3 Cycloalkanes show similar chemical properties to alkanes but have the same empirical formula as alkenes.

(a) Define empirical formula.

.....

..... [1]

(b) Cyclopentane, C_5H_{10}, has four cyclic structural isomers. One of these isomers is **C**, shown in Fig. 3.1.

Complete Fig. 3.1 to show two other cyclic structural isomers of C_5H_{10}.

cyclopentane			**C**

Fig. 3.1

[2]

(c) Cyclopentane reacts with Cl_2 in the presence of ultraviolet light to form C_5H_9Cl.

(i) The reaction is initiated by the bond fission of Cl_2.

State the type of bond fission shown in the initiation step.

..... [1]

(ii) Complete the equations to show the two propagation steps that follow the initiation step.

propagation 1 C_5H_{10} + ... → C_5H_9• + ...

propagation 2 C_5H_9• + ... → .....

[2]

(iii) The final step is shown.

$$C_5H_9\bullet + Cl\bullet \rightarrow C_5H_9Cl$$

Give the name for this step in the reaction.

..... [1]

(d) Fig. 3.2 shows a reaction cycle involving cyclopentane, cyclopentene and C_5H_9Cl.

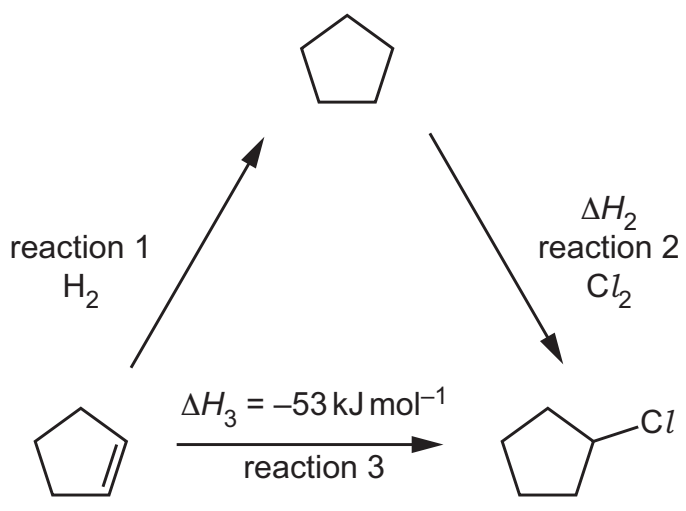

Fig. 3.2

(i) Identify a suitable reagent for reaction 3.

..... [1]

(ii) Use the data in Fig. 3.2 and in Table 3.1 to calculate the enthalpy change of reaction 2, ΔH_2.

Table 3.1

compound	enthalpy change of combustion, ΔH_c / kJ mol^{-1}
	–3292
	–3115
H_2	–286

ΔH_2 = ... kJ mol^{-1} [2]

(e) Cyclopentene, C_5H_8, reacts with hot concentrated acidified $KMnO_4$ to form compound **W**, $C_5H_8O_4$.

(i) Draw the structure of **W**.

[1]

(ii) The infrared spectrum of **W** is shown in Fig. 3.3.

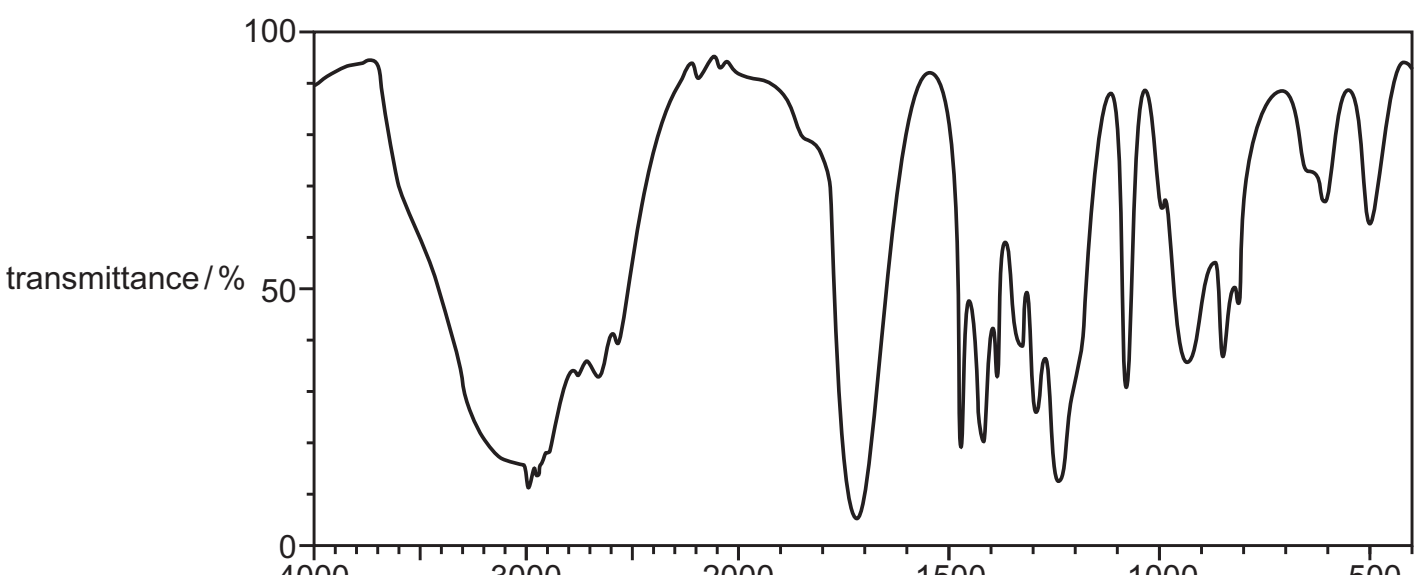

Fig. 3.3

Identify **two** absorptions in the infrared spectrum of **W** that would **not** be present in the infrared spectrum of cyclopentene.

- Write **1** or **2** on Fig. 3.3 against each of these two absorptions.
- Complete Table 3.2 to show which bond is responsible for each absorption that you have identified in Fig. 3.3.

Table 3.2

absorption	**1**	**2**
bond responsible		

[2]

Table 3.3

bond	functional groups containing the bond	characteristic infrared absorption range (in wavenumbers) / cm^{-1}
C–O	hydroxy, ester	1040–1300
C=C	aromatic compound, alkene	1500–1680
C=O	amide carbonyl, carboxyl ester	1640–1690 1670–1740 1710–1750
C≡N	nitrile	2200–2250
C–H	alkane	2850–2950
N–H	amine, amide	3300–3500
O–H	carboxyl hydroxy	2500–3000 3200–3650

[Total: 13]