Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

4918803397

CHEMISTRY **0620/32**

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.

CH_4
Cl^-
CO_2
Cr^{3+}
Cu^{2+}
Fe^{2+}
H_2
K^+
N_2
O_2
SO_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 produced by the thermal decomposition of calcium carbonate

..... [1]

(ii) an element which is used as a fuel

..... [1]

(iii) a gas which forms 78% of clean dry air

..... [1]

(iv) an ion which forms a blue precipitate when added to aqueous sodium hydroxide

..... [1]

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

..... [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	–1	

[3]

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

$^{41}_{19}K$

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+}	0.2
	NH_4^+	22.0
calcium	Ca^{2+}	0.2
iron(II)	Fe^{2+}	79.0
magnesium	Mg^{2+}	0.1
nitrate	NO_3^-	28.0
phosphate	PO_4^{3-}	14.0
potassium	K^+	39.0
	SO_4^{2-}	5.1

(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 SO_4^{2-} ion.

..... [1]

(iii) Calculate the mass of nitrate ions in 200 cm^3 of this solution.

mass = ... mg [1]

(iv) Name the compound that contains NH_4^+ ions and NO_3^- ions.

..... [1]

(b) Describe a chemical test for calcium ions.

test .....

observations .....
[2]

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

aluminium nitrate, $Al(NO_3)_3$
magnesium nitrate, $Mg(NO_3)_2$
sodium nitrate, $NaNO_3$

Deduce the formula for calcium nitrate.

..... [1]

[Total: 7]

3 Many compounds have important uses.

(a) Complete the table to show the name, number of atoms in the formula and use.

name of compound	number of atoms in the formula	formula	use
water	hydrogen = 2 oxygen = 1	H_2O	
	sulfur = 1 oxygen = 2	SO_2	
calcium hydroxide (slaked lime)	calcium = ... oxygen = ... hydrogen = ...	$Ca(OH)_2$	

[5]

(b) The table compares the reactions of four metals with steam.

metal	reaction with steam
copper	does not react
magnesium	reacts rapidly
sodium	reacts explosively
zinc	reacts slowly when warmed

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

least reactive → most reactive

[2]

(c) Sodium reacts with molten sodium hydroxide.

Complete the chemical equation for this reaction.

$$2Na + ...NaOH \rightarrow .....Na_2O + H_2$$ [2]

[Total: 9]

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4 The properties of the first four Group I elements are shown in the table.

element	density in g / cm^3	melting point / °C	boiling point / °C
lithium	0.53	181	1342
sodium	0.97	98	883
potassium	0.86	63	760
rubidium		39	686

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

(i) Describe the general trend in the boiling points of the Group I elements.

..... [1]

(ii) Explain why it is difficult to predict the density of rubidium.

.....

..... [1]

(iii) Deduce the state of rubidium at 45 °C. Explain your answer.

.....

.....
[2]

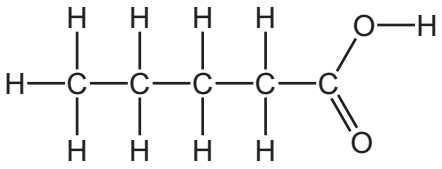
(b) When sodium reacts with carboxylic acids, hydrogen is produced.

(i) Describe a test for hydrogen.

test .....

observations .....
[2]

(ii) The structure of a carboxylic acid is shown.



Deduce the formula of this carboxylic acid to show the number of atoms of carbon, hydrogen and oxygen.

..... [1]

(c) Universal indicator is added to an aqueous solution of sodium oxide.

- What colour change is observed?

from green to .....

- Give a reason for your answer.

.....

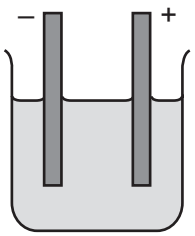
.....

[2]

[Total: 9]

5 Molten magnesium bromide is electrolysed.

The incomplete apparatus is shown.



(a) (i) Complete the diagram by:

- labelling the anode and cathode
- adding the power supply and connecting wires.

[2]

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

positive electrode .....

negative electrode. .....

[2]

(b) The electrodes must be able to conduct electricity.

(i) Give **one** other property that the electrodes must have.

..... [1]

(ii) Name a suitable element that can be used as an electrode.

..... [1]

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[Turn over

(c) Aqueous chlorine reacts with aqueous magnesium bromide.

$$Cl_2 + MgBr_2 \rightarrow Br_2 + MgCl_2$$

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

..... [1]

(ii) What colour is bromine in aqueous solution?

..... [1]

(d) Complete the chemical equation for the reaction of chlorine with phosphorus.

$$.....Cl_2 + 2P \rightarrow .....PCl_5$$ [2]

[Total: 10]

6 Acids have characteristic properties.

(a) Hydrochloric acid reacts with magnesium carbonate.

Name the products of this reaction and give the observations.

.....

.....

.....

.....

..... [4]

(b) The rate of reaction of iron with sulfuric acid can be determined by measuring the time taken to produce 20 cm^3 of hydrogen.

A student measured the time taken to produce 20 cm^3 of hydrogen using three different concentrations of sulfuric acid.

In each experiment the student used:

- 1 g of iron powder
- the same temperature
- the same volume of sulfuric acid.

The results are shown in the table.

concentration of acid in mol / dm^3	time / s
0.1	33
0.2	17
0.5	8

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

..... [1]

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[Turn over

(ii) Describe the effect of each of the following on the rate of this reaction with 0.5 mol / dm^3 of sulfuric acid.

