



Cambridge IGCSE™ (9–1)

CHEMISTRY

0971/22

Paper 2 Multiple Choice (Extended)

October/November 2023

45 minutes

You must answer on the multiple choice answer sheet.



You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

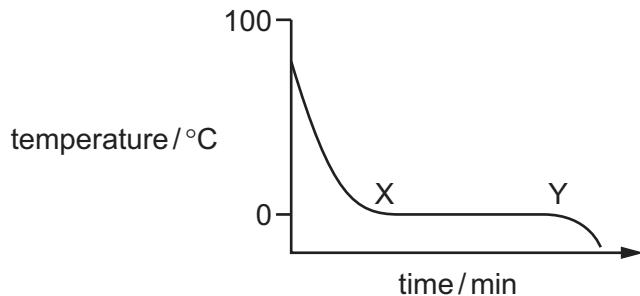
- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages.

1 Part of a cooling curve for water is shown.



What is occurring between points X and Y?

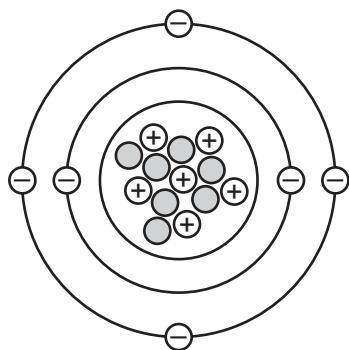
- A Steam is condensing into water.
- B The temperature of the water is decreasing.
- C Ice is melting.
- D Particles are losing heat to the surroundings.

2 Which statements about clean, dry air are correct?

- 1 It is a mixture of elements only.
- 2 It is a mixture of elements and compounds.
- 3 It contains only non-metals.

- A 1 and 3
- B 1 only
- C 2 and 3
- D 2 only

3 A representation of an atom is shown.



What is the nucleon number of this atom?

- A 6
- B 7
- C 12
- D 13

4 The percentage abundances of three isotopes in a sample of neon are shown.

isotope	percentage abundance / %
$^{20}_{10}\text{Ne}$	90.48
$^{21}_{10}\text{Ne}$	0.27
$^{22}_{10}\text{Ne}$	9.25

What is the relative atomic mass, A_r , of this sample of neon?

A 10.19 B 20.19 C 21.00 D 30.19

5 Potassium reacts with iodine to form potassium iodide.

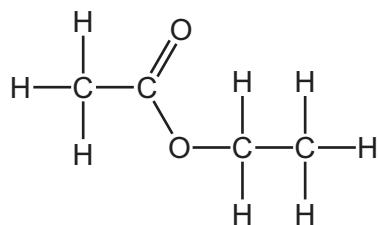
Which statement about potassium iodide is correct?

A Each potassium atom shares a pair of electrons with an iodine atom.
 B In potassium iodide, the particles of potassium have more protons than electrons.
 C Potassium iodide has a high melting point because it is a covalent compound.
 D Potassium iodide has a low melting point because it is an ionic compound.

6 Which substance has the lowest melting point?

A graphite
 B methanol
 C silicon(IV) oxide
 D sodium chloride

7 The diagram shows the structure of a molecule of ethyl ethanoate.



What is the molecular formula of a molecule of ethyl ethanoate?

A CHO B $\text{C}_4\text{H}_8\text{O}_2$ C $\text{C}_4(\text{H}_2)_2(\text{O}_2)$ D $\text{C}_2\text{H}_4\text{O}$

8 A hydrocarbon contains 85.7% of carbon by mass.

What is the empirical formula of the hydrocarbon?

A CH_2 **B** CH_4 **C** C_2H_5 **D** C_3H_6

9 The formula of a compound containing element X is $\text{Na}_2\text{X}_2\text{O}_3$.

The relative formula mass of the compound is 158.

What is the relative atomic mass of X?

