



# Cambridge IGCSE™

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**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.



(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.



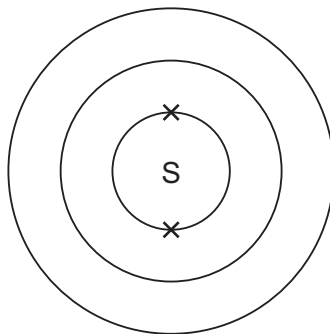
Deduce the number of protons and neutrons in this isotope.

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  $1000\text{ cm}^3$  samples of air taken over a four month period.

month	mass of pollutant in $1000\text{ cm}^3$ of air / nanograms				
	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  $250\text{ cm}^3$  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.

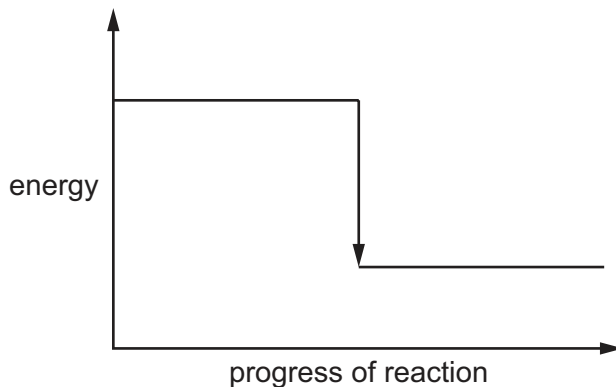
..... [1]

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



(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
<b>A</b>	does not conduct	does not conduct	low	insoluble
<b>B</b>	conducts	conducts	high	insoluble
<b>C</b>	does not conduct	does not conduct	very high	soluble
<b>D</b>	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.

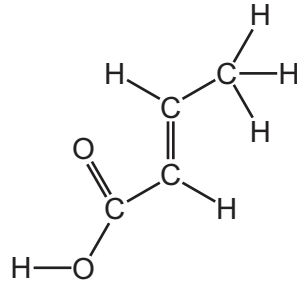
substance .....

explanation .....

..... [3]

[Total: 6]

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]

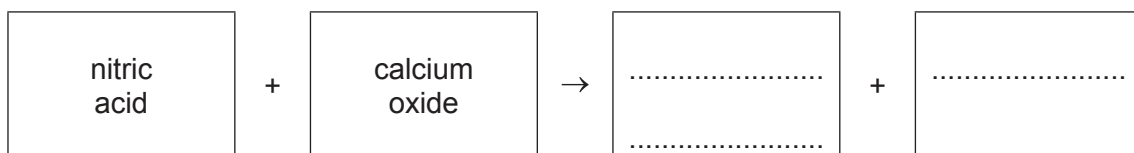
(iii) Complete the table to calculate the relative molecular mass of crotonic acid. Use your Periodic Table to help you.

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.



[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 .....

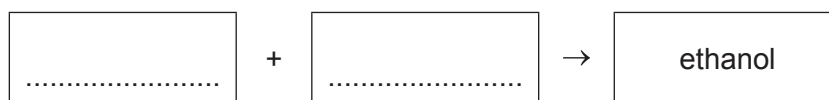
[2]

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

..... [2]

(e) Alcohols can also be manufactured from alkenes.

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



[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.



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



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

..... [1]

[Total: 8]

- 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.

