Chemistry

Standard Level

Paper 2 — Mock Examination

Mock Exam 2

Calculator required

Time allowed: **1 hour 30 minutes**

Maximum mark: **50 marks**

Candidate information

Candidate name: .....

Session number: .....

Date: .....

Topic emphasis: models of the particulate nature of matter, the periodic table and periodicity, models of bonding and structure, what drives chemical reactions, how much and how fast, and electron transfer reactions.

Instructions to candidates

- Write your session number in the box on the cover.
- Do not open this examination paper until you are told to do so.
- Answer **all** questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- A clean copy of the **chemistry data booklet** is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.

The mark allocation is shown in square brackets at the end of each question or part question. Where a numerical answer is required, values of constants, molar masses, electronegativities and enthalpy data should be taken from the chemistry data booklet unless they are given in the question. Show your working for all calculations; marks are available for correct method even where the final answer is incorrect.

Take the molar volume of an ideal gas at STP to be 22.7 $dm^3\,mol^{-1}$, Avogadro's constant to be $6.02 \times 10^{23}\ mol^{-1}$, the specific heat capacity of water to be 4.18 $J\,g^{-1}\,K^{-1}$ and the ideal gas constant to be R = 8.31 $J\,K^{-1}\,mol^{-1}$. All questions refer to standard conditions and to a temperature of 298 K unless otherwise stated.

Mark allocation

Question	Marks
Question 1 — Magnesium and its compounds	[17]
Question 2 — Ethanol, ethene and polymers	[18]
Question 3 — Electron transfer reactions	[15]
Total	**[50]**

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Magnesium is a group 2 metal used in lightweight alloys and in emergency flares.

(a) (i) Deduce the full electron configuration of the magnesium atom. **[1]**

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(ii) Explain why the first ionization energy of magnesium is greater than that of sodium. **[2]**

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(iii) The first four successive ionization energies of magnesium, in $kJ\,mol^{-1}$, are:

738 1451 7733 10 540

Explain the large increase between the second and the third ionization energy. **[2]**

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(Question 1 continued)

(b) Magnesium burns in oxygen with a bright white flame. In one experiment 1.215 g of magnesium was heated with 1.60 g of oxygen.

(i) Write the equation for this reaction. **[1]**

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(ii) Determine the limiting reactant and calculate the mass of magnesium oxide formed. Use section 7 of the data booklet. **[3]**

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(iii) Magnesium oxide has a melting point of 3125 K. Explain this high melting point with reference to structure and bonding. **[2]**

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(Question 1 continued)

(c) Deduce, showing your working, the type of bonding present in magnesium chloride, $MgCl_2$. Use section 9 of the data booklet. **[1]**

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(d) Magnesium reacts with dilute hydrochloric acid.

$$Mg(s) + 2\,HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

(i) Write the ionic equation for this reaction, including state symbols. **[1]**

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(ii) Calculate the volume of hydrogen, in dm^3, produced from 0.0500 mol of magnesium at 300 K and 1.00×10^5 Pa. Use section 1 of the data booklet. **[2]**

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(iii) Explain why powdered magnesium reacts more rapidly with the acid than a magnesium ribbon of the same mass. **[2]**

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2. Ethanol is used as a fuel additive. It is manufactured both by the fermentation of glucose and by the hydration of ethene.

(a) (i) Write the equation for the complete combustion of ethanol. **[1]**

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In a calorimetry experiment, 0.500 g of ethanol was burned and the heat released raised the temperature of 200.0 g of water by 14.0 °C.

(ii) Calculate the heat released, in kJ. Use section 1 of the data booklet. **[1]**

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(iii) Calculate the experimental enthalpy of combustion of ethanol, in kJ mol^{-1}. **[2]**

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(Question 2 continued)

(iv) The data booklet value for the enthalpy of combustion of ethanol is $-1367\ \text{kJ mol}^{-1}$.

Suggest **two** reasons why the experimental value differs from this value. **[2]**

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(b) Ethanol can be oxidized by acidified potassium dichromate(VI).

(i) State the conditions required to obtain ethanoic acid as the product, and give the name of the organic product formed if the product is instead distilled off immediately. **[2]**

Conditions: .....

Name of product on immediate distillation: .....

(ii) State the colour change observed during this oxidation. **[1]**

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(Question 2 continued)

(c) Ethene, C_2H_4, reacts readily with bromine.

(i) State the type of reaction and the name of the organic product. **[2]**

Type of reaction: .....

Name of product: .....

(ii) State what would be observed when ethene is bubbled through bromine water. **[1]**

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(iii) Draw the repeating unit of poly(ethene) and state the type of polymerization that occurs. **[2]**

Type of polymerization: .....

(Question 2 continued)

(d) Explain why ethanol, C_2H_5OH, has a much higher boiling point than ethane, C_2H_6, even though the two molecules have a similar molar mass. **[2]**

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(e) State the name of a functional group isomer of ethanol. **[1]**

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3. The concentration of iron(II) ions in a solution can be found by titration with acidified potassium manganate(VII).

$$MnO_4^-(aq) + 5\,Fe^{2+}(aq) + 8\,H^+(aq) \longrightarrow Mn^{2+}(aq) + 5\,Fe^{3+}(aq) + 4\,H_2O(l)$$

(a) (i) Deduce the oxidation state of manganese in MnO_4^- and in Mn^{2+}, and identify the species that is reduced. **[2]**

Oxidation state in MnO_4^-: .....

Oxidation state in Mn^{2+}: .....

Species reduced: .....

(ii) 25.00 cm^3 of the iron(II) solution required 20.00 cm^3 of 0.0200 mol dm^{-3} potassium manganate(VII) solution to reach the end point.

Calculate the concentration of the iron(II) ions, in mol dm^{-3}. **[3]**

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(Question 3 continued)

(iii) State the colour change observed at the end point. **[1]**

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(b) A voltaic cell is made by connecting a zinc half-cell to a copper half-cell.

(i) Write the half-equation for the reaction occurring at each electrode. **[2]**

Zinc electrode: ……

Copper electrode: ……

(ii) State the direction of electron flow in the external circuit and identify the negative electrode. **[2]**

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(iii) Outline the function of the salt bridge. **[1]**

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(Question 3 continued)

(c) Molten magnesium chloride, $MgCl_2(l)$, is electrolysed using inert electrodes.

(i) Write the half-equation for the reaction at each electrode. **[2]**

Cathode (negative electrode): .....

Anode (positive electrode): .....

(ii) Explain why molten magnesium chloride conducts electricity but solid magnesium chloride does not. **[1]**

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(d) Deduce, giving a reason, whether zinc metal will react with aqueous copper(II) sulfate. **[1]**

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End of examination.

Total: **50 marks**