Oxford Cambridge and RSA

A Level Chemistry B (Salters)

H433/03 Practical skills in chemistry

Wednesday 20 June 2018 – Morning

Time allowed: 1 hour 30 minutes

You must have:
- the Insert (inserted)
- the Data Sheet for Chemistry B (Salters) (sent with general stationery)

You may use:
- a scientific or graphical calculator

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- The practical insert is needed with this paper.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **16** pages.

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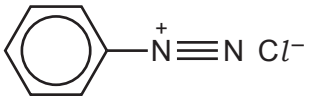
Answer **all** the questions.

1 A student decides to use a microscale method to synthesise an azo dye and dye a fabric.

(a) The student initially makes a small amount of a solution of the diazonium compound shown below, starting from an aromatic amine.



diazonium compound

Name the reagents and conditions needed to make this compound.

Reagents

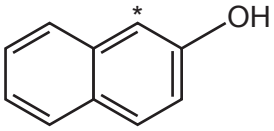
.....

Conditions

..... **[3]**

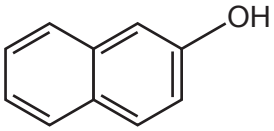
(b) Naphthalen-2-ol, shown below, is used to make the dye. A piece of cotton is dipped into naphthalen-2-ol dissolved in sodium hydroxide. The diazonium solution is then added to dye the cotton red.

The coupling reaction involves the carbon atom marked with an asterisk, *.



naphthalen-2-ol

(i) Complete the structure of the azo dye formed in this coupling reaction.



[1]

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(ii) The azo dye formed above has an extended delocalised system.

Describe the bonding occurring in a delocalised system and explain why this can lead to organic compounds being coloured.

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..... **[4]**

(c) Other functional groups can be attached to dye molecules and these can modify the properties of the dye.

(i) Give **one** property of the dye that might be affected if nitro, NO_2, groups are attached.

..... **[1]**

(ii) Give a **different** property affected by the attachment of sulfonate, SO_3^-, groups.

..... **[1]**

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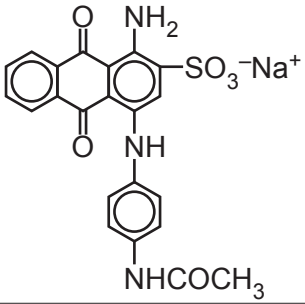
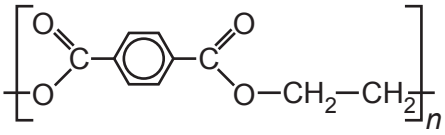
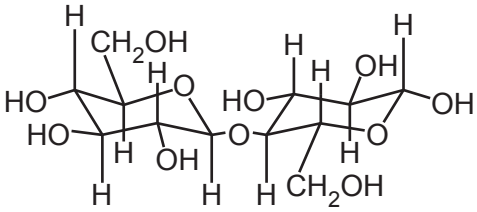
(d) Attractions between dye molecules and polymer molecules in fabric fibres can be ionic, covalent or intermolecular bonds.

Use your knowledge of molecular interactions to fill in the empty boxes in the following table.

Type of fabric	**Structure/features of polymer molecule**	**Structure/features of dye molecule**	**Strongest type of attraction between polymer and dye**
Wool	A protein chain with $–NH_3^+$ groups at the end of side chains when dyed in acid solution		
		Few polar groups on dye molecule	
Cotton		Several $–NH_2$ groups. Linear molecule	

[2]

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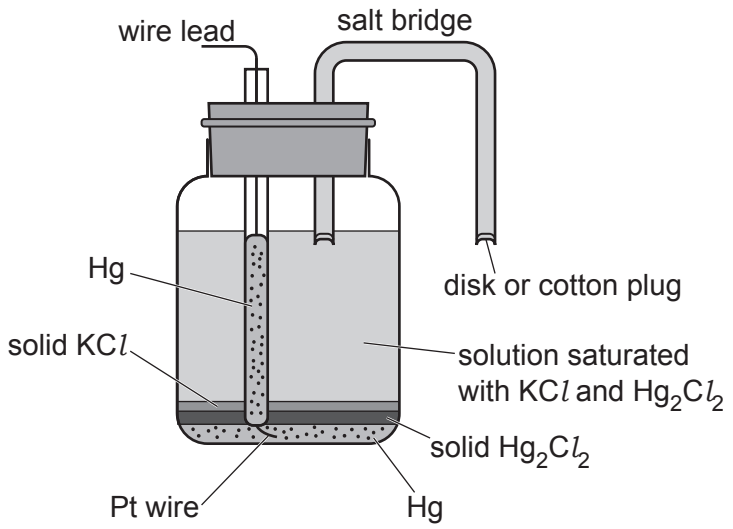
2 The use of a standard hydrogen electrode for measuring standard electrode potentials is often not practicable. The diagram below shows a calomel electrode. This is often used in preference to the standard hydrogen electrode and has a standard electrode potential, $E^{\ominus}$, of +0.27 V.



calomel electrode

(a) The electrode is based on mercury metal, Hg, in contact with a saturated solution of Hg_2Cl_2.

(i) Suggest **one** advantage and **one** disadvantage of using a calomel electrode over a standard hydrogen electrode.

Advantage .....

Disadvantage ..... **[1]**

(ii) Give the oxidation state of mercury in Hg_2Cl_2.

oxidation state = ... **[1]**

(b) A 25.0 g sample of Hg_2Cl_2 is vaporised at 400 °C and a pressure of 101 kPa.
A student assumes that the formula of the gaseous mercury chloride molecules is Hg_2Cl_2.

