Please write clearly in block capitals.

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| Centre number | | | | | | Candidate number | | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

# A-level
# CHEMISTRY

## Paper 2 Organic and Physical Chemistry

Tuesday 12 June 2018 Afternoon Time allowed: 2 hours

**Materials**

For this paper you must have:

- the Periodic Table/Data Booklet, provided as an insert (enclosed)
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

**Instructions**

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do **not** write outside the box around each page or on the blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

**Information**

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 105.

| For Examiner's Use | |
|---|---|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| **TOTAL** | |

Answer **all** questions in the spaces provided.

**0 1** This question is about the reactions of alkanes.

**0 1 . 1** Alkanes can be used as fuels. hydrocarbon + oxygen → carbon dioxide + water

Give an equation for the combustion of heptane ($C_7H_{16}$) in an excess of oxygen. [redacted]

$C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$

**0 1 . 2** Heptane can be obtained from the catalytic cracking of hexadecane ($C_{16}H_{34}$) at a high temperature.

Identify a suitable catalyst for this process.
Give **one** condition other than high temperature.
Give an equation for the catalytic cracking of one molecule of hexadecane to produce one molecule of heptane, one molecule of cyclohexane and one other product. [redacted]

Catalyst Zeolite (aluminosilicate)

Condition Moderate pressure (1-5 atm)

$C_nH_{2n}$

Equation $C_{16}H_{34} \rightarrow C_7H_{16} + C_6H_{12} + C_3H_6$

**0 1 . 3** Alkanes can be used in free-radical substitution reactions to produce halogenoalkanes.

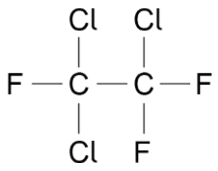
Give equations for the propagation steps in the reaction of butane to form 2-chlorobutane. [redacted]

$Cl\cdot + CH_3CH_2CH_2CH_3 \rightarrow CH_3\dot{C}HCH_2CH_3 + HCl$

$CH_3\dot{C}HCH_2CH_3 + Cl_2 \rightarrow CH_3CHClCH_2CH_3 + Cl\cdot$

**0 1 . 4** Chlorofluorocarbons (CFCs) are a group of halogenoalkanes currently banned in many countries. They cannot be used as solvents or refrigerants because of their effect on the environment.

The structure of a CFC is shown.



Identify the radical produced from this CFC that is responsible for the depletion of ozone in the atmosphere.
Explain, with the aid of equations, why a single radical can cause the decomposition of many molecules of ozone.

Radical $Cl\cdot$ - ①

Explanation $Cl\cdot + O_3 \rightarrow ClO\cdot + O_2$ - ①

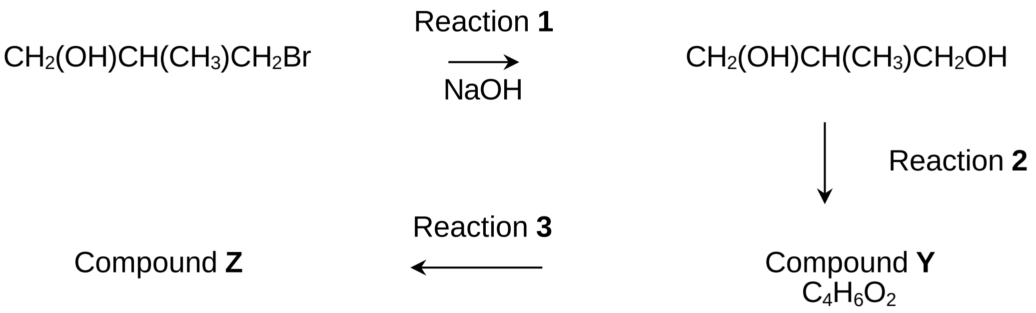
$ClO\cdot + O_3 \rightarrow 2O_2 + Cl\cdot$ - ①

$Cl\cdot$ is regenerated, it can go on to react further - ①

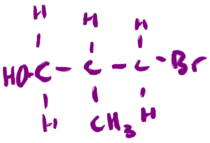
10

**Turn over for the next question**

**0 2** Halogenoalkanes are useful compounds in synthesis. A reaction pathway is shown.



**0 2 . 1** Give the IUPAC name for $CH_2(OH)CH(CH_3)CH_2Br$



[redacted]

3-bromo-2-methylPropan-1-ol

Reaction **1** occurs via a nucleophilic substitution mechanism.

Explain why the halogenoalkane is attacked by the nucleophile in this reaction.

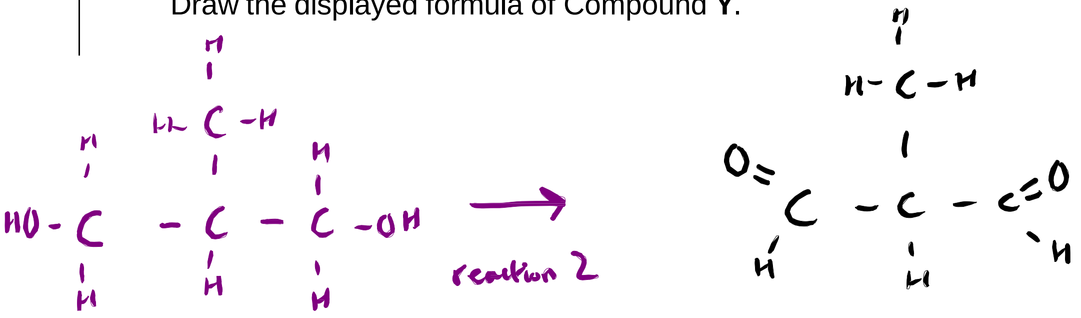
[redacted]

Bromine is more electronegative than carbon
The Carbon atom is partially positive
The lone pair on the nucleophile is attracted to the carbon atom.

