



Cambridge O Level

CANDIDATE
NAME

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--



CHEMISTRY

5070/21

Paper 2 Theory

May/June 2025

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.



- 1 Choose from the following salts to answer the questions.

aluminium chloride

barium sulfate

calcium chloride

copper(II) sulfate

magnesium chloride

potassium iodide

potassium manganate(VII)

silver nitrate

sodium bromide

sodium sulfite

Each salt can be used once, more than once or not at all.

State which salt:

- (a) is prepared using a precipitation reaction

..... [1]

- (b) in aqueous solution, reacts with an excess of aqueous ammonia to give a dark blue solution

..... [1]

- (c) reacts with warm aqueous sodium hydroxide and aluminium foil to give a gas that turns damp red litmus paper blue

..... [1]

- (d) has an aqueous solution that is used to test for an oxidising agent

..... [1]

- (e) has an aqueous solution that reacts with copper metal.

..... [1]

[Total: 5]





- 2 A concentrated aqueous solution of copper(II) bromide is electrolysed using graphite electrodes.

- (a) Graphite has good electrical conductivity.

- (i) Explain why graphite has good electrical conductivity.

Use ideas about structure and bonding.

.....
.....
.....
.....

[2]

- (ii) State one **other** property of graphite that makes it suitable for use as an electrode during electrolysis.

..... [1]

- (b) Predict the products of the electrolysis of concentrated aqueous copper(II) bromide with graphite electrodes.

product at anode

product at cathode

[2]

- (c) Dilute sulfuric acid is electrolysed using graphite electrodes to form oxygen and hydrogen.

Construct the ionic half-equation for the reaction at each electrode.

reaction at anode

reaction at cathode

[2]

- (d) Hydrogen and oxygen are used in a fuel cell to produce electricity.

- (i) Name the only chemical product formed in a fuel cell.

..... [1]

- (ii) Describe **one** disadvantage of using hydrogen–oxygen fuel cells in vehicles compared to gasoline or petrol engines.

.....
.....

[Total: 9]





- 3 The equation for the reaction between methane and chlorine is shown in Fig. 3.1.

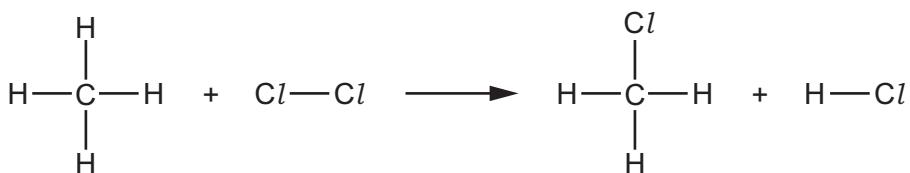


Fig. 3.1

- (a) State **one** condition for this reaction.

..... [1]

- (b) Explain why this reaction is an example of substitution.

..... [1]

- (c) Table 3.1 shows some bond energies.

Table 3.1

bond	bond energy in kJ/mol
C—H	410
C—Cl	340
Cl—Cl	242
H—Cl	431

Show by calculation that the enthalpy change of the reaction between methane and chlorine, ΔH , is -119 kJ/mol .

[3]





- (d) Complete the reaction pathway diagram in Fig. 3.2 for the reaction between methane and chlorine.

Label the:

- reactants
- products
- enthalpy change of the reaction, ΔH
- activation energy, E_a .

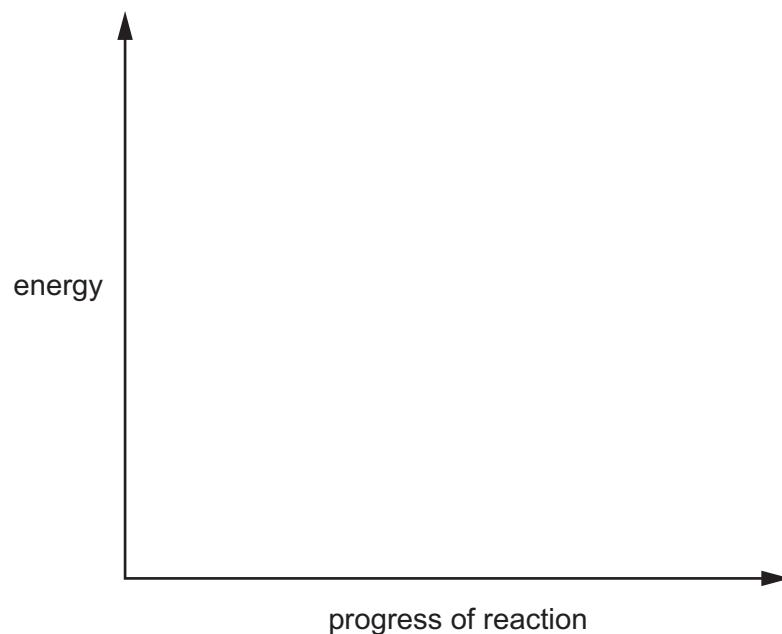


Fig. 3.2

[3]

- (e) Draw a dot-and-cross diagram to show the electronic configuration in a molecule of methane.

