



Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

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CHEMISTRY

0620/43

Paper 4 Theory (Extended)

May/June 2019

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.

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.

A copy of the Periodic Table is printed on page 16.

You may lose marks if you do not show your working or if you do not use appropriate units.

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.

This syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

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

1 Atoms contain particles called electrons, neutrons and protons.

(a) Complete the table.

particle	where the particle is found in an atom	relative mass	relative charge
	orbiting the nucleus	$\frac{1}{1840}$	
			+1
	in the nucleus		

[3]

(b) How many electrons, neutrons and protons are there in the ion shown?



number of electrons

number of neutrons

number of protons

[3]

[Total: 6]

2 Magnesium exists as three isotopes, ${}^{24}_{12}\text{Mg}$, ${}^{25}_{12}\text{Mg}$ and ${}^{26}_{12}\text{Mg}$.

(a) State, in terms of the total numbers of electrons, neutrons and protons, **one** difference and **two** similarities between these magnesium isotopes.

difference

similarity 1

similarity 2

[3]

(b) All isotopes of magnesium react with dilute hydrochloric acid to make hydrogen and a salt.

(i) Why do all isotopes of magnesium react in the same way?

.....

.....

..... [2]

(ii) Write a chemical equation for the reaction between magnesium and dilute hydrochloric acid.

..... [2]

(iii) Describe a test for hydrogen.

test

result

[2]

(c) Magnesium is a metal.

Describe the structure and bonding of metals. Include a labelled diagram in your answer.

.....

.....

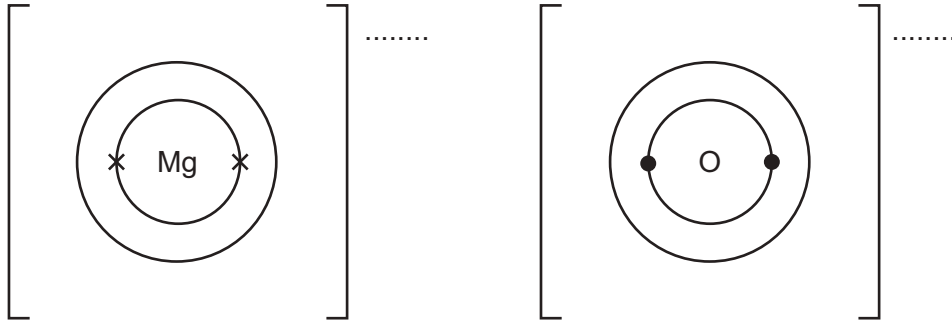
.....

.....

[3]

(d) Magnesium reacts with oxygen to form the ionic compound magnesium oxide.

- (i) Complete the dot-and-cross diagrams to show the electronic structures of the ions in magnesium oxide. Show the charges on the ions.



[3]

- (ii) Magnesium oxide melts at 2853 °C.

Why does magnesium oxide have a high melting point?

.....
 [1]

- (iii) Explain why molten magnesium oxide can conduct electricity.

.....

 [1]

[Total: 17]

3 (a) (i) Sodium is in Group I of the Periodic Table.

Describe **two** physical properties of sodium which are different from the physical properties of transition elements such as copper.

1

.....

2

.....

[2]

(ii) Sodium reacts rapidly with water.

Give **one** observation made when sodium is added to water.

..... [1]

(b) Some car airbags contain sodium azide.

When a car airbag is used the sodium azide, NaN_3 , decomposes.
The products are nitrogen and sodium.

The equation for the decomposition of sodium azide is shown.



Calculate the mass, in g, of sodium azide needed to produce 144 dm^3 of nitrogen using the following steps.

- Calculate the number of moles in 144 dm^3 of N_2 measured at room temperature and pressure.

moles of N_2 = mol

- Determine the number of moles of NaN_3 needed to produce this number of moles of N_2 .

moles of NaN_3 = mol

- Calculate the relative formula mass, M_r , of NaN_3 .

M_r =

- Calculate the mass of NaN_3 needed to produce 144 dm^3 of N_2 .

..... g

[4]

- (c) Some airbags contain silicon(IV) oxide.
When the airbag is used sodium oxide is formed.

Oxides can be classified as acidic, amphoteric, basic or neutral.

