Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0344015682

CHEMISTRY **0620/33**

Paper 3 Theory (Core) **October/November 2021**

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. Any blank pages are indicated.

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

Br_2
CO
CO_2
CH_4
C_2H_6
HCl
KBr
$LiCl$
$MgCl_2$
O_2
SO_2

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

State which formula represents:

(i) a compound that gives a red colour in a flame test

.... [1]

(ii) a compound containing an ion with a 2+ charge

.... [1]

(iii) a compound that is a product of respiration

.... [1]

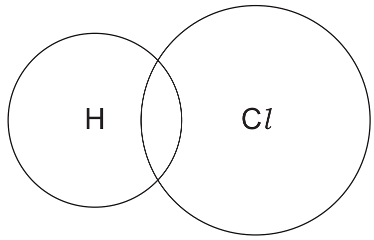
(iv) a compound used as a food preservative

.... [1]

(v) an element that is used in the production of steel.

.... [1]

(b) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of hydrogen chloride. Show outer shell electrons only.



[2]

(c) State whether carbon dioxide is a basic oxide or an acidic oxide.
Give a reason for your answer.

....

.... [1]

[Total: 8]

2 The table shows the masses of some of the ions in 1000 cm^3 of water from a river.

name of ion	formula of ion	mass of ion in 1000 cm^3 of river water / mg
ammonium	NH_4^+	1.0
	Ca^{2+}	16.5
chloride	Cl^-	7.0
iron(III)	Fe^{3+}	0.5
magnesium	Mg^{2+}	4.0
	NO_3^-	0.5
potassium	K^+	3.5
silicate	SiO_3^{2-}	7.5
sodium	Na^+	6.0
sulfate	SO_4^{2-}	11.0

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

(i) State which positive ion has the lowest concentration.

.... [1]

(ii) Name the compound containing Ca^{2+} and NO_3^- ions.

.... [1]

(iii) Calculate the mass of sulfate ions in 500 cm^3 of river water.

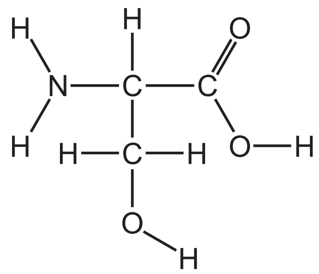
mass = ... mg [1]

(b) Describe a test for iron(III) ions.

test ....

observations ....
[2]

(c) Compound **A** is found in river water.
The structure of compound **A** is shown.



(i) On the structure draw a circle around the alcohol functional group. [1]

(ii) Deduce the formula of compound **A** to show the number of carbon, hydrogen, oxygen and nitrogen atoms.

.... [1]

(iii) Another compound found in river water has the formula $C_4H_8O_2$.

Complete the table to calculate the relative molecular mass of this compound.

type of atom	number of atoms	relative atomic mass	
carbon	4	12	$4 \times 12 = 48$
hydrogen		1	
oxygen		16	

relative molecular mass = ...
[2]

[Total: 9]

3 Iron is extracted in a blast furnace using a mixture of iron ore, coke (carbon), air and calcium carbonate (limestone).

(a) Give **two** reasons why air is blown into the blast furnace.

1 ....

2 ....
[2]

(b) Magnetite is an ore of iron which contains a compound of iron with the formula Fe_3O_4.

(i) Give the name of another ore of iron.

.... [1]

(ii) In the blast furnace Fe_3O_4 is reduced to Fe.

Complete the chemical equation for the reduction of Fe_3O_4.

$$Fe_3O_4 + 4CO \rightarrow .....Fe + ...CO_2$$ [2]

(iii) Explain how this equation shows that Fe_3O_4 is reduced.

.... [1]

(c) Calcium carbonate (limestone) is added to the blast furnace.
The calcium carbonate undergoes thermal decomposition.

Give the meaning of the term *thermal decomposition*.