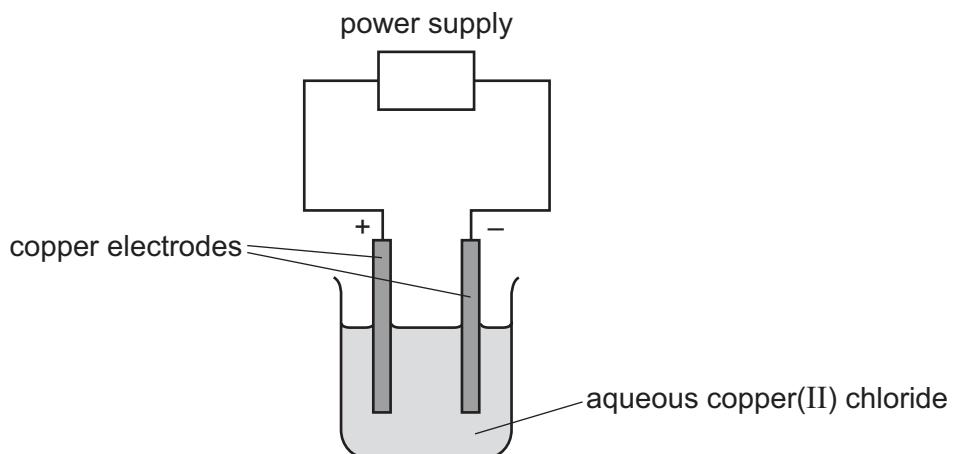
A 32 **B** 59.5 **C** 64 **D** 119

10 Dilute aqueous potassium chloride is electrolysed using platinum electrodes.

Which row identifies the product at each electrode?

	anode	cathode
A	chlorine	hydrogen
B	chlorine	potassium
C	oxygen	hydrogen
D	oxygen	potassium

11 Concentrated aqueous copper(II) chloride is electrolysed using copper electrodes, as shown.



What happens to the mass of each electrode during this process?

	positive electrode	negative electrode
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

12 The initial and final temperatures of four different reactions are measured.

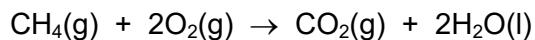
Which reaction is the **least** exothermic?

	initial temperature /°C	final temperature /°C
A	19	25
B	21	18
C	22	17
D	22	26

13 Which equation represents an endothermic reaction?

- A** $\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$
- B** $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
- C** $\text{H}(\text{g}) + \text{H}(\text{g}) \rightarrow \text{H}_2(\text{g})$
- D** $2\text{K}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{KOH}(\text{aq}) + \text{H}_2(\text{g})$

14 Methane burns in oxygen to form carbon dioxide and water.



The bond energies are shown.

bond	bond energy in kJ/mol
C–H	410
C–O	360
C=O	805
O–H	460
O–O	146
O=O	496

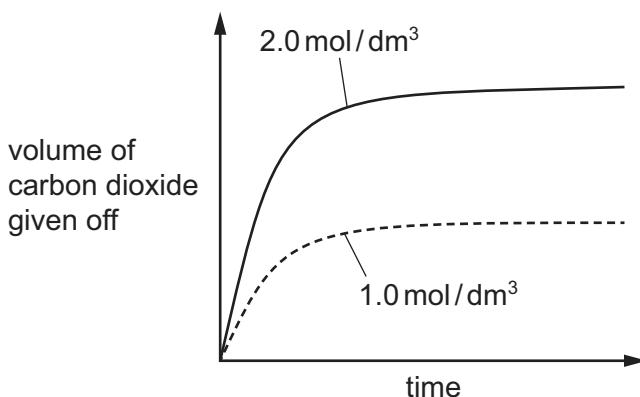
What is the energy change for this reaction?

A –818 kJ/mol **B** –102 kJ/mol **C** +102 kJ/mol **D** +818 kJ/mol

15 Hydrochloric acid is added to excess calcium carbonate in two separate experiments.

Two different concentrations of hydrochloric acid are used but the temperature is the same in both experiments.

The graph of the results shows the volume of carbon dioxide gas given off over time.

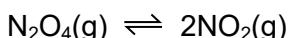


Which row is correct?

	particles in 2.0 mol/dm ³ compared to 1.0 mol/dm ³	
	collision rate	collision energy
A	higher	no change
B	higher	higher
C	lower	no change
D	lower	higher

16 The decomposition of dinitrogen tetroxide, N_2O_4 , into nitrogen dioxide, NO_2 , is a reversible reaction.

The equation for the reaction is shown.

