



# Cambridge IGCSE™

CANDIDATE  
NAME

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NUMBER

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**CHEMISTRY**

**0620/32**

Paper 3 Theory (Core)

**February/March 2022**

**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.

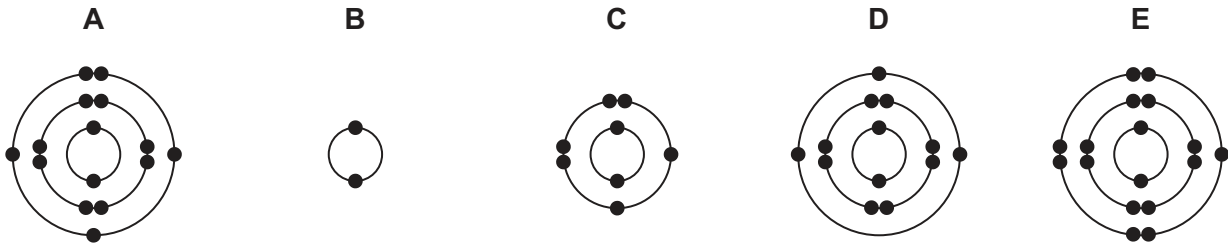
## INFORMATION

- 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) The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



Answer the following questions about these electronic structures.  
Each electronic structure may be used once, more than once or not at all.

State which electronic structure, **A**, **B**, **C**, **D** or **E**, represents:

(i) an atom in Group V of the Periodic Table

..... [1]

(ii) an atom which contains only two shells of electrons

..... [1]

(iii) an atom that forms a stable ion with a charge of 2-

..... [1]

(iv) an atom of an element that exists as a monoatomic gas

..... [1]

(v) an atom of the metal that is extracted from bauxite.

..... [1]

(b) Complete the table to show the number of electrons, neutrons and protons in the uranium atom and rubidium ion shown.

|                           | number of electrons | number of neutrons | number of protons |
|---------------------------|---------------------|--------------------|-------------------|
| ${}_{92}^{235}\text{U}$   | 92                  |                    |                   |
| ${}_{37}^{87}\text{Rb}^+$ |                     | 50                 |                   |

[3]

[Total: 8]

- 2 (a) Biogas is a mixture of gases produced when agricultural waste is broken down in the absence of oxygen.

The table compares the percentage by mass of the gases present in two samples of biogas, **X** and **Y**.

| gas              | biogas <b>X</b><br>/% by mass | biogas <b>Y</b><br>/% by mass |
|------------------|-------------------------------|-------------------------------|
| carbon dioxide   | 26                            | 32                            |
| hydrogen         | 1                             | 1                             |
| hydrogen sulfide | 0.5                           | 0.5                           |
| methane          | 67                            | 56                            |
| nitrogen         | 4                             | 9.5                           |
| oxygen           | 0.5                           | 0.5                           |
| other gases      |                               | 0.5                           |

Answer these questions using only the information in the table.

- (i) Deduce the percentage by mass of the other gases in biogas **X**.

..... [1]

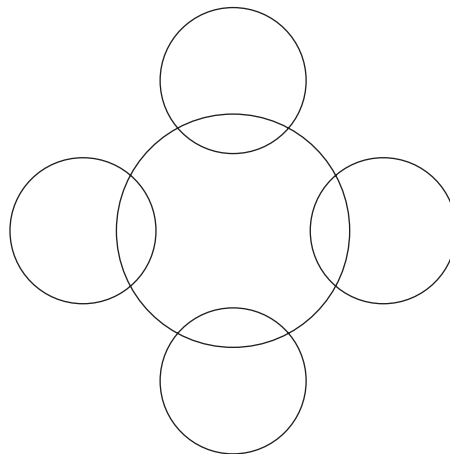
- (ii) Describe **two** major differences in the compositions of biogas **X** and biogas **Y**.

1 .....

2 .....

[2]

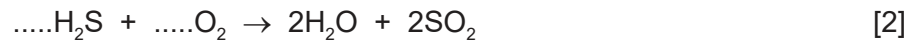
- (b) Complete the diagram to show the electronic structure in a methane molecule. Show only the outer shell electrons.



[1]

(c) Hydrogen sulfide burns in air to produce sulfur dioxide and water.

(i) Complete the chemical equation for this reaction.



(ii) Explain how this equation shows that hydrogen sulfide is oxidised.

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

[Total: 7]

3 This question is about metals.

(a) State **three** general physical properties common to most metals.

- 1 .....
- 2 .....
- 3 ..... [3]

(b) Metals are often used in the form of alloys.

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

..... [1]

(ii) Explain in terms of their properties why alloys are used instead of pure metals.

..... [1]

(iii) Stainless steel is an alloy.

