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

**CHEMISTRY** **0620/11**

Paper 1 Multiple Choice (Core) **October/November 2019**

**45 minutes**

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

*5634656915*

**READ THESE INSTRUCTIONS FIRST**

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

**Read the instructions on the Answer Sheet very carefully.**

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 16.
Electronic calculators may be used.



This syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level1/Level 2 Certificate.

This document consists of **14** printed pages and **2** blank pages.

**1** The diagram shows a cup of hot tea.

Which row describes the water particles in the air above the cup compared with the water particles in the cup?

| | moving faster | closer together |
|---|---|---|
| **A** | ✓ | ✗ |
| **B** | ✓ | ✓ |
| **C** | ✗ | ✗ |
| **D** | ✗ | ✓ |

**2** A student is asked to measure the time taken for 0.4 g of magnesium carbonate to react completely with 25.0 $cm^3$ of dilute hydrochloric acid.

Which pieces of apparatus does the student need?

**A** balance, stop-clock, pipette

**B** balance, stop-clock, thermometer

**C** balance, pipette, thermometer

**D** stop-clock, pipette, thermometer

**3** A fractionating column is used to separate the hydrocarbon fractions in petroleum by fractional distillation.

Which row describes the properties of the fractions that condense at the top of the fractionating column?

| | size of molecule | boiling point |
|---|---|---|
| **A** | large | high |
| **B** | large | low |
| **C** | small | high |
| **D** | small | low |

**4** Some information about solid silver chloride and solid sodium chloride is shown.

- Silver chloride and sodium chloride do not dissolve in kerosene.
- Silver chloride is insoluble in water but sodium chloride is soluble in water.
- The boiling point of silver chloride is 1547 °C and the boiling point of sodium chloride is 1413 °C.

Which processes are used to separate a mixture of solid silver chloride and solid sodium chloride?

**A** Add kerosene, stir and then filter.

**B** Add water, stir and then filter.

**C** Add water, stir and then leave to crystallise.

**D** Add water, stir and then perform fractional distillation.

**5** A covalent molecule M contains four shared pairs of electrons.

What is M?

**A** ammonia, $NH_3$

**B** hydrogen chloride, $HCl$

**C** methane, $CH_4$

**D** water, $H_2O$

**6** An isotope of chromium is represented by $^{52}_{24}Cr$ .

Which statement about an atom of this isotope of chromium is correct?

**A** It contains 24 electrons.

**B** It contains 24 neutrons.

**C** It contains 28 protons.

**D** It contains 52 neutrons.

**7** Substances P and Q both conduct electricity.

P is a mixture of two different types of atom.

Q is made of only one type of atom.

Which row describes P and Q?

| | P | Q |
|---|---|---|
| **A** | alloy | element |
| **B** | alloy | compound |
| **C** | compound | alloy |
| **D** | compound | element |

**8** Graphite is a form of carbon.

Why can graphite be used as a lubricant?

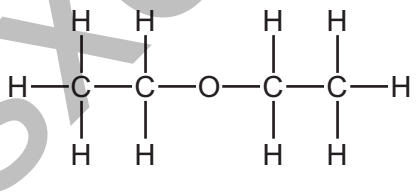
**A** Graphite contains unbonded electrons which move through the structure.

**B** Graphite contains weak covalent bonds so the atoms move easily.

**C** Graphite has a low melting point so it easily turns into a liquid.

**D** Graphite has weak attractive forces between layers so they can move.

**9** The structure of a molecule is shown.



What is the formula of the molecule?

**A** CHO **B** $C_2H_5O$ **C** $C_4H_8O$ **D** $C_4H_{10}O$

**10** During the electrolysis of concentrated hydrochloric acid, gases are produced at both electrodes.

Which statement describes the test result for the gas collected at the negative electrode?

**A** It bleaches damp litmus paper.

**B** It burns with a ‘pop’.

**C** It relights a glowing splint.

**D** It turns limewater milky.

**11** Which statements about endothermic reactions are correct?

1 The energy of the products is greater than the energy of the reactants.

2 The energy of the reactants is greater than the energy of the products.

3 The temperature of the surroundings increases during the reaction.

4 The temperature of the surroundings decreases during the reaction.

**A** 1 and 3 only **B** 1 and 4 only **C** 2 and 3 only **D** 2 and 4 only

**12** Equations for the formation of anhydrous cobalt(II) chloride and anhydrous copper(II) sulfate are shown.

$$CoCl_2 \cdot 6H_2O \rightarrow CoCl_2 + 6H_2O$$

$$CuSO_4 \cdot 5H_2O \rightarrow CuSO_4 + 5H_2O$$

Which statement about the reactions is **not** correct?

**A** Both reactions are exothermic.

**B** Both reactions are reversible.

**C** Hydrated cobalt(II) chloride changes colour from pink to blue.

**D** Hydrated copper(II) sulfate changes colour from blue to white.

**13** A method used to investigate the rate of reaction of calcium carbonate with dilute hydrochloric acid under different conditions is shown.

- Place 50 $cm^3$ of dilute hydrochloric acid in a conical flask.
- Add a known volume of water to the conical flask.
- Heat the conical flask to the required temperature.
- Add 1.0 g of calcium carbonate to the conical flask.
- Measure the time taken for the reaction to finish.

Which volume of water and which temperature gives the shortest time taken for the reaction to finish?

| | volume of water added / $cm^3$ | temperature / °C |
|---|---|---|
| **A** | 10 | 30 |
| **B** | 10 | 50 |
| **C** | 40 | 30 |
| **D** | 40 | 50 |

**14** Which is a chemical change?

**A** boiling water

**B** cooking an egg

**C** dissolving sugar

**D** melting ice cubes

**15** Mercury(II) oxide, HgO, decomposes when heated.

The equation is shown.

$$2HgO \rightarrow 2Hg + O_2$$

Why is this a reduction reaction?

**A** The products weigh less than the reactants.

**B** There are fewer reactants than products.

**C** There is a gain of oxygen.

**D** There is a loss of oxygen.

**16** Carbonic acid is a weak acid formed when carbon dioxide dissolves in water.

What is the pH of the solution?

**A** 1 **B** 5 **C** 7 **D** 9

**17** Solid X is tested as shown.

| reaction with dilute aqueous sodium hydroxide | flame test | reaction with dilute hydrochloric acid |
|---|---|---|
| no reaction | red flame | gas produced which turned limewater milky |

What is X?

**A** copper(II) carbonate

**B** lithium carbonate

**C** potassium carbonate

**D** sodium sulfate

**18** Which oxide is basic?

**A** carbon dioxide

**B** sodium oxide

**C** sulfur dioxide

**D** water

**19** A method used to make copper(II) sulfate crystals is shown.

1 Place dilute sulfuric acid in a beaker.

2 Warm the acid.

3 Add copper(II) oxide until it is in excess.

4 Filter the mixture.

5 Evaporate the filtrate until crystals start to form.

6 Leave the filtrate to cool.

What are the purposes of step 3 and step 4?

| | step 3 | step 4 |
|---|---|---|
| **A** | to ensure all of the acid has reacted | to obtain solid copper(II) sulfate |
| **B** | to ensure all of the acid has reacted | to remove the excess of copper(II) oxide |
| **C** | to speed up the reaction | to obtain solid copper(II) sulfate |
| **D** | to speed up the reaction | to remove the excess of copper(II) oxide |

**20** Which set of elements shows the change from metallic to non-metallic character across a period of the Periodic Table?

**A** beryllium → magnesium → calcium

**B** fluorine → bromine → iodine

**C** oxygen → boron → lithium

**D** sodium → silicon → chlorine

**21** Which pair of elements reacts together most violently?

**A** chlorine and lithium

**B** chlorine and potassium

**C** iodine and lithium

**D** iodine and potassium

**22** What is **not** a typical property of a transition element?

**A** acts as a catalyst

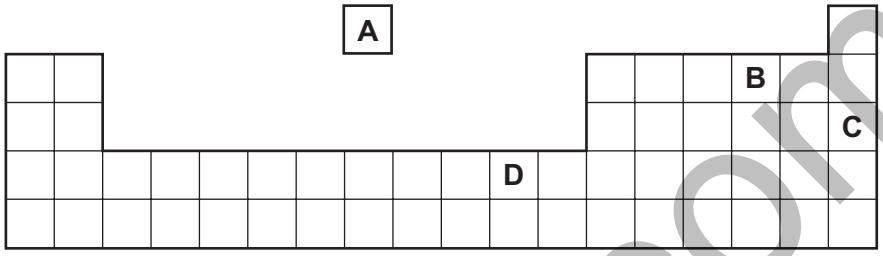
**B** forms coloured compounds

**C** has a high melting point

**D** has a low density

**23** Part of the Periodic Table is shown.

Which element is used to provide an inert atmosphere?




**24** Some properties of substance X are listed.

- It conducts electricity when molten.
- It has a high melting point.
- It burns in oxygen and the oxide dissolves in water to give a solution with pH 11.

What is X?

**A** a covalent compound

**B** a macromolecule

**C** a metal

**D** an ionic compound

**25** Four different metals are reacted with an equal volume of dilute hydrochloric acid. The results of the reactions are shown.

| metal | rate of effervescence |
|---|---|
| calcium | very high |
| copper | none |
| iron | low |
| magnesium | high |

What is the order of reactivity of the four metals starting with the most reactive?

**A** iron → magnesium → calcium → copper

**B** magnesium → calcium → copper → iron

**C** copper → iron → magnesium → calcium

**D** calcium → magnesium → iron → copper

**26** Iron is extracted from its ore in a blast furnace.

The equations for four different reactions are shown.

1 $4Fe + 3CO_2 \rightarrow 2Fe_2O_3 + 3C$

2 $CO_2 \rightarrow C + O_2$

3 $CO_2 + C \rightarrow 2CO$

4 $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Which equations represent reactions that occur in the blast furnace?

