



CANDIDATE  
NAME

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CENTRE  
NUMBER

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CANDIDATE  
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## 0620/43

October/November 2021

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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 **16** pages. Any blank pages are indicated.

1 A list of substances is shown.

ammonia  
bauxite  
carbon dioxide  
carbon monoxide  
ethanol  
hematite  
oxygen  
sodium chloride  
sulfur dioxide

Answer the questions using the list of substances.

Each substance may be used once, more than once or not at all.

State which substance is:

- (a) an element ..... [1]
- (b) an ore of aluminium ..... [1]
- (c) a gas that causes acid rain ..... [1]
- (d) used as a fuel ..... [1]
- (e) an ionic compound ..... [1]
- (f) produced in the Haber process ..... [1]
- (g) a product of respiration ..... [1]
- (h) a toxic product of the incomplete combustion of hydrocarbons  
..... [1]
- (i) a gas produced in the test for nitrate ions. .... [1]

[Total: 9]

2 This question is about electrolysis.

(a) State the meaning of the term *electrolyte*.

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

(b) The table gives information about the electrolysis of two electrolytes. Carbon (graphite) electrodes are used in each experiment.

(i) Complete the table to show the observations and products of electrolysis.

| electrolyte                         | positive electrode (anode) |                 | negative electrode (cathode) |                 |
|-------------------------------------|----------------------------|-----------------|------------------------------|-----------------|
|                                     | observations               | name of product | observations                 | name of product |
| aqueous copper(II) sulfate          | colourless bubbles         |                 |                              |                 |
| concentrated aqueous sodium bromide |                            |                 | colourless bubbles           | hydrogen        |

[5]

(ii) Hydrogen is produced at the negative electrode (cathode) during the electrolysis of concentrated aqueous sodium bromide.

Write the ionic half-equation for this reaction.

..... [2]

(iii) State **two** reasons why carbon (graphite) is suitable to use as an electrode.

1 .....

2 ..... [2]

(iv) Name the particle responsible for the conduction of electricity in the metal wires used in a circuit.

..... [1]

[Total: 12]

- 3 Lead is a metallic element in Group IV. One of the ores of lead is galena, which is an impure form of lead(II) sulfide,  $\text{PbS}$ .

Lead also occurs in the ore cerussite, which contains lead(II) carbonate,  $\text{PbCO}_3$ .

- (a) Calculate the relative formula mass,  $M_r$ , of  $\text{PbCO}_3$ .

$M_r$  of  $\text{PbCO}_3$  = ..... [1]

- (b) The  $M_r$  of  $\text{PbS}$  is 239.

Calculate the percentage of lead by mass in  $\text{PbS}$ .

percentage of lead by mass in  $\text{PbS}$  = ..... [1]

- (c) The percentage of lead by mass in  $\text{PbCO}_3$  is 77.5%.

**Use this information** and your answer to (b) to suggest whether it would be better to extract lead from  $\text{PbCO}_3$  or  $\text{PbS}$ .

Give a reason for your answer.

.....  
 ..... [1]

- (d) When lead(II) carbonate is heated it decomposes into lead(II) oxide,  $\text{PbO}$ , and carbon dioxide.

Write a chemical equation for this reaction.

..... [1]

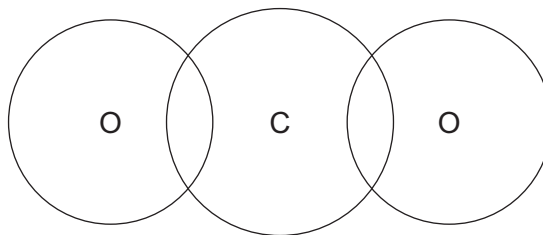
- (e) Lead(II) carbonate reacts with dilute nitric acid. One of the products is aqueous lead(II) nitrate,  $\text{Pb}(\text{NO}_3)_2$ .

Write a chemical equation for this reaction.

..... [2]

(f) Lead(II) oxide and carbon dioxide are oxides of Group IV elements.