Classify each of these oxides:

sodium oxide

silicon(IV) oxide.

[2]

- (d) Lead(II) azide is insoluble in water. Solid lead(II) azide can be made in a precipitation reaction between aqueous lead(II) nitrate and aqueous sodium azide.
Lead(II) azide has the formula $\text{Pb}(\text{N}_3)_2$.

- (i) Deduce the formula of the azide ion.

..... [1]

- (ii) Complete the chemical equation for the reaction between aqueous lead(II) nitrate and aqueous sodium azide to form solid lead(II) azide and aqueous sodium nitrate. Include state symbols.



[2]

- (iii) Describe how you could obtain a sample of lead(II) azide that is **not** contaminated with any soluble salts from the reaction mixture.

.....

 [2]

- (e) An organic compound made from sodium azide has the composition by mass: 49.5% carbon, 7.2% hydrogen and 43.3% nitrogen.

Calculate the empirical formula of the organic compound.

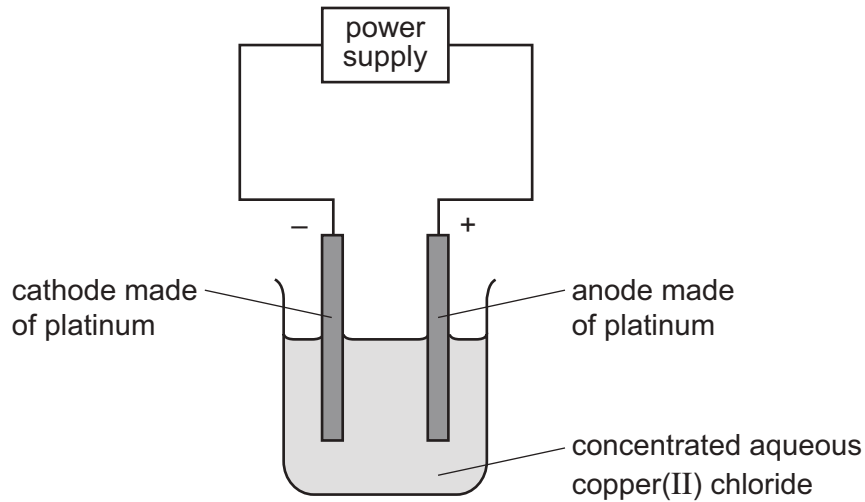
[3]

[Total: 17]

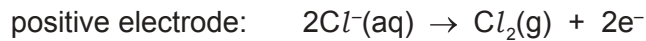
Question 4 starts on the next page.

4 Solutions of ionic compounds can be broken down by electrolysis.

(a) Concentrated aqueous copper(II) chloride was electrolysed using the apparatus shown.



The ionic half-equations for the reactions at the electrodes are shown.



(i) Platinum is a solid which is a good conductor of electricity.

State **one** other property of platinum which makes it suitable for use as electrodes.

.....
 [1]

(ii) State what would be **seen** at the positive electrode during this electrolysis.

.....
 [1]

(iii) State and explain what would happen to the mass of the negative electrode during this electrolysis.

.....

 [2]

(iv) The concentrated aqueous copper(II) chloride electrolyte is green.

Suggest what would happen to the colour of the electrolyte during this electrolysis.
Explain your answer.

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

(v) Identify the species that is oxidised during this electrolysis.
Explain your answer.

species that is oxidised

explanation

..... [2]

(b) Metal objects can be electroplated with silver.

(i) Describe how a metal spoon can be electroplated with silver.
Include:

- what to use as the positive electrode and as the negative electrode
- what to use as the electrolyte
- an ionic half-equation to show the formation of silver.

You may include a diagram in your answer.

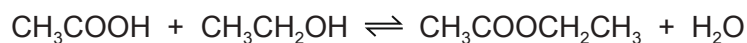
.....
.....
.....
ionic half-equation [4]

(ii) Give **one** reason why metal spoons are electroplated with silver.

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

[Total: 13]

- 5 Carboxylic acids react with alcohols to form esters. The reaction is reversible. The equation for the reaction between ethanoic acid and ethanol is shown.



- (a) (i) What is the name of the ester formed in this reaction?