**A** 1 and 2 only **B** 1 and 3 only **C** 2 and 3 only **D** 3 and 4 only

**27** Which statement is correct?

**A** Aluminium is used in the manufacture of aircraft because it has a high density.

**B** Copper is used for cooking utensils because it is a good conductor of heat.

**C** Mild steel is used for car bodies because it is resistant to corrosion.

**D** Stainless steel is used for cutlery because it is a conductor of electricity.

**28** River water contains soluble impurities, insoluble impurities and bacteria.

River water is made safe to drink by filtration and chlorination.

Which statement is correct?

**A** Filtration removes bacteria and insoluble impurities, and chlorination removes soluble impurities.

**B** Filtration removes insoluble impurities, and chlorination kills the bacteria.

**C** Filtration removes soluble and insoluble impurities, and chlorination kills the bacteria.

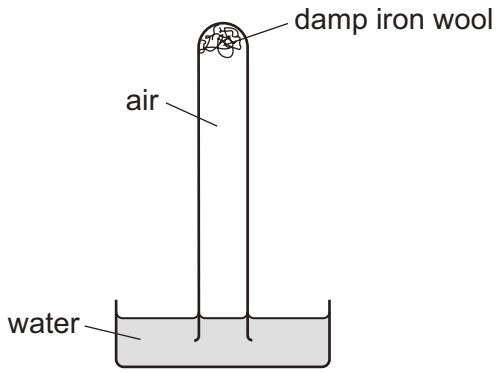
**D** Filtration removes soluble impurities and bacteria, and chlorination removes insoluble impurities.

**29** Clean, dry air contains nitrogen, oxygen and small amounts of other gases. The noble gases have been left out of the table.

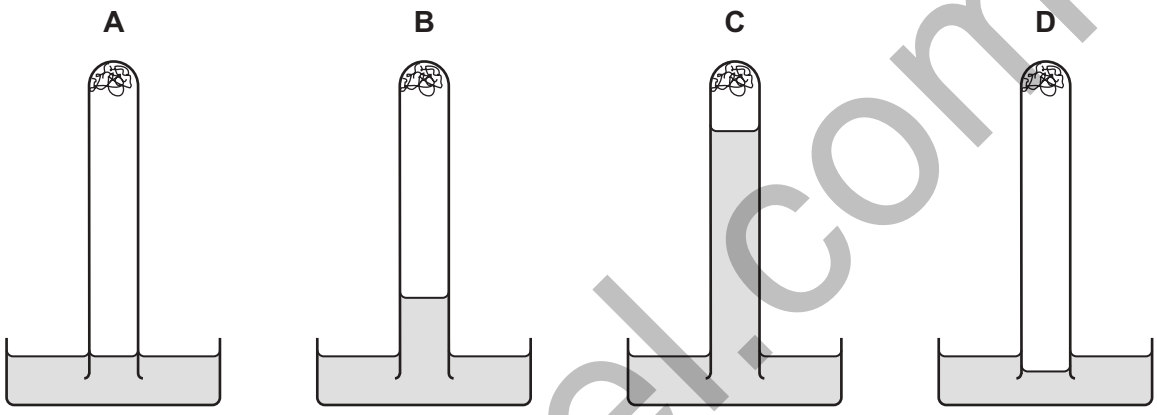
Which row shows the composition of clean, dry air?

| | nitrogen / % | oxygen / % | other gases |
|---|---|---|---|
| **A** | 21 | 78 | small amount of carbon dioxide |
| **B** | 21 | 78 | small amount of carbon monoxide |
| **C** | 78 | 21 | small amount of carbon dioxide |
| **D** | 78 | 21 | small amount of carbon monoxide |

**30** The apparatus shown is set up and left for a week.




Which diagram shows the level of the water at the end of the week?




**31** Farmers add calcium oxide (lime) and ammonium salts to their fields.

The compounds are not added at the same time because they react with each other.

Which gas is produced in this reaction?

**A** ammonia

**B** carbon dioxide

**C** hydrogen

**D** nitrogen

**32** Which information about carbon dioxide and methane is correct?

| | | carbon dioxide | methane |
|---|---|---|---|
| **A** | formed when vegetation decomposes | ✓ | ✗ |
| **B** | greenhouse gas | ✓ | ✓ |
| **C** | present in unpolluted air | ✗ | ✗ |
| **D** | produced during respiration | ✗ | ✓ |

key

✓ = true

✗ = false

**33** What is **not** a use of sulfur dioxide?

**A** as a bleach

**B** as a food preservative

**C** in the manufacture of wood pulp for paper

**D** treating acidic soils

**34** Which process is used to obtain lime from limestone?

**A** cracking

**B** fractional distillation

**C** neutralisation

**D** thermal decomposition

**35** Petroleum is separated by fractional distillation.

Which statement about the fractions produced is correct?

**A** Bottled gas for heating and cooking is obtained from the naphtha fraction.

**B** Diesel oil is used as a fuel for jet aircraft.

**C** Substances used to make polishes are obtained from the lubricating fraction.

**D** The kerosene fraction contains many useful waxes.

**36** Which compounds have similar chemical properties?

**A** butanol and butanoic acid

**B** ethane and ethene

**C** methane and butane

**D** propene and propanol

**37** Which statement about a molecule of ethane is correct?

**A** An ethane molecule has at least one double covalent bond.

**B** It has C–H and C–O bonds.

**C** An ethane molecule has seven covalent bonds.

**D** Its bonds are formed by the transfer of electrons.

**38** Which products are obtained by the cracking of an alkane?

| | alkene | hydrogen | water |
|---|---|---|---|
| **A** | ✓ | ✓ | ✓ |
| **B** | ✓ | ✓ | ✗ |
| **C** | ✓ | ✗ | ✓ |
| **D** | ✗ | ✓ | ✓ |

**39** Which statements about aqueous ethanoic acid are correct?

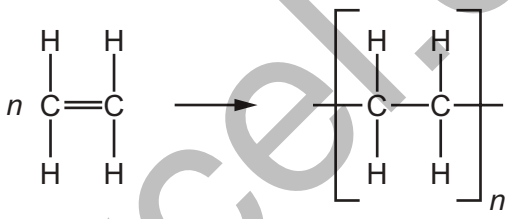
1 It has a pH value of 10.

2 It reacts with metal carbonates to produce carbon dioxide gas.

3 It reacts with magnesium metal to produce hydrogen gas.

**A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

**40** The diagram shows the structure of a monomer and of the polymer made from it.



What are the monomer and polymer?

| | monomer | polymer |
|---|---|---|
| **A** | ethane | poly(ethane) |
| **B** | ethane | poly(ethene) |
| **C** | ethene | poly(ethane) |
| **D** | ethene | poly(ethene) |

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## The Periodic Table of Elements

| Group I | Group II | | | | | | | | | | | Group III | Group IV | Group V | Group VI | Group VII | Group 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.).

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**CHEMISTRY** **0620/21**

Paper 2 Multiple Choice (Extended) **October/November 2019**

**45 minutes**

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**1** Samples of four gases are released in a room at the same time.

The gases are carbon dioxide, $CO_2$, hydrogen chloride, $HCl$, hydrogen sulfide, $H_2S$, and nitrogen dioxide, $NO_2$.

Which gas diffuses fastest?

**A** carbon dioxide

**B** hydrogen chloride

**C** hydrogen sulfide

**D** nitrogen dioxide

**2** A student is asked to measure the time taken for 0.4 g of magnesium carbonate to react completely with 25.0 $cm^3$ of dilute hydrochloric acid.

Which pieces of apparatus does the student need?

**A** balance, stop-clock, pipette

**B** balance, stop-clock, thermometer

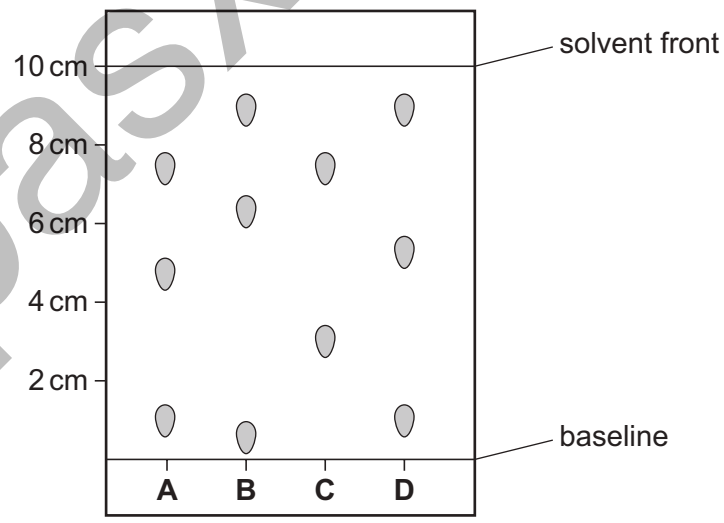
**C** balance, pipette, thermometer

**D** stop-clock, pipette, thermometer

**3** Four different food colourings are analysed using chromatography.

The results are shown on the chromatogram. The diagram is not drawn to scale.

Which food colouring contains a component with an $R_f$ value of 0.3?



**4** Which statement about an ionic compound is **not** correct?

**A** It conducts electricity when dissolved in water.

**B** It has a high melting point due to strong attractive forces between ions.

**C** It has a regular lattice of oppositely charged ions in a 'sea of electrons'.

**D** The ionic bonds are formed between metallic and non-metallic elements.

**5** An isotope of chromium is represented by $^{52}_{24}\mathrm{Cr}$.

Which statement about an atom of this isotope of chromium is correct?

**A** It contains 24 electrons.

**B** It contains 24 neutrons.

**C** It contains 28 protons.

**D** It contains 52 neutrons.

**6** Element X has two isotopes, $^{12}_{6}\mathrm{X}$ and $^{14}_{6}\mathrm{X}$.

Which statement about these isotopes is correct?