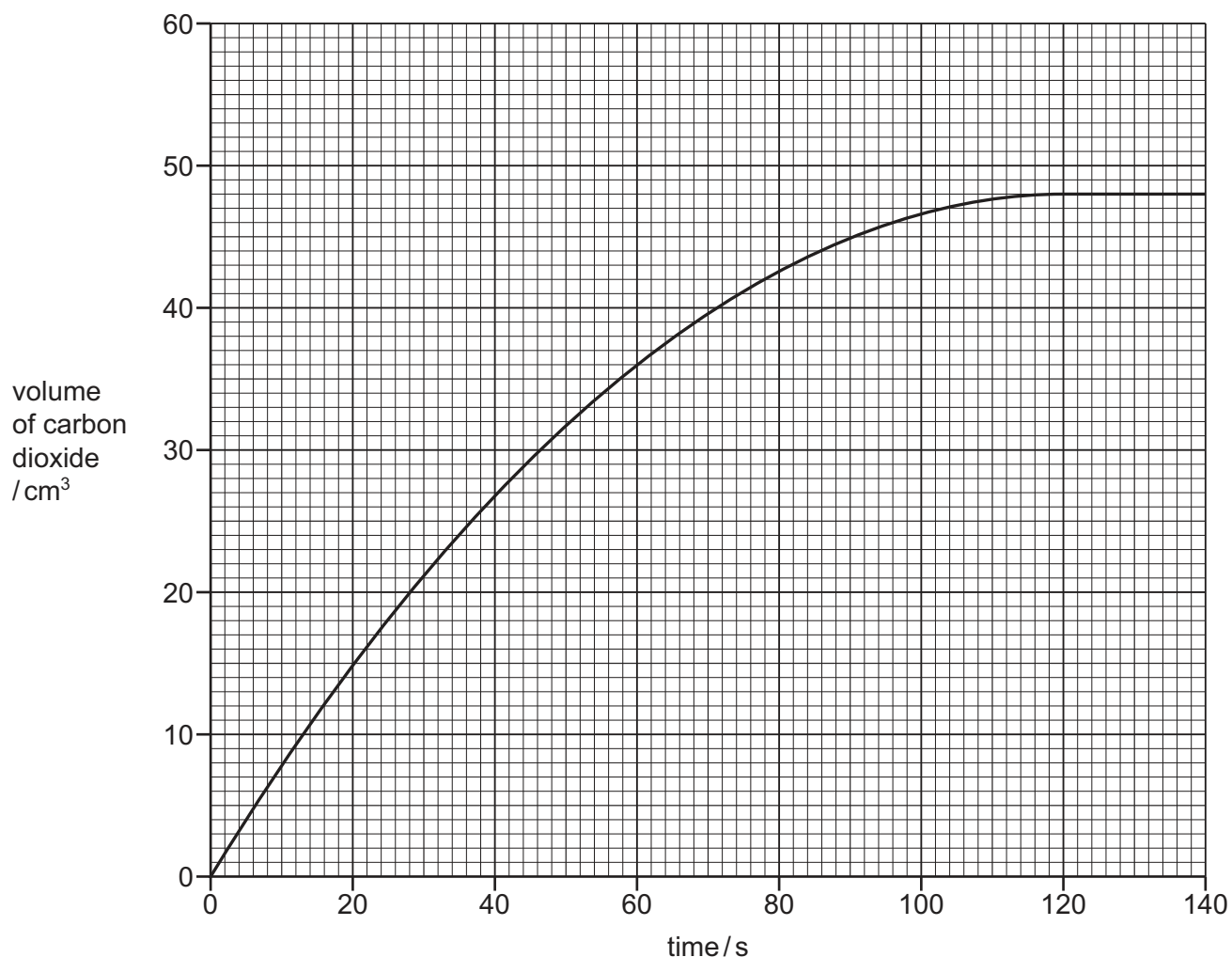
- (a) (i) Suggest **one** advantage of Method 1 compared with Method 2.

.....  
 ..... [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<sup>3</sup> 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.

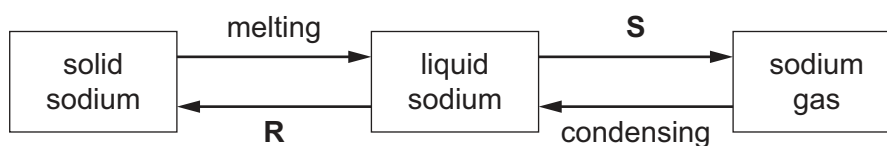
It forms coloured chlorides.

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]



- (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)**

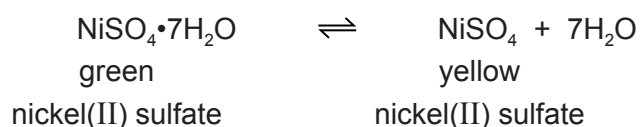
**sulfate(VI)**

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.



- (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  $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$ .

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

lanthanoids

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

actinoids

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