..... [1]

- (ii) Draw the structure of the ester formed. Show all of the atoms and all of the bonds.

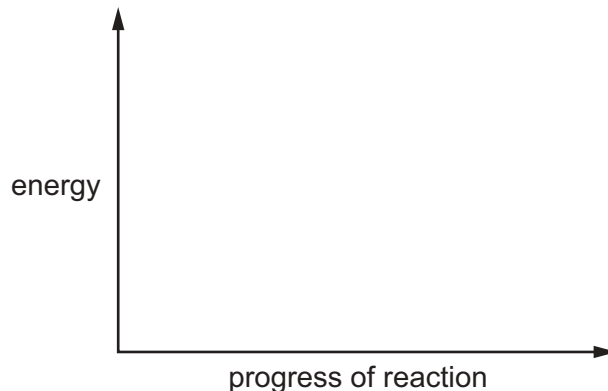
[1]

- (b) The reaction between ethanoic acid and ethanol is exothermic.

Draw an energy level diagram for this reaction.

On your diagram label:

- the reactants and products
- the energy change of the reaction, ΔH .



[3]

- (c) Concentrated sulfuric acid is a catalyst for this reaction.

What is meant by the term *catalyst*?

.....
 [2]

(d) The rate of reaction can be increased by increasing the temperature.

Explain why increasing the temperature increases the rate of reaction.

.....
.....
.....
.....
.....
..... [4]

(e) The reaction between ethanoic acid and ethanol reaches equilibrium.

(i) The reaction between ethanoic acid and ethanol is exothermic.

State and explain the effect, if any, of increasing the temperature on the amount of ester at equilibrium.

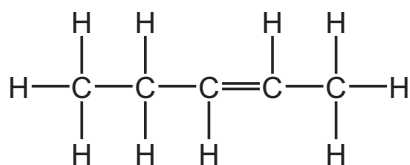
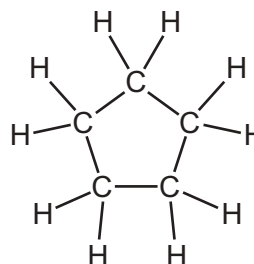
.....
.....
..... [2]

(ii) State and explain the effect, if any, of removing water from the mixture on the amount of ester at equilibrium.

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

[Total: 15]

- 6 (a) Two hydrocarbons have the structures shown.

hydrocarbon **A**hydrocarbon **B**

- (i) Why are these **two** compounds *hydrocarbons*?

.....
 [2]

- (ii) Hydrocarbon **B** reacts in the same way as a typical alkane.

Describe a chemical test to tell the difference between hydrocarbon **A** and hydrocarbon **B**.

State the name of the reagent you would use and the result you would obtain with hydrocarbon **A** and hydrocarbon **B**.

reagent

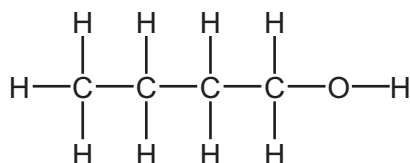
result with hydrocarbon **A**

result with hydrocarbon **B**

[3]

- (b) Alkenes react with steam to form alcohols.

Compound **C** is an alcohol.

compound **C**

Draw the structure of the alkene which could be reacted with steam to make compound **C**. Show all of the atoms and all of the bonds.

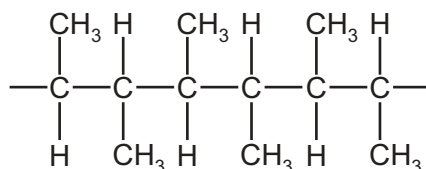
[1]

(c) Alkenes can form polymers.

(i) What type of polymerisation occurs when alkenes form polymers?

..... [1]

(ii) Part of the structure of a polymer is shown.

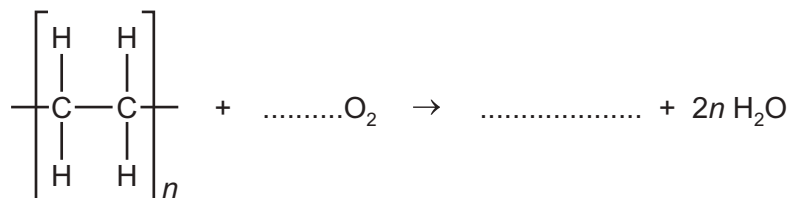


Draw the structure of the alkene from which this polymer can be made. Show all of the atoms and all of the bonds.