- (i) Complete the diagram to show the electron arrangement in one molecule of  $\text{CO}_2$ . Show only the outer electrons.



[2]

- (ii) The melting points of lead(II) oxide and carbon dioxide are shown.

|                | melting point/ $^{\circ}\text{C}$ |
|----------------|-----------------------------------|
| lead(II) oxide | 886                               |
| carbon dioxide | -56                               |

Use your knowledge of structure and bonding to explain why lead(II) oxide has a much higher melting point than carbon dioxide.

Your answer should refer to:

- the types of particles involved
- the relative strength of the forces of attraction between the particles.

.....

.....

.....

..... [3]

(g) Part of the reactivity series is shown.

|           |                |
|-----------|----------------|
| magnesium | most reactive  |
| lead      | ↑              |
| copper    | least reactive |

Aqueous lead(II) nitrate contains  $\text{Pb}^{2+}$  ions.

Two experiments are carried out.

In Experiment 1, magnesium is added to aqueous lead(II) nitrate.

In Experiment 2, copper is added to aqueous lead(II) nitrate.

Write an ionic equation for any reaction that occurs in each experiment. If no reaction occurs write 'no reaction'.

Experiment 1 .....

Experiment 2 .....

[2]

(h) When lead(II) nitrate is heated it decomposes to produce the same gaseous products as when copper(II) nitrate is heated.

(i) One of the gaseous products is oxygen.

Describe a test for oxygen.

test .....

observations .....

[2]

(ii) Name the other gaseous product.

..... [1]

[Total: 16]

4 Carbon is an important element.

(a) Carbon exists as the isotopes  $^{12}_6\text{C}$  and  $^{13}_6\text{C}$ .

Complete the table.

| isotope           | number of protons<br>in one atom | number of electrons<br>in one atom | number of neutrons<br>in one atom |
|-------------------|----------------------------------|------------------------------------|-----------------------------------|
| $^{12}_6\text{C}$ |                                  |                                    |                                   |
| $^{13}_6\text{C}$ |                                  |                                    |                                   |

[2]

(b) Name **two** forms of the element carbon which have giant covalent structures.

..... and ..... [1]

(c) The Avogadro constant is the number of particles in 1 mole.

The numerical value of the Avogadro constant is  $6.02 \times 10^{23}$ .

(i) Calculate the number of molecules in 22.0 g of carbon dioxide,  $\text{CO}_2$ .

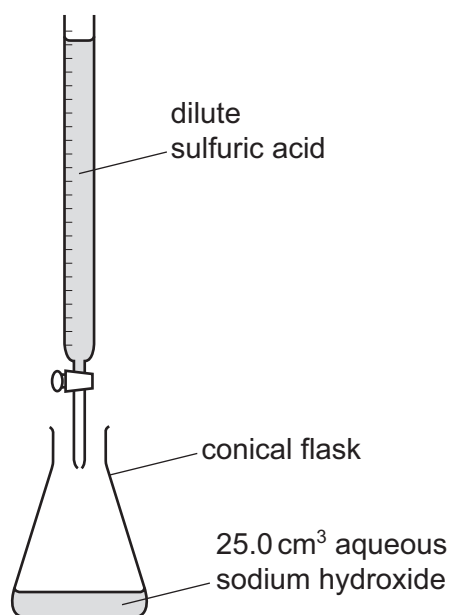
..... molecules [2]

(ii) Calculate the number of molecules in  $6.00 \text{ dm}^3$  of carbon dioxide gas at room temperature and pressure.

..... molecules [1]

[Total: 6]

- 5 (a) Dilute sulfuric acid and aqueous sodium hydroxide can be used to prepare sodium sulfate crystals using a method that involves titration.



- (i) Suggest why universal indicator is **not** suitable for this titration.

..... [1]

- (ii) Name an indicator that can be used in this titration.