**0 2** . **3** The infrared spectrum of Compound **Y** shows a significant absorption in the range [redacted]

C=O

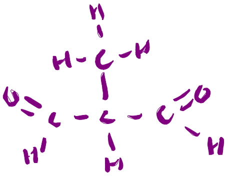
Draw the displayed formula of Compound **Y**. [redacted]



**0 2** . **4** Compound **Z** has the empirical formula $C_3H_4NO$

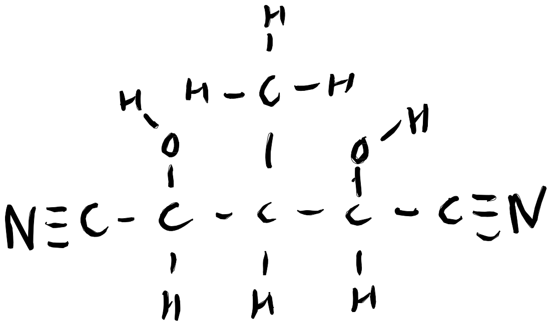
Give the structure of Compound **Z**.
Suggest the reagent for Reaction **3**. [redacted]

Formed from :



$C_4H_6O_2 + 2HCN \rightarrow C_6H_8N_2O_2$

Structure



Reagent for Reaction **3** KCN and dilute acid

7

**Turn over ▶**

**0 3** The oxidation of propan-1-ol can form propanal and propanoic acid.
The boiling points of these compounds are shown in **Table 1**.

**Table 1**

| Compound | Boiling point / °C |
|---|---|
| propan-1-ol | 97 |
| propanal | 49 |
| propanoic acid | 141 |

In a preparation of propanal, propan-1-ol is added dropwise to the oxidising agent and the aldehyde is separated from the reaction mixture by distillation.

**0 3 . 1** Explain, with reference to intermolecular forces, why distillation allows propanal to be separated from the other organic compounds in this reaction mixture.

[redacted]

The Strongest intermolecular forces in propanal are dipole-dipole forces.

Propan-1-ol and propanoic acid have hydrogen bonding.

The intermolecular forces in propanal are weaker so it evaporates first.

**0 3 . 2** Give **two** ways of maximising the yield of propanal obtained by distillation of the reaction mixture.

[redacted]

1 Cooling the collection Vessel

2 Keep the temperature below 97°C

**0 3 . 3** Describe how you would carry out a simple test-tube reaction to confirm that the sample of propanal obtained by distillation does **not** contain any propanoic acid.

[redacted]

Add Sodium hydrogencarbonate to the sample
Effervescence would confirm the presence of an acid

**Question 3 continues on the next page**

**Turn over ►**

**0 3 . 4** A student carried out an experiment to determine the enthalpy of combustion of ethanol.
Combustion of [redacted] of ethanol increased the temperature of [redacted]f water from [redacted]

Calculate a value, in kJ mol$^{-1}$, for the enthalpy of combustion of ethanol in this experiment.
Give your answer to the appropriate number of significant figures.

(The specific heat capacity of water is [redacted])

[redacted]

$q = mc\Delta T$

$\Delta T = 40.2 - 25.1 = 15.1\,^\circ C = 15.1\,K$

$q = 150 \times 4.18 \times 15.1 = 9467.7\,J$

$= 9.4677\,kJ$ — ①

$n = \frac{m}{M_r} = \frac{0.457}{46} = 9.93 \times 10^{-3}$ — ①

$C_2H_6O$

$(2 \times 12) + (6 \times 1) + 16$

$\Delta H = \frac{-9.4677}{9.93 \times 10^{-3}} = -952.99\,kJ\,mol^{-1}$

$= -953\,kJ\,mol^{-1}$

①

Enthalpy of combustion $-953$ kJ mol$^{-1}$

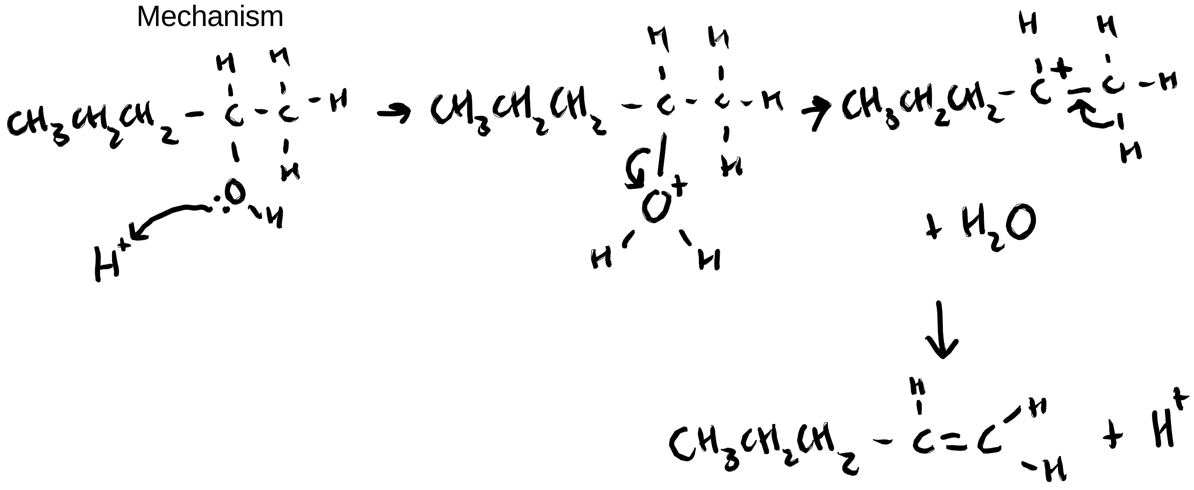
**0 3 . 5** A mixture of isomeric alkenes is produced when pentan-2-ol is dehydrated in the presence of hot concentrated sulfuric acid. Pent-1-ene is one of the isomers produced.

