

22. Analytical techniques

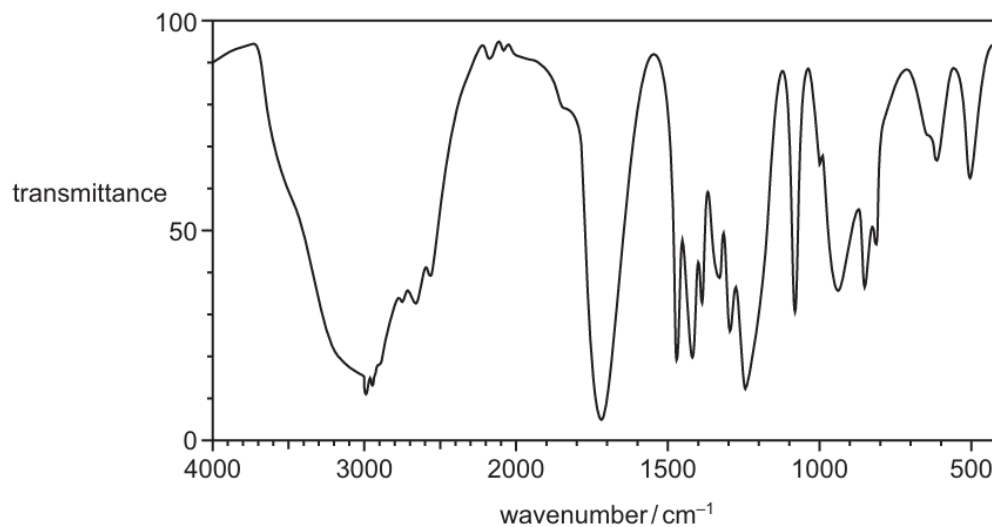
22.1 Infrared spectroscopy

Paper 1

Question Paper

1 Compound X reacts with acidified $K_2Cr_2O_7$ to form compound Y.

The infrared spectrum of compound Y is shown.

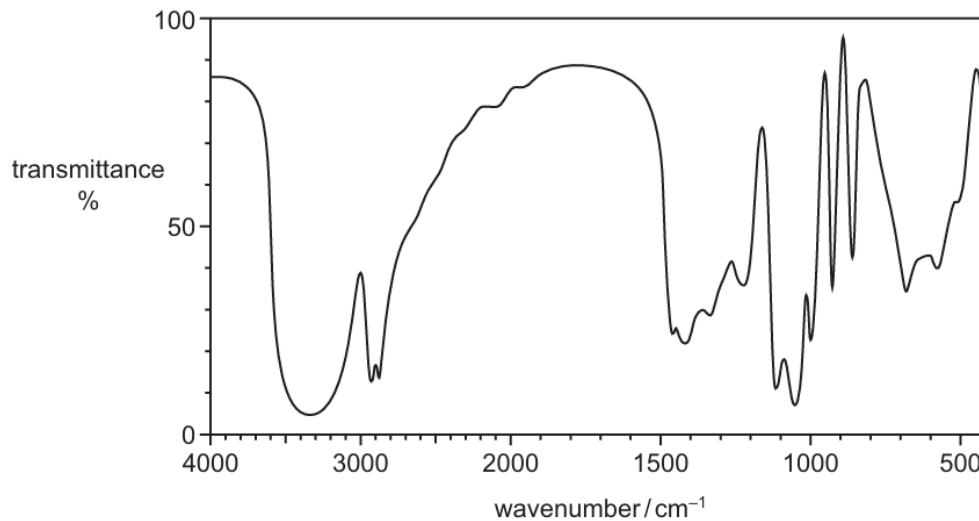


bond	functional groups containing the bond	characteristic infrared absorption range (in wavenumbers)/ cm^{-1}
C–O	hydroxy, ester	1040–1300
C=C	aromatic compound, alkene	1500–1680
C=O	amide carbonyl, carboxyl ester	1640–1690 1670–1740 1710–1750
C≡N	nitrile	2200–2250
C–H	alkane	2850–2950
N–H	amine, amide	3300–3500
O–H	carboxyl hydroxy	2500–3000 3200–3600

What is the identity of compound X?