**A** They have different chemical properties because they have different numbers of neutrons.

**B** They have the same chemical properties because they have the same number of outer shell electrons.

**C** They have the same nucleon number because the sum of the number of protons and electrons is the same.

**D** They have different positions in the Periodic Table because they have different numbers of neutrons.

**7** How are the structures of diamond and silicon(IV) oxide similar?

**A** Molecules of both diamond and silicon(IV) oxide are held together by weak attractive forces.

**B** They both contain atoms arranged in planes held together by weak bonds.

**C** They both contain ions that are free to move.

**D** The carbon in diamond and the silicon in silicon(IV) oxide each have four covalent bonds.

**8** Which statement describes the structure of copper?

**A** It has a lattice of negative ions in a 'sea of electrons'.

**B** It has a lattice of negative ions in a 'sea of protons'.

**C** It has a lattice of positive ions in a 'sea of electrons'.

**D** It has a lattice of positive ions in a 'sea of protons'.

**9** Four fertilisers are each supplied in 100 kg bags.

Which fertiliser supplies the greatest mass of nitrogen per 100 kg bag?

**A** ammonium nitrate, $NH_4NO_3$

**B** ammonium phosphate, $(NH_4)_3PO_4$

**C** ammonium sulfate, $(NH_4)_2SO_4$

**D** urea, $CO(NH_2)_2$

**10** Calcium carbonate reacts with dilute hydrochloric acid.

The equation for the reaction is shown.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

1.00 g of calcium carbonate is added to 50.0 $cm^3$ of 0.0500 mol / $dm^3$ hydrochloric acid.

Which volume of carbon dioxide is made in this reaction?

**A** 30 $cm^3$ **B** 60 $cm^3$ **C** 120 $cm^3$ **D** 240 $cm^3$

**11** Which rows correctly show cathode and anode products from the electrolysis of the named electrolyte?

| | electrolyte | cathode product | anode product |
|---|---|---|---|
| 1 | copper(II) sulfate solution using copper electrodes | copper | oxygen |
| 2 | molten lead(II) bromide | lead | bromine |
| 3 | dilute sodium bromide solution | hydrogen | oxygen |
| 4 | copper(II) sulfate solution using carbon electrodes | hydrogen | oxygen |

**A** 1 and 2 only **B** 1 and 4 only **C** 2 and 3 only **D** 3 and 4 only

**12** What are the ionic half-equations for the electrode reactions during the electrolysis of concentrated aqueous sodium chloride?

| | anode | cathode |
|---|---|---|
| **A** | $Cl_2 + 2e^- \rightarrow 2Cl^-$ | $H_2 \rightarrow 2H^+ + 2e^-$ |
| **B** | $2Cl^- \rightarrow Cl_2 + 2e^-$ | $2H^+ + 2e^- \rightarrow H_2$ |
| **C** | $H_2 \rightarrow 2H^+ + 2e^-$ | $Cl_2 + 2e^- \rightarrow 2Cl^-$ |
| **D** | $2H^+ + 2e^- \rightarrow H_2$ | $2Cl^- \rightarrow Cl_2 + 2e^-$ |

**13** Which statements about endothermic reactions are correct?

1 The energy of the products is greater than the energy of the reactants.

2 The energy of the reactants is greater than the energy of the products.

3 The temperature of the surroundings increases during the reaction.

4 The temperature of the surroundings decreases during the reaction.

**A** 1 and 3 only **B** 1 and 4 only **C** 2 and 3 only **D** 2 and 4 only

**14** Which gases are used to generate electricity in a fuel cell?

**A** carbon dioxide and oxygen

**B** hydrogen and methane

**C** hydrogen and oxygen

**D** methane and carbon dioxide

**15** Which is a chemical change?

**A** boiling water

**B** cooking an egg

**C** dissolving sugar

**D** melting ice cubes

**16** The rate of reaction between magnesium and dilute hydrochloric acid is increased by increasing the concentration of the acid.

How does this affect the reacting particles?

| | collision rate of particles | proportion of particles with sufficient energy to react |
|---|---|---|
| **A** | increases | increases |
| **B** | increases | stays the same |
| **C** | stays the same | increases |
| **D** | stays the same | stays the same |

**17** Dinitrogen tetroxide, $N_2O_4$, is converted into nitrogen dioxide, $NO_2$, in a reversible reaction.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

The forward reaction is endothermic.

Which conditions give the highest equilibrium yield of nitrogen dioxide?

| | pressure / atmospheres | temperature |
|---|---|---|
| **A** | 2 | high |
| **B** | 2 | low |
| **C** | 50 | high |
| **D** | 50 | low |

**18** The equation for the reaction between iron(II) sulfate and bromine is shown.

$$6FeSO_4 + 3Br_2 \rightarrow 2Fe_2(SO_4)_3 + 2FeBr_3$$

Which row identifies the oxidising agent and the reducing agent?

| | oxidising agent | reducing agent |
|---|---|---|
| **A** | $Br_2$ | $FeSO_4$ |
| **B** | $FeSO_4$ | $Br_2$ |
| **C** | $FeBr_3$ | $Fe_2(SO_4)_3$ |
| **D** | $Fe_2(SO_4)_3$ | $FeBr_3$ |

**19** Which statement about amphoteric oxides is correct?

**A** They are made by combining an acidic oxide with a basic oxide.

**B** They react with water to give a solution of pH 7.

**C** They react with both acids and bases.

**D** They do not react with acids or bases.

**20** Carbonic acid is a weak acid formed when carbon dioxide dissolves in water.

What is the pH of the solution?

**A** 1 **B** 5 **C** 7 **D** 9

**21** A method used to make copper(II) sulfate crystals is shown.

1 Place dilute sulfuric acid in a beaker.

2 Warm the acid.

3 Add copper(II) oxide until it is in excess.

4 Filter the mixture.

5 Evaporate the filtrate until crystals start to form.

6 Leave the filtrate to cool.

What are the purposes of step 3 and step 4?

| | step 3 | step 4 |
|---|---|---|
| **A** | to ensure all of the acid has reacted | to obtain solid copper(II) sulfate |
| **B** | to ensure all of the acid has reacted | to remove the excess of copper(II) oxide |
| **C** | to speed up the reaction | to obtain solid copper(II) sulfate |
| **D** | to speed up the reaction | to remove the excess of copper(II) oxide |

**22** Lead(II) sulfate is an insoluble salt.

Which process is **not** used to prepare a pure sample of this salt?

**A** crystallisation

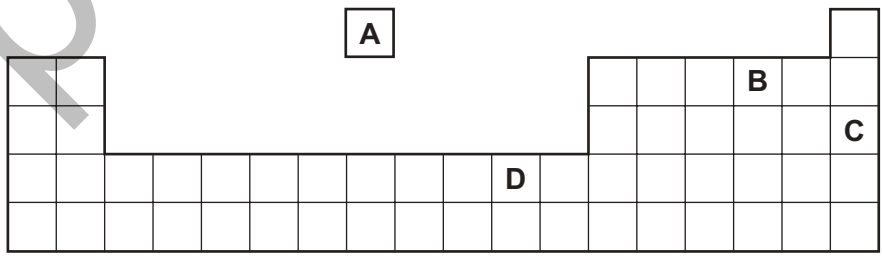
**B** drying

**C** filtration

**D** precipitation

**23** Part of the Periodic Table is shown.

Which element is used to provide an inert atmosphere?



**24** Which pair of elements reacts together most violently?

**A** chlorine and lithium

**B** chlorine and potassium

**C** iodine and lithium

**D** iodine and potassium

**25** Which pair of compounds shows that transition elements have variable oxidation states?

**A** $Cr_2O_3$ and $CrBr_3$

**B** $CuSO_4$ and $CuCl_2$

**C** $Fe_2O_3$ and $FeCl_2$

**D** NiO and $NiCl_2$

**26** Some properties of substance X are listed.

- It conducts electricity when molten.
- It has a high melting point.
- It burns in oxygen and the oxide dissolves in water to give a solution with pH 11.

What is X?

**A** a covalent compound

**B** a macromolecule

**C** a metal

**D** an ionic compound

**27** Which statement is correct?

**A** Aluminium is used in the manufacture of aircraft because it has a high density.

**B** Copper is used for cooking utensils because it is a good conductor of heat.

**C** Mild steel is used for car bodies because it is resistant to corrosion.

**D** Stainless steel is used for cutlery because it is a conductor of electricity.

**28** Iron rusts but aluminium does not easily corrode.

Which statement explains why aluminium does **not** easily corrode?

**A** It is an alloy.

**B** It is below iron in the reactivity series.

**C** It is not a transition element.

**D** Its surface is protected by an oxide layer.

**29** Which statement about the extraction of aluminium is correct?

**A** Aluminium is formed at the cathode during the electrolysis of aluminium oxide.

**B** Hematite is mainly aluminium oxide.

**C** Molten cryolite is used to raise the melting point of the aluminium oxide.

**D** Oxygen gains electrons at the anode during the electrolysis of aluminium oxide.

**30** River water contains soluble impurities, insoluble impurities and bacteria.

River water is made safe to drink by filtration and chlorination.

Which statement is correct?