.... [2]

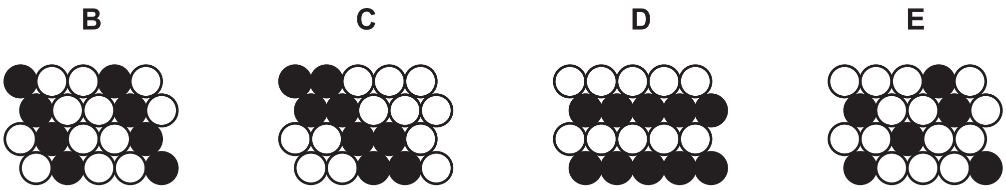
(d) Iron can form alloys such as vanadium steel.

(i) State the meaning of the term *alloy*.

....

.... [1]

(ii) Choose from the diagrams, **B**, **C**, **D** or **E**, the structure which best represents an alloy.



structure .... [1]

(iii) The symbol for an isotope of vanadium is shown.

$$^{51}_{23}V$$

Deduce the number of electrons, neutrons and protons in one atom of this isotope of vanadium.

number of electrons ....

number of neutrons ....

number of protons ....
[3]

(iv) Vanadium is malleable and conducts electricity.

Give two **other** physical properties of vanadium that are characteristic of **all** metals.

1 ....

2 ....
[2]

[Total: 15]

4 The table shows some properties of four halogens in Group VII.

halogen	melting point / °C	boiling point / °C	density of liquid at boiling point in g/cm^3
chlorine	–101	–35	1.56
bromine	–7	59	
iodine	114		4.93
astatine	302	337	6.35

(a) (i) Complete the table by predicting:

- the boiling point of iodine
- the density of bromine. [2]

(ii) Describe the trend in the melting points of the halogens down Group VII.

.... [1]

(b) (i) Deduce the electronic structure of chlorine.
Use the Periodic Table to help you.

.... [1]

(ii) Explain why a bromide ion has a single negative charge.

....

.... [1]

(c) Scientists have predicted that sodium astatide reacts with chlorine.

Complete the word equation for this reaction.

sodium astatide	+	chlorine	→	....	+	....

[2]

(d) Hydrogen chloride is produced when chlorine reacts with ammonia.
An aqueous solution of hydrogen chloride is acidic.

Describe how you could determine the pH of an acidic solution without using a pH meter.

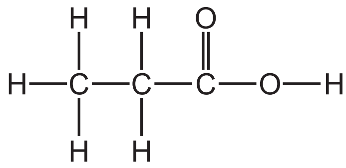
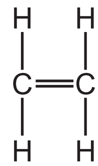
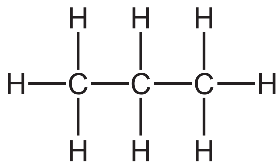
....

....

.... [2]

[Total: 9]

5 The table shows the structures of some organic compounds.

compound	structure of compound	homologous series
F		carboxylic acid
G		
H		

(a) Complete the table by naming the homologous series.
The first one has been done for you. [2]

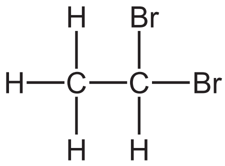
(b) Draw the structure of a compound containing two carbon atoms which belongs to the same homologous series as compound **F**.
Show all of the atoms and all of the bonds.

[1]

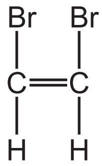
(c) Compound **G** reacts with bromine.

Choose from the structures, **P**, **Q**, **R** or **S**, the structure of the product formed.

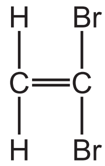
P



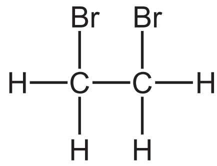
Q



R



S



.... [1]

(d) **(i)** Compound **G** can be obtained by cracking petroleum fractions.

Describe what is meant by the term *cracking*.

....

.... [2]

(ii) Name the product of the reaction when compound **G** reacts with steam.

.... [1]

(iii) Many molecules of compound **G** can join together to form a compound with a very long chain.

Choose from the list the general name given to a compound that is formed by the addition of many small units.

