Cambridge IGCSE

**Cambridge International Examinations**
Cambridge International General Certificate of Secondary Education

| | |
|---|---|
| CANDIDATE NAME | |
| CENTRE NUMBER | |
| CANDIDATE NUMBER | |

*3868593465*

**CHEMISTRY** **0620/32**

Paper 3 Theory (Core) **May/June 2018**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **16** printed pages.


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**1** The names of nine gases are given.

**ammonia**
**carbon monoxide**
**chlorine**
**ethane**
**ethene**
**helium**
**hydrogen**
**neon**
**oxygen**

**(a)** Answer the following questions about these gases.
Each gas may be used once, more than once or not at all.
State which gas:

**(i)** bleaches damp litmus paper

..... [1]

**(ii)** dissolves in water to form an alkali

..... [1]

**(iii)** is a monatomic gas with ten protons in its nucleus

..... [1]

**(iv)** is formed when hydrocarbons undergo incomplete combustion

..... [1]

**(v)** is an unsaturated hydrocarbon.

..... [1]

**(b)** Diatomic hydrogen molecules contain covalent bonds.

State what is meant by the terms:

**(i)** *diatomic* .....

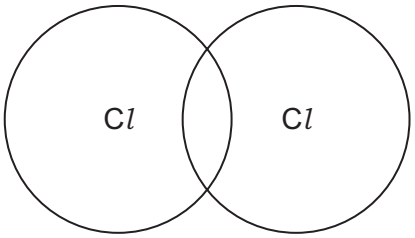
..... [1]

**(ii)** *covalent bonds* .....

..... [1]

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**(c)** Complete the dot-and-cross diagram to show the electron arrangement in a molecule of chlorine. Show outer shell electrons only.




[2]

[Total: 9]

**2** The table shows the percentage by volume of each of the gases present in the exhaust gases from a petrol engine with a catalytic converter.

| name | percentage by volume |
|---|---|
| carbon monoxide | 0.20 |
| carbon dioxide | 15.00 |
| hydrocarbons | 0.02 |
| hydrogen | 0.01 |
| nitrogen | |
| oxides of nitrogen | 0.02 |
| water vapour | 12.75 |
| | total 100.00 |

**(a) (i)** Calculate the percentage by volume of nitrogen in the exhaust gases.

.....% [1]

**(ii)** Which gas shown in the table is present in the lowest percentage by volume?

..... [1]

**(b) (i)** Give **one** adverse effect of oxides of nitrogen on health.

..... [1]

**(ii)** Balance the chemical equation for the reaction of nitrogen dioxide with sodium hydroxide.

$$.....NO_2 + .....NaOH \rightarrow NaNO_3 + NaNO_2 + H_2O$$ [2]

**(iii)** State the name of the salt with the formula $NaNO_3$.

..... [1]

**(c)** Petrol contains saturated hydrocarbons.

State what is meant by the terms:

**(i)** *saturated* .....

..... [1]

**(ii)** *hydrocarbon* .....

..... [2]

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**(d)** The table shows the composition of a sample of dry natural gas.

| name of gas | percentage by volume |
|---|---|
| methane | 95.0 |
| ethane | 3.2 |
| propane | 0.2 |
| butane | 0.1 |
| carbon dioxide | 0.5 |
| nitrogen | 1.0 |
| | total 100.0 |

Calculate the percentage by volume of hydrocarbons in the sample of dry natural gas.

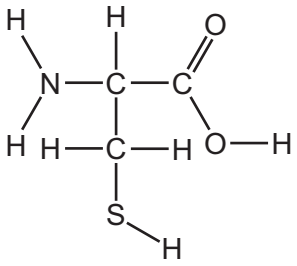
.....% [1]

[Total: 10]

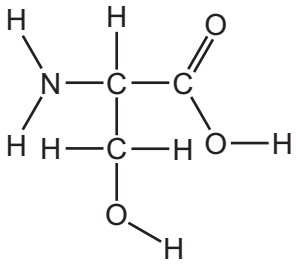
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**[Turn over**

**3** **(a)** The structures of two compounds, **A** and **B**, are shown.



compound **A**



compound **B**

**(i)** How many different types of atoms are present in compound **A**?

..... [1]

**(ii)** On structure **B** draw a circle around the alcohol functional group. [1]

**(iii)** Compounds **A** and **B** are formed in the body by enzyme-catalysed reactions.

What is the purpose of a catalyst?

