Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8830014055

CHEMISTRY **0620/32**

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

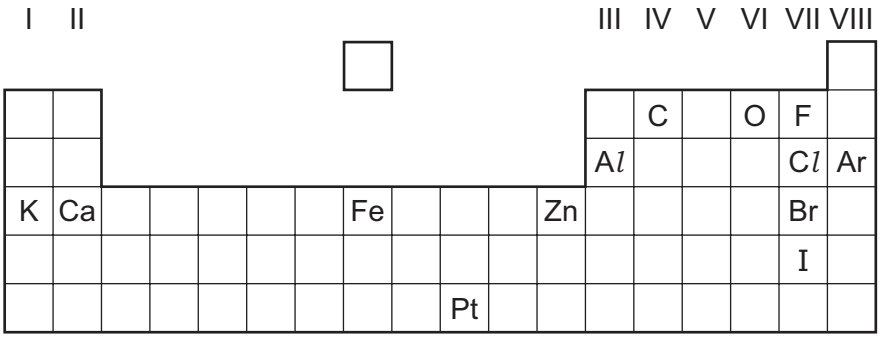
INFORMATION

- 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)** The diagram shows part of the Periodic Table.



Answer the following questions using only the symbols of the elements in the diagram. Each symbol may be used once, more than once or not at all.

State the symbol of the element that:

(i) provides an inert atmosphere in lamps

..... [1]

(ii) forms an oxide which is used to neutralise acidic industrial waste

..... [1]

(iii) has an atom which forms a stable ion by the loss of one electron

..... [1]

(iv) is a metal used as an inert electrode

..... [1]

(v) forms an ion whose aqueous solution gives a green precipitate on addition of aqueous sodium hydroxide.

..... [1]

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(b) Chlorine is an element.

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

.....

..... [1]

(ii) An isotope of chlorine is shown.

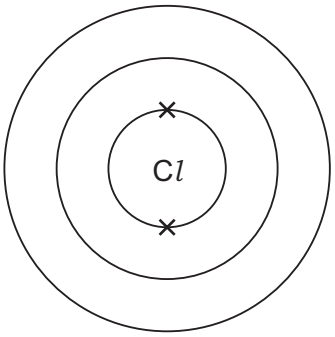
$^{35}_{17}Cl$

Deduce the number of protons and neutrons in this isotope.

number of protons .....

number of neutrons .....
[2]

(c) Complete the electronic structure of a chlorine atom.



[1]

[Total: 9]

2 The table shows the mass of air pollutants, in nanograms, in 1000 cm^3 samples of air taken over a four month period.

	mass of pollutant in 1000 cm^3 of air / nanograms				
month	oxides of nitrogen	sulfur dioxide	carbon monoxide	ozone	particulates
April	144.3	5.9	2.5	33.9	21.9
May	114.2	2.0	2.1	39.6	21.7
June	110.2	6.1	1.8	31.5	21.3
July	115.4	2.5	2.6	24.2	19.0

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

(i) Name the pollutant that shows a continual decrease in concentration between April and July.

..... [1]

(ii) Name the pollutant present in the lowest concentration in May.

..... [1]

(iii) Calculate the mass of carbon monoxide in 200 cm^3 of the sample of air taken in April.

..... nanograms [1]

(b) Sulfur dioxide contributes to acid rain.

(i) State **one** source of the sulfur dioxide in the air.

..... [1]

(ii) Give **one** adverse effect of acid rain on buildings.

..... [1]

(iii) State **one** use of sulfur dioxide.

..... [1]

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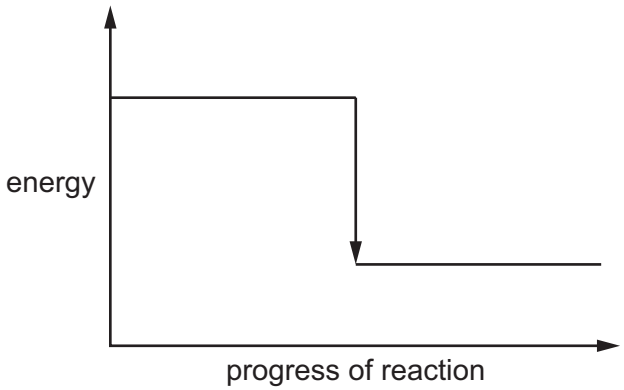
(c) Sulfur dioxide is oxidised to sulfur trioxide, SO_3.

