N5

National Qualifications

2025

Chemistry

Section 2

Thursday, 1 May

Instructions to Candidates

Candidates should enter their surname, forename(s), date of birth, Scottish candidate number and the name and level of the subject at the top of their first answer sheet.

Section 2 — 75 marks

Attempt ALL questions

You may refer to the Chemistry Data Booklet for National 5.

An ow in the margin indicates a new question.

Questions marked with an asterisk differ in some respect from those in the printed paper.

You must clearly identify the question number you are attempting on your answer sheet.

Any rough work must be written on your answer sheet.

Tactile diagrams are produced in a separately bound booklet.

Marks are shown in square brackets at the end of each question or part question.

[Braille page 2] SECTION 2 — 75 marks

Attempt ALL questions

ow 1. (a) Refer to the diagram for Question 1a. The reaction of zinc with sulfuric acid, $H_2SO_4(aq)$, is shown.

$Zn(s)+H_2SO_4(aq) \rightarrow ZnSO_4(aq)+H_2(g)$

(i) Hydrogen gas is produced in this reaction.

State the test, including the result, for hydrogen gas. [1 mark]

(ii) A student was asked to draw a diagram of the apparatus used to COLLECT AND MEASURE the volume of hydrogen gas produced during the reaction. Their diagram is shown by the separate diagram and described as follows.

A flask is shown with zinc powder in sulfuric acid. It has a delivery tube which goes into a tub containing water and a measuring cylinder. There are bubbles entering the measuring cylinder from the delivery tube.

Describe ONE way in which the student's diagram is incorrect. [1 mark]

[Braille page 3] (iii) A solution of zinc(II) sulfate, $ZnSO_4(aq)$, is produced in this reaction.

Name the technique that could be used to obtain a DRY sample of zinc(II) sulfate, $ZnSO_4(s)$. [1 mark]

(b) Refer to the diagram for Question 1b. It shows a graph. The volume of hydrogen gas collected over time when zinc powder is added to 100 cm^3 of dilute sulfuric acid was recorded.

A graph of the results is shown.

(i) Calculate the average rate of reaction, in cm^3s^{-1}, for the first 50 seconds. SHOW YOUR WORKING CLEARLY. [2 marks]

(ii) State the results that would be expected if the experiment was repeated using the same mass of zinc lumps. [1 mark]

(iii) A similar experiment was carried out using the same mass of zinc powder and the same volume and concentration of hydrochloric acid, HCl(aq), in place of sulfuric acid, $H_2SO_4(aq)$.

Predict the volume of gas, in cm^3, produced in this reaction. [1 **[Braille page 4]** mark]

ow 2. Oxygen is an odourless, colourless gas that is present in the Earth's atmosphere.

(a) Describe, in detail, how a molecule of oxygen O_2, Showing ALL the outer electrons, would be represented in a diagram. [1 mark]

(b) Name an element that has similar chemical properties to oxygen. [1 mark]

(c) Refer to the diagram for Question 2c. It shows a graph. The graph shows the solubility of a compound containing oxygen at different temperatures.

State the relationship between temperature and the solubility of the compound. [1 mark]

(d) Refer to the diagram for Question 2d. Oxygen can react with fluorine to form oxygen fluoride molecules, containing covalent bonds.

A molecule of oxygen fluoride is shown.

(i) State the name used to describe the shape of an oxygen fluoride molecule. [1 mark]

(ii) From the options in the 2 sets of brackets below, write the correct words to complete the sentence. [1 mark]

[Braille page 5] A covalent bond forms when two (positive/negative/neutral) nuclei are held together by their common attraction for a shared pair of (protons/neutrons/electrons).

ow * 3. Refer to the diagram for Question 3a. Plastics which soften when heated are classed as thermosoftening plastics.

(a) Poly(vinyl chloride), PVC, is an example of a thermosoftening plastic and is used in the manufacture of clothing.

The repeating unit of PVC is shown.