[1]

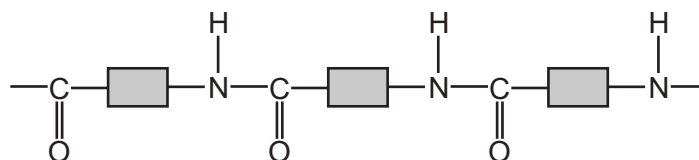
(iii) Polymers can undergo incomplete combustion to form carbon monoxide.

Complete the chemical equation for the incomplete combustion of poly(ethene). The only carbon-containing product is carbon monoxide.



[2]

(d) Part of the structure of a polyamide is shown.



This polyamide is formed from identical monomers. Complete the diagram to show the structure of **one** monomer. Show all of the atoms and all of the bonds.



[2]

[Total: 12]

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The Periodic Table of Elements

		Group							
I	II	III	IV	V	VI	VII	VIII		
1	2	3	4	5	6	7	8	9	10
H hydrogen 1	He helium 4	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20		
11	12	13	14	15	16	17	18		
Na sodium 23	Mg magnesium 24	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40		
19	20	21	22	23	24	25	26	27	28
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59
37	38	39	40	41	42	43	44	45	46
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106
55	56	57–71	72	73	74	75	76	77	78
Cs caesium 133	Ba barium 137	lanthanoids	Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195
87	88	89–103	104	105	106	107	108	109	110
Fr francium —	Ra radium —	actinoids	Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —
81	82	83	84	85	86	87	88	89	90
Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium —	At astatine —	Rn radon —	Cn copernicium —	Hg mercury 201	Au gold 197	Pt platinum 195
113	114	115	116	117	118	119	120	121	122
In indium 115	Sn tin 119	Sb antimony 122	Te tellurium 128	I iodine 127	Xe xenon 131	Pb lead 207	Hg mercury 201	Au gold 197	Pt platinum 195
151	152	153	154	155	156	157	158	159	160
Fl flerovium —	Lv livermorium —	Cn copernicium —	Rg roentgenium —	Ds darmstadtium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —
167	168	169	170	171	172	173	174	175	176
Er erbium 167	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175	Ho holmium 165	Er erbium 167	Dy dysprosium 163	Tm thulium 169	Yb ytterbium 173	Lu lutetium 175
101	102	103	104	105	106	107	108	109	110
Md mendelevium —	No nobelium —	Lr lawrencium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —	Es einsteinium —	Fm fermium —
99	100	101	102	103	104	105	106	107	108
Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —
97	98	99	100	101	102	103	104	105	106
Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —	Es einsteinium —	Fm fermium —	Md mendelevium —
95	96	97	98	99	100	101	102	103	104
Am americium —	Cm curium —	Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —	Lr lawrencium —	Es einsteinium —
93	94	95	96	97	98	99	100	101	102
Np neptunium —	Pu plutonium —	Am americium —	Cm curium —	Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —	Md mendelevium —	No nobelium —
91	92	93	94	95	96	97	98	99	100
Pa protactinium 231	U uranium 238	Np neptunium —	Pu plutonium —	Am americium —	Cm curium —	Bk berkelium —	Cf californium —	Es einsteinium —	Fm fermium —
89	90	91	92	93	94	95	96	97	98
Ac actinium —	Th thorium 232	Pa protactinium 231	U uranium 238	Np neptunium —	Pu plutonium —	Am americium —	Cm curium —	Bk berkelium —	Cf californium —
139	140	141	142	143	144	145	146	147	148
La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium —	Sm samarium 150	Eu europium 152	Gd gadolinium 157	Tb terbium 159	Dy dysprosium 163
57	58	59	60	61	62	63	64	65	66
La lanthanum 139	Ce cerium 140	Pr praseodymium 141	Nd neodymium 144	Pm promethium —	Sm samarium 150	Eu europium 152	Gd gadolinium 157	Tb terbium 159	Dy dysprosium 163

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).