(aq) ions function as catalysts in the reaction. (2 marks)
- (iii) The diagram below shows the energy profile of the uncatalysed reaction between peroxodisulphate ions and iodide ions.



Sketch the energy profile for the reaction catalysed by Fe³⁺(aq) ions.

(2 marks)

1. (c) Ester *N* undergoes alkaline hydrolysis according to the following equation.



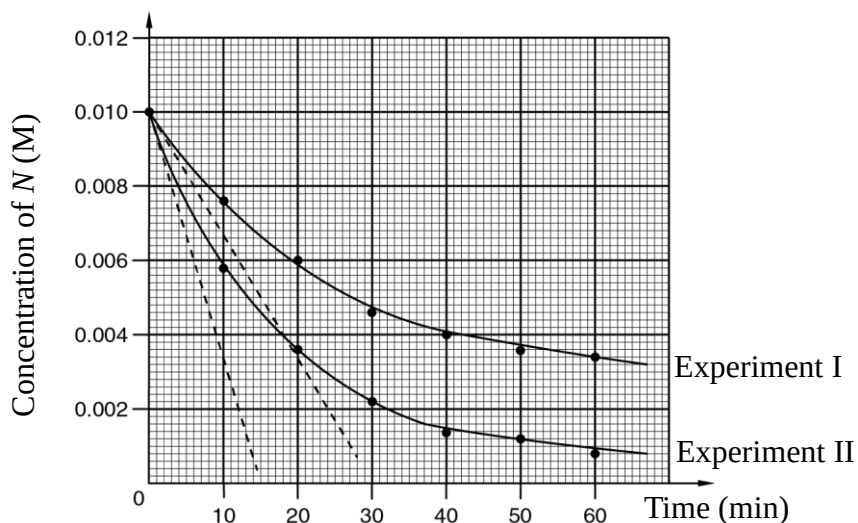
(i) Suggest a method that can be used to study the progress of the reaction. (1 mark)

(ii) The kinetics of the hydrolysis of 0.01 M ester *N* is studied under two different hydroxide ion concentrations at a certain temperature.

Experiment I: $[\text{OH}^-] = 0.5 \text{ M}$

Experiment II: $[\text{OH}^-] = 1.0 \text{ M}$

The following graph shows how the concentration of *N* varied with time in the two experiments.



- (1) Using the graph above, determine the initial rates of reactions in Experiments I and II.
- (2) Using your results in (1), deduce the order of reaction with respect to OH^- .
- (3) Given that the order of reaction with respect to *N* is 1. Write a rate equation for the alkaline hydrolysis of *N*.
- (4) Calculate the rate constant for this reaction at that temperature.

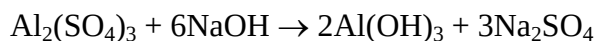
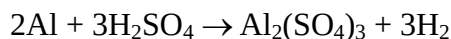
(6 marks)

1. (d) Aluminium hydroxide is a common active ingredient in antacids. To synthesize aluminium hydroxide, two different pathways can be utilized.

Pathway I:



Pathway II:



- (i) By calculating the atom economy of each pathway, deduce which pathway is greener.

(Formula masses: $\text{H}_2\text{O} = 18.0$, $\text{Al} = 27.0$, $\text{NaOH} = 40.0$, $\text{Al}(\text{OH})_3 = 78.0$, $\text{H}_2\text{SO}_4 = 98.1$, $\text{Al}_2\text{O}_3 = 102.0$)

(2 marks)

- (ii) Explain whether Al_2O_3 or Al is a greener feedstock for synthesizing aluminium hydroxide.

(1 mark)

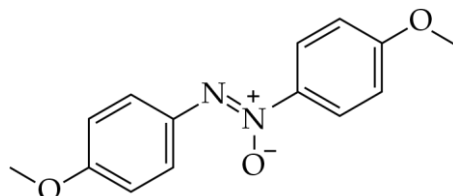
END OF SECTION A

Section B Materials Chemistry

Answer **ALL** parts of the question.

2. (a) Answer the following short questions:

- (i) Chitin can dissolve in sodium hydroxide solution. Explain this phenomenon. (2 marks)
- (ii) Consider the following compound which exhibits liquid crystalline behaviour.