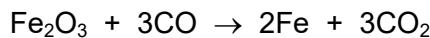


The forward reaction is endothermic.

Which row shows the effect on the position of equilibrium and the rate of the reverse reaction when the temperature is increased?

	position of equilibrium	rate of the reverse reaction
A	shifts to the left	decreases
B	shifts to the left	increases
C	shifts to the right	decreases
D	shifts to the right	increases

17 In a blast furnace, iron(III) oxide is converted to iron and carbon monoxide is converted to carbon dioxide.



What happens to each of these reactants?

- A Both iron(III) oxide and carbon monoxide are oxidised.
- B Both iron(III) oxide and carbon monoxide are reduced.
- C Iron(III) oxide is oxidised and carbon monoxide is reduced.
- D Iron(III) oxide is reduced and carbon monoxide is oxidised.

18 Which row describes what happens to Fe^{2+} ions when they are oxidised?

	electron movement	oxidation number of iron
A	they gain electrons	decreases
B	they gain electrons	increases
C	they lose electrons	decreases
D	they lose electrons	increases

19 In which reaction does an acid react with a base?

- A Dilute sulfuric acid is added to a piece of magnesium ribbon producing hydrogen.
- B Dilute sulfuric acid is added to aqueous barium chloride producing a white precipitate of barium sulfate.
- C Aqueous sodium hydroxide is added to aqueous copper(II) sulfate producing a blue precipitate of copper(II) hydroxide.
- D Aqueous sodium hydroxide is added to solid ammonium sulfate producing gaseous ammonia.

20 Which element forms an oxide that reacts with an aqueous solution of a base?

- A argon
- B sulfur
- C magnesium
- D copper

21 Which method is used to produce insoluble salts?

- A addition of excess insoluble base to an acid
- B addition of excess metal to an acid
- C precipitation using two aqueous solutions
- D titration using an acid and an alkali

22 The noble gases are in Group VIII of the Periodic Table.

Some properties of the first four noble gases are shown.

noble gas	boiling point in °C	density in g/dm ³
helium	–267	0.179
neon	–246	0.900
argon	–186	1.782
krypton	–152	3.708

Which row identifies the trends in boiling point and in density as Group VIII is descended?

	boiling point	density
A	decreasing	increasing
B	increasing	increasing
C	decreasing	decreasing
D	increasing	decreasing

23 Some properties of element R are shown.

melting point in °C	98
boiling point in °C	883
reaction with cold water	gives off H ₂ gas
reaction when heated with oxygen	burns to give a white solid

In which part of the Periodic Table is R found?

- A Group I
- B Group VII
- C Group VIII
- D transition elements

24 Which pair of compounds shows that transition elements have variable oxidation states?

- A Cr_2O_3 and CrBr_3
- B CuSO_4 and CuCl_2
- C Fe_2O_3 and FeCl_2
- D NiO and NiCl_2

25 The list gives the order of some metals and hydrogen in the reactivity series.

Metal X is also included.

most reactive	K
Mg	
Zn	
H	
X	
least reactive	Cu

Which row shows the properties of metal X?

	reacts with dilute acids	oxide reduced by carbon
A	no	no
B	no	yes
C	yes	no
D	yes	yes

26 When zinc is added to an aqueous solution containing magnesium ions, there is no reaction.

Which species has the greatest tendency to lose electrons?

- A Mg
- B Mg^{2+}
- C Zn
- D Zn^{2+}

27 Which gas in the air is needed for iron to rust?

- A argon
- B carbon dioxide
- C nitrogen
- D oxygen

28 Which coating prevents iron from rusting even when the coating is damaged?

- A grease
- B paint
- C plastic
- D zinc

29 Why is limestone added to the blast furnace?

- A It neutralises the molten slag produced.
- B It reacts with impurities to form slag.
- C It releases carbon dioxide which reduces the iron(III) oxide.
- D It removes acidic gases such as carbon dioxide.

30 The flow chart shows stages in the treatment of river water to produce drinking water.



What occurs at stages J and K?