Show only the outer shell electrons.

[1]

[Total: 9]





- 4 Ethanol, C_2H_5OH , is a member of the homologous series of alcohols.

- (a) Give the general formula of the homologous series of alcohols.

..... [1]

- (b) Members of a homologous series have the same general formula and share similar chemical properties.

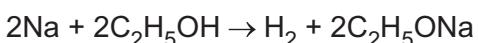
State two **other** general characteristics of a homologous series.

1

2

[2]

- (c) The equation for the reaction between ethanol and sodium is shown.



A sample of 1.35 g of sodium is added to excess ethanol.

- (i) Calculate the volume of hydrogen formed measured at room temperature and pressure.

Give your answer to **two** significant figures.

volume = dm³ [3]

- (ii) Water is added to the reaction mixture to make an aqueous solution.

A few drops of litmus are then added. The litmus changes colour to blue.

Suggest the name of the ion present in the aqueous solution responsible for the colour change.

..... [1]

- (d) State **two** uses for ethanol.

1

2

[2]





(e) Describe the manufacture of ethanol from ethene.

Include the other reactant and the conditions for the manufacture.

.....
.....
.....
.....
.....

[3]

[Total: 12]





- 5 Vehicles that use petrol as a fuel produce several air pollutants.

- (a) Petrol is a mixture of hydrocarbons which includes octane, C₈H₁₈.

Explain why octane is a hydrocarbon.

.....
.....

[1]

- (b) Two of the air pollutants produced are carbon monoxide and nitrogen monoxide.

- (i) Explain how carbon monoxide, CO, is formed in a petrol engine.

Include a symbol equation.

.....
.....
.....

[2]

- (ii) Explain how nitrogen monoxide, NO, is formed in a petrol engine.

Include a symbol equation.

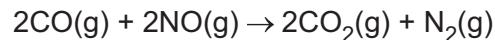
.....
.....
.....

[2]





- (c) A catalytic converter removes most of the CO and NO formed in a petrol engine.



- (i) Explain why this reaction involves both oxidation **and** reduction.

.....
.....
.....
.....

[2]

- (ii) The reaction is catalysed using platinum metal.

Explain how a catalyst increases the rate of a reaction.

.....
.....

[1]

- (iii) State and explain the effect of increasing the temperature on the rate of this reaction.

.....
.....
.....

[2]

- (iv) State and explain the effect of decreasing the pressure on the rate of this reaction.

.....
.....
.....

[2]

[Total: 12]





- 6 Chlorine, Cl_2 , is in Group VII of the Periodic Table.

(a) The melting point of chlorine is -101°C and the boiling point is -35°C .

(i) Explain why chlorine is a liquid at -50°C .

.....
.....
.....

[1]

(ii) Describe the arrangement and motion of chlorine molecules at -50°C .

.....
.....
.....
.....

[3]

(b) A sample of chlorine gas contains 1.204×10^{20} molecules.

One mole of chlorine gas contains 6.02×10^{23} molecules.

Calculate the mass of this sample of chlorine gas.

mass of chlorine = g [2]

(c) The ionic equation for the reaction of chlorine with cold dilute aqueous sodium hydroxide is shown.



(i) State the oxidation number of chlorine in Cl_2 and in Cl^- .

Cl_2

Cl^-

[2]

(ii) During the reaction chlorine is reduced.

Explain why, using ideas about electrons.

.....
.....

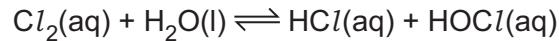
[1]





- (d) Chlorine reacts with cold water to form an equilibrium mixture containing the acids HCl(aq) and HOCl(aq) .

The forward reaction releases thermal energy into the surroundings.



- (i) The temperature of the equilibrium mixture is increased.

State and explain what happens to the acidity of the equilibrium mixture.

statement

explanation

.....

.....