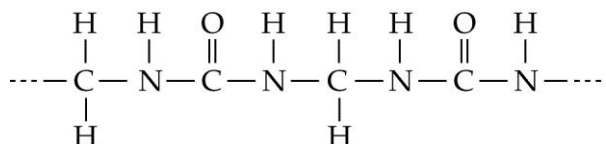
State TWO structural features of the above compound that make it exhibit liquid crystalline behaviour.

(2 marks)

(iii) Suggest one use of silver nanoparticles in daily life.

(1 mark)

(b) Urea-methanal is a polymer commonly used in making electric sockets. The following diagram shows a part of the structure of urea-methanal:



- (i) Write the structural formulae of the monomers of urea-methanal. (2 marks)
- (ii) Explain whether urea-methanal is an addition polymer or a condensation polymer. (1 mark)
- (iii) Suggest why the polymerization of urea-methanal can be regarded as a green process. (1 mark)
- (iv) With reference to the structure of urea-methanal, explain why urea-methanal can be used in making electric sockets. (2 marks)
- (v) Suggest a moulding method for making electric sockets. (1 mark)

2. (c) Iron exists in two forms. It has a body-centred cubic structure below 900°C, but it has a cubic close-packed structure between 900°C and 1400°C.

(i) Draw the unit cell for the body-centred cubic structure of iron.

(1 mark)

(ii) State the number of iron atoms in a unit cell of the body-centred cubic structure.

(1 mark)

(iii) Given that the density of iron is 7.92 g cm^{-3} and the volume of the unit cell is $2.34 \times 10^{-23} \text{ cm}^3$. Calculate the value of Avogadro number (L).

(2 marks)

(iv) Compare the packing efficiency of atoms in body-centred cubic structure and cubic close-packed structure.

(1 mark)

(v) Steel is an alloy of iron and carbon. It is stronger than pure iron.

(1) What is the meaning of the term 'alloy'?

(2) With reference to the structure of steel, explain why steel is stronger than pure iron.

(3 marks)

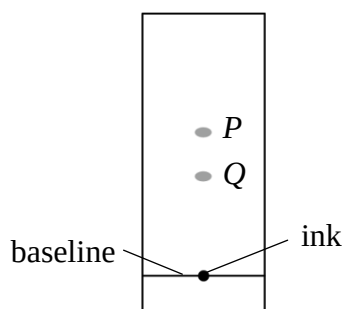
END OF SECTION B

Section C Analytical Chemistry

Answer **ALL** parts of the question.

3. (a) Answer the following short questions:

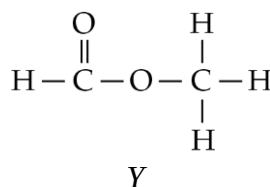
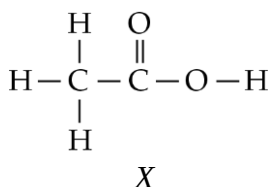
- (i) The dyes in a sample of ink are separated by paper chromatography. The bottom end of the filter paper is dipped into hexane. Two spots (*P* and *Q*) can be seen in the chromatogram as shown below.



- (1) Identify the stationary phase in the chromatography.
- (2) Which spot (*P* or *Q*) is less polar? Explain briefly.

(2 marks)

- (ii) Suggest a chemical test to show how the following two compounds can be distinguished.



(2 marks)

- (iii) State the expected observation when a piece of moist blue litmus paper is put into a test tube containing chlorine.

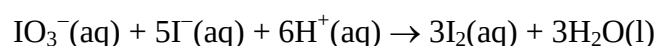
(1 mark)

- (b) Sulphite ion (SO_3^{2-}) is a preservative used in wine. To determine the sulphite ion content in a sample of white wine, a student performed a titrimetric analysis. The procedure is as follows.

Step 1: Excess dilute $\text{NaI}(\text{aq})$ and dilute $\text{H}_2\text{SO}_4(\text{aq})$ are added to 5.0 cm^3 of 0.005 M $\text{NaIO}_3(\text{aq})$. The mixture is then diluted to 250.0 cm^3 using distilled water. Then a standard iodine solution is freshly prepared.

Step 2: 25.0 cm^3 portions of white wine sample are titrated against the standard iodine solution. The mean titre is 5.05 cm^3 .