Name and outline a mechanism for the reaction producing pent-1-ene.

[redacted]

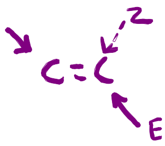
Name of mechanism Elimination

Mechanism



**0 3 . 6** A pair of stereoisomers is also formed in the reaction in Question **03.5**.

Name the less polar stereoisomer formed.
Explain how this type of stereoisomerism arises.



[redacted]

Name E-pent-2-ene

Explanation C=C bond cannot rotate and there are two unique substituents on each carbon in the C=C

16

**0 4** Compounds **A** and **B** react together to form an equilibrium mixture containing compounds **C** and **D** according to the equation

$$2A + B \rightleftharpoons 3C + D$$

**0 4 . 1** A beaker contained [redacted] of a [redacted] aqueous solution of **A**. [redacted] of **B** and [redacted] mol of **C** were added to the beaker and the mixture was left to reach equilibrium.
The equilibrium mixture formed contained [redacted] of **A**.

Calculate the amounts, in moles, of **B**, **C** and **D** in the equilibrium mixture.

[redacted]

$n = C \times V$ ①

$= 0.16 \times 0.04 = 6.4\times10^{-3}$ mol $= n$ A initial

$3.9\times10^{-3} = 6.4\times10^{-3} - 2x$ ✓ moles reacted for 1 in the equation

$x = \dfrac{6.4\times10^{-3} - 3.9\times10^{-3}}{2} = 1.25\times10^{-3}$ mol ①

$nB = 9.5\times10^{-3} - 1.25\times10^{-3} = 8.25\times10^{-3}$ mol ①

$nC = 2.8\times10^{-2} + 3(1.25\times10^{-3}) = 0.0318$ mol ①

$nD = 0 + 1.25\times10^{-3} = 1.25\times10^{-3}$ mol ①

Amount of **B** $8.25\times10^{-3}$ mol

Amount of **C** 0.0318 mol

Amount of **D** $1.25\times10^{-3}$ mol

**0 4 . 2** Give the expression for the equilibrium constant ($K_c$) for this equilibrium **and** its units.

[redacted]

$$K_c = \frac{[C]^3[D]}{[A]^2[B]}$$

$$\frac{(mol\,dm^{-3})^3 \times mol\,dm^{-3}}{(mol\,dm^{-3})^2 \times mol\,dm^{-3}}$$

$\dfrac{\text{Products}}{\text{reactants}}$ $2A + B \rightleftharpoons 3C + D$

Units mol dm$^{-3}$

**0 4 . 3** A different equilibrium mixture of these four compounds, at a different temperature, contained [redacted] of **B**, [redacted] of **C** and [redacted] of **D** in a total volume of [redacted] of solution.
At this temperature the numerical value of $K_c$ was [redacted] 25.5.

Calculate the concentration of **A**, in mol dm$^{-3}$, in this equilibrium mixture.
Give your answer to the appropriate number of significant figures.

[redacted]

$$K_c = \frac{[C]^3[D]}{[A]^2[B]} \qquad c = \frac{n}{V} \qquad [B] = \frac{0.21}{0.5} = 0.42\,\text{mol}$$

$$V = \frac{5\times10^2\,cm^3}{1000} = 0.5\,dm^3 \qquad [C] = \frac{1.05}{0.5} = 2.1\,\text{mol}$$

$$[A] = \sqrt{\frac{[C]^3[D]}{K_c[B]}}$$

① ✓

$$[D] = \frac{0.076}{0.5} = 0.152\,\text{mol}$$

① ✓

$$[A] = \sqrt{\frac{2.1^3 \times 0.152}{116 \times 0.42}} = 0.17$$

✓ ①

Concentration of **A** 0.17 mol dm$^{-3}$

**0 4 . 4** Justify the statement that adding more water to the equilibrium mixture in Question **04.3** will lower the amount of **A** in the mixture.

[redacted]

effect – equilibrium – reason

The concentrations in the mixture will decrease. ✓ effect

The equilibrium will move towards the side with more moles (the right) to oppose the change. ✓ equilibrium ✓ reason

13

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ANSWER IN THE SPACES PROVIDED

**0 5**

Bromate(V) ions and bromide ions react in acid conditions according to the equation

$$BrO_3^-(aq) + 5Br^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

**0 5 . 1** A series of experiments was carried out at a given temperature. The results were used to deduce the rate equation for the reaction.

[redacted]

**Table 2** shows an incomplete set of results.

**Table 2**

| Experiment | Initial $[BrO_3^-]$ / mol dm$^{-3}$ | Initial $[Br^-]$ / mol dm$^{-3}$ | Initial $[H^+]$ / mol dm$^{-3}$ | Initial rate of reaction / mol dm$^{-3}$ s$^{-1}$ |
|---|---|---|---|---|
| **1** | 0.10 | 0.20 | 0.30 | $2.4 \times 10^{-2}$ |
| **2** | 0.15 | 0.20 | 0.30 | $3.6 \times 10^{-2}$ |
| **3** | 0.20 | 0.40 | 0.50 | 0.26 |
| **4** | 0.10 | 0.10 | 0.46 | $2.7 \times 10^{-2}$ |

Use the data from Experiment **1** to calculate a value for the rate constant, *k*, at this temperature and give its units.