[2]

- (ii) HCl(aq) is a strong acid and HOCl(aq) is a weak acid.

Describe the difference between a strong acid and a weak acid.

.....

.....

.....

[2]

- (e) A chloride of iron contains 34.5% iron by mass.

Calculate the empirical formula of this chloride.

Show your working.

empirical formula [3]

[Total: 16]



* 0000800000012 *



12

BLANK PAGE

DO NOT WRITE IN THIS MARGIN





- 7 Aluminium is used in the manufacture of aircraft and food containers.

Aluminium is resistant to corrosion by water and oxygen.

- (a) Give one **other** reason why aluminium is used in the manufacture of aircraft.

..... [1]

- (b) Explain why aluminium is resistant to corrosion by water and oxygen.

.....

.....

- (c) Aluminium metal reacts with hot dilute sulfuric acid to form hydrogen and aqueous aluminium sulfate as the only products.

Construct the symbol equation for this reaction.

Include state symbols.

..... [2]

- (d) Aluminium oxide reacts with sulfuric acid and with the alkali aqueous sodium hydroxide.

State the name of the type of oxide that reacts with both acids and alkalis.

..... [1]

[Total: 6]





- 8** Fig. 8.1 shows the displayed formula of methylbut-2-enoate.

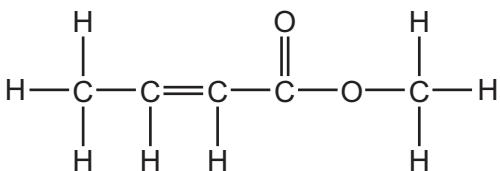


Fig. 8.1

- (a) Methylbut-2-enoate is an unsaturated ester.

- (i) Explain why methylbut-2-enoate is unsaturated.

[1]

- (ii) Describe a chemical test to show that methylbut-2-enoate is unsaturated.

[2]

- (b) Methylbut-2-enoate is made by the reaction of an alcohol and a carboxylic acid in the presence of a catalyst.

- (i) State the name of the type of catalyst used in this reaction.

[1]

- (ii) State the name of the alcohol used in this reaction.

[1]

- (iii) Draw the displayed formula of the carboxylic acid used in this reaction.

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.





(c) Methylbut-2-enoate is a monomer used to make an addition polymer.

(i) Draw the structure of this addition polymer.

Include at least **two** repeat units.

[2]

(ii) A sample of 80 g of methylbut-2-enoate is reacted to make the addition polymer.

There is a 100% yield.

State the mass of addition polymer made.

Explain your answer.

mass of addition polymer = g

explanation

[2]

(d) Fig. 8.2 shows compound **B**.

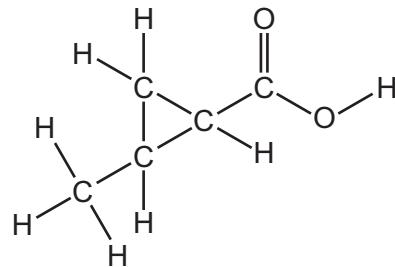


Fig. 8.2

Explain why methylbut-2-enoate and compound **B** are a pair of structural isomers.

..... [1]

[Total: 11]