(i) Describe the monomer used to make PVC. [1 mark]

(ii) When PVC is burned, the gas hydrogen chloride is formed.

Hydrogen chloride molecules, HCl(g), contain only two atoms.

State the term used to describe a molecule containing only two atoms. [1 mark]

(b) Refer to the diagram for Question 3b. It shows a graph. The melting points of five thermosoftening plastics are given in the graph, to the nearest 10 degrees Celsius.

(i) Produce a table to show this information for the five thermosoftening plastics. [2 marks]

[Braille page 6] You can write your table in linear braille format as follows.

[In the table below, _ is followed by: _.]

_: _.

_: _.

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_: _.

_: _.

(ii) Suggest why PVC could NOT be used as a container for boiling water. [1 mark]

ow 4. Refer to the diagrams for Question 4, figures 1-3. Many medicines are compounds that contain carbon atoms.

The table below shows some examples of these medicines and their use.

[In the table below, Name of medicine is followed by: Use of medicine; Structure of molecule.]

L-DOPA: treatment of Parkinson's disease; Figure 1.

Dopamine: treatment of low blood pressure; Figure 2.

Ibuprofen: treatment of pain and inflammation; Figure 3.

[Braille page 7] (a) Name the functional group that is present in both L-DOPA and ibuprofen but is NOT present in dopamine. [1 mark]

(b) A key step in producing L-DOPA involves an addition reaction with hydrogen molecules. This is carried out using a catalyst.

(i) Name the type of addition reaction that involves the addition of hydrogen. [1 mark]

(ii) State what is meant by the term catalyst. [1 mark]

(c) Refer to the 2 diagrams for Question 4c. Many medicine molecules contain a chiral carbon which can affect their ability to work as a medicine.

A chiral carbon is any carbon atom that is attached to four different atoms or groups of atoms.

The chiral carbon in the L-DOPA molecule is circled in the diagram.

Ibuprofen also has a chiral carbon in its molecule.

Describe where the chiral carbon is in the ibuprofen structure diagram. [1 mark]

(d) An antagonist is a medicine that works by blocking the body's normal function.

[Braille page 8] Painkillers are common examples of antagonists which work by blocking the body's response to pain.

Name the medicine, from the table above, before 4(a), which would be described as an antagonist. [1 mark]

ow 5. Petrol is a fuel used in some car engines.

(a) State what is meant by the term fuel. [1 mark]

(b) The hydrocarbon iso-octane is added to petrol to improve performance in car engines.

(i) The systematic name for iso-octane is 2,2,4-trimethylpentane.

Describe a structure for iso-octane. [1 mark]

(ii) Refer to the diagram for Question 5b(ii). Iso-octane is produced by reacting together iso-butane and iso-butene.

State the test, including the result, that could be used to distinguish between a sample of iso-butane and iso-butene. [1 mark]

(c) The flash point is the lowest temperature at which a fuel can catch fire.

The table shows the flash point of some alkanes.

[Braille page 9] [In the table below, Alkane is followed by: Flash point (°C).

Hexane: −22.

2,2,4-trimethylpentane: −12.

Heptane: −4.

2,2-dimethylhexane: −3.

2-methylheptane: 4.

Octane: 13.

(i) State the effect that increasing the number of branches in alkanes, containing the same number of carbon atoms, has on the flash point of the alkane. [1 mark]

(ii) Refer to the diagram for Question 5c(ii). Predict the flash point, in °C, of the alkane shown. [1 mark]

(d) Alcohols are commonly added to petrol to help them burn. These compounds are often described as oxygenates.

(i) Suggest why oxygenates help petrol burn. [1 mark]

(ii) The alcohols most commonly added to petrol are methanol and ethanol.

[Braille page 10] The boiling points of methanol and ethanol are shown.

[In the table below, Alcohol is followed by: Boiling point (°C).]

Methanol: 65.

Ethanol: 78.

Explain why ethanol has a higher boiling point than methanol. [2 marks]

ow 6. Fertilisers are substances which restore the elements essential for healthy plant growth to the soil.