	J	K
A	distillation	chlorination
B	distillation	filtration
C	filtration	chlorination
D	filtration	distillation

31 Carbon dioxide acts as a greenhouse gas by interacting with a particular type of energy that radiates from the Earth's surface into the atmosphere.

Which type of energy is involved and what happens when this energy interacts with carbon dioxide molecules?

	type of energy involved	what happens
A	thermal	carbon dioxide molecules increase the Earth's energy loss to space
B	thermal	carbon dioxide molecules absorb the energy
C	light	carbon dioxide molecules increase the Earth's energy loss to space
D	light	carbon dioxide molecules absorb the energy

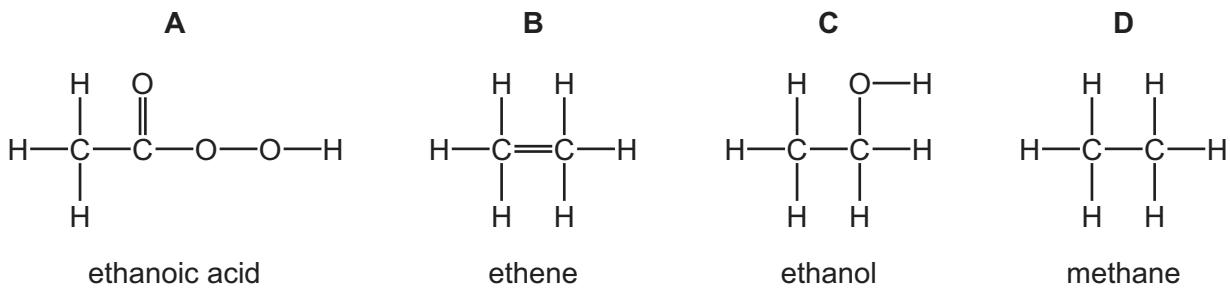
32 Oxides of nitrogen, such as NO and NO_2 , are formed in the petrol engines of cars.

They are removed from the exhaust gases by reactions in the car's catalytic converter.

Which row describes how oxides of nitrogen are formed in a petrol engine and a reaction that happens in the catalytic converter?

	how oxides of nitrogen are formed	a reaction that happens in the catalytic converter
A	by the reaction between nitrogen and oxygen from the air	$2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$
B	by the reaction between nitrogen and oxygen from the air	$2\text{NO} + 2\text{H}_2 \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$
C	by the reaction between nitrogen compounds in petrol and oxygen from the air	$2\text{NO} + 2\text{CO} \rightarrow \text{N}_2 + 2\text{CO}_2$
D	by the reaction between nitrogen compounds in petrol and oxygen from the air	$2\text{NO} + 2\text{H}_2 \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$

33 Which diagram shows the displayed formula for the named organic compound?



34 What is the total number of covalent bonds in a molecule of butane, C_4H_{10} ?

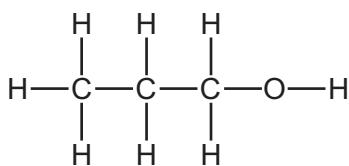
A 3 **B** 10 **C** 13 **D** 14

35 Propane reacts with chlorine in a substitution reaction.

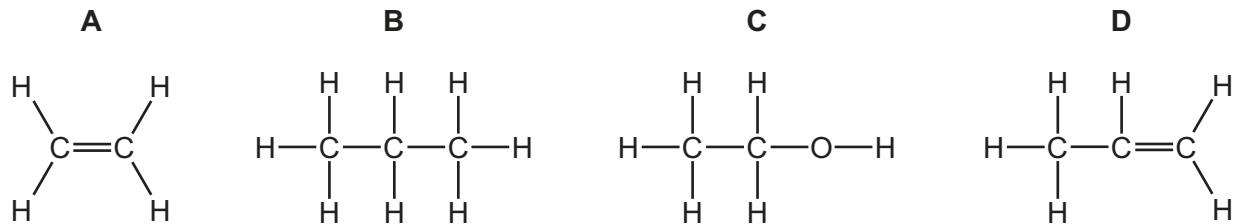
Which reaction condition is required for the reaction to occur?

