Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

5000873390

CHEMISTRY **0620/31**

Paper 3 Theory (Core) **May/June 2020**

1 hour 15 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 **20** pages. Blank pages are indicated.

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1 **(a)** A list of symbols and formulae is shown.

Al^{3+}
CH_4
CO_2
Fe^{3+}
N_2
NO_2
O_2
O^{2-}
Zn^{2+}

Answer the following questions about these symbols and formulae.
Each symbol or formula may be used once, more than once or not at all.

Which symbol or formula represents:

(i) a compound which contributes to acid rain

..... [1]

(ii) a compound which is a product of respiration

..... [1]

(iii) a gas which forms 21% of clean dry air

..... [1]

(iv) an ion which forms a red-brown precipitate when added to aqueous sodium hydroxide

..... [1]

(v) an ion formed when an atom gains electrons?

..... [1]

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(b) Complete the table to show the relative charge and approximate relative mass of a proton, a neutron and an electron.

type of particle	relative charge	approximate relative mass
proton	+1	
neutron		
electron		$\frac{1}{2000}$

[3]

(c) Deduce the number of electrons and neutrons in an atom of the isotope of iron shown.

$^{58}_{26}Fe$

number of electrons .....

number of neutrons .....

[2]

[Total: 10]

2 A solution is obtained by filtering a mixture of soil and water. The table shows the mass of some of the ions in 1000 cm^3 of this solution.

name of ion	formula of ion	mass of ion in 1000 cm^3 of soil solution / mg
aluminium	Al^{3+}	0.1
	NH_4^+	35.0
calcium	Ca^{2+}	1.3
iron(II)	Fe^{2+}	47.0
magnesium	Mg^{2+}	0.2
	NO_3^-	23.0
phosphate	PO_4^{3-}	4.2
potassium	K^+	99.0
sulfate	SO_4^{2-}	7.5

(a) Answer these questions using the information in the table.

(i) Which negative ion has the lowest concentration?

..... [1]

(ii) State the name of the NO_3^- ion.

..... [1]

(iii) Calculate the mass of phosphate ions in 250 cm^3 of this solution.

mass = ... mg [1]

(iv) Name the compound that contains NH_4^+ ions and PO_4^{3-} ions.

..... [1]

(b) Describe a test for potassium ions.

test .....

observations .....
[2]

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(c) The names and formulae for some compounds are shown.

aluminium phosphate, $AlPO_4$
calcium phosphate, $Ca_3(PO_4)_2$
potassium phosphate, K_3PO_4

Deduce the formula for magnesium phosphate.

..... [1]

[Total: 7]

3 Many compounds and elements have important uses.

(a) Complete the table to show the name, formula and use of each compound and element.

name of compound or element	number of atoms in the formula	formula	use
chlorine	chlorine = 2	Cl_2	
	carbon = 1 hydrogen = 4	CH_4	
calcium carbonate	calcium = 1 carbon = 1 oxygen = 3		

[5]

(b) The table shows the minimum temperature for the reduction of four metal oxides by carbon.

metal oxide	minimum temperature for reduction by carbon
calcium oxide	not reduced at 1530 °C
iron(II) oxide	reduced at 650 °C
titanium oxide	reduced at 1530 °C
zinc oxide	reduced at 720 °C

Put the four metals in order of their reactivity.
Put the least reactive metal first.

least reactive → most reactive

[2]

(c) Anhydrous copper(II) sulfate, $CuSO_4$, is used to test for water.

(i) Describe the change in colour when water is added to anhydrous copper(II) sulfate.

from ..... to .....
[2]

(ii) This reaction is reversible.

Describe how this reaction can be reversed.

..... [1]

(iii) State **one** use of water in industry.

..... [1]

[Total: 11]

4 The properties of five alkenes at room temperature are shown in the table.

alkene	number of carbon atoms in a molecule	state at room temperature	density in g / cm^3	boiling point / °C
ethene	2	gas	0.0012	–104
propene	3	gas	0.0018	–47
butene	4	gas	0.0024	
pentene	5	liquid	0.64	30
hexene	6	liquid	0.67	63

(a) Answer these questions using only the information in the table.

(i) Predict the boiling point of butene.

..... °C [1]

(ii) Describe the general trend in the density of the alkenes.

..... [1]

(iii) Suggest why the densities of the first three alkenes are much lower than the density of pentene and hexene.

..... [1]

(b) (i) Complete the chemical equation for the complete combustion of propene.

$$2C_3H_6 + ...O_2 \rightarrow 6CO_2 + 6H_2O$$ [1]

(ii) Describe a test for carbon dioxide.

test .....

observations .....
[2]

(iii) Universal indicator is added to an aqueous solution of carbon dioxide.