USING YOUR KNOWLEDGE OF CHEMISTRY, describe the chemistry of fertilisers. [3 marks]

ow 7. Radioactive decay occurs when unstable radioisotopes emit radiation to become more stable.

(a) State the part of the atom involved in radioactive decay. [1 mark]

(b) Phosphorus-32 is a radioisotope that is fed to mosquitoes to track how far they travel.

A solution of sodium hydrogen phosphate, containing phosphorus-32, was fed to mosquitoes.

(i) Name the other elements present in sodium hydrogen phosphate. [1 **[Braille page 11]** mark]

(ii) State how the half-life of phosphorus-32, present in sodium hydrogen phosphate, compares to the half-life of a pure phosphorus-32 sample. [1 mark]

(c) Iodine-131 is a radioisotope which emits beta radiation and is used in medicine.

(i) The equation for the beta decay of iodine-131 is shown.

$$^{131}_{53}\mathrm{I} \rightarrow \mathrm{X} + {}^{0}_{-1}\mathrm{e}$$

Name the element represented by X in the equation. [1 mark]

(ii) A sample of iodine-131 had a mass of 40 g. After being left for 32 days the sample had a mass of 2.5 g.

Calculate the half-life, in days, of iodine-131. [2 marks]

(d) Refer to the diagram for Question 7d. It shows a graph. Another radioisotope used in medicine is cobalt-60. Cobalt-60 has a half-life of 5 years.

A graph of the percentage of a cobalt-60 sample remaining over time is shown.

(i) State the scale to the x-axis. [1 mark]

[Braille page 12] (ii) State the label to the x-axis. [1 mark]

ow 8. Read the passage and answer the questions that follow.

The Mole

Atoms and molecules are so small that even one gram of a substance contains many trillions of atoms.

To simplify this, chemists measure the quantity of a chemical using a unit called the mole. This term was introduced in 1865 by the chemist August Wilhelm von Hofmann to describe the mass of a molecule, because the Latin term for mass is moles.

Another scientist, Amedeo Avogadro, took this one step further by defining one mole as the number of carbon atoms in 12 g of carbon, where each atom contains six protons and six neutrons. This number, known as Avogadro's number, is 6.02×10^{23}.

For example, one mole of water contains 6.02×10^{23} water molecules.

Avogadro's number is represented by the letter L. This can be used to calculate the number of atoms in one mole of molecules as shown in the table.

End of passage

[Braille page 13] [In the table below, Molecular formula is followed by: Total number of atoms in molecule; Number of atoms in one mole.]

HCl: 2; 2L.

NH_3: 4; 4L.

(a) State the meaning of the Latin term ‘moles’. [1 mark]

(b) Write the nuclide notation for the carbon atom used to define Avogadro's number. [1 mark]

(c) Calculate the mass, in grams, of 6.02×10^{23} water molecules, H_2O. [1 mark]

(d) Suggest why the number of electrons was not considered when calculating the mass of a carbon atom. [1 mark]

(e) Complete the sentences below for methane with the correct numbers at (A) and (B). [1 mark]

For the molecular formula CH_4 the total number of atoms in the molecule are (A).

For the molecular formula CH_4 the number of atoms in one mole are (B).

[Braille page 14]

ow 9. Propanol is an alcohol containing three carbon atoms.

(a) Propanol has two possible structures.

(i) State the term used to describe these two structures of propanol. [1 mark]

(ii) Describe AND name one of the structures of propanol, C_3H_7OH. [2 marks]

(b) The equation for the combustion of propanol is shown.

$C_3H_7OH+O_2 \rightarrow CO_2+H_2O$

Balance this equation. [1 mark]

(c) Refer to the diagram for Question 9c. A student carried out an investigation to calculate the energy released when burning propanol using the apparatus shown.

The water is being heated in a metal can by a burner containing propanol. There is a thermometer in the water. There is a draught shield placed on both sides of the apparatus.

