OCR
Oxford Cambridge and RSA

Friday 21 June 2024 – Morning

A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Time allowed: 1 hour 30 minutes

You must have:
- the Practical Insert (inside this document)
- the Data Sheet for Chemistry B

You can use:
- a scientific or graphical calculator
- an HB pencil

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number						Candidate number				

First name(s) ______________________________

Last name ______________________________

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Use the Insert to answer Question 4.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

ADVICE
- Read each question carefully before you start your answer.

1 This question is about electrochemical cells.

Table 1.1 shows some standard electrode potentials.

Table 1.1

Half-reaction	$E^{\ominus}$ / V
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	–0.76
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	–0.44
$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$	–0.13
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	+0.34
$Ag_2O(s) + H_2O(l) + 2e^- \rightarrow 2Ag(s) + 2OH^-(aq)$	+0.34
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.77
$Ag^+(aq) + e^- \rightarrow Ag(s)$	+0.80
$Cl_2(aq) + 2e^- \rightarrow 2Cl^-(aq)$	+1.36

(a) The values in **Table 1.1** are described as **standard** electrode potentials.

(i) Name the electrode against which these values are measured.

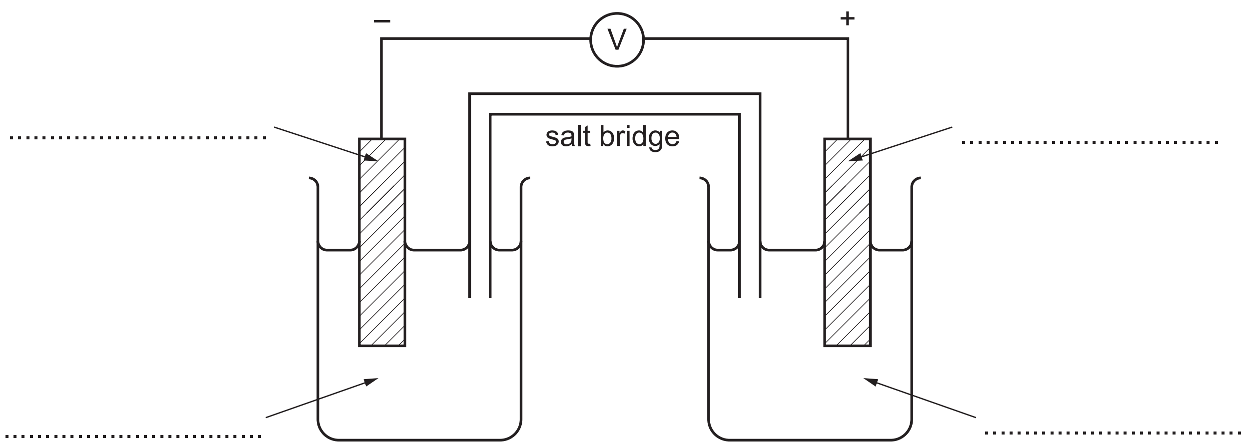
.... **[1]**

(ii) What are the standard conditions at which these standard electrode potentials are measured?

....

.... **[2]**

(b)
(i) Some students set up the cell below. The cell consists of a copper/copper ion half-cell and a lead/lead ion half-cell. The left-hand electrode is negative.



Identify the metals and ions by labelling the diagram with element symbols and ion formulae. Include state symbols. **[2]**

(ii) Suggest how the students make the salt bridge.

....