Give **one** use of stainless steel.

..... [1]

(c) Place these metals in order of their reactivity with oxygen.

**copper**  
**magnesium**  
**potassium**  
**zinc**

Put the least reactive metal first.

least reactive  $\longrightarrow$  most reactive

|  |  |  |  |
|--|--|--|--|
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[2]

- (d) When 4.8 g of magnesium reacts with excess oxygen, 8.0 g of magnesium oxide is formed.  
Calculate the minimum mass of magnesium needed to produce 24.0 g of magnesium oxide.

minimum mass = ..... g [1]

[Total: 9]

4 This question is about acids, bases and salts.

(a) Sodium hydroxide is a base.

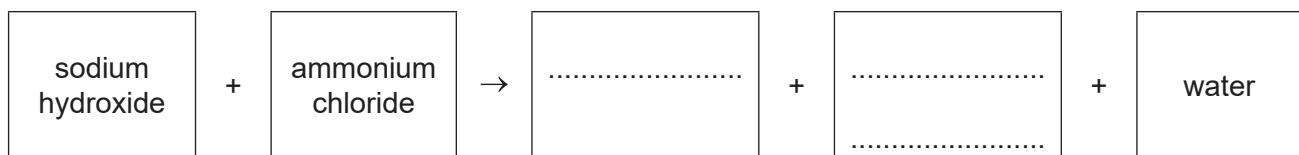
(i) Name the products formed when sodium hydroxide reacts with dilute nitric acid.

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

(ii) Describe the effect of sodium hydroxide on a named indicator.

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

(iii) Complete the word equation for the reaction of sodium hydroxide with ammonium chloride.



[2]

(b) Describe how to prepare pure, dry crystals of the salt zinc sulfate from an aqueous solution of zinc sulfate.

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

- (c) The rate of reaction of zinc powder with dilute sulfuric acid is found by measuring the increase in volume of hydrogen gas produced as time increases.

Describe the effect, if any, of each of the following on the rate of this reaction.

- The reaction is carried out with large pieces of zinc instead of zinc powder.

All other conditions stay the same.

.....

- The reaction is carried out using a catalyst.

All other conditions stay the same.

.....

- The reaction is carried out with dilute sulfuric acid of a lower concentration.

All other conditions stay the same.

.....

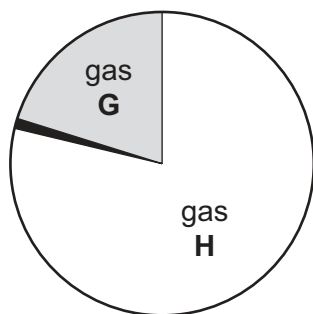
[3]

[Total: 11]



5 This question is about air.

(a) The pie chart shows the proportions of the main gases in clean, dry air.



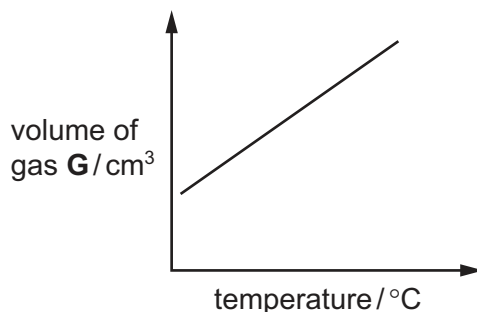
(i) Name the gases **G** and **H**.

gas **G** .....

gas **H** .....

[2]

(ii) The graph shows how the volume of a sample of gas **G** changes as temperature increases. The pressure is kept constant.



Describe how the volume of gas **G** changes as temperature increases.

..... [1]

(iii) There is a small percentage of noble gases in the air. The noble gases are unreactive.

Explain why the noble gases are unreactive in terms of their electronic structure.

..... [1]

(iv) Describe the arrangement and separation of the particles in a gas.

arrangement .....

separation .....

[2]

(b) Two of the pollutants in air are oxides of nitrogen and lead compounds.

(i) Give **one** effect of each of these pollutants on health.

oxides of nitrogen .....

lead compounds .....

[2]

(ii) Name **two** other pollutants present in air.

State the source of each of these pollutants.

pollutant 1 .....

source of pollutant 1 .....

pollutant 2 .....

source of pollutant 2 .....

[4]

[Total: 12]

6 The table shows some properties of four Group I elements.

| element   | melting point /°C | boiling point /°C | relative hardness |
|-----------|-------------------|-------------------|-------------------|
| lithium   | 181               | 1342              | .....             |
| sodium    | 98                | .....             | 0.70              |
| potassium | 63                | 760               | 0.36              |
| rubidium  | 39                | 686               | 0.22              |

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

- the boiling point of sodium
- the relative hardness of lithium.

