OCR
RECOGNISING ACHIEVEMENT

SPECIMEN

Advanced GCE

CHEMISTRY B (SALTERS)

F334 QP

Unit F334: Chemistry of Materials

Specimen Paper

Candidates answer on the question paper.

Time: 1 hour 30 minutes

Additional Materials:
Data Sheet for Chemistry B (Salters) (Inserted)
Scientific calculator

Candidate Name	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED.

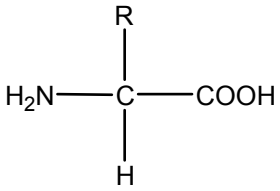
INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- You may use a scientific calculator.
- A copy of the Data Sheet for Chemistry B (Salters) is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **90**.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**21**	
2	**22**	
3	**14**	
4	**24**	
5	**9**	
TOTAL	**90**	

Answer **all** the questions.

1 A Japanese firm has marketed a range of clothes called 'amino jeans'. The garments are impregnated with arginine. The arginine softens and moisturises the wearer's legs. A simplified structure of arginine is shown below. R represents a carbon chain containing functional groups.



arginine

(a) What is the name for the group of compounds to which arginine belongs?

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

(b) Arginine is often used as a salt made by reacting arginine with hydrochloric acid.

Complete the equation below to show the **ions** formed.

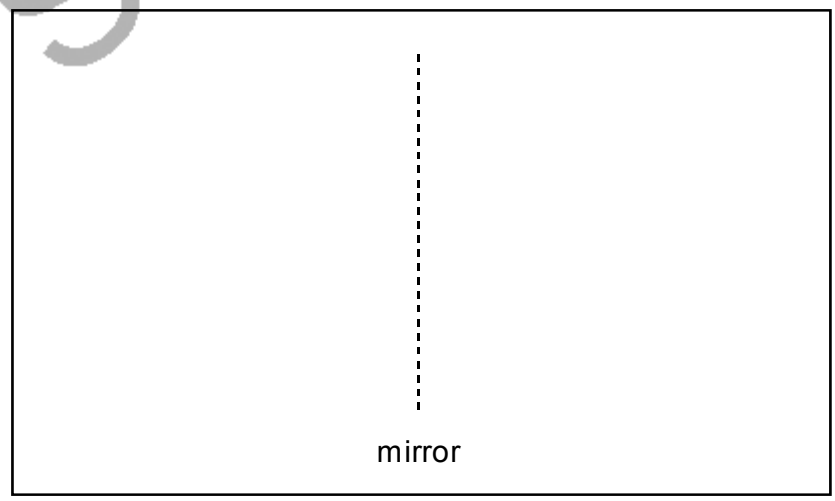
[3]

(c) Arginine forms two enantiomers.

(i) What structural feature causes arginine to have enantiomers?

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

(ii) On the diagram below, draw the **three dimensional** structures of the two enantiomers to show how they are related.



[2]

(d) Arginine is one of the monomers used to make proteins.

Draw the full structural formula of the organic molecule formed when a molecule of arginine acts as a monomer and joins with a molecule of glycine, NH_2CH_2COOH, to make a dimer.

[2]

(e) Arginine is also a muscle relaxant.

Enzymes in the body cause the breakdown of arginine to form NO, and it is the NO which affects the muscles.

In the first step of this process, only one of the two enantiomers of arginine is affected by an enzyme. The optimum temperature of the enzyme reaction is body temperature.

(i) Describe how an enzyme can catalyse the breakdown of arginine. Using ideas of protein structure and reaction rates, explain why the enzyme has an optimum temperature for its activity and why the enzyme will only catalyse the breakdown of **one** of the two enantiomers.

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..... **[5]**

(ii) When arginine is at a low concentration, the enzyme catalysed reaction is first-order with respect to arginine **and** first-order with respect to the enzyme.

Write down the rate equation for this reaction and give the units of the **rate constant**.

rate equation:

units of rate constant ..... **[3]**

(iii) At high concentrations of arginine, the order of the reaction with respect to arginine becomes zero.