[Braille page 15] (i) Explain why the use of a draught shield improves the accuracy of the student's results. [1 mark]

(ii) The student burned propanol three times and recorded the temperature change of the water each time.

(A) Calculate the average temperature change of the water, in °C, for the student's three experiments. [1 mark]

(B) Using your answer to part (c)(ii)(A), calculate the average energy, in kJ, absorbed by the water in the student's investigation. [3 marks]

ow 10. Sodium carbonate, Na_2CO_3, is a white, water-soluble compound.

(a) One of the many uses of sodium carbonate is in dishwasher tablets.

Dishwasher tablets must be soluble in water.

(i) State the term used to describe liquids, like water, in which substances dissolve to form solutions. [1 mark]

(ii) Dishwasher tablets are often coated in a water-soluble plastic known as poly(ethenol) which is formed by addition polymerisation.

[Braille page 16] (A) Name the monomer used to make poly(ethenol). [1 mark]

(B) Suggest why ethanol could NOT be used as a monomer in an addition polymerisation reaction. [1 mark]

(b) Refer to the diagram for Question 10. An experiment to determine the concentration of a hydrochloric acid solution using a solution of sodium carbonate is shown.

The diagram shows a piece of apparatus containing 0.1mol l^{-1} sodium carbonate solution. The apparatus is above a flask containing 25 cm^3 of hydrochloric acid and indicator.

(i) State the name given to this technique. [1 mark]

(ii) Suggest why an indicator is added to the flask. [1 mark]

(iii) The average volume of sodium carbonate, Na_2CO_3, used in the experiment was 19.0 cm^3.

Sodium carbonate, Na_2CO_3, reacts with hydrochloric acid, HCl, in the ratio shown.

[Braille page 17]

1 mol Na_2CO_3:2 mol HCl

Calculate the concentration, in mol l^{-1}, of the hydrochloric acid, HCl, used in the experiment.

SHOW YOUR WORKING CLEARLY. [3 marks]

ow 11. A neutralisation reaction between lithium oxide and nitric acid is shown.

$Li_2O(aq)+HNO_3(aq) \rightarrow LiNO_3(aq)+H_2O(l)$

(a) Name the salt produced in the reaction of lithium oxide and nitric acid. [1 mark]

(b) Calculate the mass, in grams, of lithium oxide, Li_2O, required to prepare 250 cm^3 of 0.5 mol l^{-1} solution.

SHOW YOUR WORKING CLEARLY. [3 marks]

(c) Another neutralisation reaction is shown.

[Braille page 18]

$H_2SO_4 + X \rightarrow CuSO_4 + H_2O + CO_2$

Name substance X. [1 mark]

(d) Refer to the 3 diagrams for Question 11(d) (ii)(A). Neutralisation reactions release heat energy.

(i) State the term used to describe any reaction that releases heat energy. [1 mark]

(ii) Activation energy, Ea, and enthalpy change, ΔH are energy values that are associated with chemical reactions.

A potential energy diagram can be used to show these values.

(A) Two potential energy diagrams are shown, X and Y.

Calculate the enthalpy change, ΔH, in kJ, for the potential energy diagram Z. [1 mark]

(B) Refer to the diagram for Question 11(d) (ii) (B). When a catalyst is added to a reaction, the effect can also be seen on potential energy diagrams.

To show the effect of a catalyst on the **[Braille page 19]** activation energy, Ea, and the enthalpy change, ΔH, from the options in the brackets below, select the correct word or phrase to complete the following two sentences. [2 marks]

1. The effect of catalyst on activation energy, Ea, shows (increase/decrease/no effect).

2. The effect of catalyst on enthalpy change, ΔH shows (increase/decrease/no effect).

ow 12. The reactivity series lists metals in order of reactivity.

USING YOUR KNOWLEDGE OF CHEMISTRY, suggest experiment(s) that a student could carry out to place calcium, copper, tin and zinc into a reactivity series. [3 marks]

[END OF QUESTION PAPER]