Give your answer to an appropriate number of significant figures.

[redacted]

$$K = \frac{rate}{[BrO_3^-][Br^-][H^+]^2} = \frac{2.4 \times 10^{-2}}{0.1 \times 0.2 \times 0.3^2} = 13 \text{ — ①} \quad ①$$

$$= \frac{mol\,dm^{-3}s^{-1}}{mol\,dm^{-3} \times mol\,dm^{-3} \times (mol\,dm^{-3})^2} \; ① = \frac{mol\,dm^{-3}s^{-1}}{mol^4\,dm^{-12}} = mol^{-3}\,dm^9\,s^{-1}$$

*k* 13

Units $mol^{-3}\,dm^9\,s^{-1}$

**0 5 . 2** Complete **Table 2**.

[redacted]

Space for working

$$[BrO_3^-] = \frac{rate}{k[Br^-][H^+]^2} = \frac{3.6 \times 10^{-2}}{13 \times 0.2 \times 0.3^2} = 0.15$$

$$rate = k[BrO_3^-][Br^-][H^+]^2 = 13 \times 0.2 \times 0.4 \times 0.5^2 = 0.26$$

$$[H^+] = \sqrt{\frac{rate}{k \times [BrO_3^-][Br^-]}} = \sqrt{\frac{2.7 \times 10^{-2}}{13 \times 0.1 \times 0.1}} = 0.46$$

**Question 5 continues on the next page**

**0 5 . 3** A second series of experiments was carried out to investigate how the rate of the reaction varies with temperature.
The results were used to obtain a value for the activation energy of the reaction, $E_a$

Identical amounts of reagents were mixed at different temperatures.
The time taken, *t*, for a fixed amount of bromine to be formed was measured at different temperatures.

The results are shown in **Table 3**.

**Table 3**

| **Temperature, *T* / K** | $\frac{1}{T}$ / K$^{-1}$ | **Time, *t* / s** | $\frac{1}{t}$ / s$^{-1}$ | **ln** $\frac{1}{t}$ |
|---|---|---|---|---|
| 286 | $3.50 \times 10^{-3}$ | 54 | $1.85 \times 10^{-2}$ | –3.99 |
| 295 | $3.39 \times 10^{-3}$ | 27 | $3.70 \times 10^{-2}$ | -3.30 |
| 302 | $3.31 \times 10^{-3}$ | 15 | $6.67 \times 10^{-2}$ | –2.71 |
| 312 | $3.21 \times 10^{-3}$ | 8 | $1.25 \times 10^{-1}$ | –2.08 |

Complete **Table 3**.

[redacted]

**0 5 . 4** The Arrhenius equation can be written as

$$\ln k = -\frac{E_a}{R}\left(\frac{1}{T}\right) + C_1$$

In this experiment, the rate constant, *k*, is directly proportional to $\frac{1}{t}$

Therefore

$$\ln \frac{1}{t} = -\frac{E_a}{R}\left(\frac{1}{T}\right) + C_2$$

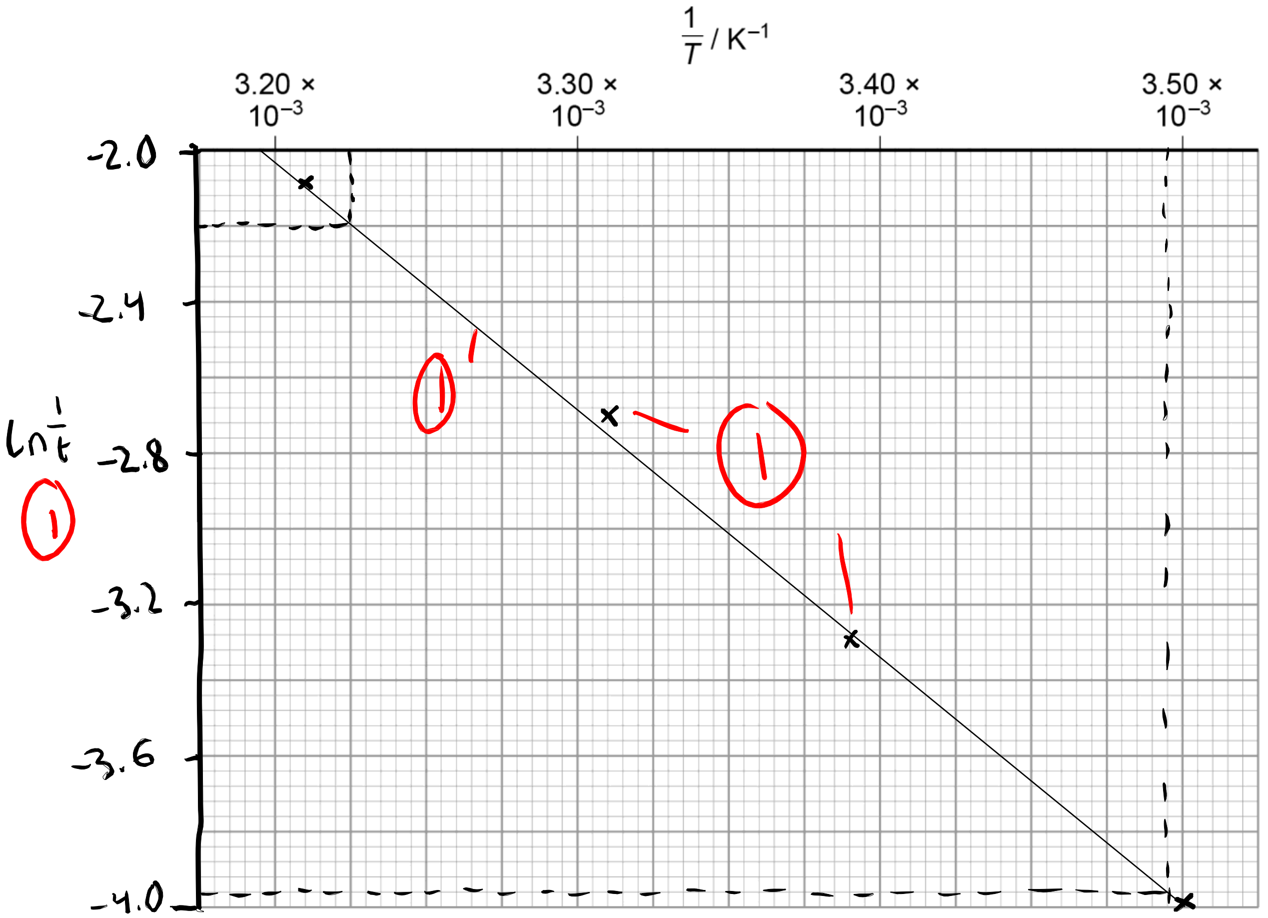
where $C_1$ and $C_2$ are constants.