..... [1]

**(iv)** Enzymes are polymers of compounds called amino acids.

What is meant by the term *polymer*?

.....

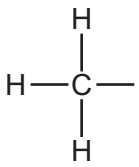
..... [1]

**(b)** Ethanoic acid is a carboxylic acid.

**(i)** Give **one** property of ethanoic acid.

..... [1]

**(ii)** Complete the structure of ethanoic acid showing all of the atoms and all of the bonds.



[1]

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**(c)** Ethanoic acid can be made by the oxidation of ethanol.

**(i)** The melting point of ethanol is –114 °C.
The boiling point of ethanol is 78 °C.

What is the physical state of ethanol at –120 °C?
Explain your answer.

.....

..... [2]

**(ii)** Complete the sentences about the manufacture of ethanol using words from the list.

**a catalyst** **addition** **an enzyme** **cracking**

**ethane** **ethene** **high** **low**

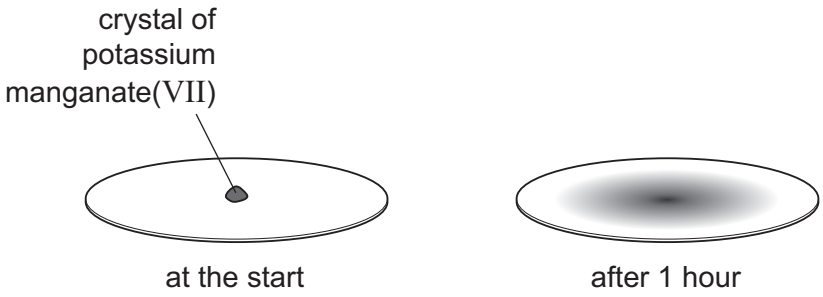
Ethanol can be manufactured by the ..... of steam to ..... .

The reaction takes place at a ..... temperature in the presence of ..... . [4]

[Total: 12]

**4** This question is about manganese and its compounds.

**(a)** Potassium manganate(VII) is soluble in water.
A purple crystal of potassium manganate(VII) was placed in the middle of a piece of damp filter paper.
After 1 hour, the purple colour had spread over most of the filter paper.




Explain these observations using the kinetic particle model.

.....

.....

.....

.....

..... [3]

**(b)** Potassium manganate(VII) is produced from manganese(IV) oxide by an oxidation reaction.

What is meant by the term *oxidation*?

.....

..... [1]

**(c)** Potassium manganate(VII) decomposes when heated. The products are oxygen and manganese(IV) oxide.

**(i)** Describe a test for oxygen.

test .....

result .....
[2]

**(ii)** Manganese(IV) oxide reacts with concentrated hydrochloric acid.

Balance the chemical equation for this reaction.

$$MnO_2 + ....HCl \rightarrow MnCl_2 + Cl_2 + ....H_2O$$

[2]

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**(d)** The table compares the reactivity of four metals with hydrochloric acid of the same concentration.

| metal | reactivity with hydrochloric acid |
|---|---|
| lead | No bubbles seen. Metal does **not** disappear. |
| magnesium | Rapid formation of bubbles. Metal disappears rapidly. |
| manganese | Steady formation of bubbles. Metal disappears slowly. |
| tin | Bubbles formed slowly. Metal disappears very slowly. |

Use this information to put the metals in order of their reactivity. Put the least reactive metal first.

least reactive → most reactive

| | | | |
|---|---|---|---|
| | | | |

[2]

**(e)** Manganese is a transition element. Sodium is an element in Group I of the Periodic Table.

Describe **three** ways in which the properties of manganese differ from those of sodium.