**A** Filtration removes bacteria and insoluble impurities, and chlorination removes soluble impurities.

**B** Filtration removes insoluble impurities, and chlorination kills the bacteria.

**C** Filtration removes soluble and insoluble impurities, and chlorination kills the bacteria.

**D** Filtration removes soluble impurities and bacteria, and chlorination removes insoluble impurities.

**31** Which physical property is used to separate the nitrogen and oxygen from air?

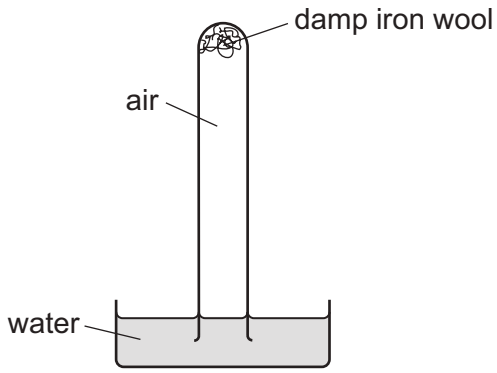
**A** boiling point

**B** density

**C** electrical conductivity

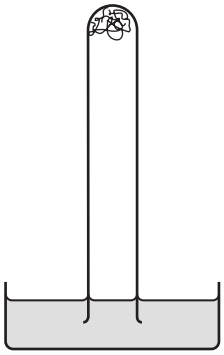
**D** molecular mass

**32** The apparatus shown is set up and left for a week.

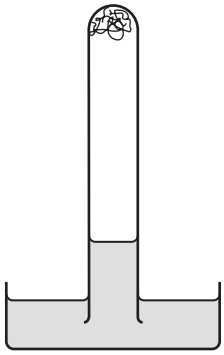



Which diagram shows the level of the water at the end of the week?

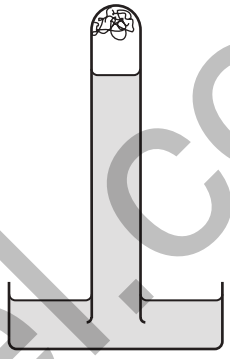
**A**



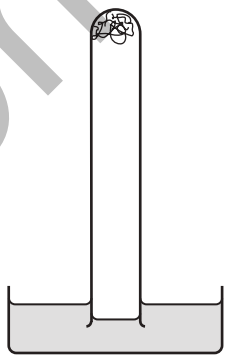
**B**



**C**



**D**



**33** Which statement about the carbon cycle is correct?

**A** Carbon is absorbed from the atmosphere by combustion and released into it by respiration.

**B** Carbon is absorbed from the atmosphere by photosynthesis and released into it by combustion.

**C** Carbon is absorbed from the atmosphere by both respiration and combustion.

**D** Carbon is released into the atmosphere by both photosynthesis and respiration.

**34** Ammonium sulfate is used as a fertiliser.

It is made from ammonia and sulfuric acid.

Which words complete gaps 1, 2 and 3?

The .....1..... is made by the .....2..... process in which .....3..... is used as a catalyst.

| | 1 | 2 | 3 |
|---|---|---|---|
| **A** | ammonia | Contact | iron |
| **B** | ammonia | Haber | vanadium(V) oxide |
| **C** | sulfuric acid | Contact | vanadium(V) oxide |
| **D** | sulfuric acid | Haber | iron |

**35** Which process is used to obtain lime from limestone?

**A** cracking

**B** fractional distillation

**C** neutralisation

**D** thermal decomposition

**36** Petroleum is separated by fractional distillation.

Which statement about the fractions produced is correct?

**A** Bottled gas for heating and cooking is obtained from the naphtha fraction.

**B** Diesel oil is used as a fuel for jet aircraft.

**C** Substances used to make polishes are obtained from the lubricating fraction.

**D** The kerosene fraction contains many useful waxes.

**37** Which products are obtained by the cracking of an alkane?

| | alkene | hydrogen | water |
|---|---|---|---|
| **A** | ✓ | ✓ | ✓ |
| **B** | ✓ | ✓ | ✗ |
| **C** | ✓ | ✗ | ✓ |
| **D** | ✗ | ✓ | ✓ |

**38** Ethanol is manufactured by the catalytic addition of steam to ethene and by fermentation.

Which statement describes an advantage of fermentation compared to the catalytic addition of steam to ethene?

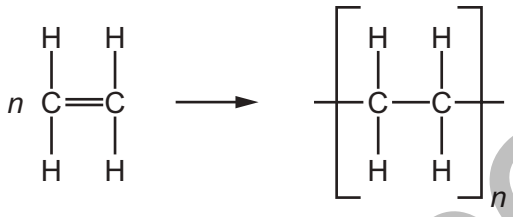
**A** Fermentation is a more rapid reaction.

**B** Fermentation produces a purer product.

**C** Fermentation uses a higher temperature.

**D** Fermentation uses renewable resources.

**39** The diagram shows the structure of a monomer and of the polymer made from it.



What are the monomer and polymer?

| | monomer | polymer |
|---|---|---|
| **A** | ethane | poly(ethane) |
| **B** | ethane | poly(ethene) |
| **C** | ethene | poly(ethane) |
| **D** | ethene | poly(ethene) |

**40** Which polymers possess the same linkage?

**A** nylon and protein

**B** protein and starch

**C** starch and nylon

**D** nylon and *Terylene*

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## The Periodic Table of Elements

| Group I | Group II | | | | | | | | | | | Group III | Group IV | Group V | Group VI | Group VII | Group 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.).

Cambridge IGCSE

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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*6072633725*

**CHEMISTRY** **0620/31**

Paper 3 Theory (Core) **October/November 2019**

**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.



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

This document consists of **15** printed pages and **1** blank page.

**1** This question is about solids, liquids and gases.

**(a)** The list gives the names of nine substances which are solids at room temperature.

**a ceramic**
**aluminium**
**anhydrous cobalt(II) chloride**
**anhydrous copper(II) sulfate**
**calcium oxide**
**graphite**
**iodine**
**iron**
**sodium**

Answer the following questions about these substances.
Each substance may be used once, more than once or not at all.

State which substance:

**(i)** turns pink when water is added to it

..... [1]

**(ii)** is a non-metal which is used as a lubricant

..... [1]

**(iii)** is used to neutralise acidic industrial waste

..... [1]

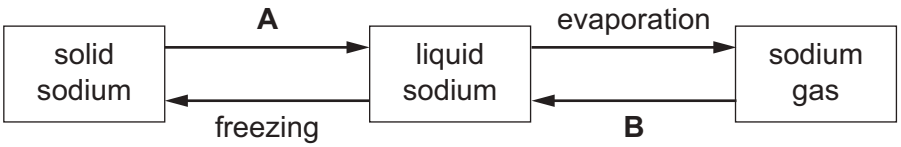
**(iv)** is extracted from bauxite

..... [1]

**(v)** is used as an electrical insulator.

..... [1]

**(b)** Some changes of state of sodium are shown.




**(i)** State the names of the changes of state represented by **A** and **B**.

**A** .....

**B** .....

[2]

**(ii)** Use the kinetic particle model to describe the arrangement **and** separation of the particles in:

solid sodium .....

.....

.....

liquid sodium. .....

.....

.....

[4]

[Total: 11]

**2** Biogas is made by fermenting animal and vegetable waste.

**(a)** The table shows the percentage composition of the gases present in a sample of biogas.

| substance present | percentage present in biogas |
|---|---|
| carbon dioxide | 28.5 |
| hydrogen | 1.0 |
| methane | 62.0 |
| nitrogen | |
| water vapour | 2.4 |
| other substances | 0.1 |
| total | 100.0 |

Deduce the percentage of nitrogen present in this sample of biogas.

..... [1]

**(b) (i)** Balance the chemical equation for the complete combustion of methane.

$$CH_4 + .....O_2 \rightarrow CO_2 + .....H_2O$$ [2]

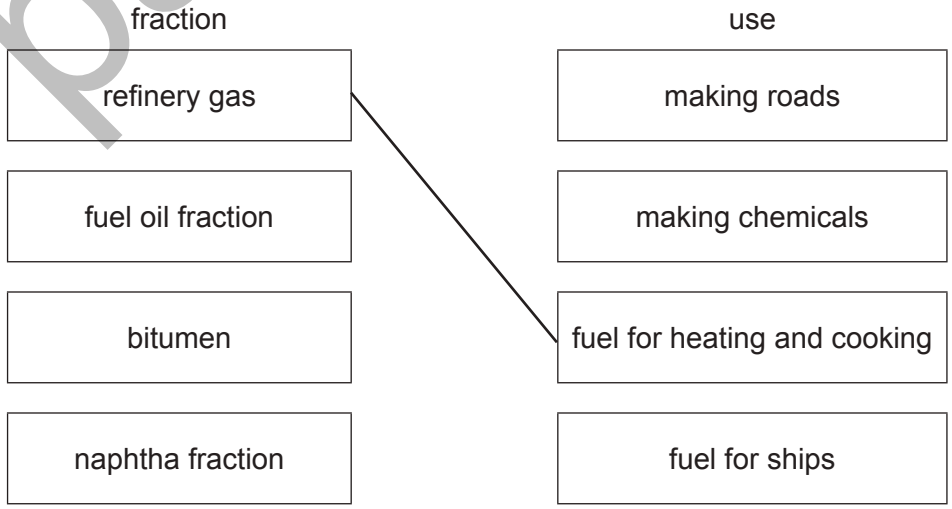
**(ii)** Which **one** of these compounds belongs to the same homologous series as methane?

Draw a circle around the correct answer.

**methanoic acid** **methanol** **propane** **propanol** **propene** [1]

**(iii)** Methane is present in the refinery gas fraction produced by the fractional distillation of petroleum.

Match the fractions on the left with their uses on the right.
The first one has been done for you.




[2]

**(c) (i)** Draw a dot-and-cross diagram to show the electron arrangement in a molecule of hydrogen.

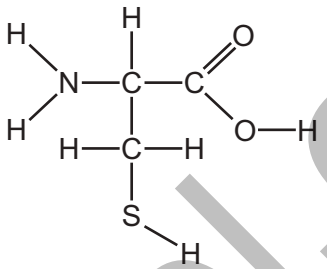
[1]

**(ii)** State **one** use of hydrogen.

..... [1]

**(d)** The biogas contains a small amount of compound **C**.

The structure of compound **C** is shown.