(i) Complete the chemical equation for this reaction.

$$.....SO_2 + O_2 \rightarrow .....SO_3$$ [2]

(ii) Complete the energy level diagram for the oxidation of sulfur dioxide to sulfur trioxide by writing these words on the diagram:

- reactants
- products.



[1]

(iii) Explain, using information on the energy level diagram, how you know that this reaction is exothermic.

..... [1]

(d) Nitrogen monoxide is a catalyst in the oxidation of sulfur dioxide to sulfur trioxide.

State the meaning of the term *catalyst*.

..... [1]

(e) Sulfur trioxide reacts with water to form dilute sulfuric acid.

Identify which **one** of these pH values represents the pH of dilute sulfuric acid.

Draw a circle around the correct answer.

pH 2 **pH 7** **pH 9** **pH 13** [1]

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[Turn over

(f) Particulates are tiny solid particles in the air.

They show Brownian motion.

Identify one statement that best describes Brownian motion.

Tick **one** box.

The particles move from a higher concentration to a lower concentration.	☐
The particles are smaller than oxygen molecules.	☐
Brownian motion is an example of diffusion.	☐
The particles move in a random zig-zag motion.	☐

[1]

[Total: 13]

3 Some properties of four substances, **E**, **F**, **G** and **H**, are shown in the table.

substance	strength	ductility (how easy it is to pull into a wire)	electrical conductivity when solid	resistance to corrosion
E	very strong	good	good	very good
F	weak	good	good	poor
G	strong	not ductile	good	poor
H	strong	very good	very good	good

Answer these questions using only the information in the table.

(a) State which substance, **E**, **F**, **G** or **H**, is best used to make electricity cables.

Explain your answer.

substance .....

explanation .....

.....

[3]

(b) State which substance, **E**, **F**, **G** or **H**, is best used for making cutlery.

Explain your answer.

substance .....

explanation .....

.....

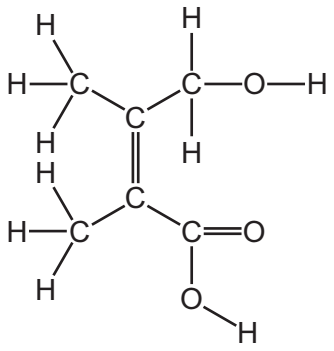
[3]

[Total: 6]

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[Turn over

4 The structure of compound **J** is shown.



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

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

..... [1]

(iii) Complete the table to calculate the relative molecular mass of compound **J**.
Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
carbon		12	
hydrogen	10	1	$10 \times 1 = 10$
oxygen		16	

relative molecular mass = ... [2]

(b) Acids react with bases such as calcium oxide.

Complete the word equation for the reaction of hydrochloric acid with calcium oxide.

hydrochloric acid	+	calcium oxide	→	....	+	.....

[2]

(c) The chemical equation for the reaction of lime (calcium oxide) with ammonium sulfate is shown.

$$CaO + (NH_4)_2SO_4 \rightarrow CaSO_4 + 2NH_3 + H_2O$$

(i) Name the compound with the formula $CaSO_4$.

..... [1]

(ii) Complete these phrases about ammonia, NH_3, using words from the list.

acid **blue** **gaseous** **green** **liquid**

pink **solid** **solution** **white**

The state of ammonia at room temperature is ..... .

Aqueous ammonia turns damp red litmus paper ..... .

[2]

[Total: 9]

5 Ethane is an alkane.

(a) Draw the structure of ethane to show all of the atoms and all of the bonds.

[1]

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

$$C_3H_8 + 5O_2 \rightarrow .....CO_2 + ...H_2O$$ [2]

(c) Methane is an alkane which is produced by the fractional distillation of petroleum.

(i) State one **other** process which puts methane into the atmosphere.

..... [1]

(ii) Give **one** major use of methane.

..... [1]

(d) Alkanes and alkenes are hydrocarbons.

State the meaning of the term *hydrocarbon*.

