OCR
Oxford Cambridge and RSA

A Level Chemistry B (Salters)

H433/02 Scientific literacy in chemistry

Practice paper – Set 2

Time allowed: 2 hours 15 minutes

You must have:
- the Advanced Notice
- the Data Sheet for Chemistry B (Salters)

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.
- 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 **100**.
- 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 **20** pages.

Answer **all** the questions.

1 Some students set out to make a sample of dry crystals of the soluble salt strontium chloride. They react excess strontium carbonate with hydrochloric acid.

They place the acid in a beaker and add spatula measures of strontium carbonate to the acid while stirring.

(a) Describe the rest of their procedure.

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

(b) **(i)** Write an equation for the reaction that occurs in **(a)** to form $SrCl_2$.
Show state symbols.

[2]

(ii) Calculate the mass of strontium carbonate that will react with $50\,cm^3$ of $2.0\,mol\,dm^{-3}$ hydrochloric acid.

mass = ... g **[2]**

(c) The strontium chloride formed is a hydrated salt with formula $SrCl_2 \cdot xH_2O$.
The students take 2.00 g of the dry salt, dissolve it in water and add an excess of silver nitrate solution so the total volume is 200 cm^3. They filter off the precipitate of silver chloride, wash it and heat it to constant mass to remove all the water.

(i) Suggest how the students would 'heat the silver chloride to constant mass'.

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..... **[2]**

(ii) 2.16 g of silver chloride, AgCl, is formed.

Calculate the value of x in $SrCl_2 \cdot xH_2O$.

x = ... **[4]**

(iii) A student says that the mass of silver chloride formed is not accurate because silver chloride is slightly soluble in water.
The solubility product of AgCl is 2.0×10^{-10} $mol^2\,dm^{-6}$.

Use calculations to comment on the student's statement.

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..... **[2]**

(iv) Another hydrated strontium chloride has formula $SrCl_2 \cdot 2H_2O$.

Calculate the percentage loss in mass when all the water is driven off by heating.

loss in mass = ... % **[1]**

(d) Strontium has an intense line at wavelength 4.08×10^{-5} cm in its emission spectrum.

(i) Explain how such lines are formed and why they are at specific frequencies.

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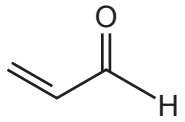
..... **[3]**

(ii) Calculate the energy (in $kJ\,mol^{-1}$) associated with this line.

energy = ... $kJ\,mol^{-1}$ **[3]**

2 The smell of burning fat is caused mainly by the presence of 'acrolein'. This is formed by the decomposition of propane-1,2,3-triol from the fat.
Acrolein is a colourless liquid that has many uses in organic chemistry.



acrolein

(a) Write in the box an equation for the decomposition of propane-1,2,3-triol to acrolein. Use **molecular** formulae.

[2]

(b) Acrolein also occurs in cigarette smoke and is the main carcinogenic agent.

How could a sample of cigarette smoke be tested for the presence of unsaturated compounds? Indicate the positive result of the test.

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

(c) A sample of acrolein is tested for the presence of the aldehyde group using hot Fehling's solution.

Describe the colour **change** in this test.
Give the formula of the inorganic substance formed.

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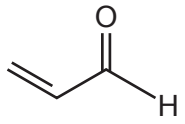

acrolein

(d) HCN reacts with acrolein at the aldehyde group.

(i) Draw the mechanism of the reaction of HCN with an aldehyde group.

Show full and partial charges and curly arrows.

Give the formula of the product.

[3]

(ii) Explain why the C=C bond would not be expected to react with HCN.

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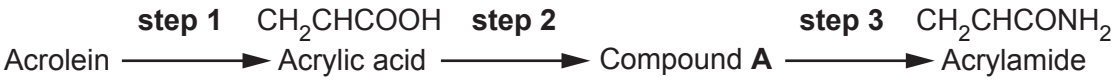
..... **[2]**

(e) Acrolein can be converted to 'acrylamide' in a laboratory, using the pathway below.



(i) Draw the **full** structural formula of compound **A**, which is an acyl chloride.

[1]

(ii) Give suitable reagents for steps **2** and **3**.
(You may need to refer to the *Data Sheet*)

step 2: .....

step 3: .....