Draw a circle around the correct answer.

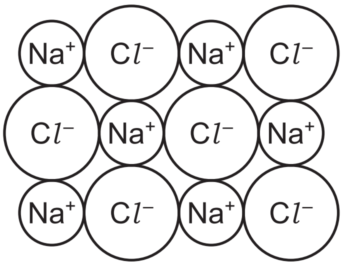
isomer **monomer** **naphtha** **polymer** [1]

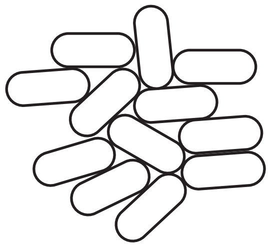
(e) State the names of the **two** compounds formed during the complete combustion of compound **H**.

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

[Total: 10]

6 The diagram shows part of the structures of sodium chloride and pentane at room temperature and pressure.





(a) Describe the differences in the physical properties of these substances in terms of:

- volatility

sodium chloride ....

pentane ....

- solubility in water

sodium chloride ....

pentane ....

- electrical conductivity when molten (liquid).

sodium chloride ....

pentane ....
[5]

(b) Concentrated aqueous sodium chloride is electrolysed using carbon (graphite) electrodes.

Name the gas produced at the positive electrode.

.... [1]

(c) Pentane is a fuel. Under some conditions pentane forms carbon monoxide.

(i) State the condition under which pentane forms carbon monoxide.

.... [1]

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

.... [1]

[Total: 8]

7 This question is about aluminium and the extraction of metals.

(a) When aluminium is heated above 660 °C it changes from solid to liquid.

(i) Name the change of state from solid to liquid.

.... [1]

(ii) Use the kinetic particle theory to describe the differences between solid aluminium and liquid aluminium in terms of:

- the separation of the particles

....

....

....

- the motion of the particles.

....

....

....
[4]

(b) Aluminium is extracted from aluminium ore by electrolysis.

Explain why aluminium is extracted by electrolysis and **not** by reduction with carbon.

.... [1]

(c) Give **two** reasons why aluminium is used in the manufacture of aircraft.

1 ....

2 ....
[2]

(d) Give **one** advantage of recycling aluminium.

....

.... [1]

(e) The table compares the ease of reduction of four metal oxides when heated with carbon.

metal oxide	ease of reduction
aluminium oxide	not reduced at 2080 °C
nickel(II) oxide	reduced at 540 °C
titanium(IV) oxide	reduced at 1600 °C
zinc oxide	reduced at 850 °C

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

least reactive ⟶ most reactive

[2]

(f) Methane is used as a fuel in the extraction of some metals.

(i) State the main source of methane.

.... [1]

(ii) State **one** adverse effect of methane on the environment.

.... [1]