- What colour change is observed?

from green to .....

- Give a reason for your answer.

.....

.....
[2]

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(c) When propene undergoes incomplete combustion, carbon monoxide is formed.

(i) What condition is needed for incomplete combustion?

.....

..... [1]

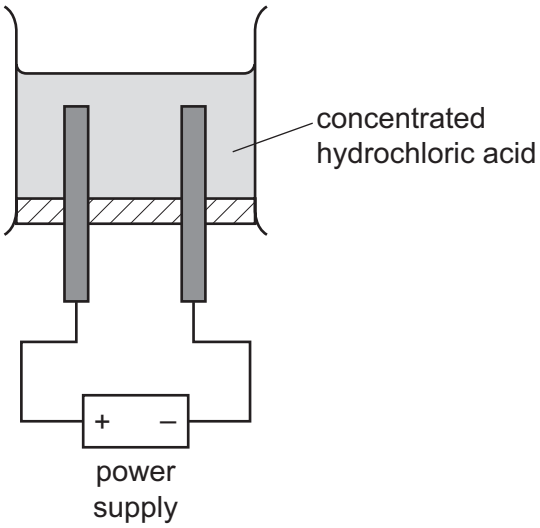
(ii) Give **one** adverse effect of carbon monoxide on health.

..... [1]

[Total: 10]

5 When concentrated hydrochloric acid is electrolysed, gases are produced at the electrodes.

The incomplete apparatus is shown.



(a) (i) Complete the diagram by:

- labelling the anode and cathode
- showing how the gases are collected.

[2]

(ii) Predict the products of this electrolysis at the:

positive electrode .....

negative electrode. .....

[2]

(iii) Graphite (carbon) electrodes are used in this electrolysis.

Suggest **one** other element that can be used as an electrode and give a reason, other than that it can conduct electricity.

element .....

reason .....

[2]

(b) Hydrogen chloride is produced when chlorine reacts with hydrogen.

Complete the chemical equation for this reaction.

$$Cl_2 + \text{.....} \rightarrow \text{.....}HCl$$ [2]

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(c) Aqueous chlorine reacts with aqueous sodium iodide.

$$Cl_2 + 2NaI \rightarrow I_2 + 2NaCl$$

(i) How does this reaction show that chlorine is more reactive than iodine?

..... [1]

(ii) What colour is iodine in aqueous solution?

..... [1]

[Total: 10]

6 Acids have characteristic properties.

(a) Hydrochloric acid reacts with magnesium.

Name the products of this reaction and give the observations.

.....

.....

.....

.....

.....

..... [4]

(b) The rate of reaction of iron(II) carbonate with hydrochloric acid can be determined by measuring the time taken to produce 20 cm^3 of carbon dioxide.

A student measured the time taken to produce 20 cm^3 of carbon dioxide at three different temperatures.

In each experiment the student used:

- 1 g of large pieces of iron(II) carbonate
- dilute hydrochloric acid of the same concentration and volume.

The results are shown in the table.

temperature / °C	time / s
20	38
25	30
30	19

(i) Use the information in the table to describe how the rate of reaction changes with temperature.

..... [1]

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(ii) Describe the effect of each of the following on the rate of this reaction at constant temperature.

- Smaller pieces of iron(II) carbonate are used.

All other conditions stay the same.

.....

- The concentration of hydrochloric acid is decreased.

All other conditions stay the same.

.....
[2]

(c) The reaction of iron(II) carbonate with hydrochloric acid is exothermic.

What is meant by the term *exothermic*?

..... [1]

(d) Rust contains compounds of iron.

State **two** conditions needed for iron to rust.

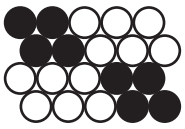
.....

..... [2]

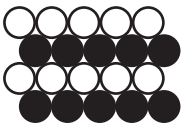
(e) Iron and magnesium are both used in alloys.

Which **one** of these diagrams, **A**, **B**, **C** or **D**, best represents an alloy?