- A propan-1-ol
- B propan-2-ol
- C propanone
- D propanoic acid

2 The infrared spectrum of compound L is shown.



bond	functional groups containing the bond	characteristic infrared absorption range (in wavenumbers)/cm ⁻¹
C–O	hydroxy, ester	1040–1300
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C=O	amide carbonyl, carboxyl ester	1640–1690 1670–1740 1710–1750
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C–H	alkane	2850–2950
N–H	amine, amide	3300–3500
O–H	carboxyl hydroxy	2500–3000 3200–3600

What is the structure of L?

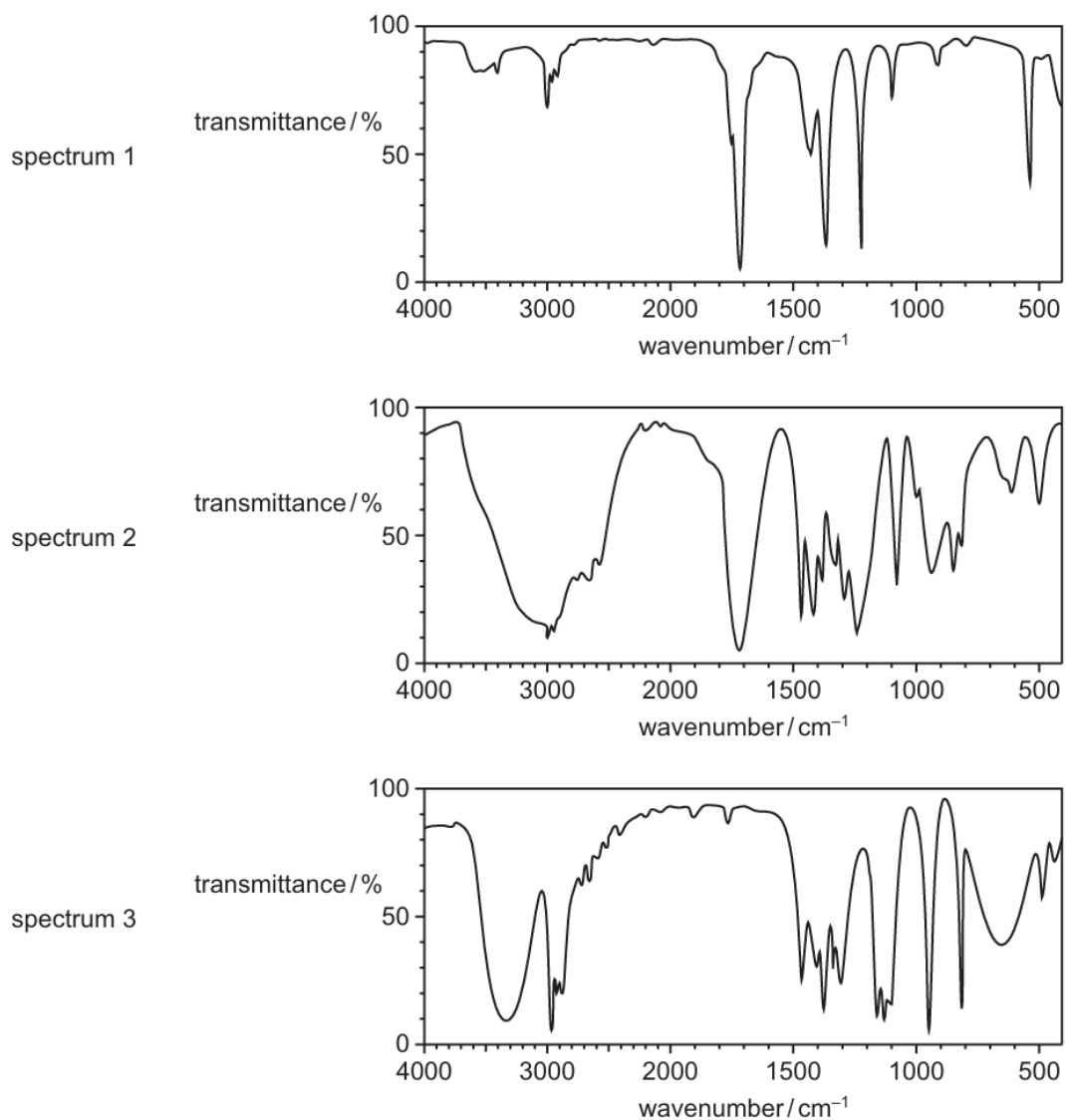
- A HOCH₂COCH₂OH
- B HOCH₂CH(OH)CHO
- C HOCH₂CH(OH)CH₂OH
- D HOCH₂CH₂COOH

- 3 A scientist chooses either infrared spectroscopy or mass spectrometry to find a particular piece of information.