[2]

(iii) A student obtains 0.55 g of acrylamide from acrolein (M_r 56.0) using this pathway and calculates that this is a 3.0% yield.

Calculate the mass of acrolein that the student started with.

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

mass = ... g **[2]**

3 't-butyl bromide', $(CH_3)_3CBr$, is used in industry to make other organic chemicals such as 't-butyl alcohol', $(CH_3)_3COH$.

Some students carry out an experiment to follow the hydrolysis of $(CH_3)_3CBr$ with water.
Since the haloalkane is not soluble in water, they use a mixture of propanone and water as a solvent.

$(CH_3)_3CBr + H_2O \rightarrow (CH_3)_3COH + HBr$ **equation 3.1**

(a) Give the systematic names of t-butyl bromide and t-butyl alcohol.

t-butyl bromide .....

t-butyl alcohol .....
[2]

(b) The students carry out the reaction in a conical flask. They follow the reaction by titrating samples with NaOH.

Suggest practical details for the students' method of following the reaction.

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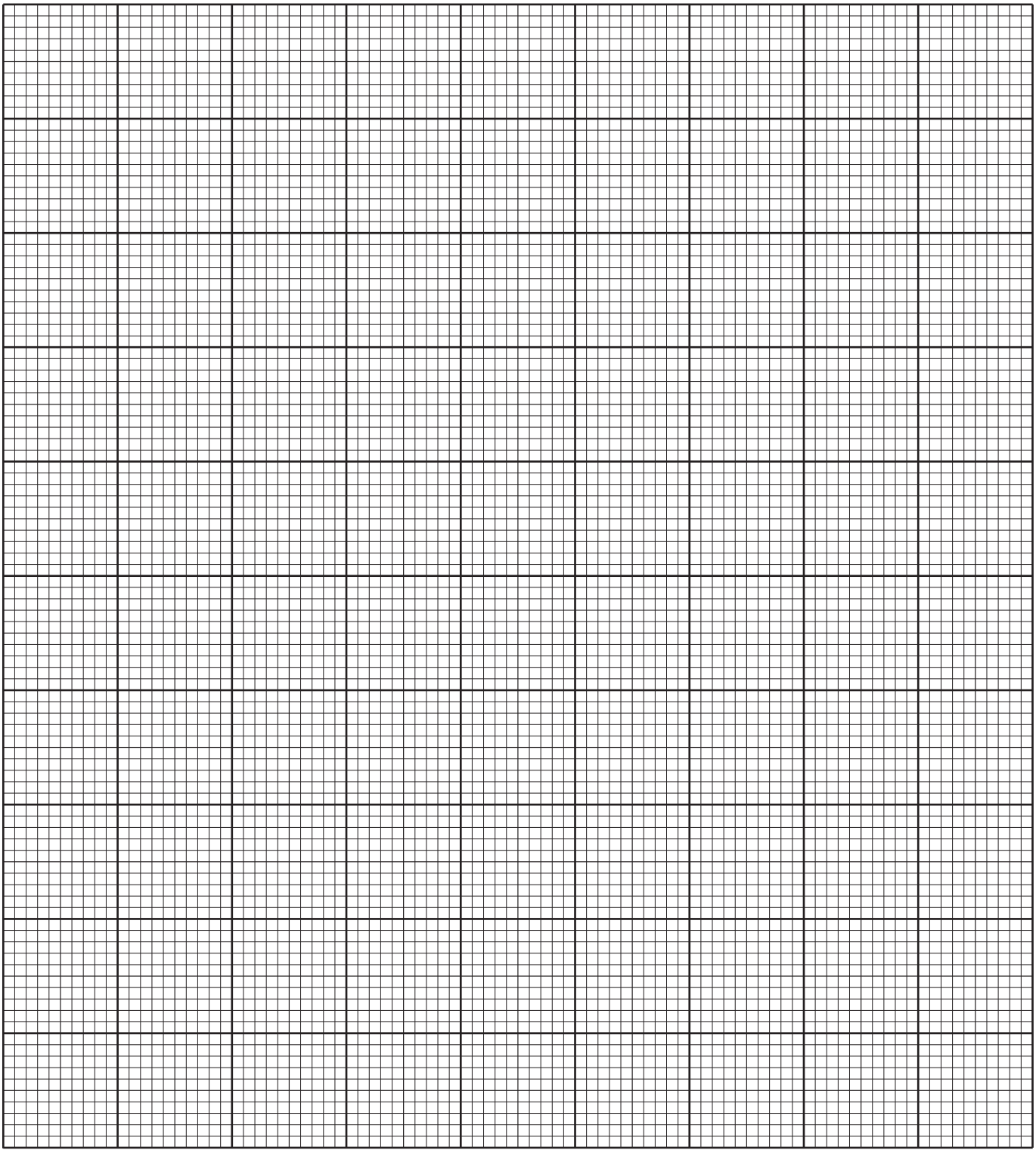
..... **[3]**