1 .....

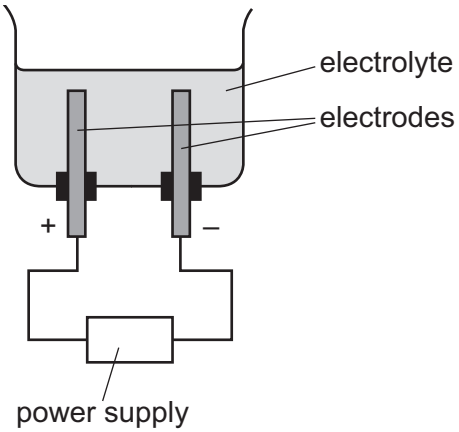
2 .....

3 .....

[3]

[Total: 13]

**5** **(a)** Electrolysis of concentrated aqueous sodium chloride can be done using the apparatus shown.




**(i)** During electrolysis, a gas is produced at each electrode.

Complete the diagram to show how the gases can be collected. [1]

**(ii)** The positive electrode is called the anode.

State the name of the negative electrode.

..... [1]

**(iii)** Predict the main products of the electrolysis of concentrated aqueous sodium chloride at:

the negative electrode .....

the positive electrode. .....
[2]

**(iv)** Give the name of a suitable element to use as the electrodes in this electrolysis.

..... [1]

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**(b)** Sodium hydroxide is manufactured by the electrolysis of sodium chloride.

**(i)** After electrolysis, 1000 $cm^3$ of solution contains 750 g of sodium hydroxide.

What mass of sodium hydroxide is present in 200 $cm^3$ of this solution?

..... [1]

**(ii)** What effect would impurities have on the melting point of sodium hydroxide?

..... [1]

**(c)** Describe how you could prepare a sample of solid sodium chloride from a solution of sodium chloride.

..... [1]

[Total: 8]

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**[Turn over**

**6** This question is about isotopes.

**(a)** An atom of an isotope of nitrogen is represented by the symbol shown.

$$^{15}_{7}N$$

Describe the structure of an atom of this isotope of nitrogen.
In your answer, include:

- the position of the protons, neutrons and electrons in the atom
- the number of protons, neutrons and electrons present in the atom.

.....

.....

.....

.....

.....

.....

..... [5]

**(b)** What is meant by the term *isotopes*?

.....

.....

..... [2]

**(c)** Give **one** industrial use of radioactive isotopes.

..... [1]

[Total: 8]

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**7** **(a)** The properties of some Group VII elements are shown in the table.

| element | melting point in °C | boiling point in °C | density at room temperature in g / cm$^3$ | colour |
|---|---|---|---|---|
| chlorine | –101 | –35 | 0.0032 | green |
| bromine | –7 | 59 | 3.1 | red-brown |
| iodine | 114 | 184 | | grey-black |
| astatine | | 337 | 6.4 | |

**(i)** Complete the table to suggest:
- the density of iodine
- the melting point of astatine
- the colour of astatine.

[3]

**(ii)** Suggest why the density of chlorine at room temperature is much lower than the density of bromine and astatine at room temperature.

.....

..... [1]

**(iii)** Describe the trend in the boiling points of the halogens.

..... [1]

**(b)** Aqueous bromine reacts with aqueous potassium iodide.

Complete the word equation for this reaction.

| bromine | + | potassium iodide | → | ..... | + | ..... ..... |
|---|---|---|---|---|---|---|

[2]

**(c)** A compound has the formula $C_2F_4Cl_2$.

Calculate the relative molecular mass of $C_2F_4Cl_2$.
Show all your working.
Use your Periodic Table to help you.