In which row has the **best** choice been made?

	target information	analytic method used
A	identities of functional groups in an organic compound	infrared spectroscopy
B	identities of functional groups in an organic compound	mass spectrometry
C	values of successive ionisation energies of Na	infrared spectroscopy
D	values of successive ionisation energies of Na	mass spectrometry

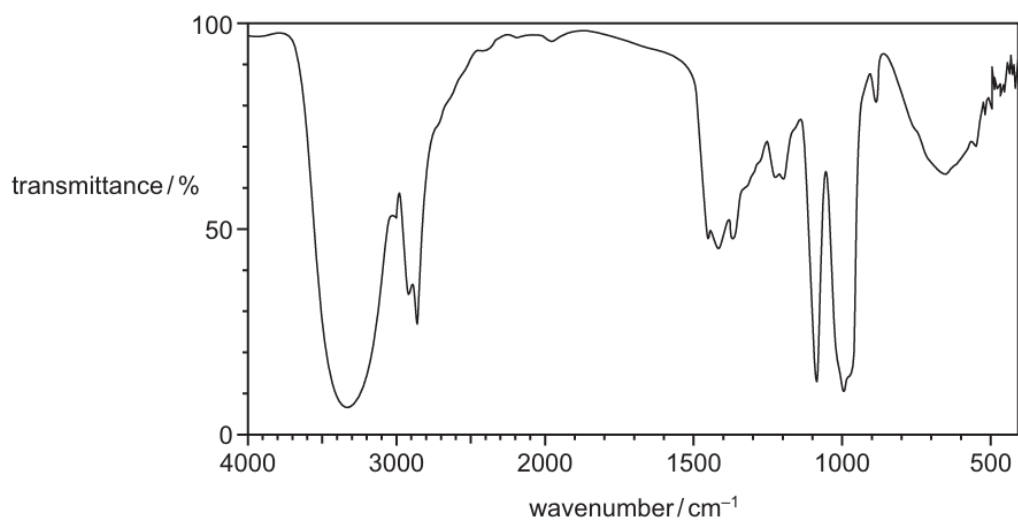
4 The infra-red spectra of three organic compounds are shown.



What could the three compounds be?

	spectrum 1	spectrum 2	spectrum 3
A	propanoic acid	propanone	propan-2-ol
B	propanone	propanoic acid	propan-2-ol
C	propanone	propan-2-ol	propanoic acid
D	propan-2-ol	propanoic acid	propanone

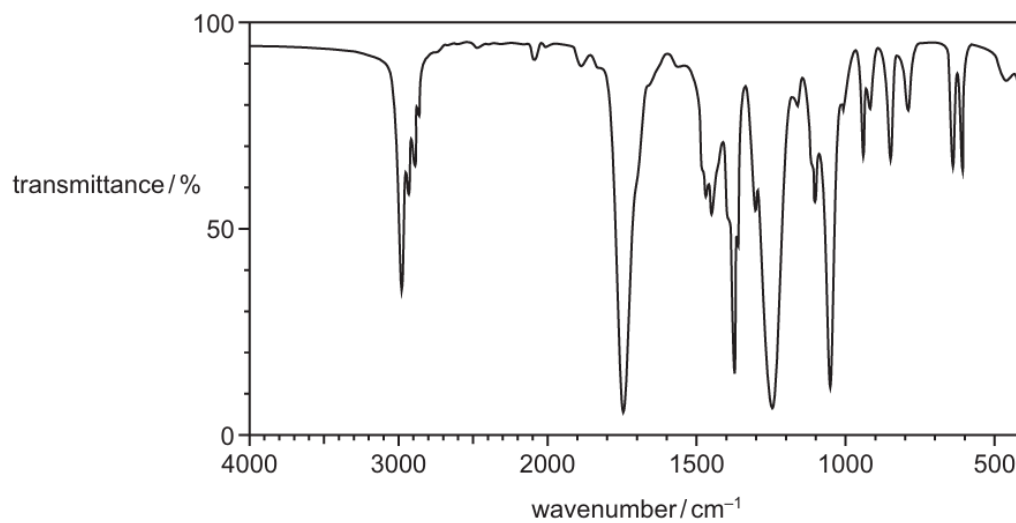
5 The infra-red spectrum of Y is shown.