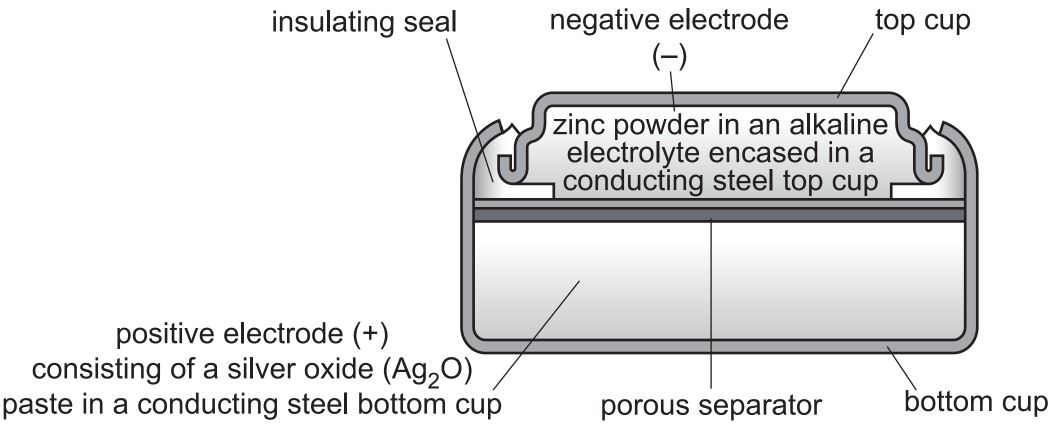
.... **[1]**

(iii) Use **Table 1.1** to calculate $E^{\ominus}$ for the cell.

$E^{\ominus}$ cell = ... V **[1]**

(c) 'Button batteries' are small cells used where there is not much space, for example, in a watch or mobile phone.

The make-up of a silver oxide (Ag_2O) button battery is shown below.



(i) Use **Table 1.1** to write ion-electron half equations for the reactions happening at the negative and positive electrodes.

Then write the equation for the overall cell reaction.

Half-equation for the negative electrode:

Half-equation for the positive electrode:

Equation for the overall cell reaction:

[3]

(ii) Suggest the purpose of the porous separator shown in the diagram.

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.... **[1]**

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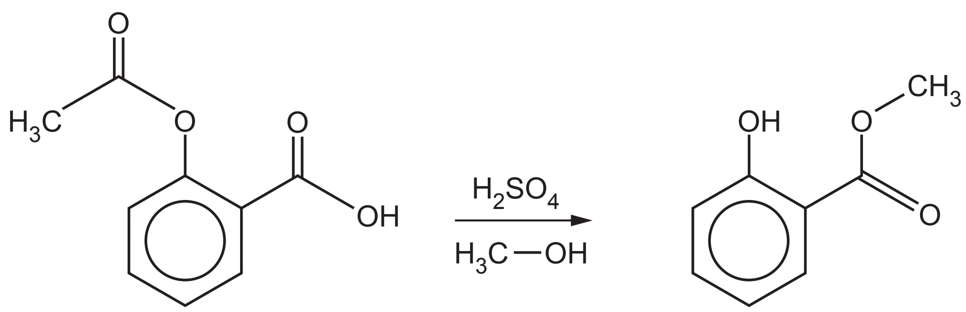
2 'Oil of wintergreen' is used by athletes to warm their muscles. It can be synthesised in the laboratory from aspirin tablets.

The reaction is shown.



aspirin **oil of wintergreen**

(a) Aspirin has a benzene ring and a carboxylic acid group.

(i) What term is used to describe compounds with benzene rings?

.... **[1]**

(ii) Name the other functional group in aspirin.

.... **[1]**

(b) Describe a simple test-tube test that could confirm the formation of oil of wintergreen.

....