- (i) The reaction in step 1 can be represented by the following equation:



Calculate the concentration of $\text{I}_2(\text{aq})$ in the standard iodine solution.

(2 marks)

3. (b) (ii) When performed the titration in step 2, the student found that the end point of the titration cannot be determined clearly. Suggest a method so that the end point can be detected more accurately.

(1 mark)

- (iii) (1) Write a chemical equation for the reaction between sulphite ions and iodine.

- (2) Calculate the sulphite ion content (in mg dm^{-3}) in the white wine sample.

(Relative atomic masses: O = 16.0, S = 32.1)

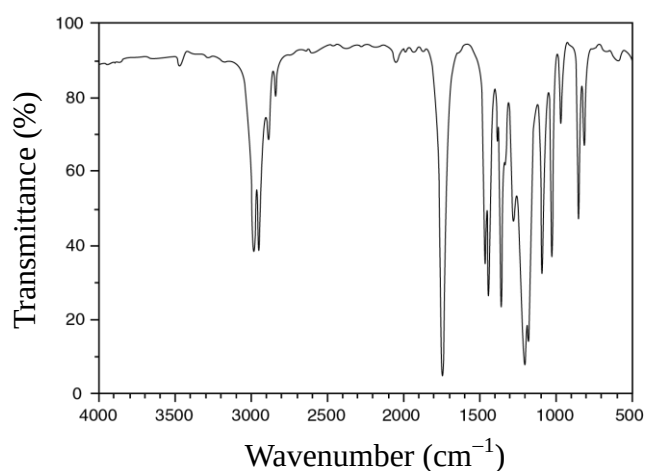
(4 marks)

- (c) Compound Z is a carbon compound. Analysis of Z shows the following results:

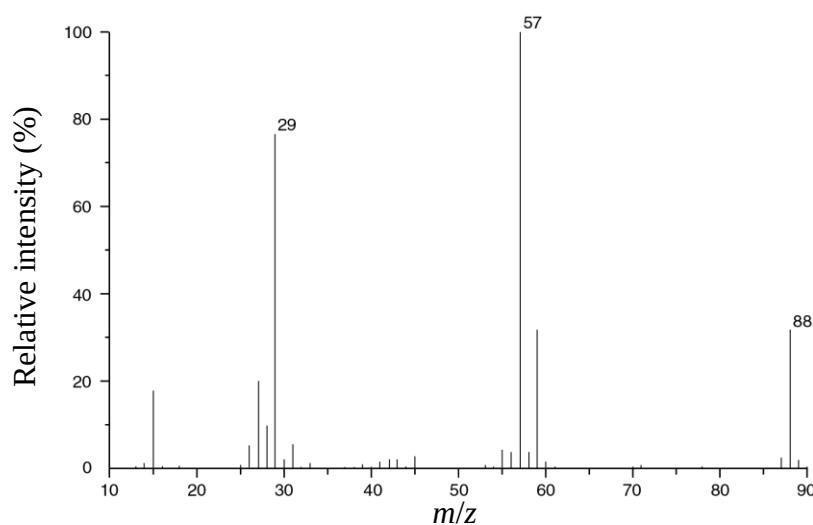
- (1) It gives a neutral solution when dissolved in water.
- (2) It has a pleasant fruity smell.
- (3) It contains 54.6% carbon, 9.1% hydrogen and 36.3% oxygen by mass.

The infrared spectrum and mass spectrum of Z are shown below:

Infrared spectrum:



Mass spectrum:



3. (c) (i) Deduce the molecular formula of Z.
(Relative atomic masses: H = 1.0, C = 12.0, O = 16.0)
(2 marks)
- (ii) With reference to its infrared spectrum and other given information, suggest a functional group present in Z.
(4 marks)
- (iii) Suggest one chemical species corresponding to each of the peaks at $m/z = 29$ and $m/z = 57$.
(2 marks)

Characteristic Infrared Absorption Wavenumber Ranges (Stretching modes)

Bond	Compound type	Wavenumber range / cm^{-1}
C=C	Alkenes	1610 to 1680
C=O	Aldehydes, ketones, carboxylic acids and derivatives	1680 to 1800
C $\equiv$ C	Alkynes	2070 to 2250
C $\equiv$ N	Nitriles	2200 to 2280
O–H	Acids (hydrogen-bonded)	2500 to 3300
C–H	Alkanes, alkenes and arenes	2840 to 3095
O–H	Alcohols (hydrogen-bonded)	3230 to 3670
N–H	Amines	3350 to 3500