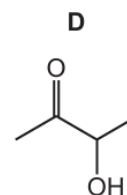
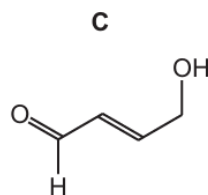
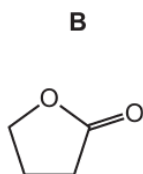
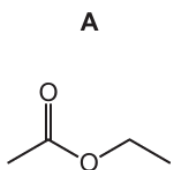
What could Y be?

- A $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5$
- B $\text{CH}_2(\text{OH})\text{CH}=\text{CHCH}_2\text{OH}$
- C $\text{CH}_3(\text{CH}_2)_2\text{CO}_2\text{H}$
- D $\text{CH}_2(\text{OH})(\text{CH}_2)_2\text{CHO}$

- 6 Compound X has the empirical formula C_2H_4O . Its infra-red spectrum is shown.

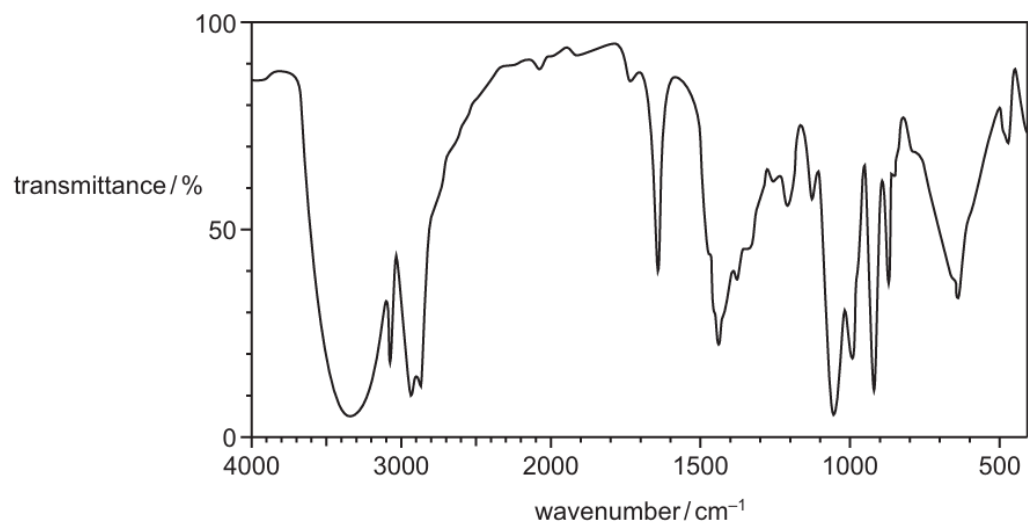


What could be the skeletal formula of compound X?

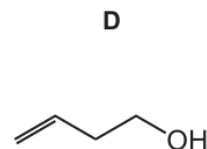
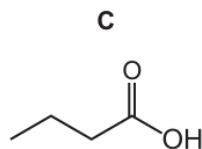
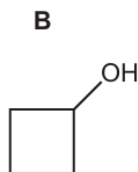
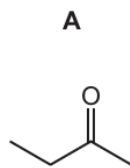


- 7 The molecular formula of Z is C_4H_8O .