Use values from **Table 3** to plot a graph of ln $\frac{1}{t}$ (y axis) against $\frac{1}{T}$ on the grid.

Use your graph to calculate a value for the activation energy, in kJ mol$^{-1}$, for this reaction.

The value of the gas constant, $R$ = 8.31 J K$^{-1}$ mol$^{-1}$

[redacted]



$\ln\frac{1}{t} = -\frac{E_a}{R}\left(\frac{1}{T}\right) + c_2$ $\quad m = -\frac{E_a}{R}$

$y = m \quad x + c$

$m = \frac{y_1 - y_2}{x_1 - x_2} = \frac{-3.96 - -2.2}{3.495\times10^{-3} - 3.225\times10^{-3}}$

$= \frac{-1.76}{2.7\times10^{-4}} = -6520$ ①

$E_a = -(m \times R) = -(-6520 \times 8.31) = 54188.2\ \text{J mol}^{-1}$

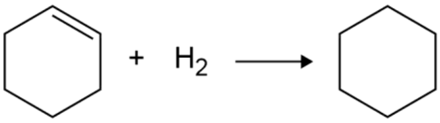
①

$= 54.2\ \text{kJ mol}^{-1}$ ①

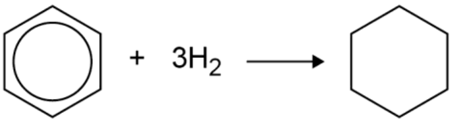
Activation energy 54.2 kJ mol$^{-1}$

14

**0 6** Data about the hydrogenation of cyclohexene and of benzene are given.



$\Delta H^{\ominus}$ = [redacted]



$\Delta H^{\ominus}$ = [redacted]

**0 6 . 1** Explain the bonding in and the shape of a benzene molecule.
Compare the stability of benzene with that of the hypothetical cyclohexa-1,3,5-triene molecule.
Use the data in your answer.

bonding, shape, stability

[redacted]

Each carbon atom in benzene forms three covalent bonds. The remaining p-orbital electrons overlap - this is delocalisation.

Benzene is planar and has a hexagonal shape. The C-C bonds are all the same length.

The expected $\Delta H^{\ominus}$ hydrogenation for cyclohexatriene would be $-360$ kJ $mol^{-1}$, but benzene's is 152 kJ less exothermic. Therefore, benzene is more stable.

**0 6 . 2** The enthalpy of hydrogenation of cyclohexa-1,3-diene is **not** exactly double that of cyclohexene.

−240 kJ mol⁻¹

Suggest a value for the enthalpy of hydrogenation of cyclohexa-1,3-diene and justify your value.

−121 kJ mol⁻¹ − −239 kJ mol⁻¹

**[3 marks]**

−164 kJ mol⁻¹

The double bonds are separated by a single bond. This allows some delocalisation, which makes the molecule more stable

9

**0 7** Acyl chlorides are useful reagents in synthesis. They react with aromatic compounds and also with alcohols.

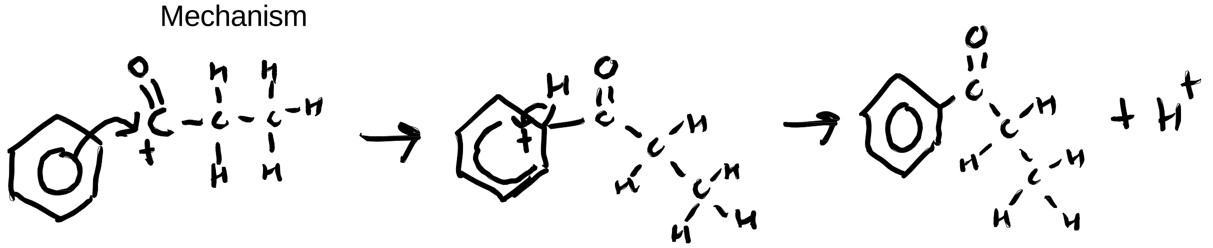
**0 7 . 1** $CH_3CH_2COCl$ reacts with benzene in the presence of $AlCl_3$ in an electrophilic substitution reaction.

Give an equation for the reaction of $CH_3CH_2COCl$ with $AlCl_3$ to form the electrophile. Outline a mechanism for the reaction of this electrophile with benzene.