- Larger pieces of iron are used.

All other conditions stay the same.

.....

- The temperature is increased.

All other conditions stay the same.

.....
[2]

(c) Heat is given out when iron reacts with sulfuric acid.

What term describes a reaction which gives out heat?

..... [1]

(d) The reaction of iron with steam is shown.

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

How does this equation show that iron gets oxidised?

.....

..... [1]

(e) Rust contains hydrated iron(III) oxide.

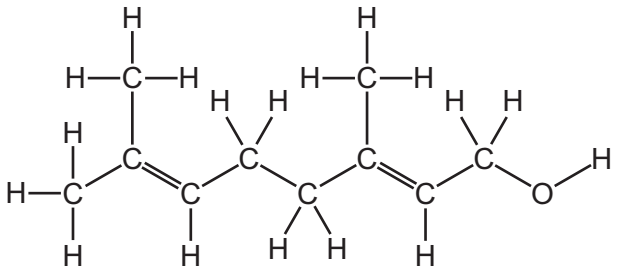
Describe and explain **one** method of preventing iron from rusting.

.....

..... [2]

[Total: 11]

7 The structure of nerol is shown.



(a) Draw a circle around the alcohol functional group on the structure of nerol. [1]

(b) What feature of the nerol molecule shows that it is an unsaturated compound?

..... [1]

(c) Nerol can be extracted from some plants.

Crushed plant leaves containing nerol are mixed with an organic solvent called octane.

Nerol dissolves in octane.

(i) Describe how you would separate the crushed plant leaves from the solution of nerol in octane.

..... [1]

(ii) The boiling point of nerol is 224 °C.
The boiling point of octane is 126 °C.

Explain how distillation separates nerol from the octane.

.....

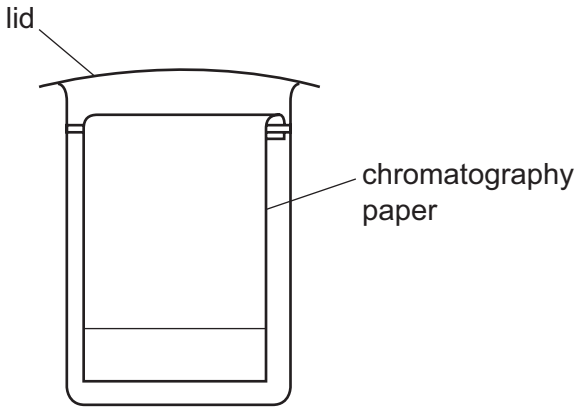
.....

.....

..... [2]

(d) The mixture of coloured compounds in plant leaves can be separated by chromatography.

The apparatus is shown.



On the diagram:

- draw an 'X' to show where the mixture of coloured compounds is placed at the start of the experiment
- draw a line to show the level of the solvent at the start of the experiment.

[2]

(e) Ethanol is a solvent.

(i) Draw the structure of ethanol to show all of the atoms and all of the bonds.

[2]

(ii) Complete the sentences about the manufacture of ethanol using words from the list.

catalyst **hydrocarbon** **hydrogen**

oxygen **plastic** **steam**

Ethanol is manufactured by the reaction of ethene with ..... . The rate of this reaction is increased by the use of a ..... .

[2]

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(f) Ethene and propene are in the same homologous series of organic compounds.

Which **two** statements about ethene and propene are correct.

Tick **two** boxes.

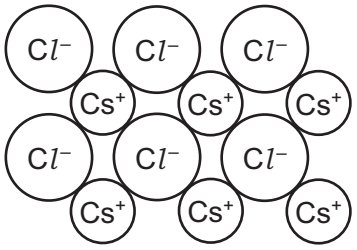
They have the same physical properties.	☐
They have the same number of carbon atoms.	☐
They have similar chemical properties.	☐
They have the same number of hydrogen atoms.	☐
They have the same functional group.	☐

[2]

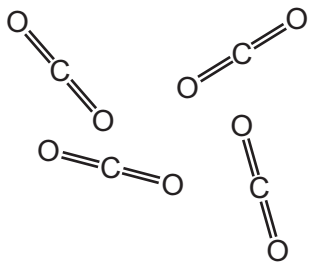
[Total: 13]

8 The diagram shows part of the structures of caesium chloride and carbon dioxide.

caesium chloride



carbon dioxide



(a) Describe both caesium chloride and carbon dioxide in terms of:

- bonding

.....

.....

.....

.....

- solubility in water

.....

.....

- arrangement of particles.

.....

.....

[5]

(b) Caesium oxide is a compound.

What is meant by the term *compound*?

.....

..... [1]

(c) Explain why caesium is **not** extracted from caesium oxide by heating with carbon.

..... [1]

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(d) Caesium is a metal.

Describe **two** properties that are characteristic of most metals.

1 .....

2 .....
[2]

(e) Carbon dioxide is a gas.

(i) Which **one** of these processes does **not** produce carbon dioxide?

Tick **one** box.

the reaction of hydrochloric acid with calcium carbonate	☐
respiration in animals and plants	☐
the reaction of hydrochloric acid with magnesium	☐
the thermal decomposition of calcium carbonate	☐

[1]

(ii) Carbon dioxide is a greenhouse gas.

Give **one** effect of an increase in the concentration of greenhouse gases in the atmosphere.

..... [1]

[Total: 11]

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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.).