Cambridge Assessment International Education

# Cambridge IGCSE™

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**CHEMISTRY** **0620/33**

Paper 3 Theory (Core) **May/June 2025**

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

**INSTRUCTIONS**

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

**INFORMATION**

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

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**1** A list of substances is shown.

**calcium**
**calcium oxide**
**carbon**
**carbon dioxide**
**chlorine**
**copper**
**gold**
**iodine**
**neon**
**nitrogen**
**oxygen**
**potassium**
**sulfur dioxide**

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

State which substance is:

**(a)** an element which forms an ion with a 3– charge

View solution

..... [1]

**(b)** a transition element

View solution

..... [1]

**(c)** a gas that is identified using limewater

View solution

..... [1]

**(d)** approximately 78% of clean, dry air

View solution

..... [1]

**(e)** used in electrical wiring

View solution

..... [1]

**(f)** the least reactive metal in the list

View solution

..... [1]

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**(g)** a diatomic molecule which is a solid at room temperature and pressure

..... [1]

**(h)** a compound that reacts with impurities in the blast furnace to form slag

View solution

..... [1]

**(i)** an element with a relative atomic mass of 12.

View solution

..... [1]

[Total: 9]

**2** This question is about sea water and the substances found in sea water.

**(a)** Table 2.1 shows the masses of the compounds present when a 2000 $cm^3$ sample of sea water is evaporated.

View solution

**Table 2.1**

| compound | formula | mass of compound / g |
|---|---|---|
| sodium chloride | NaC$l$ | 28.0 |
| | $MgSO_4$ | 5.5 |
| potassium chloride | KC$l$ | 2.5 |
| calcium carbonate | $CaCO_3$ | 2.0 |

Answer these questions using the information from Table 2.1.

**(i)** State the chemical name of $MgSO_4$.

..... [1]

**(ii)** The total mass of compounds formed from 2000 $cm^3$ of sea water is 38.0 g. Calculate the total mass of compounds present in 800 $cm^3$ of sea water.

View solution

mass = ..... g [1]

**(iii)** Potassium chloride is soluble in water.

View solution

Choose **one other** compound that is soluble in water.

Tick (✓) **one** box.

lead(II) sulfate ☐

magnesium carbonate ☐

silver chloride ☐

sodium hydroxide ☐

[1]

**(b)** Potassium iodide is also found in sea water and contains iodide ions.

View solution

Describe a test for iodide ions.

test .....

.....

observations .....

.....

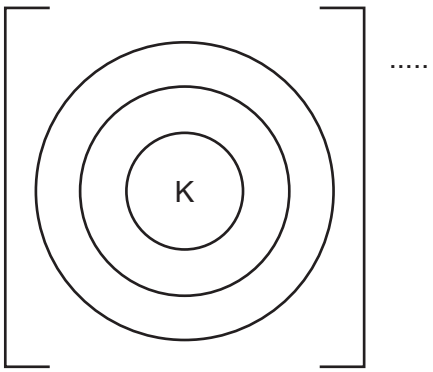
[2]

View solution

**(c)** Potassium chloride contains potassium ions.

Complete Fig. 2.1 to show:

- the electronic configuration of a potassium ion
- the charge on the ion.




.....

**Fig. 2.1**

[2]

View solution

**(d)** Sodium chloride is a solid at room temperature.

Describe the separation and motion of the particles in a solid.

separation .....

.....

motion .....

.....

[2]

**(e)** Sea water contains dissolved phosphate ions.

View solution

State **one** source of phosphate ions.

..... [1]

View solution

**(f)** Water is a simple molecular compound.

Complete the dot-and-cross diagram in Fig. 2.2 for a molecule of water.

Show outer electrons only.

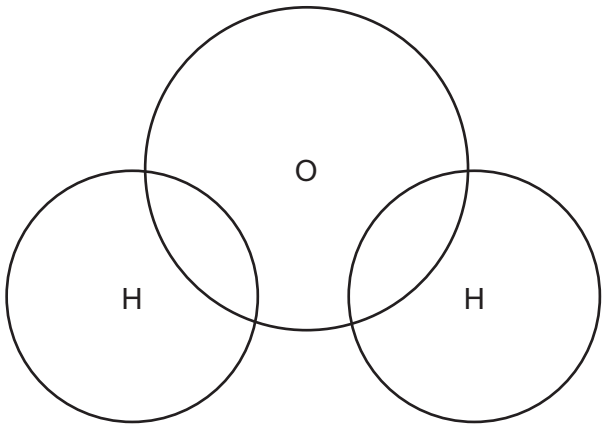



**Fig. 2.2**

[2]

[Total: 12]

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**3** This question is about organic chemistry.