**(i)** On the structure shown, draw a circle around the carboxylic acid functional group. [1]

**(ii)** How many different types of atoms are present in compound **C**?

..... [1]

**(e)** Describe the manufacture of ethanol by fermentation.
In your answer include:

- the names of the substances needed for fermentation
- the conditions needed for fermentation.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 14]

**3** A student investigated the reaction between zinc carbonate and an excess of dilute hydrochloric acid.

$$ZnCO_3 + 2HCl \rightarrow ZnCl_2 + CO_2 + H_2O$$

The rate of reaction can be found by measuring the decrease in the mass of the reaction mixture over time.

**(a)** Describe **one** other practical method for measuring the rate of this reaction.

.....

.....

.....

.....

..... [3]

**(b)** When 6.25 g of zinc carbonate is used, 2.20 g of carbon dioxide is formed.

Calculate the mass of zinc carbonate that forms 11.00 g of carbon dioxide.

mass of zinc carbonate = ..... g [1]

**(c)** What effect do the following have on the rate of this reaction?

- Decreasing the temperature of the reaction mixture.
  All other conditions are kept the same.

.....

- Increasing the concentration of hydrochloric acid.
  All other conditions are kept the same.

.....
[2]

**(d)** Carbon dioxide is formed:

- when an acid reacts with a carbonate
- as a product of the complete combustion of carbon-containing substances.

State **two** other sources of carbon dioxide.

1 .....

2 .....
[2]

[Total: 8]

**4** An isotope of sodium is written as shown.

$^{23}_{11}Na$

**(a) (i)** Deduce the number of protons, electrons and neutrons in this isotope of sodium.

number of protons .....

number of electrons .....

number of neutrons .....

[3]

**(ii)** State **one** medical use of radioactive isotopes.

..... [1]

**(b) (i)** Draw the electronic structure of a sodium atom.

[2]

**(ii)** State the name of the particle which is lost when a sodium atom forms a sodium ion.

..... [1]

**(c)** Sodium reacts with water to form:

- an alkaline solution
- a gas which 'pops' with a lighted splint.

**(i)** Complete the word equation for the reaction of sodium with water.

| | | | | | | |
|---|---|---|---|---|---|---|
| sodium | + | water | → | ..... ..... | + | ..... |

[2]

**(ii)** The reaction of sodium with water is exothermic.

What is meant by the term *exothermic*?

.....

..... [1]

**(iii)** Sodium reacts with oxygen to form sodium oxide.

Is sodium oxide an acidic oxide or a basic oxide?
Give a reason for your answer.

.....

..... [1]

**(d)** The table shows some observations for the reaction of four metals with cold water and with hot water.

| metal | reaction with cold water | reaction with hot water |
|---|---|---|
| calcium | bubbles form rapidly | bubbles form very rapidly |
| lanthanum | bubbles form slowly | bubbles form very rapidly |
| manganese | no bubbles form | bubbles form very slowly |
| uranium | bubbles form slowly | bubbles form rapidly |

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

least reactive → most reactive

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

[2]

[Total: 13]

**5** This question is about the halogens and compounds of the halogens.

**(a)** The properties of some halogens are shown in the table.

| element | melting point in °C | boiling point in °C | density of liquid at its boiling point in g / cm$^3$ | atomic radius in nm |
|---|---|---|---|---|
| chlorine | –101 | –35 | ..... | 0.099 |
| bromine | –7 | 59 | 3.12 | 0.114 |
| iodine | 114 | ..... | 4.93 | 0.133 |
| astatine | 302 | 337 | 6.35 | |

**(i)** Complete the table to estimate:

- the density of liquid chlorine
- the boiling point of iodine.

[2]

**(ii)** Describe the trend in the atomic radius of the halogens down the group.

..... [1]

**(iii)** Predict the physical state of bromine at 50 °C.
Give a reason for your answer.

.....

.....

..... [2]

**(b)** Bromine reacts with an aqueous potassium salt to form iodine and a different potassium salt.

Complete the word equation for this reaction.

| bromine | + | ..... ..... | → | iodine | + | ..... ..... |
|---|---|---|---|---|---|---|

[2]

**(c)** Fluorine is above chlorine in Group VII of the Periodic Table.

**(i)** Explain, using ideas about the reactivity of the halogens, why chlorine does **not** react with aqueous sodium fluoride.

.....

..... [1]

**(ii)** Balance the chemical equation for the reaction of fluorine with ammonia.

$$.....NH_3 + .....F_2 \rightarrow N_2 + 6HF$$ [2]

**(iii)** A compound of fluorine has the formula $XeO_3F_2$.

Complete the table to calculate the relative molecular mass of $XeO_3F_2$.
Use your Periodic Table to help you.

| type of atom | number of atoms | relative atomic mass | |
|---|---|---|---|
| xenon | | | |
| oxygen | 3 | 16 | $3 \times 16 = 48$ |
| fluorine | | | |

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

**(iv)** The compound $XeO_3F_2$ readily undergoes reduction.

What is meant by the term *reduction*?

..... [1]

[Total: 13]

**6** This question is about ammonia.

**(a)** When ammonia gas reacts with hydrogen chloride gas, white fumes of ammonium chloride are formed.

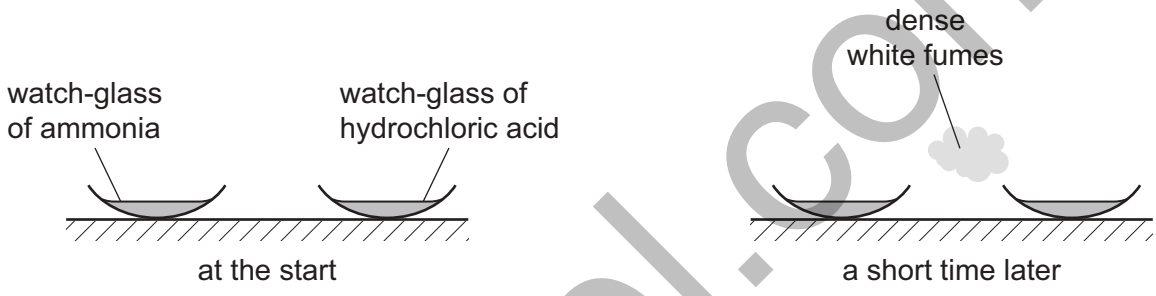
$$NH_3 + HCl \rightarrow NH_4Cl$$

**(i)** What type of chemical reaction is this?

Draw a circle around the correct answer.

**decomposition** **neutralisation** **oxidation** **reduction** [1]

**(ii)** Watch-glasses of aqueous ammonia and concentrated hydrochloric acid were placed near each other on a table.
At first no white fumes were seen.
After a short time, white fumes were seen between the watch-glasses.




Explain these observations using the kinetic particle model.

.....

.....

.....

.....

.....

..... [3]

**(b)** Ammonia is used in the manufacture of fertilisers.

Name the **three** elements present in most fertilisers which improve plant growth.

1 .....

2 .....

3 .....

[3]

**(c)** Aqueous ammonia can be used to test for aluminium ions and zinc ions.

Complete the table to show the expected observations.

| ion | observation on adding a small volume of aqueous ammonia | observation on adding an excess of aqueous ammonia |
|---|---|---|
| aluminium ($Al^{3+}$) | | |
| zinc ($Zn^{2+}$) | | |

[3]

[Total: 10]

**7** **(a)** Magnesium is manufactured by the electrolysis of molten magnesium chloride.

**(i)** The negative electrode is made of iron.

Suggest a non-metal which could be used for the positive electrode.
Give a reason for your answer.

.....

..... [2]

**(ii)** Predict the products of the electrolysis of molten magnesium chloride at:

the positive electrode .....

the negative electrode. .....
[2]

**(b)** The following statements are about the procedure for making crystals of hydrated magnesium chloride from magnesium and dilute hydrochloric acid.

**A** Leave the mixture until no more bubbles are seen.
**B** Leave the mixture at room temperature to form more crystals.
**C** Add an excess of magnesium to dilute hydrochloric acid.
**D** Warm the filtrate to the point of crystallisation.
**E** Filter off the crystals and dry between filter papers.
**F** Filter off the excess magnesium.

Put the statements **A**, **B**, **C**, **D**, **E** and **F** in the correct order.
The first one has been done for you.

| | | | | | |
|---|---|---|---|---|---|
| **C** | | | | | |

[2]

**(c)** Magnesium is a metal in Group II of the Periodic Table.
Copper is a transition element.
Copper has a higher melting point and a higher boiling point than magnesium.

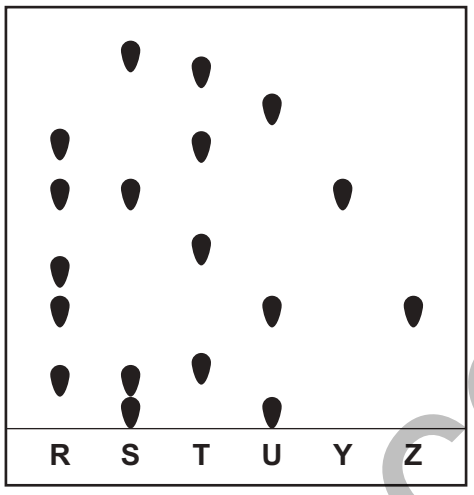
Describe **two** other properties of copper which are different from those of magnesium.

1 .....

2 .....
[2]

**(d)** Chromatography can be used to separate a mixture of ions from different transition element compounds.
Four samples, **R**, **S**, **T** and **U**, each containing transition element ions, were placed on a piece of chromatography paper.
Two solutions, **Y** and **Z**, each containing only one type of transition element ion were also placed on the same piece of chromatography paper.

The results of the chromatography are shown.




**(i)** Which sample, **R**, **S**, **T** or **U**, contains the same ions as both solution **Y and** solution **Z**?

..... [1]

**(ii)** Which sample, **R**, **S**, **T** or **U**, does **not** contain the same ions as either solution **Y** or solution **Z**?