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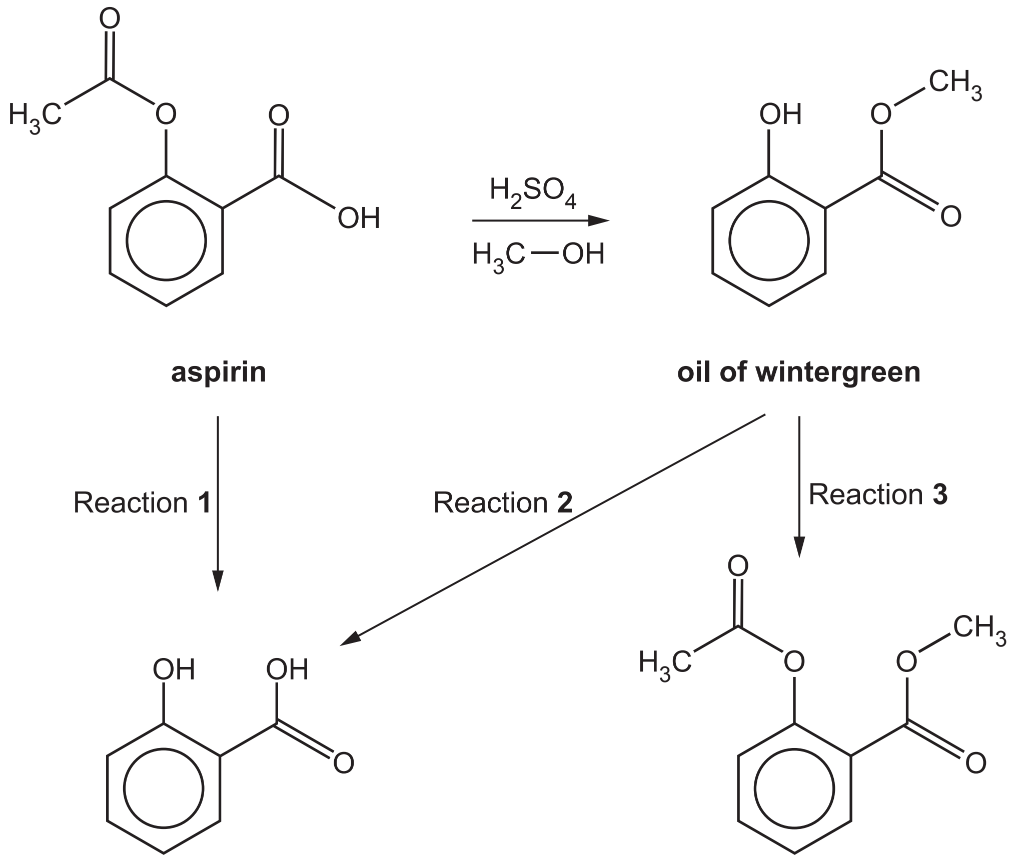
.... **[2]**

(c)* Compound **A** can be made in one step from **both** aspirin and oil of wintergreen. Compound **B** can be made in one step from oil of wintergreen but not from aspirin. The reactions are numbered from 1 to 3 in the diagram below.



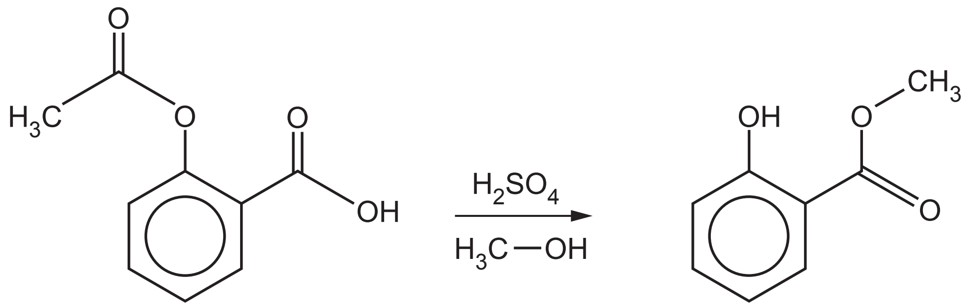
compound A **compound B**

Explain why compound **B cannot** be made in one step from aspirin.

Give the reagents and conditions and show the **formulae** of other organic products in Reaction **1**, Reaction **2** and Reaction **3**.

State whether each reaction is **hydrolysis** or **condensation**. **[6]**

Extra answer space if required.



aspirin **oil of wintergreen**

(d) A group of students carry out a small-scale synthesis of oil of wintergreen. They add two crushed tablets of aspirin to 10 cm^3 of methanol and eight drops of concentrated sulfuric acid in a boiling tube.