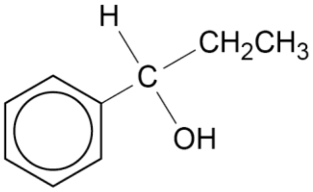
[redacted]

Equation $CH_3CH_2COCl + AlCl_3 \rightarrow CH_3CH_2\overset{+}{C}O + AlCl_4^-$

Mechanism



**0 7 . 2** The organic product in Question **07.1** can be converted into the alcohol shown.



Give the IUPAC name of the alcohol.
Give the reagent needed for this reaction and name the mechanism.

[redacted]

IUPAC name 1-phenyl propan-1-ol

Reagent NaBH$_4$ LiAlH$_4$

Name of mechanism Nucleophilic addition

**0 7 . 3** The alcohol shown in Question **07.2** reacts with ethanoyl chloride to form an ester.

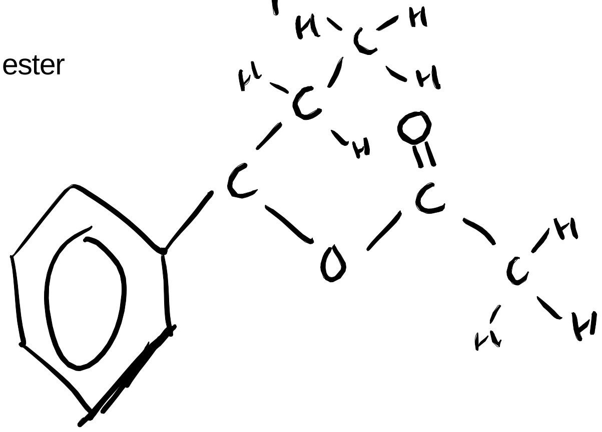
Describe what would be observed when the alcohol reacts with ethanoyl chloride.
Name the mechanism for the reaction to form the ester.
Draw the structure of the ester.

[redacted]

Observation Misty fumes

Name of mechanism Nucleophilic addition -elimination

Structure of ester



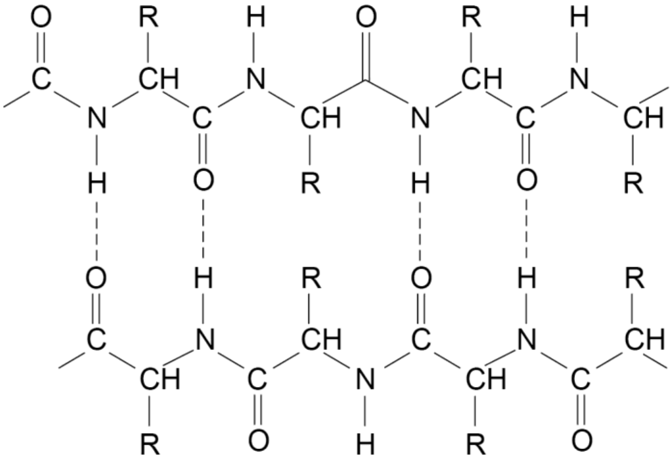
10

**Turn over for the next question**

**0 8** Use the Data Booklet to help you answer this question about amino acids.

**Figure 1** shows parts of two polypeptide chains in a beta-pleated sheet of a protein.

**Figure 1**



**0 8 . 1** The polypeptide chains are held together by hydrogen bonding as shown in **Figure 1**.

Explain how these hydrogen bonds form.

**[2 marks]**

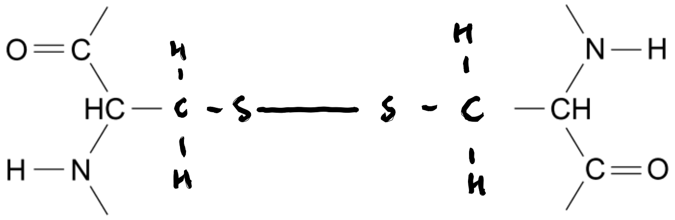
The hydrogen bonded to the Nitrogen is electron deficient

This abstracts the lone pair on the Oxygen

**0 8 . 2** A different type of bond can form between two polypeptide chains when the chains each contain the amino acid cysteine.

Complete the structure to show the bond that forms between the side chains of two cysteine molecules.

**[1 mark]**



**0 8 . 3** The type of bond in Question **08.2** between two polypeptide chains influences the three-dimensional structure of the protein.

Name this type of protein structure.

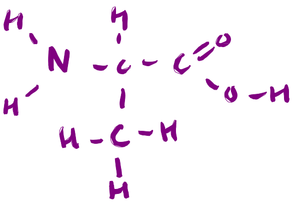
[redacted]

Tertiary

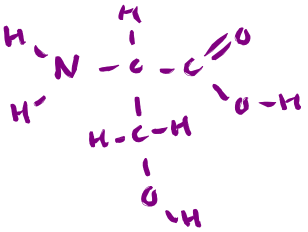
**0 8 . 4** Draw the structure of the zwitterion of a dipeptide formed by alanine and serine.

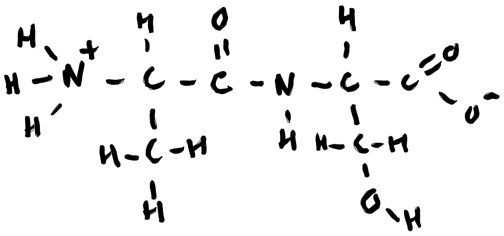
[redacted]

Alanine :



Serine :



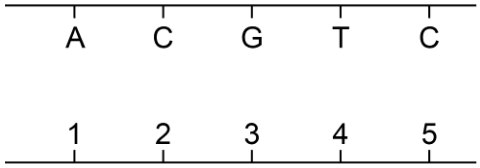


6

**Turn over for the next question**

**0 9** Use the Data Booklet to help you answer this question about DNA.
**Figure 2** shows a fragment of a DNA double helix.
The letters A, C, G and T represent the four bases in one strand.
The numbers 1, 2, 3, 4 and 5 represent the bases in the complementary strand.