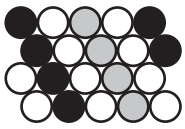
A



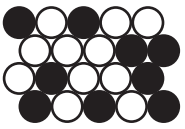
B



C



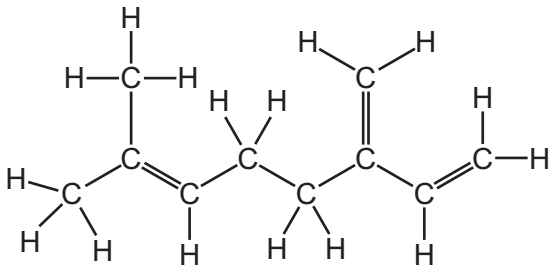
D



..... [1]

[Total: 11]

7 The structure of myrcene is shown.



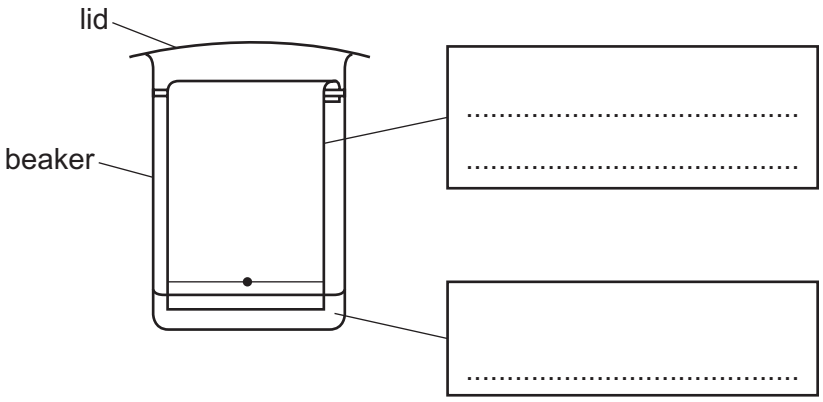
(a) Deduce the formula of myrcene to show the number of atoms of carbon and hydrogen.

..... [1]

(b) Myrcene is found in some plants.

The coloured compounds in plant leaves can be separated by chromatography.

Complete the diagram by putting the correct labels in the boxes.



[2]

(c) Myrcene is an unsaturated hydrocarbon.

Describe a chemical test to distinguish between a saturated and an unsaturated hydrocarbon.

test .....

observations with saturated hydrocarbon .....

.....

observations with unsaturated hydrocarbon .....

.....

[3]

(d) Butane is a saturated hydrocarbon.

To which homologous series does butane belong?

Draw a circle around the correct answer.

alcohol **alkane** **alkene** **carboxylic acid** [1]

(e) Large hydrocarbons can be cracked to form smaller hydrocarbons.

Complete the chemical equation for cracking tridecane, $C_{13}H_{28}$, to form an alkene and one other hydrocarbon.

$$C_{13}H_{28} \rightarrow C_3H_6 + \text{.....}$$ [1]

(f) Ethene is an alkene.

Draw the structure of ethene showing all of the atoms and all of the bonds.

[1]

(g) Complete the sentences about the separation of hydrocarbons from petroleum using words from the list.

bitumen **combustion** **condense** **crystallisation** **distillation**

evaporate **gasoline** **kerosene** **melt**

Hydrocarbons are separated in a fractionating column by fractional ..... .

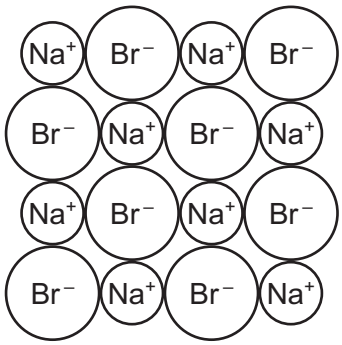
Hydrocarbons with lower boiling points move further up the column. When the temperature in the column falls below the boiling points of the hydrocarbons they ..... . The fraction at the bottom of the column which is used for making roads is called ..... .

[3]

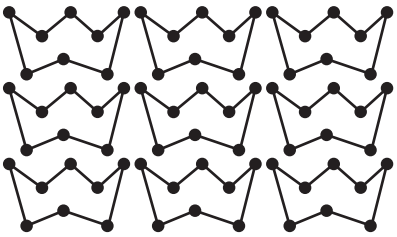
[Total: 12]

8 The diagram shows part of the structures of sodium bromide and sulfur.

sodium bromide



sulfur



(a) Describe both sodium bromide and sulfur in terms of:

- bonding

.....

.....

.....

.....

- electrical conductivity

.....

.....

- solubility in water.

.....

.....

[5]

(b) Sulfur is an element.

What is meant by the term *element*?

.....

..... [1]

(c) Sodium can be extracted from sodium bromide by electrolysis.

Sodium is a metal in Group I of the Periodic Table.

(i) Describe **one** chemical property of sodium.

..... [1]

(ii) Which **two** of these statements about the physical properties of sodium are correct?

Tick **two** boxes.

Sodium is very hard.	☐
Sodium has a high density.	☐
Sodium conducts electricity.	☐
Sodium is malleable.	☐
Sodium does not conduct heat.	☐

[2]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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