Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

5149603912

CHEMISTRY **0620/33**

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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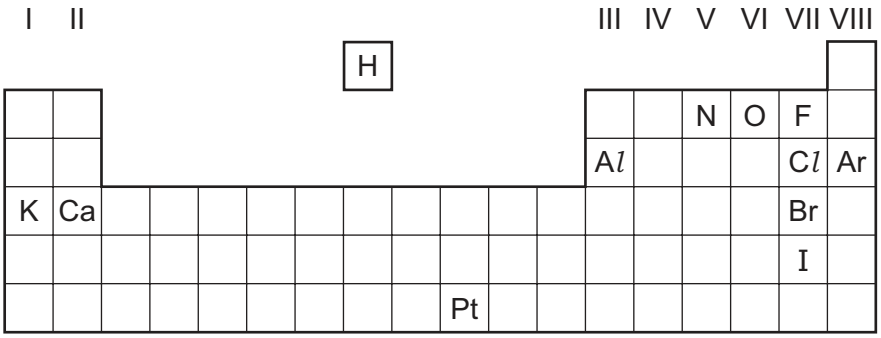
1 **(a)** The diagram shows part of the Periodic Table.



Answer the following questions using only the symbol 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) is a fuel which is a gas at room temperature

..... [1]

(ii) is used to kill bacteria in water

..... [1]

(iii) forms a stable ion of type X^{3+}

..... [1]

(iv) is a grey-black non-metallic solid at room temperature

..... [1]

(v) forms an ion which, on addition of aqueous sodium hydroxide, gives a white precipitate which is soluble in excess aqueous sodium hydroxide.

..... [1]

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(b) Sulfur has several isotopes.

(i) Identify one correct statement about isotopes.

Tick **one** box.

They are molecules with the same number of neutrons but different numbers of protons. ☐

They are atoms with the same number of protons but different numbers of neutrons. ☐

They are molecules with the same number of protons but different numbers of electrons. ☐

They are atoms with the same number of neutrons but different numbers of protons. ☐

[1]

(ii) An isotope of sulfur is shown.

$^{33}_{16}S$

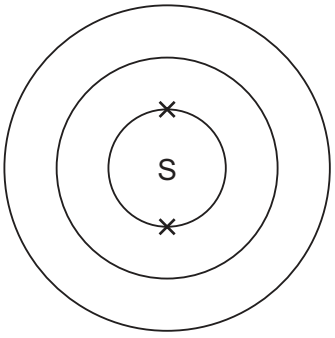
Deduce the number of protons and neutrons in this isotope.

number of protons .....

number of neutrons .....

[2]

(c) Complete the electronic structure of a sulfur 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
August	106.0	3.0	2.1	29.5	18.5
September	147.5	5.5	2.4	21.1	35.5
October	179.3	3.5	2.0	20.3	22.5
November	214.0	3.6	2.6	12.8	29.4

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

(i) Name the pollutant that shows a decrease in concentration between August and November.

..... [1]

(ii) Calculate the mass of oxides of nitrogen in 250 cm^3 of the sample of air taken in August.

..... nanograms [1]

(b) Carbon monoxide is produced by the incomplete combustion of fossil fuels.

(i) State the meaning of the term *incomplete combustion*.

.....

..... [1]

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

..... [1]

(c) Carbon monoxide is also produced when methane reacts with steam in the presence of a catalyst.

(i) Explain why a catalyst is used in this reaction.

..... [1]

(ii) Methane is an air pollutant.

State **one** source of methane in the air.