**(a)** Petroleum is a mixture of hydrocarbons and is separated by fractional distillation in an industrial process.

**(i)** State which physical property of hydrocarbons allows them to be separated by fractional distillation.

..... [1]

**(ii)** Describe how petroleum is separated into fractions by fractional distillation.

View solution

.....

.....

..... [2]

**(iii)** Name the process that breaks down long chain hydrocarbon molecules to form short chain hydrocarbon molecules.

..... [1]

**(iv)** Some of the fractions obtained from petroleum are shown.

Draw a line from each fraction to its use.

| fraction | use |
|---|---|
| bitumen | waxes and polishes |
| lubricating oil | making roads |
| naphtha | chemical feedstock |

[2]

**(b)** Ethanoic acid is an organic molecule.

View solution

**(i)** Draw the displayed formula of a molecule of ethanoic acid.

[2]

**(ii)** Ethanoic acid reacts with sodium carbonate.

View solution

Name the salt produced in this reaction.

..... [1]

**(c)** Ethane is burned in excess oxygen.

View solution

Name the **two** products of this process.

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

**(d)** Ethanol is another organic molecule.

View solution

State **two** ways to manufacture ethanol.

1 .....

2 .....

[2]

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**(e)** Fig. 3.1 shows the displayed formula of an organic molecule.

View solution

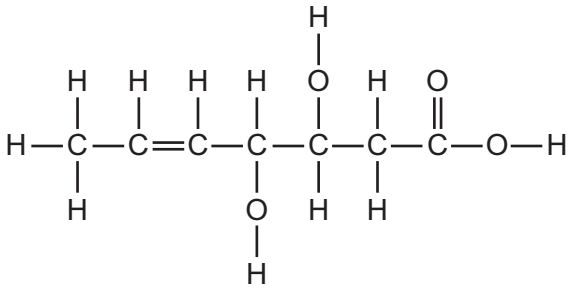


**Fig. 3.1**

**(i)** Deduce the molecular formula of the molecule in Fig. 3.1.

..... [1]

**(ii)** Explain why the molecule in Fig. 3.1 is unsaturated.

..... [1]

[Total: 15]

View solution

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

**(a)** **(i)** Explain why nitrogen is in Group V of the Periodic Table.

View solution

.....

..... [1]

**(ii)** Two isotopes of nitrogen are shown in Fig. 4.1.

View solution

$^{14}_{7}N$ $^{15}_{7}N$

**Fig. 4.1**

Complete Table 4.1 to show the number of protons, neutrons and electrons in one atom of these isotopes.

**Table 4.1**

| | protons | neutrons | electrons |
|---|---|---|---|
| $^{14}_{7}N$ | | | |
| $^{15}_{7}N$ | | | |

[3]

**(b)** Oxides of nitrogen are air pollutants.

View solution

**(i)** State **one** source of oxides of nitrogen in the air.

..... [1]

**(ii)** Ammonia reacts with oxygen to form nitrogen dioxide and water.

View solution

Complete the symbol equation for this reaction.

$$4NH_3 + 7O_2 \rightarrow 4NO_2 + .....H_2O$$

[1]

**(iii)** State the type of bonding between the atoms in nitrogen dioxide.

..... [1]

View solution

**(iv)** State whether nitrogen dioxide is an acidic or basic oxide.

View solution

Give a reason for your answer.

.....

..... [1]

View solution

**(c)** A compound of nitrogen has the formula $Al(NO_3)_3$.

Complete Table 4.2 to calculate the relative formula mass of $Al(NO_3)_3$.

**Table 4.2**

| atom | number of atoms | relative atomic mass | |
|---|---|---|---|
| oxygen | 9 | 16 | 9 × 16 = 144 |
| aluminium | | 27 | |
| nitrogen | | 14 | |

relative formula mass = .....
[2]

[Total: 10]

**5** This question is about ionic compounds and simple molecular compounds.

**(a)** Complete the word equation to show the reaction between copper(II) carbonate and nitric acid.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| copper(II) carbonate | + | nitric acid | → | ..... ..... | + | ..... ..... | + | View solution ..... |

[3]

**(b)** Aqueous magnesium chloride is prepared by adding excess magnesium oxide powder to dilute hydrochloric acid.

Describe how to prepare a sample of pure, dry magnesium chloride crystals **after** the reaction is complete.

