

**1** An organic compound, **X**, was analyzed in a laboratory.

(a) Compound **X** was found to have the following percentage composition by mass:

carbon, C = 54.5%

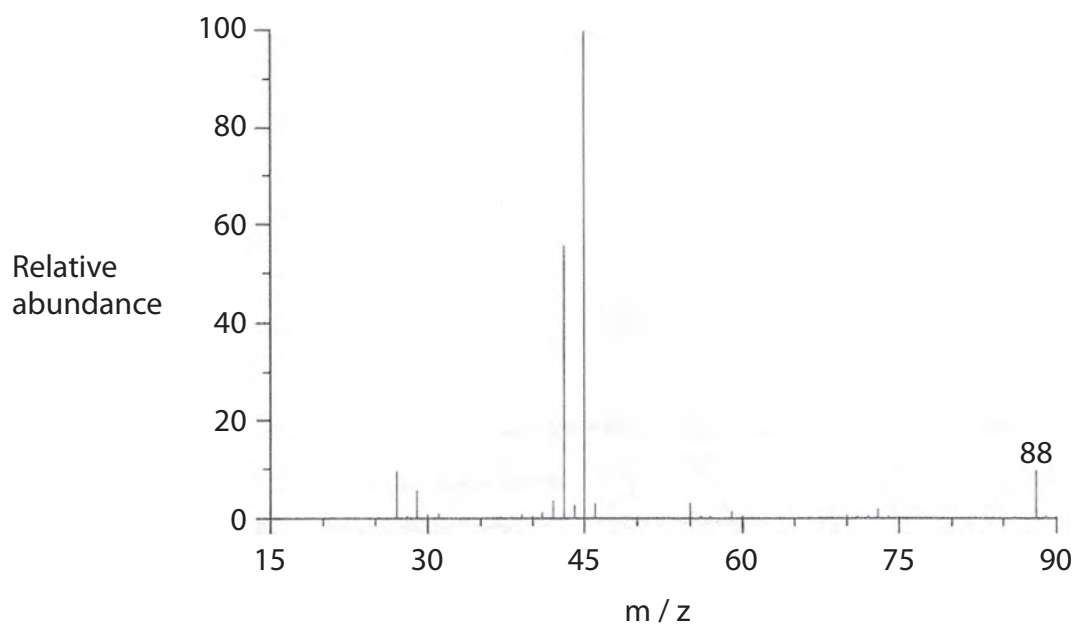
hydrogen, H = 9.1%

oxygen, O = 36.4%

(i) Use these data to calculate the empirical formula of compound **X**, showing your working.

(2)

(ii) The mass spectrum of **X** is shown below.



Use your answer to (a)(i), and the mass spectrum of **X**, to show that the molecular formula of compound **X** is  $C_4H_8O_2$ .

(2)

(b) The infrared spectrum of **X** has a broad peak at approximately  $3500\text{ cm}^{-1}$  and a sharp peak at approximately  $1700\text{ cm}^{-1}$ . Identify the **bond** responsible for the peak at

(2)

$3500\text{ cm}^{-1}$

$1700\text{ cm}^{-1}$

(c) (i) Some chemical information about compound **X** is given below.

- **X** is a neutral organic compound.
- **X** has no effect on Tollens' reagent.
- **X** turns hot acidified potassium dichromate(VI) solution from orange to green.

What does each of these three pieces of information suggest about the nature of **X**?

(4)

.....

.....

.....

.....

.....

.....

.....

(ii) Use your answers to parts (b) and (c)(i) to name the two functional groups present in **X**.

(1)

.....

\*(d) The high resolution proton nmr spectrum of **X** is shown below.