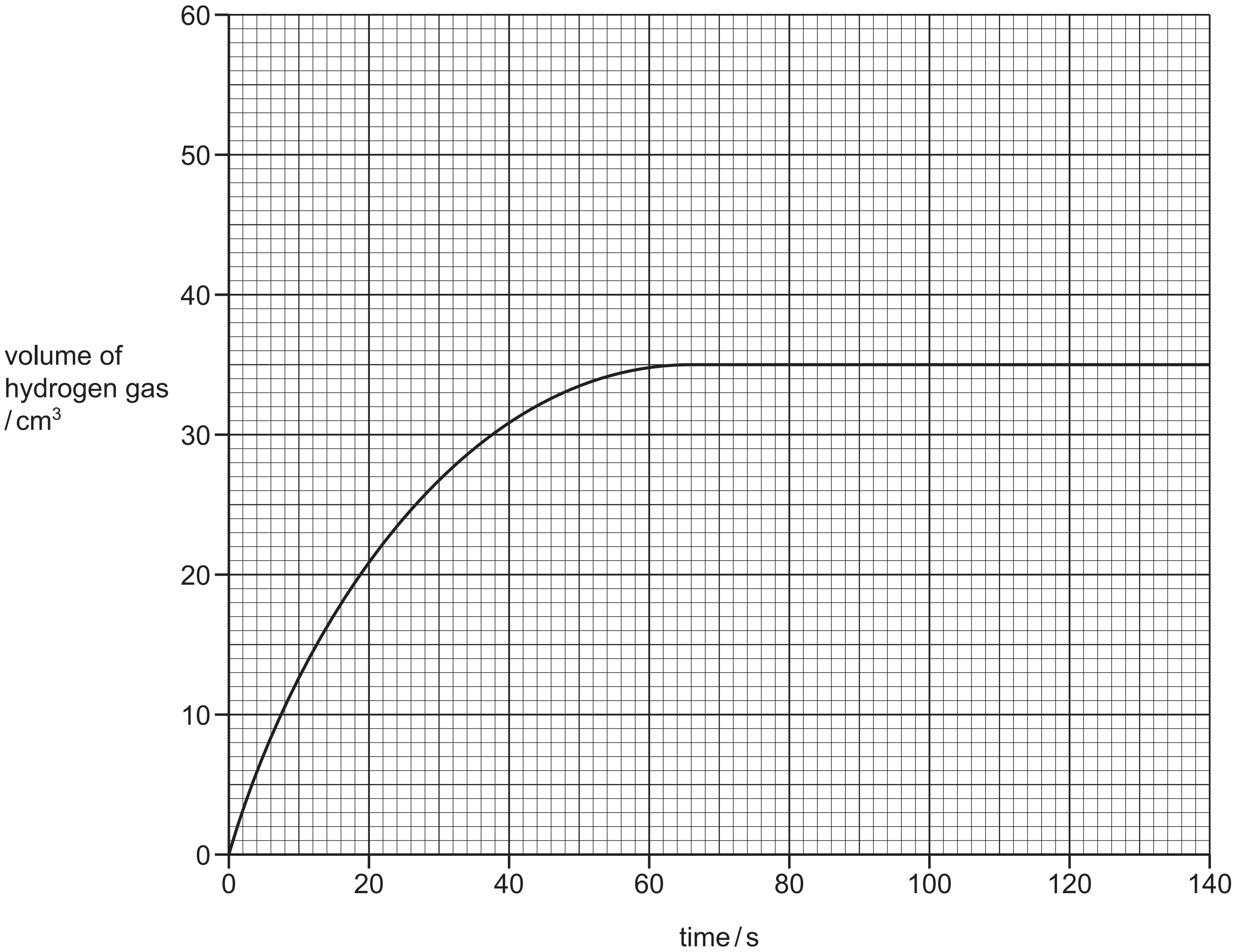
[Total: 13]

8 A student investigated the reaction of small pieces of zinc with dilute hydrochloric acid. The hydrochloric acid was in excess.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

The rate of reaction is found by measuring the increase in volume of hydrogen gas with time.

The results are shown on the graph.



(a) Deduce the time taken from the beginning of the experiment to collect 30 cm^3 of hydrogen gas.

time = ... s [1]

(b) The experiment was repeated using dilute hydrochloric acid of a higher concentration.

All other conditions stayed the same.

Draw a line **on the grid** to show how the volume of hydrogen gas changes with time. [2]

(c) Describe the effect each of the following has on the rate of reaction of zinc with dilute hydrochloric acid.

All other conditions stay the same.

- The reaction is carried out at a lower temperature.

....

- The reaction is carried out using zinc powder instead of small pieces of zinc.

....
[2]

(d) When 0.065 g of zinc is used, 24 cm^3 of hydrogen gas is formed.

Calculate the mass of zinc needed to produce 96 cm^3 of hydrogen gas.

mass of zinc = ... g [1]

(e) Aqueous ammonia is added to aqueous zinc chloride.

Describe the observations when a few drops of aqueous ammonia are added and when excess aqueous ammonia is added.

a few drops of aqueous ammonia ....

excess aqueous ammonia ....
[2]

[Total: 8]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			atomic number atomic symbol name relative atomic mass								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 –		

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.).