21 This question is about ethane and ethene.

(a) Ethane reacts with chlorine by a free radical mechanism.

(i) Explain what is meant by the term **free radical**.

(1)

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(ii) Complete the equation for the formation of free radicals from one molecule of chlorine. Use appropriate curly arrows to show electron movements.

(1)

Cl—Cl →

(iii) Write an equation for the reaction between ethane and a chlorine free radical, and name the type of step in the mechanism where this occurs. Curly arrows are not required.

(2)

Type of step .....

(iv) Give an equation for a termination step in this mechanism in which an **organic** compound other than chloroethane is formed.

(1)

(b) Ethene contains a carbon-carbon double bond.

(i) Complete the diagram below showing the σ and π bonds in the carbon-carbon double bond in ethene.

(2)

C C

*(ii) Describe and explain what happens to the σ and π bonds in ethene in an addition reaction.

(3)

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(iii) One test for a carbon-carbon double bond is the reaction with acidified potassium manganate(VII), $KMnO_4$.

Give the colour change if this reaction was carried out with ethene. Draw the **displayed** formula of the product.

(2)

From ..... to .....

Displayed formula

(iv) Describe another test for a carbon-carbon double bond and give the colour change for the positive result.

(2)

Test.....

From ..... to .....

(v) Ethene reacts with hydrogen bromide. Write the mechanism for this reaction, showing any relevant dipoles.

(4)

Mechanism:

(c) But-1-ene is an alkene with properties similar to ethene.

Write an equation, using **skeletal** formulae for the organic compounds, showing the conversion of but-1-ene to butane. State the essential condition needed.

(2)

Condition.....

(Total for Question 21 = 20 marks)

TOTAL FOR SECTION B = 60 MARKS

TOTAL FOR PAPER = 80 MARKS