END OF SECTION C

END OF PAPER

PERIODIC TABLE 周期表

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atomic number 原子序

relative atomic mass 相對原子質量

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																208	Pb	207.2	209	Bi	209.0	210	Po	(209)	211	At	(210)	212	Rn	(222)	213	Fr	(223)	214	Ra	(226)	215	Ac	(227)	216	Rf	(261)	217	Db	(262)	218	Sg	(266)	219	Bh	(264)	220	Hs	(277)	221	Mt	(268)	222	Rg	(288)	223	Ug	(294)	224	Uu	(304)	225	Uub	(310)	226	Uut	(315)	227	Uuq	(320)	228	Uub	(310)	229	Uut	(315)	230	Uuq	(320)	231	Uub	(310)	232	Uut	(315)	233	Uuq	(320)	234	Uub	(310)	235	Uut	(315)	236	Uuq	(320)	237	Uub	(310)	238	Uut	(315)	239	Uuq	(320)	240	Uub	(310)	241	Uut	(315)	242	Uuq	(320)	243	Uub	(310)	244	Uut	(315)	245	Uuq	(320)	246	Uub	(310)	247	Uut	(315)	248	Uuq	(320)	249	Uub	(310)	250	Uut	(315)	251	Uuq	(320)	252	Uub	(310)	253	Uut	(315)	254	Uuq	(320)	255	Uub	(310)	256	Uut	(315)	257	Uuq	(320)	258	Uub	(310)	259	Uut	(315)	260	Uuq	(320)	261	Uub	(310)	262	Uut	(315)	263	Uuq	(320)	264	Uub	(310)	265	Uut	(315)	266	Uuq	(320)	267	Uub	(310)	268	Uut	(315)	269	Uuq	(320)	270	Uub	(310)	271	Uut	(315)	272	Uuq	(320)	273	Uub	(310)	274	Uut	(315)	275	Uuq	(320)	276	Uub	(310)	277	Uut	(315)	278	Uuq	(320)	279	Uub	(310)	280	Uut	(315)	281	Uuq	(320)	282	Uub	(310)	283	Uut	(315)	284	Uuq	(320)	285	Uub	(310)	286	Uut	(315)	287	Uuq	(320)	288	Uub	(310)	289	Uut	(315)	290	Uuq	(320)	291	Uub	(310)	292	Uut	(315)	293	Uuq	(320)	294	Uub	(310)	295	Uut	(315)	296	Uuq	(320)	297	Uub	(310)	298	Uut	(315)	299	Uuq	(320)	300	Uub	(310)	301	Uut	(315)	302	Uuq	(320)	303	Uub	(310)	304	Uut	(315)	305	Uuq	(320)	306	Uub	(310)	307	Uut	(315)	308	Uuq	(320)	309	Uub	(310)	310	Uut	(315)	311	Uuq	(320)	312	Uub	(310)	313	Uut	(315)	314	Uuq	(320)	315	Uub	(310)	316	Uut	(315)	317	Uuq	(320)	318	Uub	(310)	319	Uut	(315)	320	Uuq	(320)	321	Uub	(310)	322	Uut	(315)	323	Uuq	(320)	324	Uub	(310)	325	Uut	(315)	326	Uuq	(320)	327	Uub	(310)	328	Uut	(315)	329	Uuq	(320)	330	Uub	(310)	331	Uut	(315)	332	Uuq	(320)	333	Uub	(310)	334	Uut	(315)	335	Uuq	(320)	336	Uub	(310)	337	Uut	(315)	338	Uuq	(320)	339	Uub	(310)	340	Uut	(315)	341	Uuq	(320)	342	Uub	(310)	343	Uut	(315)	344	Uuq	(320)	345	Uub	(310)	346	Uut	(315)	347	Uuq	(320)	348	Uub	(310)	349	Uut	(315)	350	Uuq	(320)	351	Uub	(310)	352	Uut	(315)	353	Uuq	(320)	354	Uub	(310)	355	Uut	(315)	356	