.....

..... [2]

(e) Alkanes and alkenes can be distinguished by a chemical test.

Name the reagent that can be used to distinguish between alkanes and alkenes.

..... [1]

(f) Alkenes are manufactured by cracking alkanes.

(i) Name an element that is also produced by cracking alkanes.

..... [1]

(ii) State **one** condition required for cracking alkanes.

..... [1]

[Total: 10]

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6 Electrolysis is used to extract reactive metals from metal compounds.

(a) Describe the electrolysis of molten sodium chloride.
In your answer include:

- a labelled diagram of the apparatus used
- the observations made at the positive and the negative electrode.

observation at positive electrode

.....

observation at negative electrode

.....

[5]

(b) Use the kinetic particle model to describe the arrangement and separation of the particles in solid sodium.

arrangement .....

separation .....

[2]

(c) Sodium is a metal in Group I of the Periodic Table.
Iron is a transition element.

Give **two** ways in which the physical properties of iron differ from the physical properties of sodium.

1 .....

2 .....
[2]

(d) The chemical equation for the reaction between iron(III) oxide and carbon monoxide is shown.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

Explain how this equation shows that carbon monoxide has been oxidised.

..... [1]

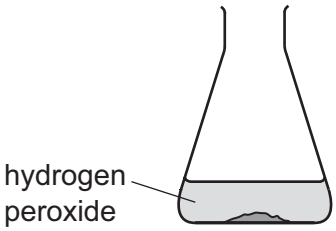
[Total: 10]

7 A student investigated the rate of decomposition of hydrogen peroxide, H_2O_2, in the presence of a catalyst by measuring the volume of oxygen released at 10 second intervals.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

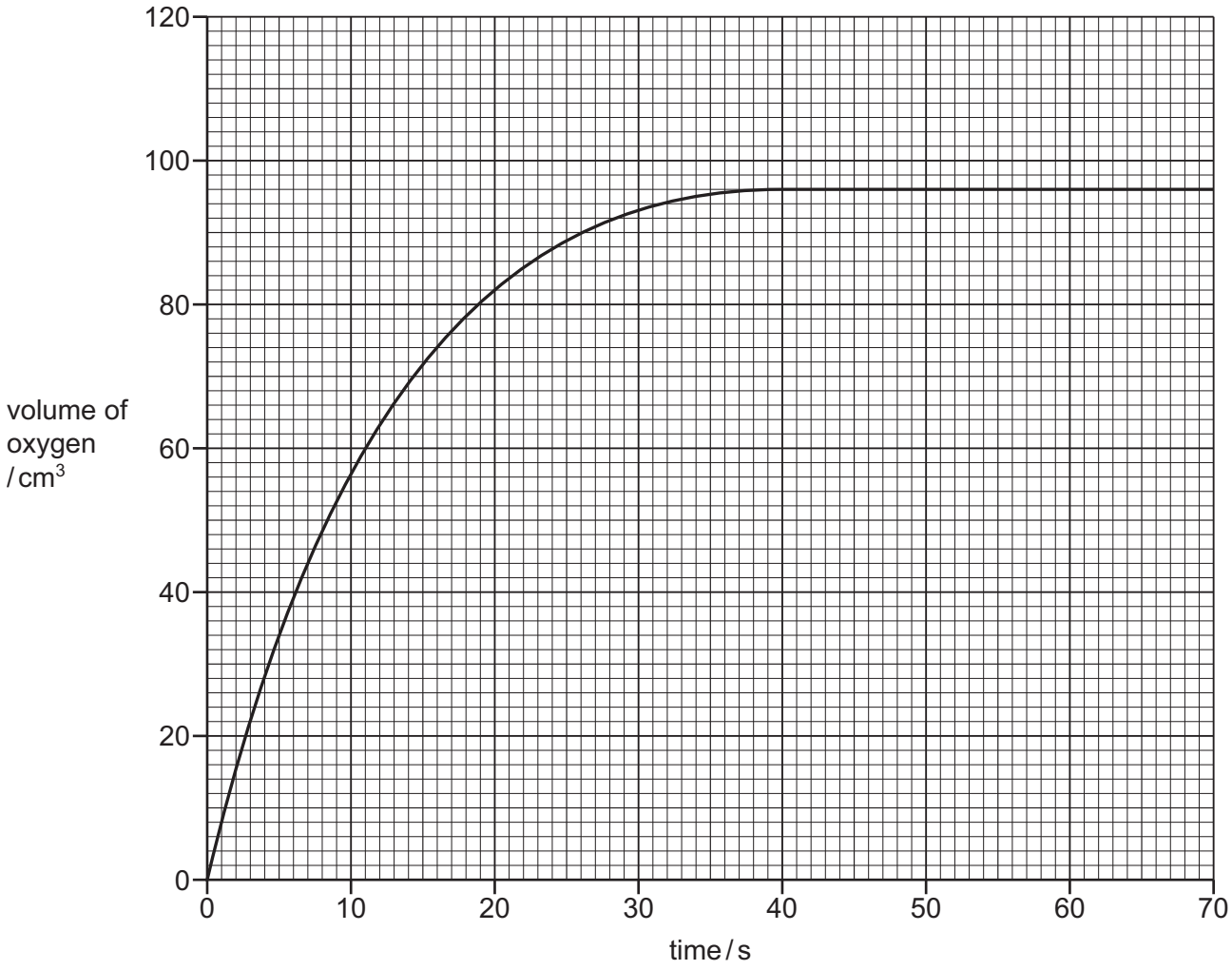
(a) Complete the diagram to show a suitable method for collecting and measuring the volume of the oxygen.