..... [1]

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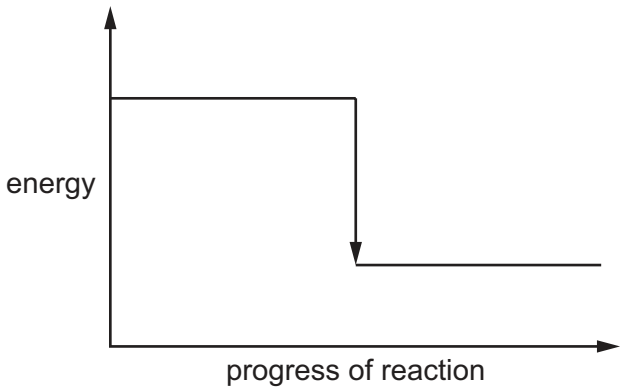
(d) (i) Complete the chemical equation for the reaction of carbon monoxide with oxygen.

$$.....CO + O_2 \rightarrow .....CO_2$$ [2]

(ii) Complete the energy level diagram for the reaction of carbon monoxide with oxygen 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]

(e) (i) Describe a test for carbon dioxide.

test .....

result .....
[2]

(ii) Identify which **one** of these pH values represents the pH of a solution of carbon dioxide in water.

Draw a circle around the correct answer.

pH 6 **pH 7** **pH 8** **pH 14** [1]

[Total: 13]

3 Some properties of four substances, **A**, **B**, **C** and **D**, are shown in the table.

substance	electrical conductivity when solid	electrical conductivity when molten	melting point	solubility in water
A	does not conduct	does not conduct	low	insoluble
B	conducts	conducts	high	insoluble
C	does not conduct	does not conduct	very high	soluble
D	does not conduct	conducts	high	soluble

Answer these questions using only the information in the table.

(a) State which substance, **A**, **B**, **C** or **D**, is sulfur.

Explain your answer.

substance .....

explanation .....

.....

[3]

(b) State which substance, **A**, **B**, **C** or **D**, is sodium chloride.

Explain your answer.

substance .....

explanation .....

.....

[3]

[Total: 6]

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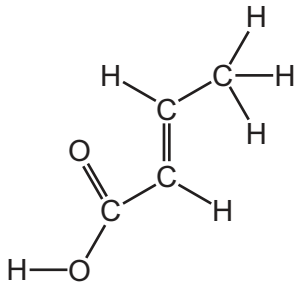
4 The structure of crotonic acid is shown.



(a) (i) On the structure, draw a circle around the functional group which shows that this is an unsaturated compound. [1]

(ii) Deduce the formula of crotonic acid to show the number of carbon, hydrogen and oxygen atoms.

..... [1]

(iii) Complete the table to calculate the relative molecular mass of crotonic acid.
Use your Periodic Table to help you.

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

relative molecular mass = ... [2]

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

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

nitric acid	+	calcium oxide	→	....	+	.....

[2]

(c) Calcium oxide is manufactured from limestone by thermal decomposition.

(i) Give the name of the main chemical compound in limestone.

..... [1]

(ii) State the meaning of the term *thermal decomposition*.

.....

..... [2]

(d) Calcium oxide reacts with water to produce slaked lime.

State **one** use of slaked lime.

.....

..... [1]

[Total: 10]

5 The formula of ethanol is C_2H_6O.

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

[2]

(b) Ethanol is a liquid at room temperature.

Describe the motion and separation of the particles in ethanol.

motion .....

separation .....
[2]

(c) Name the **two** products formed when ethanol undergoes complete combustion.

1 .....

2 .....
[2]

(d) Ethanol can be manufactured by the fermentation of glucose.
One condition is using enzymes in yeast.

(i) State two **other** conditions for fermentation.

1 .....

2 .....
[2]

(ii) Name the method used to separate the ethanol from the reaction mixture after fermentation is complete.

..... [2]

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[Turn over

(e) Alcohols can also be manufactured from alkenes.

Complete the word equation for the manufacture of ethanol by this method.

.....	+	.....	→	ethanol

[2]

[Total: 12]

6 The electrolysis of concentrated hydrochloric acid produces gases at each electrode.

(a) Describe the electrolysis of concentrated hydrochloric acid.
In your answer include:

- a labelled diagram of the apparatus used for the electrolysis and collection of gases
- the names of the products formed at the positive and the negative electrode.

positive electrode .....

negative electrode .....

[5]

(b) Carbon dioxide is produced when hydrochloric acid reacts with sodium carbonate.