..... [1]

20.0 cm<sup>3</sup> of dilute sulfuric acid neutralises 25.0 cm<sup>3</sup> of 1.00 mol/dm<sup>3</sup> aqueous sodium hydroxide. At the end of the titration the conical flask contains aqueous sodium sulfate with the dissolved indicator as an impurity.

- (b) Describe how to prepare a **pure** sample of sodium sulfate crystals from the original solutions of dilute sulfuric acid and aqueous sodium hydroxide of the same concentrations.

**You are not required to give details of how to carry out the titration.**

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]



- (c) Sodium hydrogensulfate,  $\text{NaHSO}_4$ , dissolves in water to produce an aqueous solution, **X**, containing  $\text{Na}^+$ ,  $\text{H}^+$  and  $\text{SO}_4^{2-}$  ions.

State the observations when the following tests are done.

- (i) A flame test is carried out on **X**.

..... [1]

- (ii) Copper(II) oxide is warmed with an excess of **X**.

.....

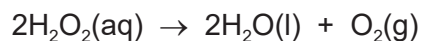
..... [2]

- (iii) Acidified aqueous barium nitrate is added to **X**.

..... [1]

[Total: 11]

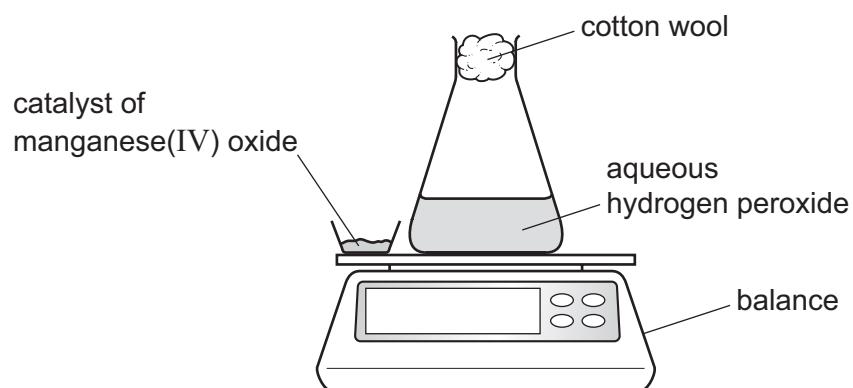
- 6 A student investigates the decomposition of hydrogen peroxide in the presence of a catalyst of manganese(IV) oxide.



- (a) State the meaning of the term *catalyst*.

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

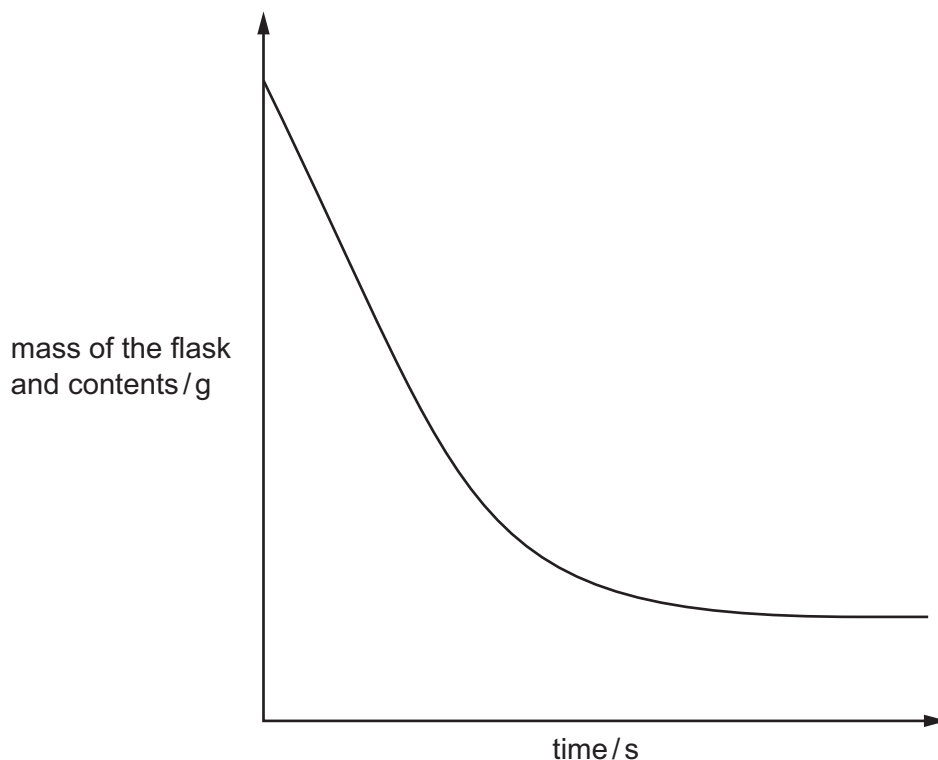
- (b) The diagram shows the equipment the student uses.