The Periodic Table of Elements

Group		I				II				III				IV				V				VI				VII																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Key		atomic number				atomic symbol				name				relative atomic mass																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
Li	3	4	Be	beryllium	9	H	hydrogen	1	B	5	C	6	O	8	F	9	Ne	10	He	2	He	4	helium	4	neon	20																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Na	11	12	Mg	magnesium	24	Ca	20	Sc	21	Ti	22	V	23	Cr	24	Mn	25	Fe	26	Co	27	Ni	28	Cu	29	Zn	30	Ga	31	Ge	32	As	33	Se	34	Br	35	Kr	36	krypton	84																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
K	19	20	Ca	calcium	40	Ca	39	Sc	40	Ti	41	V	42	Cr	43	Mn	44	Fe	45	Co	46	Ni	47	Co	48	Rh	49	In	50	Sb	51	Te	52	I	53	Xe	54	xenon	131																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
Rb	37	38	Sr	strontium	88	Y	89	Zr	90	Tc	91	Nb	92	Ta	93	Mo	94	Ru	95	Pd	96	Rhodium	97	Ir	98	Ag	99	Sn	100	In	101	Te	102	Te	103	Te	104	Te	105	Te	106	Te	107	Te	108	Te	109	Te	110	Te	111	Te	112	Te	113	Te	114	Te	115	Te	116	Te	117	Te	118	Te	119	Te	120	Te	121	Te	122	Te	123	Te	124	Te	125	Te	126	Te	127	Te	128	Te	129	Te	130	Te	131	Te	132	Te	133	Te	134	Te	135	Te	136	Te	137	Te	138	Te	139	Te	140	Te	141	Te	142	Te	143	Te	144	Te	145	Te	146	Te	147	Te	148	Te	149	Te	150	Te	151	Te	152	Te	153	Te	154	Te	155	Te	156	Te	157	Te	158	Te	159	Te	160	Te	161	Te	162	Te	163	Te	164	Te	165	Te	166	Te	167	Te	168	Te	169	Te	170	Te	171	Te	172	Te	173	Te	174	Te	175	Te	176	Te	177	Te	178	Te	179	Te	180	Te	181	Te	182	Te	183	Te	184	Te	185	Te	186	Te	187	Te	188	Te	189	Te	190	Te	191	Te	192	Te	193	Te	194	Te	195	Te	196	Te	197	Te	198	Te	199	Te	200	Te	201	Te	202	Te	203	Te	204	Te	205	Te	206	Te	207	Te	208	Te	209	Te	210	Te	211	Te	212	Te	213	Te	214	Te	215	Te	216	Te	217	Te	218	Te	219	Te	220	Te	221	Te	222	Te	223	Te	224	Te	225	Te	226	Te	227	Te	228	Te	229	Te	230	Te	231	Te	232	Te	233	Te	234	Te	235	Te	236	Te	237	Te	238	Te	239	Te	240	Te	241	Te	242	Te	243	Te	244	Te	245	Te	246	Te	247	Te	248	Te	249	Te	250	Te	251	Te	252	Te	253	Te	254	Te	255	Te	256	Te	257	Te	258	Te	259	Te	260	Te	261	Te	262	Te	263	Te	264	Te	265	Te	266	Te	267	Te	268	Te	269	Te	270	Te	271	Te	272	Te	273	Te	274	Te	275	Te	276	Te	277	Te	278	Te	279	Te	280	Te	281	Te	282	Te	283	Te	284	Te	285	Te	286	Te	287	Te	288	Te	289	Te	290	Te	291	Te	292	Te	293	Te	294	Te	295	Te	296	Te	297	Te	298	Te	299	Te	300	Te	301	Te	302	Te	303	Te	304	Te	305	Te	306	Te	307	Te	308	Te	309	Te	310	Te	311	Te	312	Te	313	Te	314	Te	315	Te	316	Te	317	Te	318	Te	319	Te	320	Te	321	Te	322	Te	323	Te	324	Te	325	Te	326	Te	327	Te	328	Te	329	Te	330	Te	331	Te	332	Te	333	Te	334	Te	335	Te	336	Te	337	Te	338	Te	339	Te	340	Te	341	Te	342	Te	343	Te	344	Te	345	Te	346	Te	347	Te	348	Te	349	Te	350	Te	351	Te	352	Te	353	Te	354	Te	355	Te	356	Te	357	Te	358	Te	359	Te	360	Te	361	Te	362	Te	363	Te	364	Te	365	Te	366	Te	367	Te	368	Te	369	Te	370	Te	371	Te	372	Te	373	Te	374	Te	375	Te	376	Te	377	Te	378	Te	379	Te	380	Te	381	Te	382	Te	383	Te	384	Te	385	Te	386	Te	387	Te	388	Te	389	Te	390	Te	391	Te	392	Te	393	Te	394	Te	395	Te	396	Te	397	Te	398	Te	399	Te	400	Te	401	