A acid catalyst
B iron catalyst
C temperature of $400\text{ }^{\circ}\text{C}$
D ultraviolet light

36 The structure of an organic compound is shown.



Which structure represents a molecule that reacts with steam to produce this product?

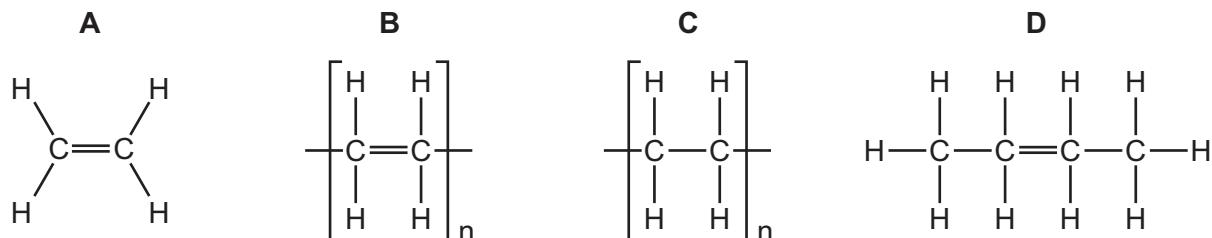


37 Which term describes nylon?

A addition polymer
B natural polymer
C polyamide
D polyester

38 Ethene can be polymerised.

Which diagram represents the structure of the product formed?



39 An acid–base titration is described.

- 25.0 cm³ of dilute aqueous alkali is put into a conical flask.
- Indicator is added to the flask.
- Dilute acid is added to the aqueous alkali until the indicator changes colour.
- The volume of acid used is then recorded.

Which use of apparatus is correct?

A The 25.0 cm³ of aqueous alkali is measured using a volumetric pipette.

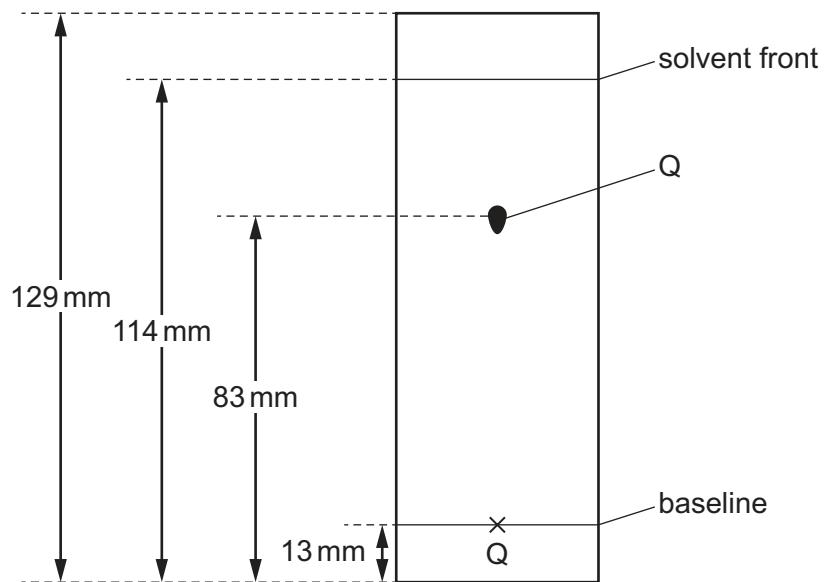
B The 25.0 cm³ of aqueous alkali is measured using the lines on the conical flask.

C The volume of acid is measured using a measuring cylinder.

D The volume of acid is measured using a volumetric pipette.

40 Substance Q is investigated using chromatography.

The chromatogram is shown. The diagram is not drawn to scale.



What is the R_f value of Q?