Describe a mechanism for this enzyme catalysed reaction which explains why the order of reaction depends on the concentration of arginine.

In your answer you should make clear how the explanation matches the description.

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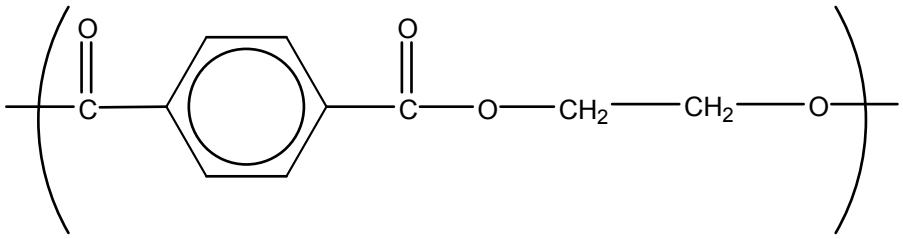
..... **[4]**

[Total: 21]

2 Non-returnable drinks bottles are often made from PET. This produces a huge problem for waste disposal. However, this polymer cannot be used to make returnable bottles.

(a) PET is a polyester. The repeating unit for PET is given below.



Draw a ring around the ester group in the repeating unit above. **[1]**

(b) Plastic waste is often buried for disposal.

Give **two** other methods which are used to deal with plastic waste and explain a different advantage for each method.

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

(c) PET is not used to make returnable bottles because its glass transition temperature, T_g, is too low.

Explain why lowering the temperature of PET below its T_g causes it to become brittle.

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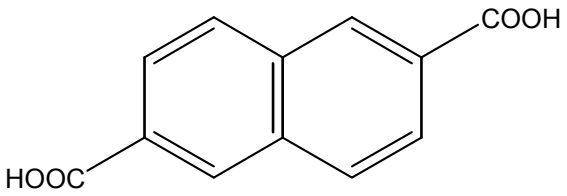
..... **[3]**

(d) Chemists have developed a new polyester which can be used for producing returnable bottles. It can be made from ethane-1,2-diol, $HOCH_2CH_2OH$, and compound **A.** The structure of compound **A** is shown below. The polymer is known as PEN.



compound A

(i) Draw the skeletal formula of the repeating unit of PEN.

[2]

(ii) **PEN** has a higher melting temperature than PET.

Assume both polymers have similar average relative molecular masses.

Suggest why PEN has a higher melting temperature than PET.

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

(iii) Explain how the infrared spectra of compound **A** and PEN would differ in **one** significant respect. Use the *Data Sheet* to look up any relevant absorbances you need.

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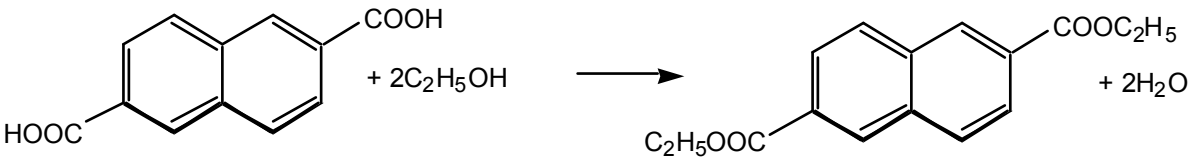
..... **[2]**

(e) Industrially, **PEN** is made by reacting a diester of compound **A** with ethane-1,2-diol.

The diester is made by reacting compound **A** with ethanol according to the equation below.



compound A

(i) What other chemical is added to an acid and alcohol mixture and what conditions are used to make an ester in the laboratory?

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

(ii) Classify the reaction in which **PEN** is made by underlining one of the following reaction types.

addition **condensation** **elimination** **rearrangement**

[1]

(iii) Explain, using ideas of atom economy, why the polymerisation reactions in which PET and PEN are formed are less environmentally friendly than those in which poly(ethene) is made.