They warm the tube in a hot water bath for about 5 minutes.

Two layers form, one of which contains oil of wintergreen.

(i) The students shake the impure product with sodium hydrogencarbonate solution in a separating funnel.

Which impurities are removed by doing this and what is seen during the process?

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.... **[2]**

(ii) The students then add ether to the separating funnel.

Oil of wintergreen and aspirin are insoluble in cold water, but very soluble in ether.
The density of ether is 0.7 $g\,cm^{-3}$.

Which organic impurity would be left in the aqueous layer, and why is this the lower layer?

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.... **[2]**

(iii) Ether is volatile and very flammable.

How could oil of wintergreen be obtained from the ether layer?

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.... **[1]**

(e) The students start with 0.90 g aspirin with the other reactants in excess.

After the reaction, they collect 0.70 g of the purified oil of wintergreen.

Calculate the percentage yield of oil of wintergreen in this synthesis.

percentage yield = ... % **[3]**

3 The element chlorine is a powerful oxidising agent.

(a) Write an ion-electron half-equation to show what occurs when chlorine acts as an oxidising agent.

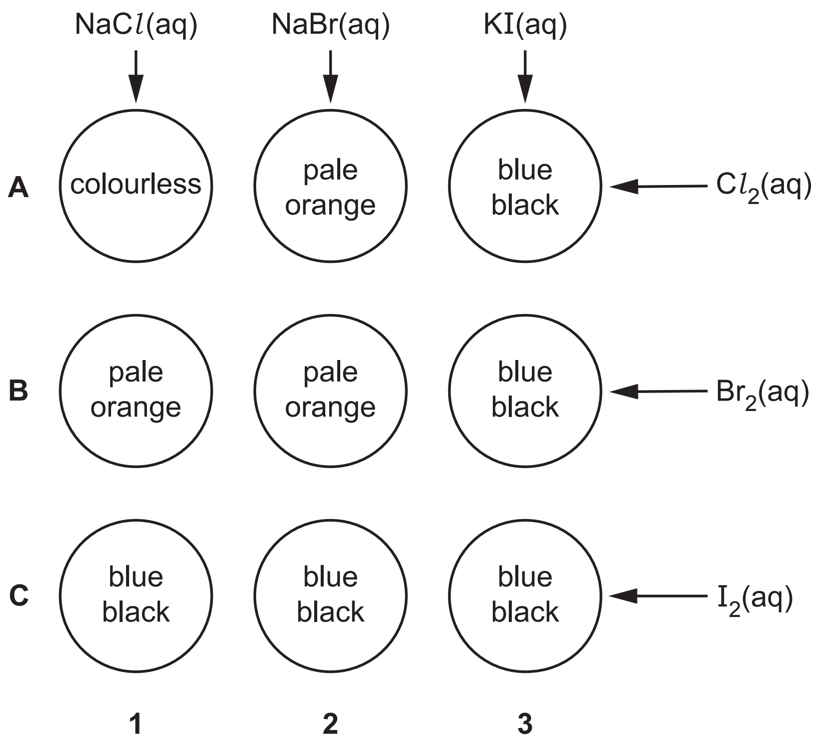
[1]

(b)* A student performs a microscale investigation on halogen displacement using a plate with nine small wells.

As shown in the diagram below, the student:

- adds two drops of starch solution to each well (**A1**, **B1**, **C1**, etc.)
- adds four drops of different sodium halide solutions to columns **1**, **2** and **3**
- adds four drops of dilute aqueous solutions of chlorine, bromine and iodine to rows **A**, **B** and **C**.

The colour (or lack of colour) of the resultant mixture in each well is described in the diagram.



Explain:

- the colour (or lack of colour) in each well
- any redox reactions that have taken place (include balanced equations)
- any patterns you see in the results.

[6]

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Extra answer space if required.

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(c) The table shows some properties of two compounds of chlorine, $NaCl$ and PCl_3.