A 0.60 B 0.64 C 0.69 D 0.72

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The Periodic Table of Elements

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3	Li	4	Be	5	Li	6	Be	7	Li	8	Be	9	Li	10	Be	11	Li	12	Be	13	Li	14	Be	15	Li	16	Be	17	Li	18	Be	19	Li	20	Be	21	Li	22	Be	23	Li	24	Be	25	Li	26	Be	27	Li	28	Be	29	Li	30	Be	31	Li	32	Be	33	Li	34	Be	35	Li	36	Be	37	Li	38	Be	39	Li	40	Be	41	Li	42	Be	43	Li	44	Be	45	Li	46	Be	47	Li	48	Be	49	Li	50	Be	51	Li	52	Be	53	Li	54	Be	55	Li	56	Be	57	Li	58	Be	59	Li	60	Be	61	Li	62	Be	63	Li	64	Be	65	Li	66	Be	67	Li	68	Be	69	Li	70	Be	71	Li	72	Be	73	Li	74	Be	75	Li	76	Be	77	Li	78	Be	79	Li	80	Be	81	Li	82	Be	83	Li	84	Be	85	Li	86	Be	87	Li	88	Be	89	Li	90	Be	91	Li	92	Be	93	Li	94	Be	95	Li	96	Be	97	Li	98	Be	99	Li	100	Be	101	Li	102	Be	103	Li	104	Be	105	Li	106	Be	107	Li	108	Be	109	Li	110	Be	111	Li	112	Be	113	Li	114	Be	115	Li	116	Be	117	Li	118	Be	119	Li	120	Be	121	Li	122	Be	123	Li	124	Be	125	Li	126	Be	127	Li	128	Be	129	Li	130	Be	131	Li	132	Be	133	Li	134	Be	135	Li	136	Be	137	Li	138	Be	139	Li	140	Be	141	Li	142	Be	143	Li	144	Be	145	Li	146	Be	147	Li	148	Be	149	Li	150	Be	151	Li	152	Be	153	Li	154	Be	155	Li	156	Be	157	Li	158	Be	159	Li	160	Be	161	Li	162	Be	163	Li	164	Be	165	Li	166	Be	167	Li	168	Be	169	Li	170	Be	171	Li	172	Be	173	Li	174	Be	175	Li	176	Be	177	Li	178	Be	179	Li	180	Be	181	Li	182	Be	183	Li	184	Be	185	Li	186	Be	187	Li	188	Be	189	Li	190	Be	191	Li	192	Be	193	Li	194	Be	195	Li	196	Be	197	Li	198	Be	199	Li	200	Be	201	Li	202	Be	203	Li	204	Be	205	Li	206	Be	207	Li	208	Be	209	Li	210	Be	211	Li	212	Be	213	Li	214	Be	215	Li	216	Be	217	Li	218	Be	219	Li	220	Be	221	Li	222	Be	223	Li	224	Be	225	Li	226	Be	227	Li	228	Be	229	Li	230	Be	231	Li	232	Be	233	Li	234	Be	235	Li	236	Be	237	Li	238	Be	239	Li	240	Be	241	Li	242	Be	243	Li	244	Be	245	Li	246	Be	247	Li	248	Be	249	Li	250	Be	251	Li	252	Be	253	Li	254	Be	255	Li	256	Be	257	Li	258	Be	259	Li	260	Be	261	Li	262	Be	263	Li	264	Be	265	Li	266	Be	267	Li	268	Be	269	Li	270	Be	271	Li	272	Be	273	Li	274	Be	275	Li	276	Be	277	Li	278	Be	279	Li	280	Be	281	Li	282	Be	283	Li	284	Be	285	Li	286	Be	287	Li	288	Be	289	Li	290	Be	291	Li	292	Be	293	Li	294	Be	295	Li	296	Be	297	Li	298	Be	299	Li	300	Be	301	Li	302	Be	303	Li	304	Be	305	Li	306	Be	307	Li	308	Be	309	Li	310	Be	311	Li	312	Be	313	Li	314	Be	315	Li	316	Be	317	Li	318	Be	319	Li	320	Be	321	Li	322	Be	323	Li	324	Be	325	Li	326	Be	327	Li	328	Be	329	Li	330	Be	331	Li	332	Be	333	Li	334	Be	335	Li	336	Be	337	Li	338	Be	339	Li	340	