Complete the chemical equation for this reaction.

$$Na_2CO_3 + 2HCl \rightarrow .....NaCl + ... + CO_2$$ [2]

(c) Carbon dioxide reacts with carbon to produce carbon monoxide.

$$CO_2 + C \rightarrow 2CO$$

Explain how this equation shows that carbon dioxide has been reduced.

..... [1]

[Total: 8]

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[Turn over

7 A student investigated the rate of reaction of excess calcium carbonate with dilute hydrochloric acid in a conical flask by two different methods.

Method 1: Measure the volume of carbon dioxide produced at 10 second intervals.

Method 2: Measure the loss in mass of the reaction mixture by weighing at 10 second intervals.

(a) (i) Suggest **one** advantage of Method 1 compared with Method 2.

.....

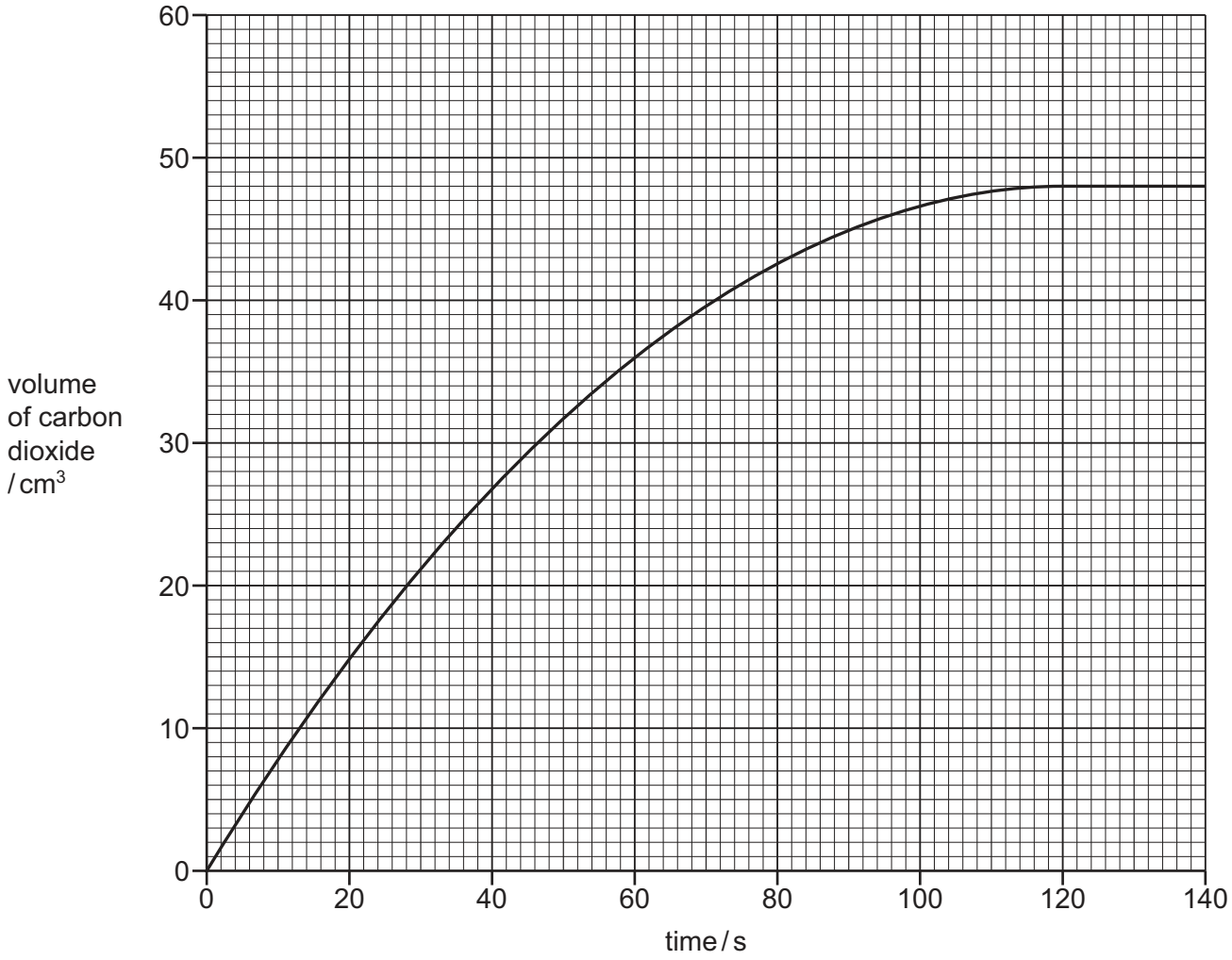
..... [1]

(ii) Explain why there is a decrease in mass of the reaction mixture in Method 2.