..... [1]

**(iii)** In which sample, **R**, **S**, **T** or **U**, has the greatest number of transition element ions been separated?

..... [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.).

Cambridge IGCSE

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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*2338402729*

**CHEMISTRY** **0620/41**

Paper 4 Theory (Extended) **October/November 2019**

**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.



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

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

**1** This question is about ions and ionic compounds.

**(a)** Choose from the following list of ions to answer the questions.

| | | | | |
|---|---|---|---|---|
| $Br^-$ | $Ca^{2+}$ | $Cl^-$ | $Cr^{3+}$ | $Cu^{2+}$ |
| $K^+$ | $Li^+$ | $Na^+$ | $SO_3^{2-}$ | $SO_4^{2-}$ |

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

State which ion:

**(i)** gives a lilac colour in a flame test ..... [1]

**(ii)** forms a grey-green precipitate with aqueous ammonia ..... [1]

**(iii)** forms a white precipitate with aqueous sodium hydroxide ..... [1]

**(iv)** forms a cream precipitate with acidified aqueous silver nitrate ..... [1]

**(v)** forms a white precipitate with acidified aqueous barium nitrate. ..... [1]

**(b)** Describe how to do a flame test on a sample of a salt.

.....

.....

.....

..... [2]

**(c)** Magnesium phosphate contains magnesium ions, $Mg^{2+}$, and phosphate ions, $PO_4^{3-}$.

Deduce the formula of magnesium phosphate.

..... [1]

[Total: 8]

**2** **(a)** Sulfur exists as a number of different isotopes.

What is meant by the term *isotopes*?

.....

.....

..... [2]

**(b)** A sulfide ion has the symbol shown.

$$^{34}_{16}S^{2-}$$

**(i)** How many neutrons are contained in this sulfide ion?

..... [1]

**(ii)** How is a sulfide ion, $S^{2-}$, formed from a sulfur atom?

..... [1]

**(iii)** Which element forms an ion with a 2+ charge that has the same number of electrons as a $S^{2-}$ ion?

..... [1]

**(c)** The manufacture of sulfuric acid by the Contact process occurs in four stages.

**stage 1** Molten sulfur is burned in air to produce sulfur dioxide gas.

**stage 2** Sulfur dioxide is reacted with oxygen to form sulfur trioxide.

**stage 3** Sulfur trioxide is combined with concentrated sulfuric acid to form oleum, $H_2S_2O_7$.

**stage 4** Oleum is added to water to form sulfuric acid.

**(i)** Complete the chemical equation for **stage 1** by adding the appropriate state symbols.

$$S(.....) + O_2(.....) \rightarrow SO_2(.....)$$ [1]

**(ii)** Name the catalyst used in **stage 2** and state the temperature used.

catalyst .....

temperature ..... °C

[2]

**(iii)** Write chemical equations for the reactions in **stage 3** and **stage 4**.

**stage 3** .....

**stage 4** .....

[2]

**(d)** Sulfur dioxide is a toxic gas.

**(i)** State one **environmental** reason why sulfur dioxide should **not** be released into the atmosphere.

..... [1]

**(ii)** Describe the test for sulfur dioxide.

test .....

.....

observations .....

.....

[2]

**(e)** Sulfur dioxide reacts with aqueous sodium sulfite to produce a compound with the following composition by mass: 29.1% Na, 40.5% S and 30.4% O.

Calculate the empirical formula of this compound.

empirical formula = ..... [3]

[Total: 16]

**3** This question is about metals and metal oxides.

**(a)** Most metals have a high melting point.

State **one** other physical property that all metals have.

..... [1]

**(b)** Iron often rusts.

Name the **two** substances, other than iron, that must be present for iron to rust.

1 .....

2 .....
[1]

**(c)** Iron can be obtained by heating iron(III) oxide with zinc powder.

$$Fe_2O_3 + 3Zn \rightarrow 2Fe + 3ZnO$$

**(i)** What can be deduced about the reactivity of zinc from this reaction?

..... [1]

**(ii)** The ionic equation for this reaction is shown.

$$2Fe^{3+} + 3Zn \rightarrow 2Fe + 3Zn^{2+}$$

Identify the oxidising agent in this reaction. Explain your answer in terms of electron transfer.

oxidising agent .....

explanation .....

.....
[2]

**(d)** Zinc oxide is amphoteric.

Describe **two** simple experiments to show that zinc oxide is amphoteric.
Name the reagents you would use and describe the observations you would make.

reagent 1 .....

observation .....

reagent 2 .....

observation .....

[3]

[Total: 8]

**4** Insoluble salts can be made by precipitation reactions.

A student mixed solutions of some soluble salts.

The results the student obtained are shown in the table.

| | | second salt solution | | |
|---|---|---|---|---|
| | | $Co(NO_3)_2(aq)$ | $AgNO_3(aq)$ | $Pb(NO_3)_2(aq)$ |
| first salt solution | NaI(aq) | no change | yellow precipitate | yellow precipitate |
| | $Na_2CO_3(aq)$ | purple precipitate | yellow precipitate | white precipitate |
| | $Na_2SO_4(aq)$ | no change | white precipitate | white precipitate |

All sodium salts are soluble in water.
Use only results from the table to answer the following questions.

**(a)** Name:

**(i)** an insoluble cobalt salt ..... [1]

**(ii)** an insoluble yellow lead salt. ..... [1]

**(b)** Write the chemical equation for the reaction in which silver carbonate is formed.

..... [2]

**(c)** Write the ionic equation for the reaction in which lead(II) iodide is formed.

..... [2]

**(d)** Aqueous silver nitrate produces a yellow precipitate with both iodide ions and carbonate ions. When testing an unknown solution for iodide ions, the aqueous silver nitrate is acidified.

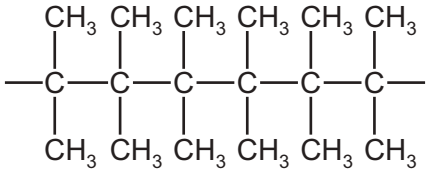
Explain why the aqueous silver nitrate is acidified.

.....

..... [1]

[Total: 7]

**5** **(a)** Part of the structure of synthetic polymer **A** is shown.



**(i)** What type of synthetic polymer is **A**?

..... [1]

**(ii)** Deduce the empirical formula of polymer **A**.

..... [1]

**(iii)** Draw the structure of the monomer from which polymer **A** is made.

[2]

**(b)** The formula $C_4H_{10}$ represents two different structural isomers.

**(i)** What is meant by the term *structural isomers*?

.....

.....

..... [2]

**(ii)** Draw the structures of **two** structural isomers with the formula $C_4H_{10}$.
Show all of the atoms and all of the bonds.

[2]

**(iii)** All structural isomers of $C_4H_{10}$ are flammable.

Write a chemical equation for the **incomplete** combustion of $C_4H_{10}$.

..... [2]

[Total: 10]

**6** Dilute hydrochloric acid, $HCl(aq)$, reacts with aqueous sodium carbonate, $Na_2CO_3(aq)$.

The chemical equation for the reaction is shown.

$$2HCl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O$$

**(a)** A 25.0 $cm^3$ portion of $Na_2CO_3(aq)$ was placed in a conical flask with a few drops of a suitable indicator. It was titrated against $HCl(aq)$ of concentration 0.180 $mol/dm^3$.

20.0 $cm^3$ of $HCl(aq)$ was required to reach the end-point.

Calculate the concentration of the $Na_2CO_3(aq)$, in $mol/dm^3$, using the following steps.

- Calculate the number of moles of $HCl$ used in the titration.

..... mol

- Calculate the number of moles of $Na_2CO_3$ contained in the 25.0 $cm^3$ portion of $Na_2CO_3(aq)$.

..... mol

- Calculate the concentration of the $Na_2CO_3(aq)$ in $mol/dm^3$.

..... $mol/dm^3$
[3]

**(b)** In another experiment, the volume of carbon dioxide, $CO_2$, produced was 48.0 $cm^3$, measured at room temperature and pressure.

How many moles of $CO_2$ is this?

moles of $CO_2$ = ..... mol [1]

**(c)** A sample of concentrated hydrobromic acid, HBr(aq), was electrolysed using platinum electrodes.
The concentration of the hydrobromic acid was 8.89 mol / $dm^3$.

**(i)** Calculate the concentration of the HBr(aq) in g / $dm^3$.

concentration of HBr(aq) = ..... g / $dm^3$ [1]

**(ii)** Explain why concentrated HBr(aq) can conduct electricity.

.....

.....

..... [2]

**(iii)** Magnesium is **not** a suitable material from which to make the electrodes.

Explain why.

.....

..... [1]

**(iv)** Predict the product formed at the anode when concentrated HBr(aq) is electrolysed.

..... [1]

**(v)** Write the ionic half-equation for the reaction occurring at the cathode.

..... [2]

[Total: 11]

**7** This question is about ethanol.

**(a)** Ethanol that is suitable for use as a fuel can be manufactured from sugars such as glucose, $C_6H_{12}O_6$, by a two-step process.

Describe how this can be done. In your answer, include:

- an equation for the reaction in which ethanol is formed
- the essential conditions for the reaction in which ethanol is formed
- the name of the process used to obtain ethanol that is pure enough to use as a fuel from the reaction mixture.

.....

.....

.....

.....

.....

.....

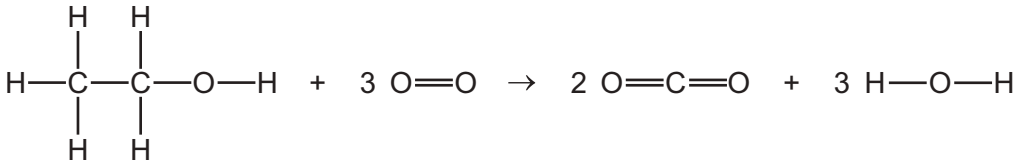
.....