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

(iv) Compound **A** and its diester can be distinguished by thin-layer chromatography.

A spot of a mixture of the two is run on a TLC plate.

Draw a diagram of the resulting TLC plate showing the located spots.

Explain how you would measure the R_f values of the spots.

[2]

[Total: 22]

[Turn over

3 Groundwater usually contains iron compounds and therefore water from wells will contain significant amounts of iron compounds. The main problem with household water containing iron compounds is the staining it causes to laundry, porcelain and plumbing fittings.

(a) Water containing iron in an oxidation state of +2 is known as 'clear water' since it appears colourless. However, on leaving the tap it may become coloured and it is then referred to as 'red water'. 'Red water' contains iron(III) compounds.

(i) Give the formula of the complex ion which causes the 'red' colour.

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

(ii) What causes the colour change when clear water leaves the tap?

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

(iii) If the 'red water' is made slightly alkaline, for example by adding sodium hydroxide solution, a red–brown precipitate will form.

Write an ionic equation for the formation of the red–brown precipitate.

Include state symbols.

→

[3]

(b) 'Iron stains' contain iron(III) compounds and can be removed using a variety of products available in the supermarket. One commonly used chemical is ethanedioic acid. It is used in stain removers as the disodium salt.

(i) Draw the full structural formula of the ethanedioate ion, $C_2O_4^{2-}$.

[1]

(ii) Name the type of reaction that occurs when ethanedioate ions in aqueous solution react with 'red water' to form green $[Fe(C_2O_4)_3]^{3-}$ ions.

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

(iii) Explain why a green substance looks green.

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

(c) Iron stains can be removed by adding a solution of a suitable reducing agent.

Use the data in the table below to identify a reducing agent which can reduce iron(III) ions under standard conditions. Explain your answer and write an equation for the reaction that occurs.

half-reaction	$E^{\ominus}$ **/ V**
$SO_4^{2-} + 2H^+ + 2e^- \rightarrow SO_3^{2-} + H_2O$	–0.93
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.44
$2H^+ + O_2 + 2e^- \rightarrow H_2O_2$	+0.68

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[4]

[Total: 14]

4 Hydrogen peroxide is a mild oxidising agent which is used in the restoration of oil paintings. Paintings darken over time as some of the metal ions in the paints react with atmospheric pollutants. Hydrogen peroxide can be used to convert these unwanted dark coloured compounds to white products.

(a) Write down the half-equation (ion-electron equation) for hydrogen peroxide, H_2O_2, acting as an oxidising agent. This reaction takes place in acid solution and water is the only product.

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[2]

(b) The concentration of an H_2O_2 solution can be found by titration of samples of this with aqueous potassium manganate(VII) of known concentration using acidic conditions.

(i) Describe how this titration would be carried out. Give clear experimental details and state how the end point is determined.

In your answer you should use appropriate technical terms, spelled correctly.

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..... **[7]**

(ii) 25.0 cm^3 of a concentrated solution of hydrogen peroxide is diluted to 250 cm^3.

10.0 cm^3 of this diluted H_2O_2 reacted with exactly 17.2 cm^3 of 0.0200 mol dm^{-3} MnO_4^- solution.

The equation for the reaction taking place is given below.

$$2MnO_4^-(aq) + 6H^+(aq) + 5H_2O_2(aq) \rightarrow 2Mn^{2+}(aq) + 8H_2O(l) + 5O_2(g)$$

Calculate the concentration of the **concentrated** H_2O_2 solution.

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

concentration = ... mol dm^{-3}

[4]

(iii) The concentration of the hydrogen peroxide solution used for treating paintings must not be greater than 3.0%. Assume this means 3.0 g of H_2O_2 in 100 cm^3 of solution.

Is the undiluted solution of H_2O_2 suitable to be used for treating paintings?

Show your working.