[2]

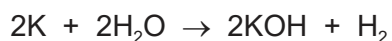
(ii) Predict the physical state of lithium at 200 °C.

Give a reason for your answer.

.....

..... [2]

(b) Potassium reacts with water.



Describe **two** observations when potassium reacts with water.

1 .....

2 .....

[2]

(c) Lithium is extracted by the electrolysis of molten lithium chloride.

(i) Name a non-metal used to make the electrodes.

..... [1]

(ii) Give one property, **other** than the conduction of electricity, that makes this substance suitable for use as an electrode.

..... [1]

(iii) State the products of the electrolysis of molten lithium chloride at:

the negative electrode (cathode) .....

the positive electrode (anode). .....

[2]

(d) Lithium chloride conducts electricity when molten and when in aqueous solution.

Give two **other** physical properties of lithium chloride that show it is an ionic compound.

1 .....

2 .....

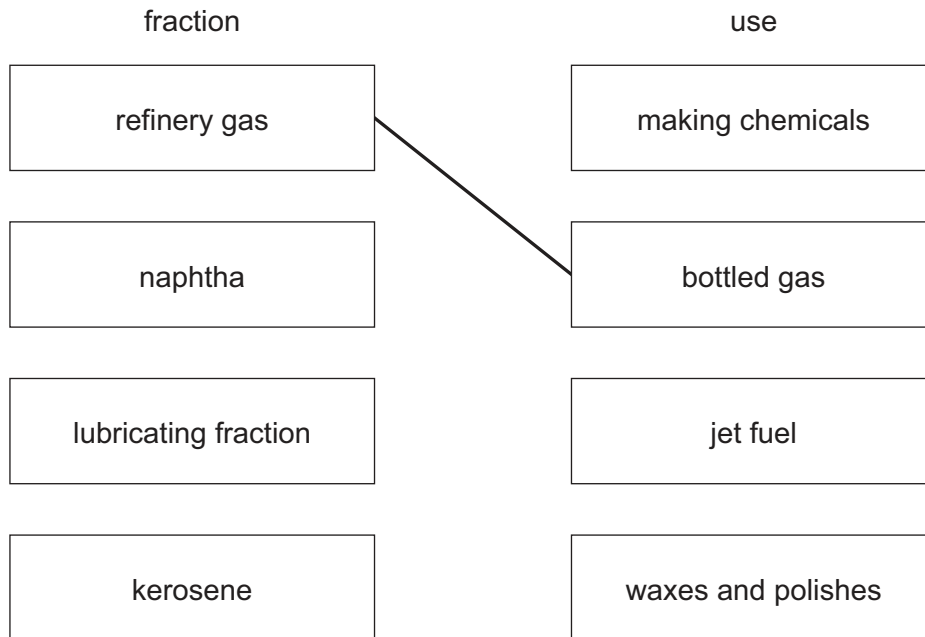
[2]

[Total: 12]



(c) Link each petroleum fraction on the left to its use on the right.

The first one has been done for you.



[2]

[Total: 9]

8 This question is about chlorine and compounds of chlorine.

(a) Chlorine is an element in Group VII of the Periodic Table.

State the meaning of the term *element*.

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

(b) State **one** use of chlorine.

..... [1]

(c) Chlorine reacts with phosphorus to produce phosphorus(V) chloride.

(i) Balance the equation for this reaction.



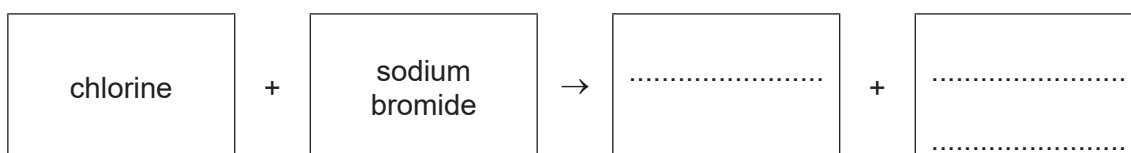
(ii) This reaction is exothermic.

State the meaning of the term *exothermic*.

..... [1]

(d) Chlorine reacts with aqueous sodium bromide.

(i) Complete the word equation for this reaction.



[2]

(ii) Describe a test for bromide ions.

test .....

observations .....

[2]

(iii) When bromine is mixed with aqueous sodium chloride there is no reaction.

Suggest in terms of chemical reactivity why there is no reaction.

..... [1]

(e) A compound of chlorine has the formula  $C_3H_6Cl_2$ .