.....

.....

..... [5]

**(b)** The equation for the complete combustion of ethanol is shown.



Use the bond energies in the table to calculate the energy change, in kJ / mol, for the complete combustion of ethanol.

| bond | bond energy in kJ / mol |
|---|---|
| C–C | 347 |
| C–H | 413 |
| C–O | 358 |
| C=O | 805 |
| O–H | 464 |
| O=O | 498 |

- Energy needed to break bonds.

..... kJ

- Energy released when bonds are formed.

..... kJ

- Energy change for the complete combustion of ethanol.

energy change = ..... kJ / mol
[3]

**(c)** Ethanol can be oxidised by hydrogen peroxide to form ethanal, $CH_3CHO$. A catalyst for this reaction is $Fe^{3+}$.

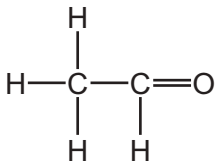
**(i)** What is meant by the term *catalyst*?

.....

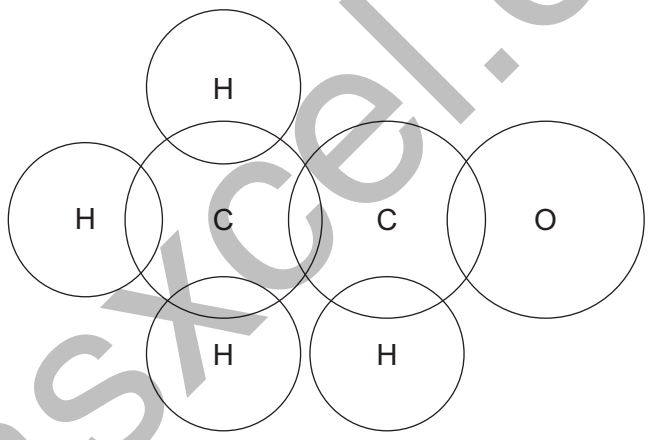
.....

..... [2]

**(ii)** The structure of ethanal is shown.




Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ethanal. Show outer shell electrons only.




[3]

**(iii)** The table gives the boiling points of ethanal and ethanol.

| substance | boiling point / °C |
|---|---|
| ethanal | 20 |
| ethanol | 78 |

In terms of attractive forces between particles, suggest why ethanal has a lower boiling point than ethanol.

.....

..... [1]

**(d)** Ethene gas reacts with steam to form gaseous ethanol.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons CH_3CH_2OH(g)$$

The reaction can reach a position of equilibrium. The forward reaction is exothermic.

**(i)** State and explain the effect of increasing the pressure on the **position of equilibrium**. All other conditions are unchanged.

.....

.....

..... [2]

**(ii)** Increasing the pressure of a gas increases its concentration.

State and explain the effect of increasing the pressure on the **rate** of the reaction. All other conditions are unchanged.

.....

.....

..... [2]

**(iii)** State and explain the effect of increasing the temperature on the **position of equilibrium**. All other conditions are unchanged.

.....

.....

..... [2]

[Total: 20]

## 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 |
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| 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.).

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

**CHEMISTRY** **0620/11**

Paper 1 Multiple Choice (Core) **October/November 2019**

MARK SCHEME

Maximum Mark: 40

**Published**

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

| Question | Answer | Marks |
|---|---|---|
| 1 | A | **1** |
| 2 | A | **1** |
| 3 | D | **1** |
| 4 | B | **1** |
| 5 | C | **1** |
| 6 | A | **1** |
| 7 | A | **1** |
| 8 | D | **1** |
| 9 | D | **1** |
| 10 | B | **1** |
| 11 | B | **1** |
| 12 | A | **1** |
| 13 | B | **1** |
| 14 | B | **1** |
| 15 | D | **1** |
| 16 | B | **1** |
| 17 | B | **1** |
| 18 | B | **1** |
| 19 | B | **1** |
| 20 | D | **1** |
| 21 | B | **1** |
| 22 | D | **1** |
| 23 | C | **1** |
| 24 | C | **1** |
| 25 | D | **1** |
| 26 | D | **1** |
| 27 | B | **1** |
| 28 | B | **1** |

| Question | Answer | Marks |
|---|---|---|
| 29 | C | **1** |
| 30 | B | **1** |
| 31 | A | **1** |
| 32 | B | **1** |
| 33 | D | **1** |
| 34 | D | **1** |
| 35 | C | **1** |
| 36 | C | **1** |
| 37 | C | **1** |
| 38 | B | **1** |
| 39 | D | **1** |
| 40 | D | **1** |

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

**CHEMISTRY** **0620/21**

Paper 2 Multiple Choice (Core) **October/November 2019**

MARK SCHEME

Maximum Mark: 40

**Published**

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This document consists of **3** printed pages.

| Question | Answer | Marks |
|---|---|---|
| 1 | C | **1** |
| 2 | A | **1** |
| 3 | C | **1** |
| 4 | C | **1** |
| 5 | A | **1** |
| 6 | B | **1** |
| 7 | D | **1** |
| 8 | C | **1** |
| 9 | D | **1** |
| 10 | A | **1** |
| 11 | C | **1** |
| 12 | B | **1** |
| 13 | B | **1** |
| 14 | C | **1** |
| 15 | B | **1** |
| 16 | B | **1** |
| 17 | A | **1** |
| 18 | A | **1** |
| 19 | C | **1** |
| 20 | B | **1** |
| 21 | B | **1** |
| 22 | A | **1** |
| 23 | C | **1** |
| 24 | B | **1** |
| 25 | C | **1** |
| 26 | C | **1** |
| 27 | B | **1** |
| 28 | D | **1** |

| Question | Answer | Marks |
|---|---|---|
| 29 | A | **1** |
| 30 | B | **1** |
| 31 | A | **1** |
| 32 | B | **1** |
| 33 | B | **1** |
| 34 | C | **1** |
| 35 | D | **1** |
| 36 | C | **1** |
| 37 | B | **1** |
| 38 | D | **1** |
| 39 | D | **1** |
| 40 | A | **1** |

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

**CHEMISTRY** **0620/31**

Paper 3 Theory (Core) **October/November 2019**

MARK SCHEME

Maximum Mark: 80

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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**PUBLISHED**

## Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

| |
|---|
| GENERIC MARKING PRINCIPLE 5:<br><br>Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen). |
| GENERIC MARKING PRINCIPLE 6:<br><br>Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind. |

| Question | Answer | Marks |
|---|---|---|
| 1(a)(i) | (anhydrous) cobalt chloride | **1** |
| 1(a)(ii) | graphite | **1** |
| 1(a)(iii) | calcium oxide | **1** |
| 1(a)(iv) | aluminium | **1** |
| 1(a)(v) | ceramic | **1** |
| 1(b)(i) | A: melting (1)<br><br>B: condensing / condensation (1) | **2** |
| 1(b)(ii) | ***solid:***<br>particles arranged regularly / particles ordered (1)<br><br>particles touching / particles close together (1)<br><br>***liquid:***<br>particles arranged irregularly / particles randomly arranged (1)<br><br>particles close together / particles touching (1) | **4** |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | 6.0 / 6 (%) | **1** |
| 2(b)(i) | 2 ($O_2$) (1)<br><br>2 ($H_2O$) (1) | **2** |
| 2(b)(ii) | propane | **1** |
| 2(b)(iii) | 3 correct (2)<br>1 or 2 correct (1)<br><br>fuel oil → fuel for ships<br>bitumen → making roads<br>naphtha → making chemicals | **2** |
| 2(c)(i) | two (hydrogen) atoms with pair of electrons between and no other electrons | **1** |
| 2(c)(ii) | fuel | **1** |
| 2(d)(i) | circle around the COOH group only | **1** |
| 2(d)(ii) | 5 | **1** |
| 2(e) | glucose / sugar (1)<br><br>yeast (1)<br><br>**AND**<br><br>1 mark each for any two of:<br>• oxygen absent / anaerobic<br>• room temperature / stated temperature between 5 °C and 40 °C (inclusive)<br>• pH near neutral<br>• presence of water / aqueous solution<br>• purify by distillation | **4** |

| Question | Answer | Marks |
|---|---|---|
| 3(a) | measuring volume of carbon dioxide (1)<br>use of gas measuring apparatus e.g. syringe / inverted measuring cylinder full of water (1)<br>(measure gas volume) at time intervals (1) | **3** |
| 3(b) | 31.25 (g) | **1** |
| 3(c) | decreases (rate) / slower (rate) (1)<br>increases (rate) faster (rate) (1) | **2** |
| 3(d) | (thermal) decomposition of carbonates (1)<br>respiration (1) | **2** |

| Question | Answer | Marks |
|---|---|---|
| 4(a)(i) | protons: 11 (1)<br>electrons: 11 (1)<br>neutrons: 12 (1) | 3 |
| 4(a)(ii) | treating cancer / thyroid function / tracer for diagnosis | 1 |
| 4(b)(i) | electron in outer shell (1)<br>electrons in first shell **AND** eight electrons in the second shell (1) | 2 |
| 4(b)(ii) | electron | 1 |
| 4(c)(i) | sodium hydroxide (1)<br>hydrogen (1) | 2 |
| 4(c)(ii) | heat given out / heat evolved | 1 |
| 4(c)(iii) | basic (no mark alone)<br>**AND**<br>sodium is a metal (1) | 1 |
| 4(d) | manganese < uranium < lanthanum < calcium (2)<br>if 2 marks not scored allow 1 mark for 1 consecutive pair reversed | 2 |

| Question | Answer | Marks |
|---|---|---|
| 5(a)(i) | density of chlorine: any value between 1 g / $cm^3$ and 3 g / $cm^3$ inclusive (1)<br><br>boiling point of iodine: any value between 115 °C and 320 °C inclusive (1) | **2** |
| 5(a)(ii) | increases (down the group) | **1** |
| 5(a)(iii) | liquid (1)<br><br>50 °C is between the melting point and boiling point / 50 °C is higher than the melting point but lower than the boiling point (1) | **2** |
| 5(b) | potassium iodide (1)<br><br>potassium bromide (1) | **2** |
| 5(c)(i) | fluorine more reactive than chlorine ORA | **1** |
| 5(c)(ii) | 2 ($NH_3$) (1)<br><br>3 ($F_2$) (1) | **2** |
| 5(c)(iii) | 217 (2)<br><br>if 2 marks not scored 1 mark for F = 2 × 19 **OR** 38 (1) | **2** |
| 5(c)(iv) | removal of oxygen / addition of hydrogen / gain of electrons / decrease in oxidation number | **1** |