.....

..... [1]

(b) The graph shows how the volume of carbon dioxide changes as the reaction proceeds, using Method 1.



The student used large pieces of calcium carbonate.

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 36 cm^3 of carbon dioxide.

time = ... s [1]

(iii) The experiment is repeated using smaller pieces of calcium carbonate.

Draw a line **on the grid** to show how the volume of carbon dioxide changes with time when smaller pieces of calcium carbonate are used.

All other conditions stay the same. [2]

(iv) Describe what effect the following changes have on the rate of this reaction.

- The temperature is increased.

  All other conditions stay the same.

  .....

- The concentration of the hydrochloric acid is decreased.

  All other conditions stay the same.

  .....
  [2]

[Total: 8]

8 This question is about metals and compounds of metals.

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

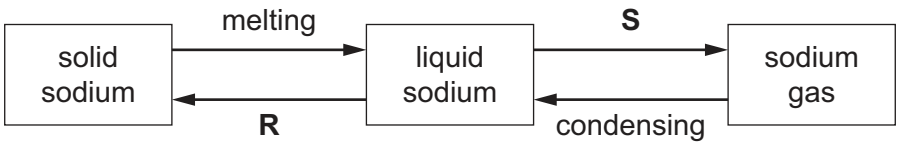
Identify two correct statements about sodium.

Tick **two** boxes.

It is a relatively soft metal.	☐
It has a high melting point.	☐
It forms coloured chlorides.	☐
It has a lower density than most metals.	☐
It is a good insulator.	☐

[2]

(ii) Some changes of state of sodium are shown.



Give the names of the changes of state represented by **R** and **S**.

R .....

S .....

[2]

(b) The table compares the reactions of four metals with dilute and with concentrated hydrochloric acid.

metal	observation with dilute hydrochloric acid	observation with concentrated hydrochloric acid
beryllium	bubbles form rapidly	bubbles form very rapidly
copper	no bubbles seen	no bubbles seen
iron	bubbles form very slowly	bubbles form slowly
nickel	no bubbles seen	bubbles form slowly

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

least reactive ⟶ most reactive

[2]

(c) Crystals of magnesium chloride, $MgCl_2 \cdot 6H_2O$, can be prepared by adding excess magnesium powder to dilute hydrochloric acid.

Describe how to prepare a sample of pure dry magnesium chloride crystals after the reaction is complete.

In your answer describe how to:

- remove the excess magnesium from the reaction mixture
- crystallise the magnesium chloride
- dry the crystals.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(d) When magnesium reacts with concentrated sulfuric acid, sulfur dioxide is produced.

Complete this description of the test for sulfur dioxide using words from the list.

blue	**chloride**	**colourless**
green	**manganate(VII)**	**sulfate(VI)**

The test for sulfur dioxide uses acidified aqueous potassium ..... .

The colour change is from purple to ..... .

[2]

(e) Green nickel(II) sulfate crystals turn yellow when heated.

$$\underset{\text{green nickel(II) sulfate}}{NiSO_4 \bullet 7H_2O} \rightleftharpoons \underset{\text{yellow nickel(II) sulfate}}{NiSO_4} + 7H_2O$$

(i) Suggest how you would change yellow nickel(II) sulfate to green nickel(II) sulfate.

..... [1]

(ii) Identify which word best describes green nickel(II) sulfate with the formula $NiSO_4 \bullet 7H_2O$.

Draw a circle around the correct answer.

anhydrous **decomposed** **hydrated** **oxidised** **reduced** [1]

[Total: 14]

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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.).