Te	402	Te	403	Te	404	Te	405	Te	406	Te	407	Te	408	Te	409	Te	410	Te	411	Te	412	Te	413	Te	414	Te	415	Te	416	Te	417	Te	418	Te	419	Te	420	Te	421	Te	422	Te	423	Te	424	Te	425	Te	426	Te	427	Te	428	Te	429	Te	430	Te	431	Te	432	Te	433	Te	434	Te	435	Te	436	Te	437	Te	438	Te	439	Te	440	Te	441	Te	442	Te	443	Te	444	Te	445	Te	446	Te	447	Te	448	Te	449	Te	450	Te	451	Te	452	Te	453	Te	454	Te	455	Te	456	Te	457	Te	458	Te	459	Te	460	Te	461	Te	462	Te	463	Te	464	Te	465	Te	466	Te	467	Te	468	Te	469	Te	470	Te	471	Te	472	Te	473	Te	474	Te	475	Te	476	Te	477	Te	478	Te	479	Te	480	Te	481	Te	482	Te	483	Te	484	Te	485	Te	486	Te	487	Te	488	Te	489	Te	490	Te	491	Te	492	Te	493	Te	494	Te	495	Te	496	Te	497	Te	498	Te	499	Te	500	Te	501	Te	502	Te	503	Te	504	Te	505	Te	506	Te	507	Te	508	Te	509	Te	510	Te	511	Te	512	Te	513	Te	514	Te	515	Te	516	Te	517	Te	518	Te	519	Te	520	Te	521	Te	522	Te	523	Te	524	Te	525	Te	526	Te	527	Te	528	Te	529	Te	530	Te	531	Te	532	Te	533	Te	534	Te	535	Te	536	Te	537	Te	538	Te	539	Te	540	Te	541	Te	542	Te	543	Te	544	Te	545	Te	546	Te	547	Te	548	Te	549	Te	550	Te	551	Te	552	Te	553	Te	554	Te	555	Te	556	Te	557	Te	558	Te	559	Te	560	Te	561	Te	562	Te	563	Te	564	Te	565	Te	566	Te	567	Te	568	Te	569	Te	570	Te	571	Te	572	Te	573	Te	574	Te	575	Te	576	Te	577	Te	578	Te	579	Te	580	Te	581	Te	582	Te	583	Te	584	Te	585	Te	586	Te	587	Te	588	Te	589	Te	590	Te	591	Te	592	Te	593	Te	594	Te	595	Te	596	Te	597	Te	598	Te	599	Te	600	Te	601	Te	602	Te	603	Te	604	Te	605	Te	606	Te	607	Te	608	Te	609	Te	610	Te	611	Te	612	Te	613	Te	614	Te	615	Te	616	Te	617	Te	618	Te	619	Te	620	Te	621	Te	622	Te	623	Te	624	Te	625	Te	626	Te	627	Te	628	Te	629	Te	630	Te	631	Te	632	Te	633	Te	634	Te	635	Te	636	Te	637	Te	638	Te	639	Te	640	Te	641	Te	642	Te	643	Te	644	Te	645	Te	646	Te	647	Te	648	Te	649	Te	650	Te	651	Te	652	Te	653	Te	654	Te	655	Te	656	Te	657	Te	658	Te	659	Te	660	Te	661	Te	662	Te	663	Te	664	Te	665	Te	666	Te	667	Te	668	Te	669	Te	670	Te	671	Te	672	Te	673	Te	674	Te	675	Te	676	Te	677	Te	678	Te	679	Te	680	Te	681	Te	682	Te	683	Te	684	Te	685	Te	686	Te	687	Te	688	Te	689	Te	690	Te	691	Te	692	Te	693	Te	694	Te	695	Te	696	Te	697	Te	698	Te	699	Te	700	Te	701	Te	702	Te	703	Te	704	Te	705	Te	706	Te	707	Te	708	Te	709	Te	710	Te	711	Te	712	Te	713	Te	714	Te	715	Te	716	Te	717	Te	718	Te	719	Te	720	Te	721	Te	722	Te	723	Te	724	Te	725	Te	726	Te	727	Te	728	Te	729	Te	730	Te	731	Te	732	Te	733	Te	734	Te	735	Te	736	Te	737	Te	738	Te	739	Te	740	Te	741	Te	742	Te	743	Te	744	Te	745	Te	746	Te	747	Te	748	Te	749	Te	750	Te	751	Te	752	Te	753	Te	754	Te	755	Te	756	Te	757	Te	758	Te	759	Te	760	Te	761	Te	762	Te	763	Te	764	Te	765	Te	766	Te	767	Te	768	Te	769	Te	770	Te	771	Te	772	Te	773	Te	774	Te	775	Te	776	Te	777	Te	778	Te	779	Te	780	Te	781	Te	782	Te	783	Te	784	Te	785	Te	786	Te	787	Te	788	Te	789	Te	790	Te	791	Te	792	Te	793	Te	794	Te	795	Te	796	Te	797	Te	798	Te	799	Te	800	Te	801	Te	802	Te	803	Te	804	Te	805	Te	806	Te	807	Te	808	Te	809	Te	810	Te	811	Te	812	Te	813	Te	814	Te	815	Te	816	Te	817	Te	818	Te	819	Te	820	Te	821	Te	822	Te	823	Te	824	Te	825	

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

Lanthanoids

actinoids