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6(a)(i)</td><td>neutralisation</td><td>1</td></tr>
<tr><td>6(a)(ii)</td><td>1 mark each for any three of:<br>• evaporation / molecules escape from surface of the liquids<br>• diffusion<br>• molecules in (constant) movement / molecules collide<br>• (movement of) molecules is random / in every direction<br>• molecules spread out / molecules mix<br>• (molecules spread) from higher concentration to lower<br>• concentration<br>• molecules react (when they collide)</td><td>3</td></tr>
<tr><td>6(b)</td><td>nitrogen (1)<br><br>phosphorus (1)<br><br>potassium (1)</td><td>3</td></tr>
<tr><td>6(c)</td><td>1 mark each for any three of:<br><br><table><tr><td>white precipitate (1)</td><td>(precipitate) does not dissolve / (precipitate) insoluble / white precipitate remains (1)</td></tr><tr><td>white precipitate (1)</td><td>(precipitate) dissolves / (precipitate) soluble (in excess) / colourless solution (1)</td></tr></table></td><td>3</td></tr>
</table>

| Question | Answer | Marks |
|---|---|---|
| 7(a)(i) | graphite (1)<br><br>conducts electricity / inert (1) | **2** |
| 7(a)(ii) | positive electrode: chlorine (1)<br><br>negative electrode: magnesium (1) | **2** |
| 7(b) | (C), A, F, D, B, E (2)<br>if 2 marks not scored 1 mark for 1 consecutive pair reversed | **2** |
| 7(c) | 1 mark each for any two of:<br>• high density ORA for Mg<br>• forms coloured compounds ORA for Mg<br>• forms ions with different charges / has variable oxidation number ORA for Mg<br>• forms complex ions ORA for Mg<br>• copper is catalyst ORA for Mg<br>• reference to difference in chemical properties e.g. magnesium reacts with dilute acid / copper does not react with dilute acid | **2** |
| 7(d)(i) | R | **1** |
| 7(d)(ii) | T | **1** |
| 7(d)(iii) | R | **1** |

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

**CHEMISTRY** **0620/41**

Paper 4 Theory (Extended) **October/November 2019**

MARK SCHEME

Maximum Mark: 80

**Published**

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.



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## Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

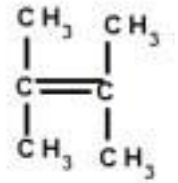
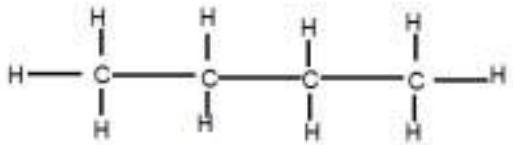
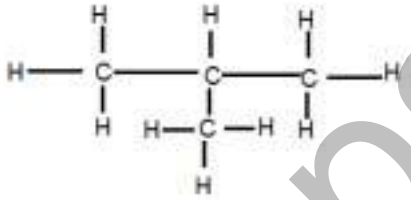
| |
|---|
| GENERIC MARKING PRINCIPLE 5:<br><br>Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen). |
| GENERIC MARKING PRINCIPLE 6:<br><br>Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind. |

| Question | Answer | Marks |
|---|---|---|
| 1(a)(i) | $K^+$ | **1** |
| 1(a)(ii) | $Cr^{3+}$ | **1** |
| 1(a)(iii) | $Ca^{2+}$ | **1** |
| 1(a)(iv) | $Br^-$ | **1** |
| 1(a)(v) | $SO_4^{2-}$ | **1** |
| 1(b) | (compound / salt) on wooden splint **or** (nichrome / platinum) wire (1)<br>into (roaring) Bunsen flame (1) | **2** |
| 1(c) | $Mg_3(PO_4)_2$ | **1** |

| Question | Answer | Marks |
|---|---|---|
| 2(a) | atoms with same number of protons **or** atoms of the same element **or** atoms with same atomic number (1)<br>atoms with different number of neutrons **or** atoms with different mass number **or** atoms with different nucleon number (1) | **2** |
| 2(b)(i) | 18 | **1** |
| 2(b)(ii) | gain of two electrons | **1** |
| 2(b)(iii) | Ca / calcium | **1** |
| 2(c)(i) | l…..g…..g. | **1** |
| 2(c)(ii) | vanadium (V) oxide **or** vanadium pentoxide (1)<br>450 (°C) (1) | **2** |
| 2(c)(iii) | $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ (1)<br>$H_2S_2O_7 + H_2O \rightarrow 2\ H_2SO_4$ (1) | **2** |
| 2(d)(i) | (it causes) acid rain | **1** |
| 2(d)(ii) | test – (aqueous) potassium manganate (VII) (1)<br>(purple to) colourless (1) | **2** |
| 2(e) | 29.1 / 23 40.5 / 32 30.4 / 16 **or** 1.2(65) 1.2(65) 1.9 (1)<br>1:1:1.5 (1)<br>$Na_2S_2O_3$ (1) | **3** |

| Question | Answer | Marks |
|---|---|---|
| 3(a) | malleable / conduct electricity / conduct heat | **1** |
| 3(b) | water and oxygen / air | **1** |
| 3(c)(i) | (zinc is) more reactive than iron | **1** |
| 3(c)(ii) | $Fe^{3+}$ (1)<br>accept / take / gain electrons (1) | **2** |
| 3(d) | (add a) named acid (1)<br>(add a) named alkali (1)<br>disappears / dissolves in both (1) | **3** |

| Question | Answer | Marks |
|---|---|---|
| 4(a)(i) | cobalt carbonate | **1** |
| 4(a)(ii) | lead iodide | **1** |
| 4(b) | $2\ AgNO_3 + Na_2CO_3 \rightarrow Ag_2CO_3 + 2\ NaNO_3$<br>formula of silver carbonate correct (1)<br>fully correct equation (1) | **2** |
| 4(c) | $Pb^{2+} + 2\ I^- \rightarrow PbI_2$<br>$Pb^{2+}$ **and** $I^-$ on left of equation (1)<br>fully correct equation (1) | **2** |
| 4(d) | (nitric) acid reacts with / removes carbonate ions | **1** |

| Question | Answer | Marks |
|---|---|---|
| 5(a)(i) | addition | **1** |
| 5(a)(ii) | $CH_2$ | **1** |
| 5(a)(iii) |  <br>one C=C (1)<br>fully correct structure (1) | **2** |
| 5(b)(i) | (compounds / molecules with) the same molecular formula (1)<br>different structural formulae (1) | **2** |
| 5(b)(ii) |  <br>(1)<br>  <br>(1) | **2** |
| 5(b)(iii) | $H_2O$ **and** CO **or** C formed (1)<br>$2\ C_4H_{10} + 9\ O_2 \rightarrow 8\ CO + 10\ H_2O$ (1) | **2** |

| Question | Answer | Marks |
|---|---|---|
| 6(a) | correct final answer = 0.072(0)<br><br>**M1** moles HC*l* = 0.0036(0)<br>**M2** moles $Na_2CO_3$ = 0.0018(0) (**M1** / 2)<br>**M3** concentration $Na_2CO_3$ = 0.072 (**M2** / 0.025) | **3** |
| 6(b) | 0.002(00) | **1** |
| 6(c)(i) | 720(.09) | **1** |
| 6(c)(ii) | (it contains) ions (1)<br>(ions) are able to move (1) | **2** |
| 6(c)(iii) | magnesium is not inert | **1** |
| 6(b)(iv) | bromine / $Br_2$ | **1** |
| 6(b)(v) | $H^+$ and $e^{(-)}$ on LHS (1)<br>fully correct, i.e.: $2H^+ + 2e^- \rightarrow H_2$ (1) | **2** |
| 7(a) | $C_6H_{12}O_6 \rightarrow 2CO_2 + 2C_2H_5OH$ (1)<br><br>any three from<br>• anaerobic<br>• 30 °C<br>• yeast<br>• glucose aqueous<br><br>fractional distillation (of aqueous ethanol) (1) | **5** |
| 7(b) | (energy to break bonds) = 4728 (1)<br>(energy released by making bonds) = 6004 (1)<br>–1276 (1) | **3** |

| Question | Answer | Marks |
|---|---|---|
| 7(c)(i) | speeds up a (chemical) reaction (1)<br>not used up **or** unchanged (at end) (1) | **2** |
| 7(c)(ii) | 4 electrons in double bond between C and O (1)<br>all single bonds correct (1)<br>C and O each have 8 electrons in outer shell, all H have 2 electrons in outer shell (1) | **3** |
| 7(c)(iii) | (attractive) forces between molecules weak**er** in ethanal | **1** |
| 7(d)(i) | moves right (1)<br>fewer moles / molecules (of gas) on right (1) | **2** |
| 7(d)(ii) | (reaction is faster) because more collisions per second (1)<br>particles / molecules closer together **or** more particles / molecules per unit volume (1) | **2** |
| 7(d)(iii) | moves left (1)<br>(forward) reaction is exothermic **or** backward reaction is endothermic (1) | **2** |