Uuq	(320)	357	Uub	(310)	358	Uut	(315)	359	Uuq	(320)	360	Uub	(310)	361	Uut	(315)	362	Uuq	(320)	363	Uub	(310)	364	Uut	(315)	365	Uuq	(320)	366	Uub	(310)	367	Uut	(315)	368	Uuq	(320)	369	Uub	(310)	370	Uut	(315)	371	Uuq	(320)	372	Uub	(310)	373	Uut	(315)	374	Uuq	(320)	375	Uub	(310)	376	Uut	(315)	377	Uuq	(320)	378	Uub	(310)	379	Uut	(315)	380	Uuq	(320)	381	Uub	(310)	382	Uut	(315)	383	Uuq	(320)	384	Uub	(310)	385	Uut	(315)	386	Uuq	(320)	387	Uub	(310)	388	Uut	(315)	389	Uuq	(320)	390	Uub	(310)	391	Uut	(315)	392	Uuq	(320)	393	Uub	(310)	394	Uut	(315)	395	Uuq	(320)	396	Uub	(310)	397	Uut	(315)	398	Uuq	(320)	399	Uub	(310)	400	Uut	(315)	401	Uuq	(320)	402	Uub	(310)	403	Uut	(315)	404	Uuq	(320)	405	Uub	(310)	406	Uut	(315)	407	Uuq	(320)	408	Uub	(310)	409	Uut	(315)	410	Uuq	(320)	411	Uub	(310)	412	Uut	(315)	413	Uuq	(320)	414	Uub	(310)	415	Uut	(315)	416	Uuq	(320)	417	Uub	(310)	418	Uut	(315)	419	Uuq	(320)	420	Uub	(310)	421	Uut	(315)	422	Uuq	(320)	423	Uub	(310)	424	Uut	(315)	425	Uuq	(320)	426	Uub	(310)	427	Uut	(315)	428	Uuq	(320)	429	Uub	(310)	430	Uut	(315)	431	Uuq	(320)	432	Uub	(310)	433	Uut	(315)	434	Uuq	(320)	435	Uub	(310)	436	Uut	(315)	437	Uuq	(320)	438	Uub	(310)	439	Uut	(315)	440	Uuq	(320)	441	Uub	(310)	442	Uut	(315)	443	Uuq	(320)	444	Uub	(310)	445	Uut	(315)	446	Uuq	(320)	447	Uub	(310)	448	Uut	(315)	449	Uuq	(320)	450	Uub	(310)	451	Uut	(315)	452	Uuq	(320)	453	Uub	(310)	454	Uut	(315)	455	Uuq	(320)	456	Uub	(310)	457	Uut	(315)	458	Uuq	(320)	459	Uub	(310)	460	Uut	(315)	461	Uuq	(320)	462	Uub	(310)	463	Uut	(315)	464	Uuq	(320)	465	Uub	(310)	466	Uut	(315)	467	Uuq	(320)	468	Uub	(310)	469	Uut	(315)	470	Uuq	(320)	471	Uub	(310)	472	Uut	(315)	473	Uuq	(320)	474	Uub	(310)	475	Uut	(315)	476	Uuq	(320)	477	Uub	(310)	478	Uut	(315)	479	Uuq	(320)	480	Uub	(310)	481	Uut	(315)	482	Uuq	(320)	483	Uub	(310)	484	Uut	(315)	485	Uuq	(320)	486	Uub	(310)	487	Uut	(315)	488	Uuq	(320)	489	Uub	(310)	490	Uut	(315)	491	Uuq	(320)	492	Uub	(310)	493	Uut	(315)	494	Uuq	(320)	495	Uub	(310)	496	Uut	(315)	497	Uuq	(320)	498	Uub	(310)	499	Uut	(315)	500	Uuq	(320)	501	Uub	(310)	502	Uut	(315)	503	Uuq	(320)	504	Uub	(310)	505	Uut	(315)	506	Uuq	(320)	507	Uub	(310)	508	Uut	(315)	509	Uuq	(320)	510	Uub	(310)	511	Uut	(315)	512	Uuq	(320)	513	Uub	(310)	514	Uut	(315)	515	Uuq	(320)	516	Uub	(310)	517	Uut	(315)	518	Uuq	(320)	519	