Label your diagram.



[3]

(b) The graph shows how the volume of oxygen changes as the reaction proceeds.



Answer these questions using information from the graph.

(i) Describe how the rate of this reaction changes with time.

..... [1]

(ii) Deduce the time taken to collect 60 cm^3 of oxygen.

time = ... s [1]

(iii) The experiment is repeated without using a catalyst.

Draw a line **on the grid** to show how the volume of oxygen changes with time when no catalyst is used.

All other conditions stay the same. [1]

(iv) Describe what effect an increase in temperature has on the rate of this reaction.

All other conditions stay the same.

..... [1]

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(c) Identify which **one** of these elements is likely to act as a catalyst in chemical reactions.

Draw a circle around the correct answer.

C **Mg** **Na** **Ni** **S** [1]

(d) Describe a test for oxygen.

test .....

result .....
[2]

[Total: 10]

8 This question is about metals and compounds of metals.

(a) Iron reacts with dilute hydrochloric acid to form an iron(II) salt and a gas which pops with a lighted splint.

Complete the word equation for this reaction.

iron	+	hydrochloric acid	→	....	+	.....

[2]

(b) Identify two correct statements about iron.

Tick **two** boxes.

Iron forms an alloy called steel.	☐
The commonest ore of iron is called bauxite.	☐
Iron is usually extracted from its ore by electrolysis.	☐
Iron is oxidised by carbon in the blast furnace.	☐
Both oxygen and water are needed for iron to rust.	☐

[2]

(c) The table compares the reactions of four metals with warm water and with steam.

metal	reaction with warm water	reaction with steam
chromium	no reaction	slow reaction
copper	no reaction	no reaction
iron	very slow reaction	slow reaction
magnesium	very slow reaction	rapid reaction

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

least reactive → most reactive

[2]

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(d) Crystals of cobalt(II) chloride, $CoCl_2 \cdot 6H_2O$, can be prepared by reacting excess cobalt(II) carbonate powder with dilute hydrochloric acid.

Describe how to prepare a sample of pure dry cobalt(II) chloride crystals after the reaction is complete.

In your answer describe how to:

- remove the excess cobalt(II) carbonate from the reaction mixture
- crystallise the cobalt(II) chloride
- dry the crystals.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(e) A few drops of water were added to a sample of solid anhydrous cobalt(II) chloride, $CoCl_2$. The equation for the reaction is shown.

$$CoCl_2 + 6H_2O \rightleftharpoons CoCl_2 \cdot 6H_2O$$

(i) State the meaning of the symbol $\rightleftharpoons$.

..... [1]

(ii) State the colour change observed when water is added to anhydrous cobalt(II) chloride.

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

[Total: 13]

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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.).