

CHEMISTRY

CH2

SPECIMEN PAPER

(1 hr 30 min)

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a

- calculator
- a Data Sheet supplied by WJEC containing a Periodic Table, NMR and IR data

INSTRUCTIONS TO CANDIDATES

Answer all questions.

Write your name, centre number and candidate number in the spaces at the top of this page.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication used in your answers.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A

Answer all the questions in the spaces provided.

1. (i) Draw partial charges, if any, on the formula of iodine monochloride below, to indicate any polarity in this covalent compound.

Explain the reason for your answer. [1]

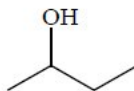


- (ii) Showing outer electrons only, draw a dot and cross diagram for this molecule. [1]

2. (i) Write the balanced equation for the reaction between aqueous strontium ions and aqueous sulfate ions. [1]

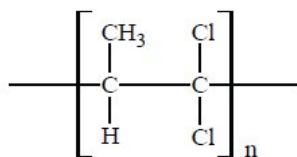
- (ii) State what is seen in the reaction in (i) above. [1]

3. State the name of the compound having the skeletal formula. [1]



4. The carbon-bromine bond in 2-bromopropane breaks by heterolytic fission. Write the structural formulae of the 2-bromopropane and the resulting species. [2]

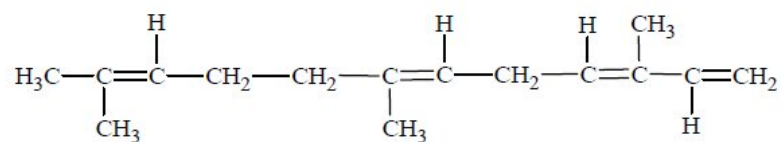
5. Part of the formula of an addition polymer is shown below.



Write the structural formula of the monomer used to produce this polymer.

[1]

6. The pheromone of one species of ant is



- (i) State the number of moles of hydrogen gas required to produce one mole of the corresponding alkane from this pheromone. [1]

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- (ii) State a suitable catalyst for this hydrogenation. [1]

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Section A Total [10]

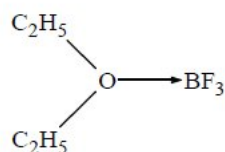
SECTION B

Answer all the questions in the spaces provided.

7. (a) Use the valence shell electron pair repulsion principle (VSEPR) to explain the shape of a molecule of gaseous boron trifluoride, giving the value of the F-B-F bond angle. [3]

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- (b) Boron trifluoride reacts with ethoxyethane to give an addition compound containing a co-ordinate bond between oxygen and boron.



- (i) Explain why a co-ordinate bond is formed between oxygen and boron. [2]

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- (ii) Apply the VSEPR principle to predict the arrangement of the four bonds around the central boron atom. [2]

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- (c) Magnesium sulfate, an important compound in horticulture, can be made in industry by reacting the mineral dolomite with dilute sulfuric acid to give calcium sulfate and magnesium sulfate as two of the products.

- (i) Complete and balance the equation for this reaction. [2]



- (ii) Describe what is seen during this reaction. [2]

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- (iii) After removal of the calcium sulfate, the solution is heated to increase the concentration of the magnesium sulfate and then cooled. Crystals of hydrated magnesium sulfate are then filtered off and dried. The solubility of hydrated magnesium sulfate at two temperatures is given in the table below.

Temperature / °C	Solubility / g per 100 g of water
20	36
90	123

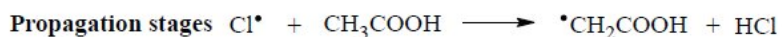
In a batch process, a saturated solution of magnesium sulfate at 90 °C contained 200 kg of water.

Use the table to calculate the mass of solid hydrated magnesium sulfate crystals produced when this solution is cooled to 20 °C. [2]

Mass producedkg.

Total [13]

8. (a) Chloroethanoic acid can be made by reacting ethanoic acid with chlorine in the presence of ultraviolet light. This reaction is similar to the reaction of methane with chlorine. Part of a possible mechanism for this reaction is shown below.



- (i) State the function of ultraviolet light in the initiation stage. [1]

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- (ii) Use the propagation stages to give the overall equation for the reaction. [1]

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- (iii) Use the stages of the mechanism above to write a termination stage for the reaction. [1]

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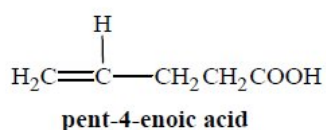
- (b) Describe a test to show the presence of a C-Cl bond in chloroethanoic acid. Your answer should state the reagent(s) required after hydrolysing the C-Cl bond by heating the acid with excess of an alkali. State what is seen after adding the reagent(s). [3]

Reagent(s)

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Observation

- (c) 5-Chloropentanoic acid, $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$, used as a plant growth hormone, can be made from pent-4-enoic acid.