Uub	(310)	520	Uut	(315)	521	Uuq	(320)	522	Uub	(310)	523	Uut	(315)	524	Uuq	(320)	525	Uub	(310)	526	Uut	(315)	527	Uuq	(320)	528	Uub	(310)	529	Uut	(315)	530	Uuq	(320)	531	Uub	(310)	532	Uut	(315)	533	Uuq	(320)	534	Uub	(310)	535	Uut	(315)	536	Uuq	(320)	537	Uub	(310)	538	Uut	(315)	539	Uuq	(320)	540	Uub	(310)	541	Uut	(315)	542	Uuq	(320)	543	Uub	(310)	544	Uut	(315)	545	Uuq	(320)	546	Uub	(310)	547	Uut	(315)	548	Uuq	(320)	549	Uub	(310)	550	Uut	(315)	551	Uuq	(320)	552	Uub	(310)	553	Uut	(315)	554	Uuq	(320)	555	Uub	(310)	556	Uut	(315)	557	Uuq	(320)	558	Uub	(310)	559	Uut	(315)	560	Uuq	(320)	561	Uub	(310)	562	Uut	(315)	563	Uuq	(320)	564	Uub	(310)	565	Uut	(315)	566	Uuq	(320)	567	Uub	(310)	568	Uut	(315)	569	Uuq	(320)	570	Uub	(310)	571	Uut	(315)	572	Uuq	(320)	573	Uub	(310)	574	Uut	(315)	575	Uuq	(320)	576	Uub	(310)	577	Uut	(315)	578	Uuq	(320)	579	Uub	(310)	580	Uut	(315)	581	Uuq	(320)	582	Uub	(310)	583	Uut	(315)	584	Uuq	(320)	585	Uub	(310)	586	Uut	(315)	587	Uuq	(320)	588	Uub	(310)	589	Uut	(315)	590	Uuq	(320)	591	Uub	(310)	592	Uut	(315)	593	Uuq	(320)	594	Uub	(310)	595	Uut	(315)	596	Uuq	(320)	597	Uub	(310)	598	Uut	(315)	599	Uuq	(320)	600	Uub	(310)	601	Uut	(315)	602	Uuq	(320)	603	Uub	(310)	604	Uut	(315)	605	Uuq	(320)	606	Uub	(310)	607	Uut	(315)	608	Uuq	(320)	609	Uub	(310)	610	Uut	(315)	611	Uuq	(320)	612	Uub	(310)	613	Uut	(315)	614	Uuq	(320)	615	Uub	(310)	616	Uut	(315)	617	Uuq	(320)	618	Uub	(310)	619	Uut	(315)	620	Uuq	(320)	621	Uub	(310)	622	Uut	(315)	623	Uuq	(320)	624	Uub	(310)	625	Uut	(315)	626	Uuq	(320)	627	Uub	(310)	628	Uut	(315)	629	Uuq	(320)	630	Uub	(310)	631	Uut	(315)	632	Uuq	(320)	633	Uub	(310)	634	Uut	(315)	635	Uuq	(320)	636	Uub	(310)	637	Uut	(315)	638	Uuq	(320)	639	Uub	(310)	640	Uut	(315)	641	Uuq	(320)	642	Uub	(310)	643	Uut	(315)	644	Uuq	(320)	645	Uub	(310)	646	Uut	(315)	647	Uuq	(320)	648	Uub	(310)	649	Uut	(315)	650	Uuq	(320)	651	Uub	(310)	652	Uut	(315)	653	Uuq	(320)	654	Uub

*	58	Ce	140.1	59	Pr	140.9	60	Nd	144.2	61	Pm	(145)	62	Sm	150.4	63	Eu	152.0	64	Gd	157.3	65	Tb	158.9	66	Dy	162.5	67	Ho	164.9	68	Er	167.3	69	Tm	168.9	70	Yb	173.0	71	Lu	175.0																								
																									90	Th	232.0	91	Pa	(231)	92	U	238.0	93	Np	(237)	94	Pu	(244)	95	Am	(243)	96	Cm	(247)	97	Bk	(247)	98	Cf	(251)	99	Es	(252)	100	Fm	(257)	100	Md	(258)	102	No	(259)	103	Lr	(260)