The student uses this method:

- the catalyst is added to the aqueous hydrogen peroxide
- the stop-clock is started
- the mass of the flask and contents is recorded at regular time intervals.

A graph of the mass of the flask and contents against time is shown.



- (i) Suggest why the mass of the flask and contents decreases as time increases.

..... [1]

- (ii) Describe what happens to the rate of the reaction as time increases.

.....

..... [2]

- (c) The student repeats the experiment at a higher temperature. All other conditions stay the same. The rate of reaction increases.

- (i) Explain, in terms of collisions between particles, why the rate of reaction increases at a higher temperature.

.....

.....

.....

..... [3]

- (ii) Draw a line on the graph in (b) for the experiment at a higher temperature. [2]

[Total: 10]

- 7 (a) Ethanol is a member of the homologous series of alcohols.

Give **two** characteristics of members of a homologous series.

1 .....

2 ..... [2]

- (b) Ethanol can be manufactured from ethene.

Ethene can be made from long chain hydrocarbons such as decane,  $C_{10}H_{22}$ .

Ethene is then converted into ethanol.

- (i) Name the process used to obtain ethene from long chain hydrocarbons such as decane,  $C_{10}H_{22}$ .

..... [1]

- (ii) Complete the chemical equation to show the formation of ethene from decane,  $C_{10}H_{22}$ .



- (iii) Write the chemical equation for the conversion of ethene into ethanol.

..... [1]

- (iv) Name the type of reaction occurring when ethene is converted into ethanol.

..... [1]

- (v) Give **one** condition for the reaction in which ethene is converted into ethanol.

..... [1]

- (c) Ethanol can also be produced by fermentation of carbohydrates such as glucose.

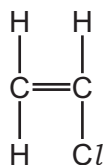
Give **two** advantages of manufacturing ethanol by fermentation compared to manufacturing ethanol from ethene.

1 .....

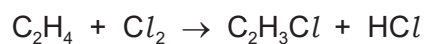
2 ..... [2]

- (d) (i) Under certain conditions ethene can react with chlorine to produce chloroethene.

The structure of chloroethene is shown.



The equation for the chemical reaction is shown.



State the type of chemical reaction between ethene and chlorine that this equation shows.

..... [1]

- (ii) Chloroethene monomers can be converted into a polymer called poly(chloroethene).

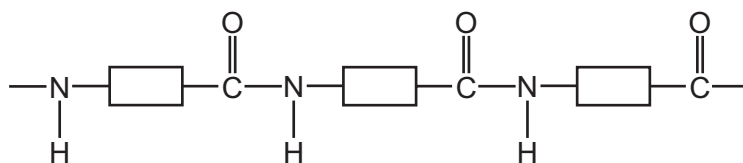
State the type of polymerisation that produces poly(chloroethene) from chloroethene.

..... [1]

- (iii) Draw a section of the poly(chloroethene) molecule made from **two** monomer molecules.

[2]

(e) The structure of part of a polymer is shown.



This polymer is made from one type of monomer only.

Complete the diagram to show the structure of the monomer used to produce this polymer. Show all of the atoms and all of the bonds in the functional groups.



[2]

[Total: 16]

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The Periodic Table of Elements

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