View solution

In your answer describe how to:

- remove the excess magnesium oxide from the reaction mixture
- crystallise the magnesium chloride
- dry the crystals.

.....

.....

.....

.....

.....

..... [3]

**(c)** Fig. 5.1 shows the apparatus for the electrolysis of molten cobalt(II) bromide using inert electrodes.

View solution

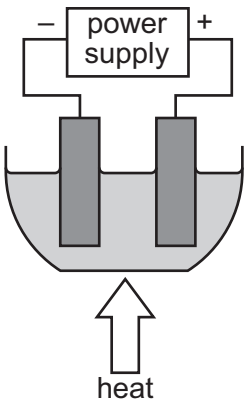



**Fig. 5.1**

**(i)** Label Fig. 5.1 to show the:

- anode
- electrolyte. [2]

**(ii)** Name the products formed at the positive and negative electrodes.

positive electrode .....

negative electrode .....

[2]

View solution

**(d)** Table 5.1 shows some properties of five compounds, **A**, **B**, **C**, **D** and **E**.

**Table 5.1**

| compound | electrical conductivity when molten | density in g/cm$^3$ | melting point in °C |
|---|---|---|---|
| **A** | conducts | 1.85 | 115 |
| **B** | does not conduct | 2.65 | 1713 |
| **C** | does not conduct | 0.42 | –182 |
| **D** | conducts | 2.99 | 1190 |
| **E** | does not conduct | 1.56 | –101 |

State which **two** of the compounds, **A**, **B**, **C**, **D** and **E**, are simple molecules.

Give **two** reasons for your answer.

compounds ..... and .....

reason 1.....

reason 2 .....

[3]

[Total: 13]

**6** This question is about chemical reactions and their energy changes.

View solution

**(a)** Tick (✓) **one** box that shows a chemical change.

| | |
|---|---|
| boiling ethanol | ☐ |
| decomposing vegetation | ☐ |
| dissolving salt | ☐ |
| mixing ink and water | ☐ |

[1]

View solution

**(b)** Table 6.1 shows the results of four experiments.

**Table 6.1**

| experiment | initial temperature / °C | final temperature / °C |
|---|---|---|
| 1 | 20 | 14 |
| 2 | 18 | 26 |
| 3 | 19 | 25 |
| 4 | 17 | 12 |

**(i)** State which experiment shows the greatest temperature change.

..... [1]

**(ii)** State which experiment is the most endothermic.

..... [1]