- (i) State whether or not pent-4-enoic acid can exist as E-Z geometric isomers, explaining your choice of answer. [1]

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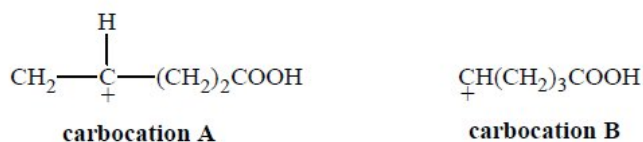
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- (ii) Addition of hydrogen chloride to pent-4-enoic acid gives the two compounds 4-chloropentanoic acid and 5-chloropentanoic acid.

- I State the type of reaction mechanism occurring when hydrogen halides such as hydrogen chloride or hydrogen bromide add to compounds containing C=C bonds. [2]

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- II The mechanism for this reaction involves the carbocations A and B.



- Use these carbocations to explain why the preferred product of the reaction is 4-chloropentanoic acid. [2]

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- (d) Dichlorodifluoromethane was formerly used as a refrigerant, but its use is not now allowed as it has been found to deplete ozone in the upper atmosphere.

Explain why dichlorodifluoromethane causes this effect but 1,1,1-trifluoroethane does not affect the ozone layer. [2]

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- (e) The boiling temperatures of two fluorinated compounds are shown in the table.

<i>Name</i>	<i>Formula</i>	<i>Boiling temperature / °C</i>
1,1,1-trifluoroethane	CF ₃ CH ₃	- 47
2,2,2-trifluoroethanol	CF ₃ CH ₂ OH	78

Explain, in terms of intermolecular forces, why the boiling temperatures of these two compounds are so different.

You are advised to use a diagram in your answer. [3]

(QWC) [1]

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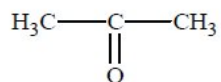
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Total [16]

(ii) You are given the three main products of fermentation in separate unlabelled bottles.

I Describe how you would use infrared spectroscopy to identify which of the three liquids was propanone, [2]



propanone

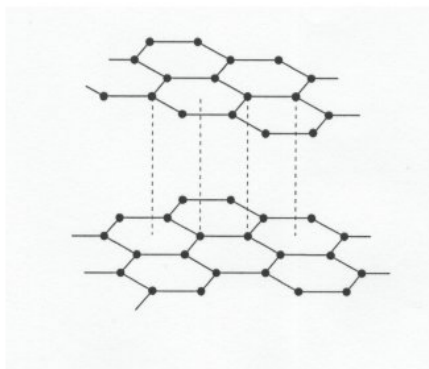
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II Describe how you would identify the two remaining liquids by the use of a physical property, explaining why the liquids differ in this physical property. [2]

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Total [16]

10. (a) The diagram shows the structure of graphite



(i) Describe the bonding in graphite. [2]

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- (ii) Describe the hardness and electrical conductivity of graphite and explain these in terms of the structure. [2]

Hardness

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Electrical conductivity

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- (iii) Describe the structure of a carbon nanotube and relate this to the structure of graphite. [2]

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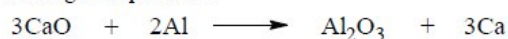
- (b) Nano-sized particles are very small, typically less than 100 nm across. At this scale the properties of materials change drastically from those of larger particles.

Give an example of the use of nanoparticles. [1]

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- (c) (i) Solid calcium oxide, CaO, has the same crystal structure as sodium chloride. Draw a labelled diagram which shows the crystal structure of calcium oxide and gives the formulae of its ions. State the crystal co-ordination numbers of the ions present. [3]

- (ii) One method of making pure calcium is to heat calcium oxide with aluminium at a high temperature.



By use of oxidation states (numbers) explain why this is a redox reaction. [2]

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- (d) Describe what is seen when calcium metal is added to water and pH indicator is added to the resulting mixture. [3]

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Total [15]

11. (a) Bromine combines with reactive metals such as sodium giving sodium bromide, which contains sodium and bromide ions.

- (i) Explain why there is a tendency for a bromine atom to become a bromide ion. [1]

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- (ii) You are provided with a solution that contains colourless bromide ions. State what is seen when chlorine gas is passed into the solution, giving an ionic equation for the reaction that occurs. [2]

Observation

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Ionic equation

- (b) An organic compound, X, containing carbon, hydrogen and bromine, was formerly used as a pesticide.

- (i) Analysis of compound X showed that it had a relative molecular mass of 94.9. Use the information given to deduce the molecular formula of compound X. [3]

- (ii) The use of compound X was discontinued after it was found that it caused damage to the ozone layer in the upper atmosphere. A major use for compound X was as a fumigant. Vapours of compound X were allowed to circulate in a grain warehouse. This vapour killed insects and rodents that would eat the grain. Residual vapour was then removed by extractor fans before the grain was removed. Scientists need to choose another organic compound in place of compound X.

Suggest **two** features, apart from cost and possible ozone damage, that the compound should possess if it is to be used as a fumigant in this way. [2]

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(c) When ethene is bubbled into dilute bromine water, one of the products is 2-bromoethanol. Describe how you would confirm that the compound is likely to be 2-bromoethanol, by use of infrared and mass spectroscopy. Bromine consists of two isotopes ^{79}Br and ^{81}Br in equal quantities. [2]

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Total [10]

Section B Total [70]