**Figure 2**



**0 9 . 1** Complete **Table 4** to show the correct sequence of bases in the complementary strand represented by the numbers 1 to 5

A-T
C-G

[redacted]

**Table 4**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| T | G | C | A | G |

**0 9 . 2** Deduce the total number of hydrogen bonds formed between the five bases in each strand.

A-T = 2 h bonds C-G = 3 h bonds
3(3) + 2(2) = 13

Tick (✓) **one** box.

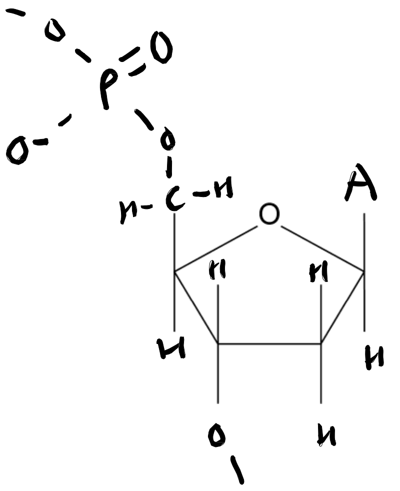
[redacted]

| 10 | 12 | 13 | 15 |
|---|---|---|---|
| ☐ | ☐ | ☑ | ☐ |

**0 9 . 3** Base A is part of a nucleotide in the DNA strand shown in **Figure 2**.
A nucleotide contains a 2-deoxyribose molecule.
An incomplete 2-deoxyribose molecule is shown.

Complete the structure to show the nucleotide that contains base A.
You should represent base A by the letter A.

**[2 marks]**



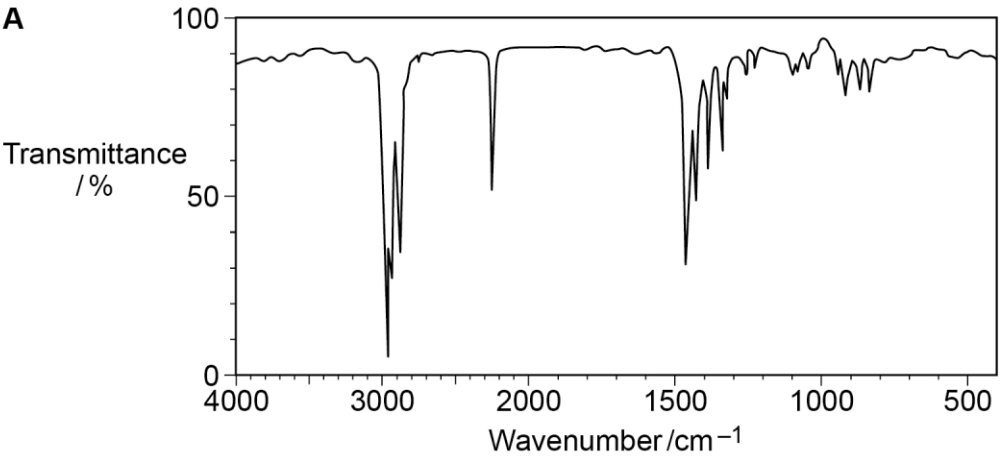
**4**

**Turn over for the next question**

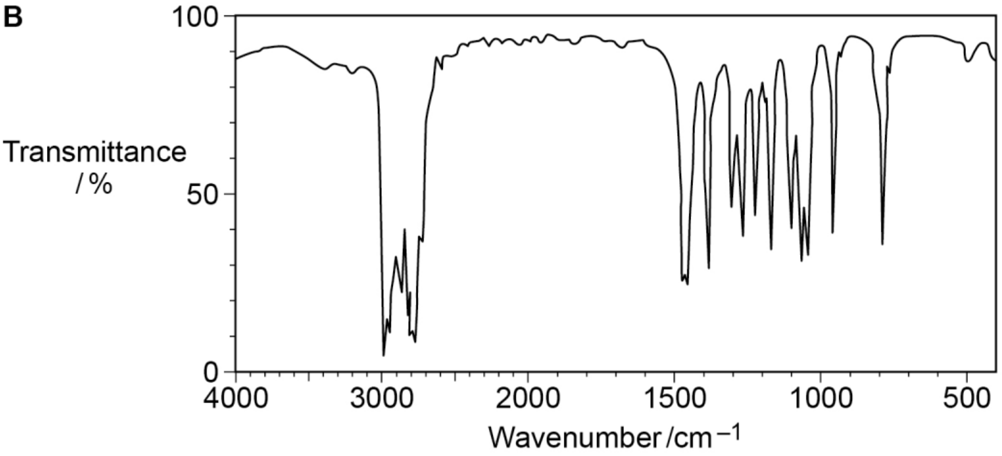
**1 0** This question is about amines.

**1 0 . 1** The infrared spectra **A**, **B** and **C** are those of a primary amine, a tertiary amine and a nitrile, but not necessarily in that order.