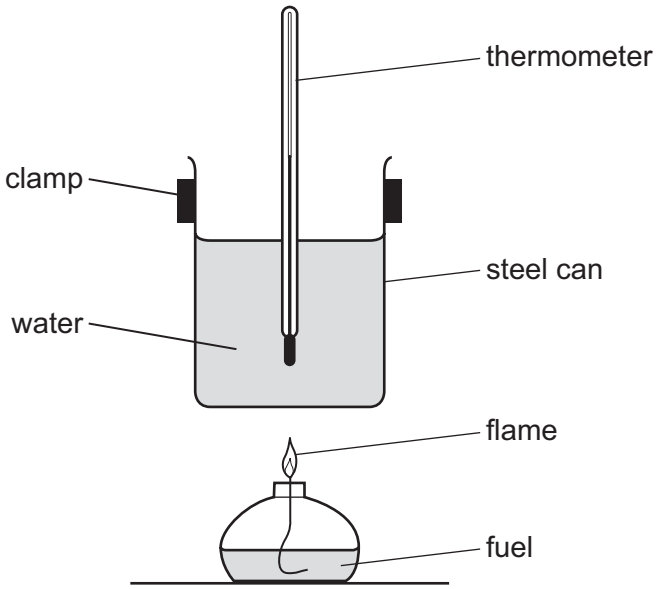
relative molecular mass = ..... [2]

[Total: 9]

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**[Turn over**

**8** The energy released by burning four different fuels is compared using the apparatus shown. A known mass of each fuel is burned and the temperature rise of the water is measured.




**(a)** Suggest **two** factors that should be kept constant in this experiment.

1 .....

2 .....
[2]

**(b)** The table shows the temperature changes when four different fuels, **A**, **B**, **C** and **D**, are burned.

| fuel | mass of fuel burned / g | initial temperature of the water / °C | final temperature of the water / °C |
|---|---|---|---|
| **A** | 2 | 20 | 30 |
| **B** | 1 | 18 | 24 |
| **C** | 4 | 21 | 37 |
| **D** | 2 | 20 | 28 |

Which fuel gave the greatest temperature rise per gram?

..... [1]

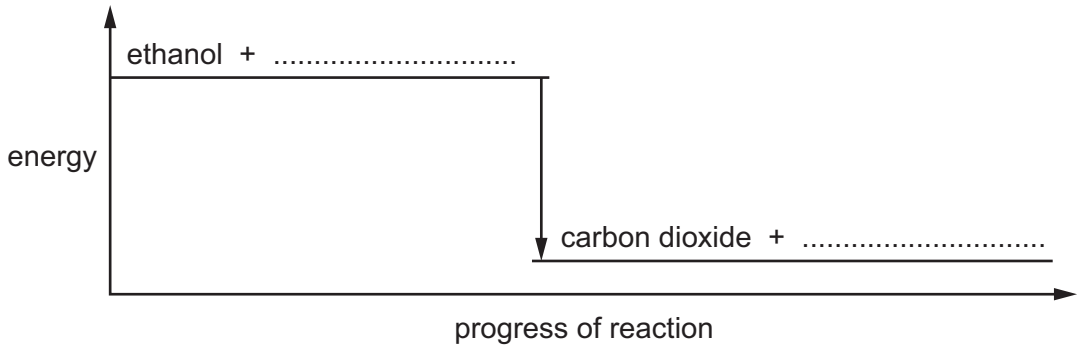
**(c)** Ethanol is a fuel.

Give **one** other use of ethanol.

..... [1]

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**(d)** The energy level diagram for the complete combustion of ethanol is shown.




**(i)** Complete the diagram by filling in the missing reactant and the missing product. [2]

**(ii)** Is the complete combustion of ethanol exothermic or endothermic?
Use the information in the diagram to explain your answer.

.....

..... [1]

**(e)** A steel can is used in the experiment.

**(i)** Stainless steel is an alloy of iron.

What is meant by the term *alloy*?

.....

..... [1]

**(ii)** Describe the arrangement and type of motion of the particles in solid iron.

arrangement .....

type of motion .....
[2]

**(iii)** Suggest why stainless steel is used instead of pure iron for making cutlery.

.....

..... [1]

[Total: 11]

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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.).