Be	341	Li	342	Be	343	Li	344	Be	345	Li	346	Be	347	Li	348	Be	349	Li	350	Be	351	Li	352	Be	353	Li	354	Be	355	Li	356	Be	357	Li	358	Be	359	Li	360	Be	361	Li	362	Be	363	Li	364	Be	365	Li	366	Be	367	Li	368	Be	369	Li	370	Be	371	Li	372	Be	373	Li	374	Be	375	Li	376	Be	377	Li	378	Be	379	Li	380	Be	381	Li	382	Be	383	Li	384	Be	385	Li	386	Be	387	Li	388	Be	389	Li	390	Be	391	Li	392	Be	393	Li	394	Be	395	Li	396	Be	397	Li	398	Be	399	Li	400	Be	401	Li	402	Be	403	Li	404	Be	405	Li	406	Be	407	Li	408	Be	409	Li	410	Be	411	Li	412	Be	413	Li	414	Be	415	Li	416	Be	417	Li	418	Be	419	Li	420	Be	421	Li	422	Be	423	Li	424	Be	425	Li	426	Be	427	Li	428	Be	429	Li	430	Be	431	Li	432	Be	433	Li	434	Be	435	Li	436	Be	437	Li	438	Be	439	Li	440	Be	441	Li	442	Be	443	Li	444	Be	445	Li	446	Be	447	Li	448	Be	449	Li	450	Be	451	Li	452	Be	453	Li	454	Be	455	Li	456	Be	457	Li	458	Be	459	Li	460	Be	461	Li	462	Be	463	Li	464	Be	465	Li	466	Be	467	Li	468	Be	469	Li	470	Be	471	Li	472	Be	473	Li	474	Be	475	Li	476	Be	477	Li	478	Be	479	Li	480	Be	481	Li	482	Be	483	Li	484	Be	485	Li	486	Be	487	Li	488	Be	489	Li	490	Be	491	Li	492	Be	493	Li	494	Be	495	Li	496	Be	497	Li	498	Be	499	Li	500	Be	501	Li	502	Be	503	Li	504	Be	505	Li	506	Be	507	Li	508	Be	509	Li	510	Be	511	Li	512	Be	513	Li	514	Be	515	Li	516	Be	517	Li	518	Be	519	Li	520	Be	521	Li	522	Be	523	Li	524	Be	525	Li	526	Be	527	Li	528	Be	529	Li	530	Be	531	Li	532	Be	533	Li	534	Be	535	Li	536	Be	537	Li	538	Be	539	Li	540	Be	541	Li	542	Be	543	Li	544	Be	545	Li	546	Be	547	Li	548	Be	549	Li	550	Be	551	Li	552	Be	553	Li	554	Be	555	Li	556	Be	557	Li	558	Be	559	Li	560	Be	561	Li	562	Be	563	Li	564	Be	565	Li	566	Be	567	Li	568	Be	569	Li	570	Be	571	Li	572	Be	573	Li	574	Be	575	Li	576	Be	577	Li	578	Be	579	Li	580	Be	581	Li	582	Be	583	Li	584	Be	585	Li	586	Be	587	Li	588	Be	589	Li	590	Be	591	Li	592	Be	593	Li	594	Be	595	Li	596	Be	597	Li	598	Be	599	Li	600	Be	601	Li	602	Be	603	Li	604	Be	605	Li	606	Be	607	Li	608	Be	609	Li	610	Be	611	Li	612	Be	613	Li	614	Be	615	Li	616	Be	617	Li	618	Be	619	Li	620	Be	621	Li	622	Be	623	Li	624	Be	625	Li	626	Be	627	Li	628	Be	629	Li	630	Be	631	Li	632	Be	633	Li	634	Be	635	Li	636	Be	637	Li	638	Be	639	Li	640	Be	641	Li	642	Be	643	Li	644	Be	645	Li	646	Be	647	Li	648	Be	649	Li	650	Be	651	Li	652	Be	653	Li	654	Be	655	Li	656	Be	657	Li	658	Be	659	Li	660	Be	661	Li	662	Be	663	Li	664	Be	665	Li	666	Be	667	Li	668	Be	669	Li	670	Be	671	Li	672	Be	673	Li	674	Be	675	Li	676	Be	677	Li	678	Be	679	Li	680	Be	681	Li	682	Be	683	Li	684	Be	685	Li	686	Be</td