(c) The students produce the results in the table below.

Time / minutes	Amount of $(CH_3)_3CBr$ / mol
2	8.80×10^{-3}
5	6.90×10^{-3}
10	6.65×10^{-3}
14	5.70×10^{-3}
20	4.60×10^{-3}
25	3.78×10^{-3}
30	3.23×10^{-3}
45	1.85×10^{-3}

(i) Plot the points on the grid below and draw the curve or straight line of best fit.



[4]

(ii) Use the graph to show that the reaction in **equation 3.1** is first order with respect to the haloalkane.
Show working on the graph and give your reasoning below.

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..... **[2]**

(d)* t-butyl bromide and 1-bromobutane, an isomer, react with hydroxide ions as shown.

$(CH_3)_3CBr + OH^- \rightarrow (CH_3)_3COH + Br^-$ **equation 3.2**
't-butyl bromide'

$CH_3CH_2CH_2CH_2Br + OH^- \rightarrow CH_3CH_2CH_2CH_2OH + Br^-$ **equation 3.3**
1-bromobutane

The reaction in **equation 3.2** has the rate-determining step shown below.

$(CH_3)_3CBr \rightarrow (CH_3)_3C^+ + Br^-$

The reaction in **equation 3.3** occurs in a single step.

What can be deduced from this information about the mechanisms, orders of reaction and rate equations of the two reactions?

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(e) The product of hydrolysis of t-butyl bromide is t-butyl alcohol.

What **type** of alcohol is $(CH_3)_3COH$? Explain why.

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

(f) Compound **A** is an isomer of $(CH_3)_3COH$ that exists as two enantiomers.
Compound **A** can be oxidised to organic compound **B**.

Deduce the **skeletal** formulae and names of compounds **A** and **B**.

Compound	Skeletal formula	Name
A		.....
B		.....

[4]

4 Sodium chloride is used to melt ice on roads each winter.

(a) (i) Some data for the dissolving of sodium chloride are given below.

	$\Delta H^{\ominus}$ / kJ mol^{-1}
lattice enthalpy of NaCl	–780
enthalpy change of solution of NaCl	+4
enthalpy change of hydration of Na^+	–406

Draw an enthalpy level diagram that connects these values and the enthalpy change of hydration of the chloride ion.
Label the energy levels.

Use the data to calculate the enthalpy change of hydration of the chloride ion.

$\Delta_{hyd}H^{\ominus}\,Cl^-$ = ... kJ mol^{-1} **[4]**

(ii) Draw a diagram of a hydrated sodium ion in solution.

Show full and partial charges.

[2]

(iii) A student says:

- there are ionic bonds in the lattice
- ionic bonds are formed between the water and the ions in solution
- the energy required to break bonds in the lattice is very similar to the energy given out when bonds are made.

Comment on these statements.

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

(b) 10.0 g of sodium chloride are dissolved in 200 cm^3 of water.

Calculate the temperature change that would occur. Give the sign.
(Take the mass of solution as 210 g and its specific heat capacity to be the same as that of water.)

temperature change = ... °C **[2]**

(c) The main effect of adding sodium chloride is to lower the freezing point of the water.

(i) The lowering of the freezing point of a liquid depends on the amount, in mol, **of particles** of solute dissolved in a certain volume.
1.00 mol of particles dissolved in 100 cm^3 of water lowers the freezing point by 18.6 K.