[2]

(c) Restorers of paintings are instructed to make up the solutions of hydrogen peroxide in a polythene bottle with pure water rather than tap water. Traces of transition metal ions, such as Fe^{2+}, present in tap water, can catalyse the decomposition of hydrogen peroxide.

(i) Write the equation for the decomposition of hydrogen peroxide into water and oxygen. Give the state symbols.

→

[1]

(ii) The decomposition of hydrogen peroxide is a redox reaction.

Explain how $Fe^{2+}(aq)$ ions can catalyse a redox reaction in aqueous solution.

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

(iii) A solution of hydrogen peroxide stored in a glass bottle at room temperature was found to be completely decomposed after two weeks.

Describe an experimental procedure you could use to measure the oxygen produced when hydrogen peroxide decomposes.

Show how you would use your results to find the initial rate of the reaction.

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

(iv) The reaction is found to be first-order with respect to hydrogen peroxide with a rate constant of 2.0×10^{-6} s^{-1} at 298 K.

Calculate the rate of decomposition of a 2.0 mol dm^{-3} hydrogen peroxide solution at 298 K.

rate of decomposition = ...mol dm^{-3} s^{-1}

[2]

[Total: 24]

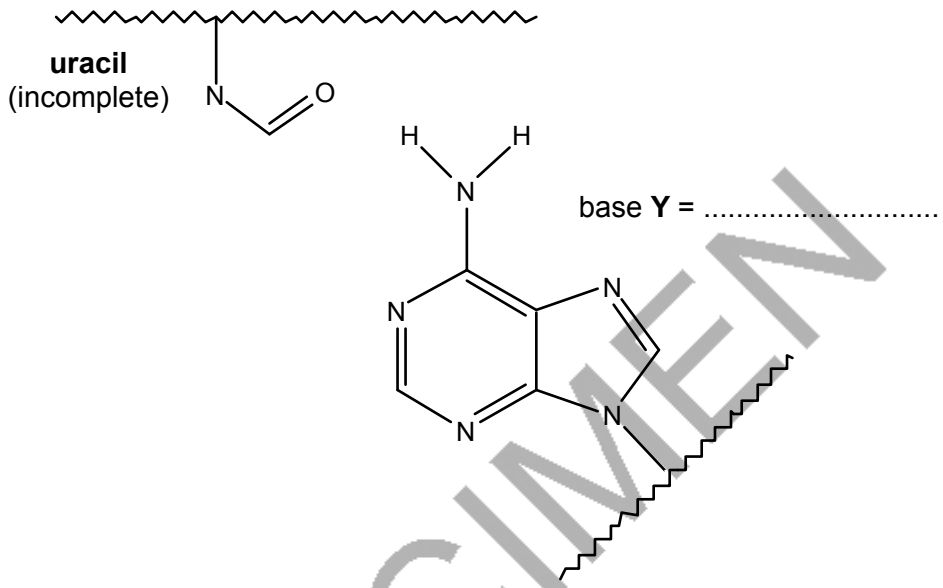
5 Now that chemists have unlocked the significance of the DNA structure and developed experimental methods, DNA technology is being used by people tracing their family histories.

DNA is a polymer made from monomers called nucleotides.

Nucleotides consist of a base joined to a sugar joined to a phosphate group.

(a) (i) DNA is formed from two polynucleotide chains. These chains are held together by hydrogen bonds between base units on adjacent chains. On the diagram below:

- use the *Data Sheet* to name the base **Y** and complete the structure of uracil;
- show clearly the hydrogen bonds between the bases including any relevant lone pairs and partial charges.



[4]

(ii) On the diagram of the base **Y** above, circle the atom which enables it to act as a base.

Explain how the atom acts as a base.

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

(iii) What is the shape of a DNA molecule?

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

(b) The model of DNA discussed in **(a)** was first described by Watson and Crick in 1953. Before 1953, several other models of DNA had been published by other scientists.

Suggest a reason why, after 50 years, scientists are still using Watson and Crick's model for DNA.

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

[Total: 9]

Paper Total [90]