	NaCl	**PCl_3**
Melting point / K	1074	161
Electrical conductivity when molten	good	none

Use your knowledge and understanding of structure and bonding to explain the differences in melting points and electrical conductivity of $NaCl$ and PCl_3.

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.... **[5]**

(d) The 'Dead Sea' is a lake that contains much more bromide than 'normal' sea water. Water from the Dead Sea is used to produce bromine.

Some data about water from the Dead Sea and 'normal' sea water are shown.

mass bromide concentration in water from the Dead Sea	$5.1\,g\,dm^{-3}$
average molar chloride concentration in normal sea water	$0.546\,mol\,dm^{-3}$
average molar bromide concentration in normal sea water	= average molar chloride concentration in normal sea water ÷ 650

Calculate the value of **X**, where:

$$\frac{\text{average molar bromide concentration in water from the Dead Sea}}{\text{average molar bromide concentration in normal sea water}} = \frac{\mathbf{X}}{1.0}$$

Give your answer to an **appropriate** number of significant figures.

X = ... **[4]**

4 This question refers to the **Practical Insert** that is provided with this paper.

(a) The students plot their results of temperature against time. They are told to **start the temperature axis from 13 °C**.

Show the students' plot below, labelling the axes. **[2]**

(b) What term describes a reaction where the temperature decreases?

.... **[1]**

(c)
(i) The students use the graph to allow for the warming that occurs from the surroundings during the dissolving process.

Draw lines on your graph in **(a)** to show what the students do and calculate the temperature decrease they obtain.

temperature decrease = ... °C **[2]**

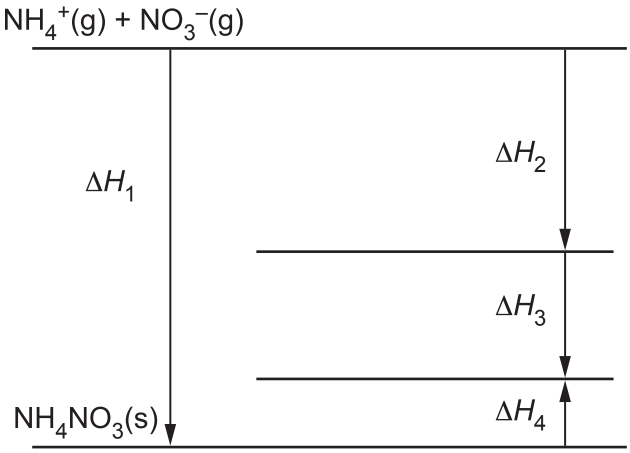
(ii) The students use the temperature decrease to calculate that the energy transferred in the experiment is 2200 J.

Calculate a value for the enthalpy change of solution of ammonium nitrate from this result.

Give your answer in $kJ\,mol^{-1}$.

enthalpy change of solution = ... $kJ\,mol^{-1}$ **[2]**

(d) The students, in their research, find the diagram below for the dissolving of ammonium nitrate.



They also find the following data table (**Table 4.1**).

Table 4.1

Enthalpy change / ΔH	**Value / $kJ\,mol^{-1}$**
Lattice enthalpy of NH_4NO_3 $\Delta_{LE}H$	–647
Hydration enthalpy of NH_4^+ $\Delta_{hyd}H\ (NH_4^+)$	–307
Hydration enthalpy of NO_3^- $\Delta_{hyd}H\ (NO_3^-)$	–314

(i) Use **Table 4.1** and your knowledge of ions in solution to **name** the enthalpy changes ΔH_1 to ΔH_4.

ΔH_1 ....

....

ΔH_2 ....

....

ΔH_3 ....

....

ΔH_4 ....

.... **[4]**

(ii) Use the data in **Table 4.1** to calculate ΔH_4.

Give the correct sign.

ΔH_4 = ... $kJ\,mol^{-1}$ **[2]**

(iii) Suggest and explain the **two** enthalpy changes that occur when ions are hydrated, and explain why the overall process is always exothermic.

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.... **[2]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.