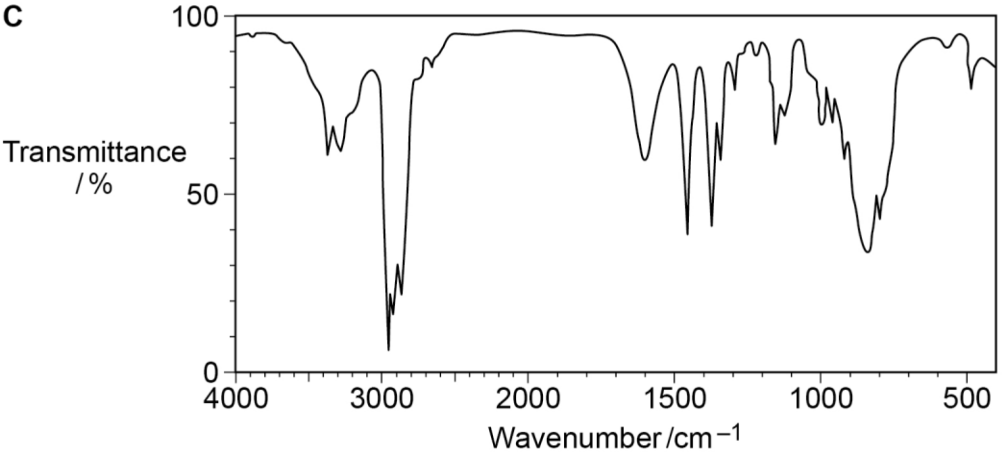
**A**



**B**



**C**



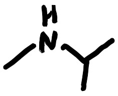
Give the letter of each compound in the correct box.

| primary amine | tertiary amine | nitrile |
|---|---|---|
| C | B | A |

**1 0 . 2** There are **three** secondary amines that contain four carbon atoms per molecule.

Draw the skeletal formulas of these **three** secondary amines.

[redacted]



**1 0 . 3** Primary amines can be prepared by the reaction of halogenoalkanes with ammonia or by the reduction of nitriles.

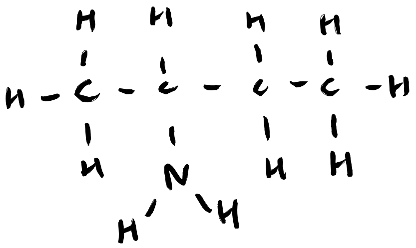
Justify the statement that it is better to prepare primary amines from nitriles rather than from halogenoalkanes.

[redacted]

Reducing nitriles does not lead to any further reactions. Reducing nitriles produces a single product, so has a better atom economy.

Draw the structure of a primary amine with four carbon atoms that **cannot** be formed from a nitrile.

[redacted]



**1 0 . 5** A student dissolves a few drops of propylamine in 1 $cm^3$ of water in a test tube.

Give an equation for the reaction that occurs.
Describe what is observed when Universal Indicator is added to this solution.

[redacted]

Equation $CH_3CH_2CH_2NH_2 + H_2O \rightleftharpoons CH_3CH_2CH_2NH_3^+ + OH^-$

Observation Solution turns blue

**1 0 . 6** Phenylamine can be prepared by a process involving the reduction of nitrobenzene using tin and an excess of hydrochloric acid.

Give an equation for the reduction of nitrobenzene to form phenylamine. Use [H] to represent the reducing agent.
Explain why an aqueous solution is obtained in this reduction even though phenylamine is insoluble in water.

[redacted]

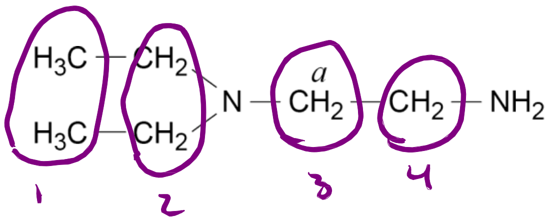
Equation $C_6H_5NO_2 + 6[H] \rightarrow C_6H_5NH_2 + 2H_2O$

Explanation Phenylamine is present as an ionic salt, $C_6H_5NH_3^+$ $(Cl^-)$

**10**

**1 1** There are several isomers with the molecular formula $C_6H_{16}N_2$

**1 1 . 1** One isomer is shown.



Give the number of peaks in the $^{13}C$ NMR spectrum of this isomer.

State and explain the splitting pattern of the peak for the hydrogens labelled *a* in its $^{1}H$ NMR spectrum.

[redacted]

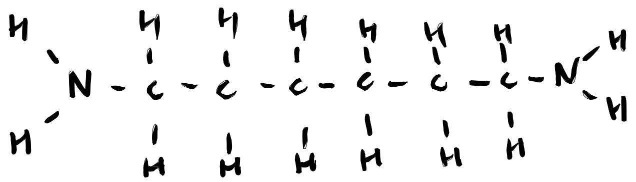
Number of $^{13}C$ peaks 4

Splitting pattern 3

Explanation The adjacent carbon has 2 hydrogen atoms bonded to it, so n+1 =3

**1 1 . 2** Draw the structure of the isomer of $C_6H_{16}N_2$ used to make nylon 6,6

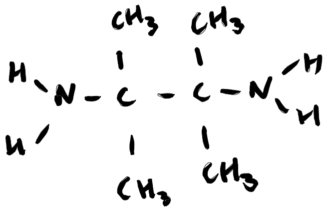
[redacted]



**Question 11 continues on the next page**

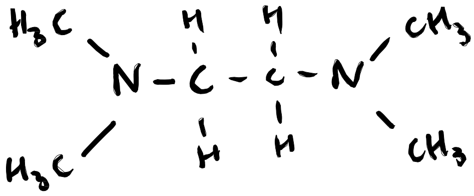
**1 1** . **3** Draw the structure of the isomer of $C_6H_{16}N_2$ that contains two **primary** amine groups and has only two peaks in its $^{13}$C NMR spectrum.

[1 mark]



**1 1** . **4** Draw the structure of the isomer of $C_6H_{16}N_2$ that contains two **tertiary** amine groups and has only two peaks in its $^{13}$C NMR spectrum.

[1 mark]



## END OF QUESTIONS

**6**

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