Complete the table to calculate the relative molecular mass of  $C_3H_6Cl_2$ .

| atom     | number of atoms | relative atomic mass |                    |
|----------|-----------------|----------------------|--------------------|
| carbon   | 3               | 12                   | $3 \times 12 = 36$ |
| hydrogen |                 | 1                    |                    |
| chlorine |                 | 35.5                 |                    |

relative molecular mass = ..... [2]

[Total: 12]







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## The Periodic Table of Elements

|                                   |                                    | Group  |                                     |                                       |                                      |                                      |                                    |                                  |                                    |                                     |                                     |                                 |
|-----------------------------------|------------------------------------|--|-------------------------------------|---------------------------------------|--------------------------------------|--------------------------------------|------------------------------------|----------------------------------|------------------------------------|-------------------------------------|-------------------------------------|---------------------------------|
| I                                 | II                                 | III  | IV                                  | V                                     | VI                                   | VII                                  | VIII                               |                                  |                                    |                                     |                                     |                                 |
| 3<br><b>Li</b><br>lithium<br>7    | 4<br><b>Be</b><br>beryllium<br>9   | 1<br><b>H</b><br>hydrogen<br>1   | 5<br><b>B</b><br>boron<br>11        | 6<br><b>C</b><br>carbon<br>12         | 7<br><b>N</b><br>nitrogen<br>14      | 8<br><b>O</b><br>oxygen<br>16        | 9<br><b>F</b><br>fluorine<br>19    | 10<br><b>Ne</b><br>neon<br>20    |                                    |                                     |                                     |                                 |
| 11<br><b>Na</b><br>sodium<br>23   | 12<br><b>Mg</b><br>magnesium<br>24 | <b>Key</b><br>atomic number<br>atomic symbol<br>name<br>relative atomic mass |                                     |                                       |                                      |                                      |                                    |                                  |                                    |                                     |                                     |                                 |
| 19<br><b>K</b><br>potassium<br>39 | 20<br><b>Ca</b><br>calcium<br>40   | 26<br><b>Fe</b><br>iron<br>56  | 27<br><b>Co</b><br>cobalt<br>59     | 28<br><b>Ni</b><br>nickel<br>59       | 29<br><b>Cu</b><br>copper<br>64      | 30<br><b>Zn</b><br>zinc<br>65        | 31<br><b>Al</b><br>aluminium<br>27 | 32<br><b>Si</b><br>silicon<br>28 | 33<br><b>P</b><br>phosphorus<br>31 | 34<br><b>S</b><br>sulfur<br>32      | 35<br><b>Cl</b><br>chlorine<br>35.5 | 36<br><b>Ar</b><br>argon<br>40  |
| 37<br><b>Rb</b><br>rubidium<br>85 | 38<br><b>Sr</b><br>strontium<br>88 | 44<br><b>Ru</b><br>ruthenium<br>101  | 45<br><b>Rh</b><br>rhodium<br>103   | 46<br><b>Pd</b><br>palladium<br>106   | 47<br><b>Ag</b><br>silver<br>108     | 48<br><b>Cd</b><br>cadmium<br>112    | 13<br><b>Al</b><br>aluminium<br>27 | 14<br><b>Si</b><br>silicon<br>28 | 15<br><b>P</b><br>phosphorus<br>31 | 16<br><b>S</b><br>sulfur<br>32      | 17<br><b>Cl</b><br>chlorine<br>35.5 | 18<br><b>Ar</b><br>argon<br>40  |
| 55<br><b>Cs</b><br>caesium<br>133 | 56<br><b>Ba</b><br>barium<br>137   | 76<br><b>Os</b><br>osmium<br>190   | 77<br><b>Ir</b><br>iridium<br>192   | 78<br><b>Pt</b><br>platinum<br>195    | 79<br><b>Au</b><br>gold<br>197       | 80<br><b>Hg</b><br>mercury<br>201    | 49<br><b>In</b><br>indium<br>115   | 50<br><b>Sn</b><br>tin<br>119    | 51<br><b>Sb</b><br>antimony<br>122 | 52<br><b>Te</b><br>tellurium<br>128 | 53<br><b>I</b><br>iodine<br>127     | 54<br><b>Xe</b><br>xenon<br>131 |
| 87<br><b>Fr</b><br>francium<br>—  | 88<br><b>Ra</b><br>radium<br>—     | 108<br><b>Hs</b><br>hassium<br>—   | 109<br><b>Mt</b><br>meitnerium<br>— | 110<br><b>Ds</b><br>darmstadtium<br>— | 111<br><b>Rg</b><br>roentgenium<br>— | 112<br><b>Cn</b><br>copernicium<br>— | 81<br><b>Tl</b><br>thallium<br>204 | 82<br><b>Pb</b><br>lead<br>207   | 83<br><b>Bi</b><br>bismuth<br>209  | 84<br><b>Po</b><br>polonium<br>—    | 85<br><b>At</b><br>astatine<br>—    | 86<br><b>Rn</b><br>radon<br>—   |

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

lanthanoids

actinoids

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