Calculate the volume of gas, in dm^3, that would be expected under these conditions.

volume of gas = ... dm^3 **[3]**

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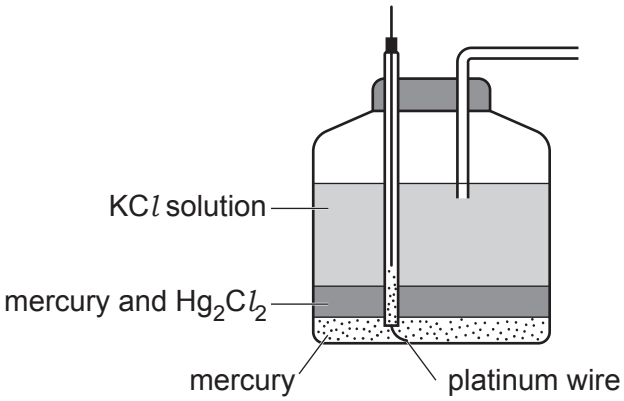
(c)* A student investigating the rusting of iron is given a calomel electrode.

The diagram shows a simplified calomel electrode.



simplified calomel electrode

The student wants to use this electrode to measure the standard electrode potential of a Fe^{2+}(aq)|Fe(s) half-cell.

Give instructions on how to do this, justifying the uses of the pieces of apparatus you name. You may add to the diagram above to illustrate your answer.

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..... **[6]**

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(d) An equilibrium, represented by **equation 2.1**, exists between the solid Hg_2Cl_2 and its ions in solution.

$$Hg_2Cl_2(s) \rightleftharpoons Hg_2^{2+}(aq) + 2Cl^-(aq)$$ **Equation 2.1**

The solubility of the solid Hg_2Cl_2 in a saturated solution at 298 K is 3.5×10^{-4} g dm^{-3}.

Calculate the solubility product, K_{sp}, for Hg_2Cl_2 at 298 K. Include the units.

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

solubility product, K_{sp} = ... units ..... **[5]**

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3 Iodine, I_2, is an essential dietary element. The recommended maximum daily intake of iodine for an adult is 1.5×10^{-4} g (150 μg).

A group of chemistry students read that fish is a good source of iodine in the form of iodide ions. They decide to extract the iodine from 600 g of fish.

The students blend the fish in a food processor with 100 cm^3 of water, leave it to stand overnight and then filter the mixture into a beaker.

(a) One of the students suggests that if they add silver nitrate solution they can confirm the presence of iodide ions in the solution.

(i) Describe what the students would observe if the only halide ion present in the solution was the iodide.

..... **[1]**

(ii) Write an **ionic** equation for this reaction. Include state symbols.

[1]

(b) The students pour the filtered mixture into a separating funnel containing 20 cm^3 of hexane, 5 cm^3 of dilute sulfuric acid and 5 cm^3 of hydrogen peroxide solution.

Iodine is formed and dissolves in the hexane layer which goes purple. The purple layer is separated from the aqueous layer and transferred to a conical flask.

The purple coloured solution is titrated with standard 0.0010 mol dm^{-3} sodium thiosulfate solution. The end point is indicated by the disappearance of the purple colour.

(i) The hydrogen peroxide oxidises the iodide ions in the fish to iodine.

Write a half equation for this oxidation reaction.
Explain why this reaction is classified as oxidation.

Half equation .....

Explanation ..... **[1]**

(ii) The equation for the titration reaction is given below.

$$I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$$

Name the element oxidised in this reaction. Give its oxidation state before and after the reaction.

Element oxidised .....

Oxidation state before reaction ..... oxidation state after reaction ..... **[2]**

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(iii) The students obtained an average titre of 5.30 cm^3 of 0.0010 mol dm^{-3} sodium thiosulfate.

Calculate the **mass** of iodine in μg in a **120 g** portion of fish.

Give your answer to **two** significant figures.

mass of iodine = ... μg **[4]**

(iv) One of the students suggests that the titre value is too small and will lead to an unacceptably high percentage error.

Calculate the percentage error based on the students' titre value.

percentage error = ... % **[1]**

(v) Suggest how the experiment could be modified to improve the accuracy of the result.

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..... **[1]**

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(c)* The mass of the iodine in the hexane solution could also have been determined using colorimetry.

Suggest a suitable method that could be used to measure the mass of iodine in the hexane solution using a colorimeter or visible spectrophotometer.

Show how you would process the results.

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..... **[6]**

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4 This question refers to the **Practical Insert** that is provided as an insert to this paper.

(a) The equation for the reaction producing phenyl benzoate is as follows:

$$C_6H_5COCl + C_6H_5OH \rightarrow C_6H_5COOC_6H_5 + HCl$$

(i) Draw a structural formula for phenyl benzoate, showing the bonding in the ester group.

[1]

(ii) Use the student results to calculate the percentage yield of phenyl benzoate obtained from the practical.

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

(b) **(i)** In **step 8** of the procedure the water reacts with any remaining benzoyl chloride.

Write the equation for this reaction.

[1]

(ii) Suggest and explain the reason for **step 13** in the procedure.

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..... **[1]**

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(iii) Describe the practical procedure used to measure the melting point of an organic solid. You **do not** need to discuss the type of melting point apparatus you use.

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..... **[3]**

(iv) What information can the students get from their melting point?

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..... **[1]**

(v) The recrystallisation procedure uses ethanol as the solvent.

Give the key properties needed by a solvent to be effective in recrystallisation.

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..... **[1]**

(c) The students carry out thin layer chromatography of the phenyl benzoate formed. One student states that this will enable them to assess the purity of their product.

Comment on the validity of this statement.
You should describe any possible observations to back up your comments.

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..... **[4]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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