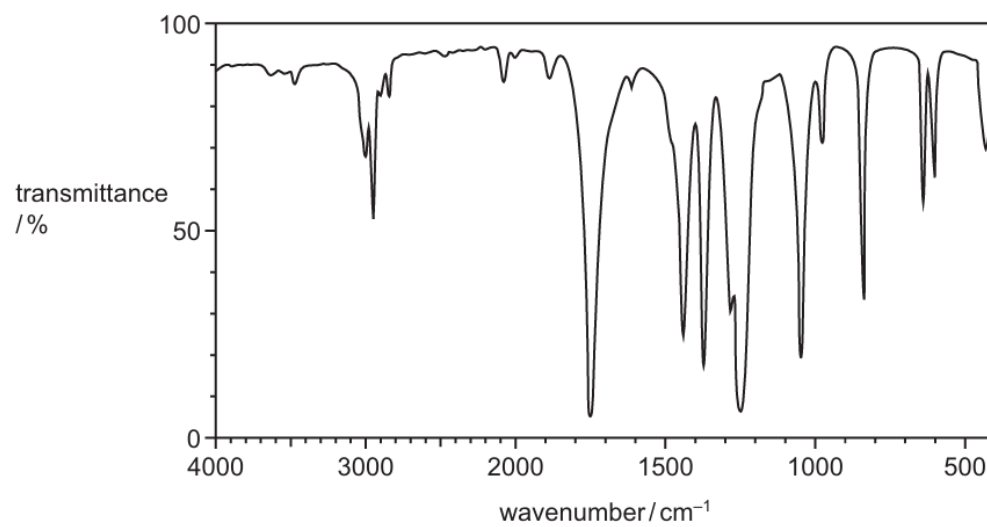
The infra-red spectrum of Z is shown.



What could be Z?



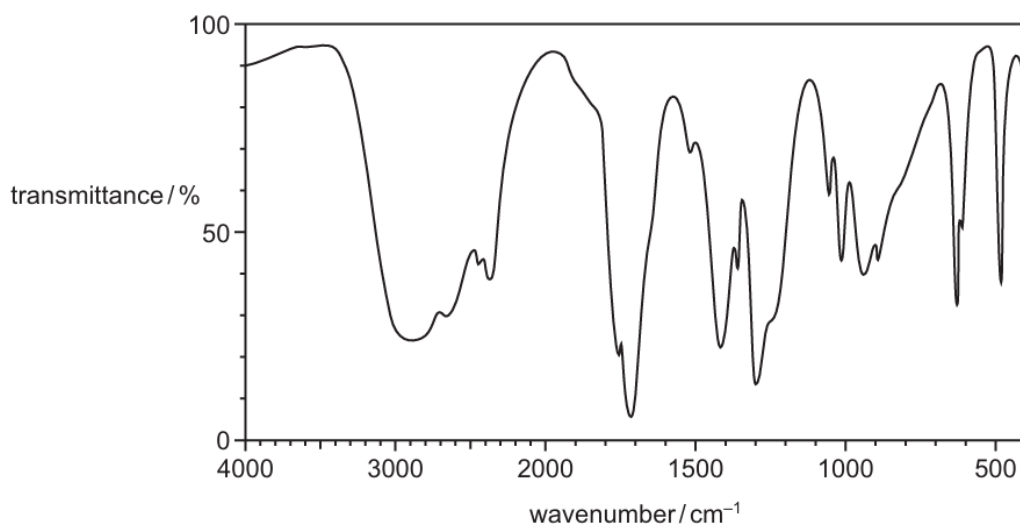
- 8 The infra-red spectrum shown was obtained from compound G.



What could be compound G?

- A $\text{CH}_3\text{COCH}_2\text{OH}$
- B $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
- C $\text{CH}_3\text{CO}_2\text{CH}_3$
- D $\text{CH}_3\text{CHCHCH}_3$

- 9 Compound X has the infra-red spectrum shown.



What could be the identity of compound X?