View solution

**(iii)** Fig. 6.1 shows an incomplete reaction pathway diagram for an exothermic reaction.

View solution

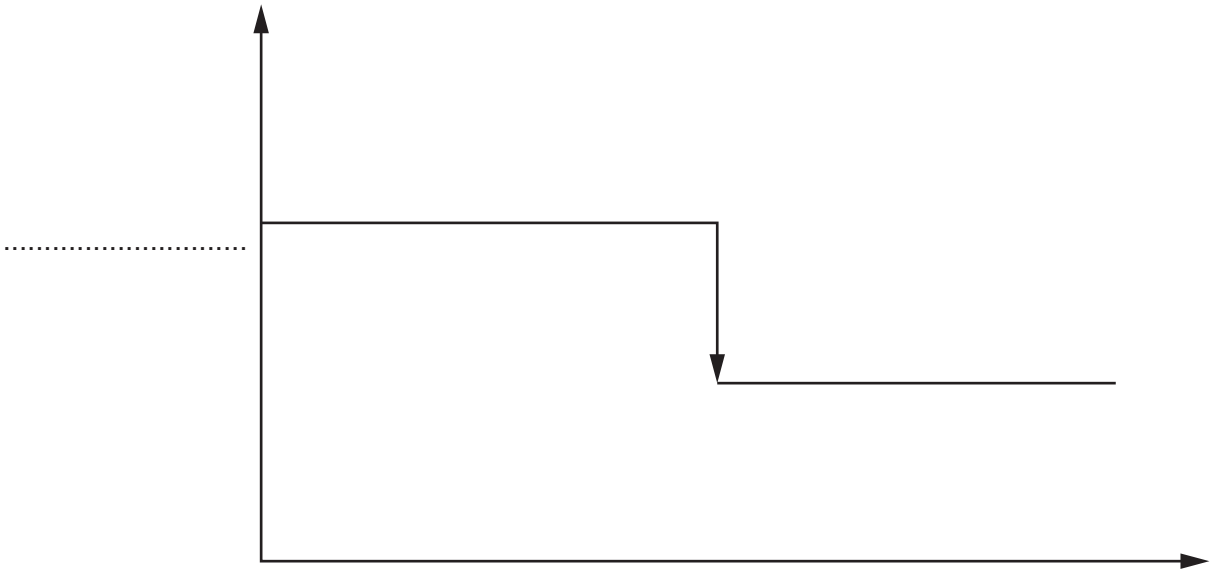



**Fig. 6.1**

Complete Fig. 6.1 by labelling:

- the vertical axis
- the reactants
- the products. [2]

[Total: 5]

**7** This question is about air and water.

**(a)** Water needs to be treated to make it safe to drink.

View solution

Complete Fig. 7.1 to show the three stages needed in the treatment of domestic water. The second stage has been completed.

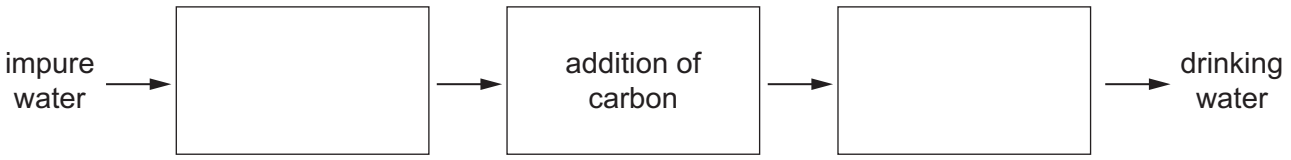



**Fig. 7.1**

[2]

**(b)** Describe a chemical test for the presence of water.

View solution

test .....

.....

observations .....

.....

[2]

**(c)** A sample of air contains carbon dioxide and oxides of nitrogen.

View solution

State **one** harmful effect of each of these air pollutants.

carbon dioxide .....

oxides of nitrogen .....

[2]

[Total: 6]

**8** This question is about metals.

**(a) (i)** A student investigates the reaction of four different metals, **A**, **B**, **C** and **D**, with dilute sulfuric acid.

View solution

All other conditions are the same.

The results of the experiments are shown in Table 8.1.

**Table 8.1**

| metal | observations |
|---|---|
| **A** | lots of bubbles at room temperature |
| **B** | no bubbles |
| **C** | few bubbles on warming |
| **D** | lots of bubbles on warming |

Put the metals, **A**, **B**, **C** and **D**, in order of their reactivity.

most reactive .....

.....

.....

least reactive ..... [1]

**(ii)** Increasing the temperature of the acid increases the rate of reaction.

View solution

State **two other** ways to increase the rate of this reaction.

1 .....

.....

2 .....

.....

[2]

**(b)** In another experiment, a student adds lithium to water. An alkaline solution is formed.

View solution

**(i)** State the colour seen in the flame test for lithium ions.

..... [1]

**(ii)** State the ion that all aqueous alkalis contain.

View solution

..... [1]

**(iii)** State the colour of thymolphthalein in an aqueous alkali.

View solution

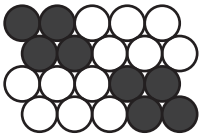
..... [1]

**(c)** Pewter is an alloy that contains tin.

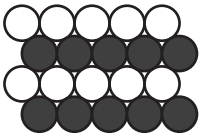
View solution

**(i)** State which **one** of these diagrams, **A**, **B**, **C** or **D**, best represents an alloy.

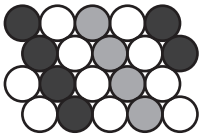
**A**



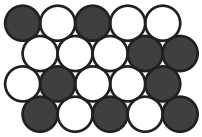
**B**



**C**



**D**



..... [1]

**(ii)** Suggest **one** property of pewter that makes it more useful than pure tin.

View solution

..... [1]

**(d)** Metals are good thermal conductors.

View solution

Describe **two other** physical properties that are typical of metals.

1 .....

2 .....

[2]

[Total: 10]

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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 – | 113 Nh nihonium – | 114 Fl flerovium – | 115 Mc moscovium – | 116 Lv livermorium – | 117 Ts tennessine – | 118 Og oganesson – |

**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.).