Calculate the freezing point of a 1.00 mol dm^{-3} solution of NaC*l*.

freezing point = ... °C **[2]**

(ii) The freezing point depression of a 0.50 mol dm^{-3} solution of $CaCl_2$ is –2.8 °C.
Some students try to verify this. They use a balance reading to the nearest gram and make up the solution in a 1.0 dm^3 measuring cylinder, graduated in 20 cm^3 units. They measure the temperature using a thermometer marked in °C.

Which piece of apparatus gives the greatest uncertainty in the overall measurement? Show your calculations and give your reasoning.

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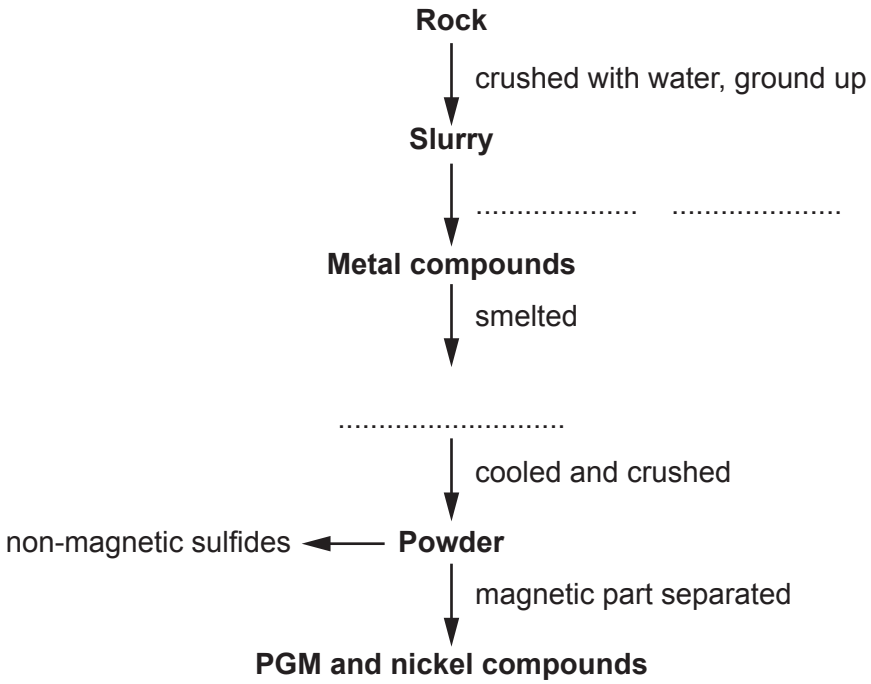
..... **[3]**

5 This question is based on the article *The Platinum Group Metals* which is included as an insert to this paper.

(a) (i) Write words on the dotted lines to complete the flowchart below to summarise the extraction of PGM from rocks.



[1]

(ii) Suggest an equation for the reaction of one of the 'non-magnetic sulfides' with sulfuric acid to form a sulfate.

[1]

(iii) How is the metal obtained from the solution of its sulfate?

[1]

(b) (i) Suggest **two** reasons why PGM are used in catalytic converters rather than other equally effective catalysts.

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

(ii) Write the equation for a reaction in which both CO and NO are removed from exhaust gases in a catalytic converter.

[1]

(c) Complete the electron configuration of Rh^{3+}, by comparison with Co^{3+}.

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

(d) **(i)** $[Ru_2OCl_{10}]^{4-}$ has an oxygen atom connecting two Ru atoms.
Draw a three-dimensional diagram to suggest the shape of this ion. Give the co-ordination number of Ru in your structure.

co-ordination number ..... **[2]**

(ii) Suggest a **name** for the shape of $[AuCl_4]^-$.

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

(e) Give the formula of a 'bulky organic monocation' from the article and explain why three such species are needed by $[MCl_6]^{3-}$.

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..... **[2]**

(f) Estimate how much faster $[Ag(H_2O)_2]^+$ exchanges chloride ions compared with $[Ru(H_2O)_6]^{3+}$.

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

(g) Give the equation for a ligand exchange reaction of copper involving ammonia. Give the starting and finishing colours involved.

[2]

(h) A student says that silver(I) salts are colourless because the d subshells are not split by the ligands.

Discuss this statement. (Ag has the same outer electron configuration as Cu.)

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(i)* Describe how compounds of palladium, platinum and osmium are each extracted from a mixture of PGM chlorides, giving chemical details from the article.

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END OF QUESTION PAPER

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).