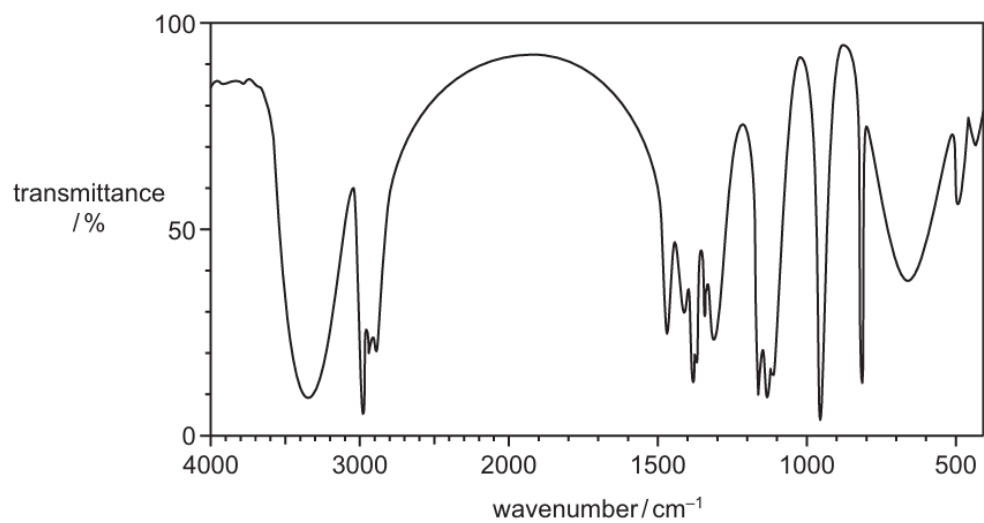
- A ethanoic acid
 - B ethanol
 - C ethylethanoate
 - D propanone
- 10 The table shows the molecular formulae of three molecules P, Q and R. None of the molecules are cyclic.

molecule	molecular formula
P	CH_4O
Q	CH_2O_2
R	CH_2O

Which molecules show a strong absorption between 1610 cm^{-1} and 1750 cm^{-1} in their infra-red spectra?

- A Q only
- B R only
- C Q and R only
- D P, Q and R

11 The infra-red spectrum of compound P is shown.

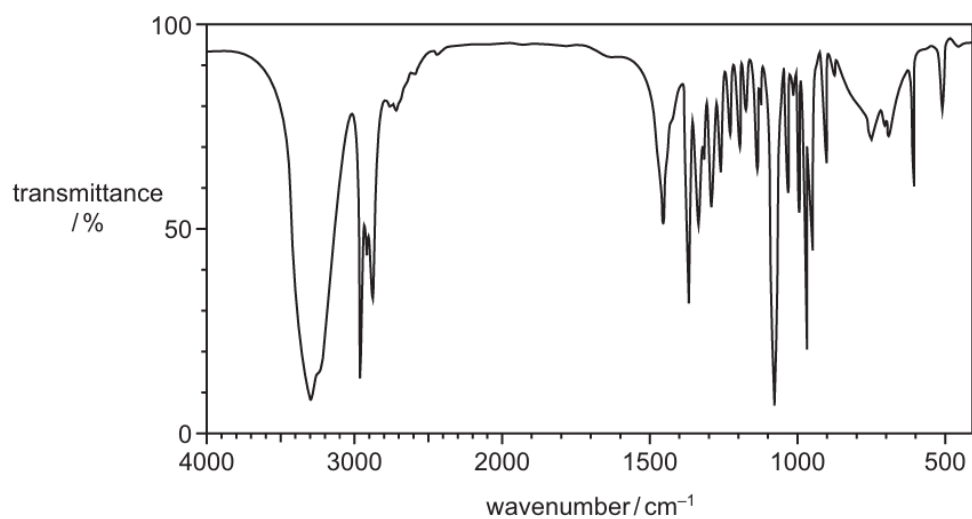


What could be compound P?

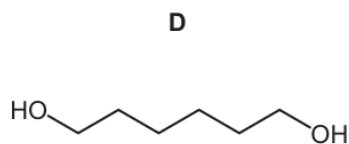
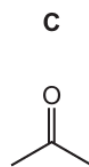
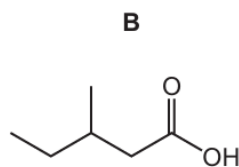
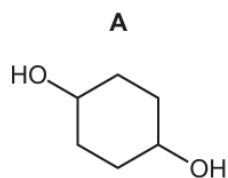
- A methyl ethanoate
- B propanal
- C propanoic acid
- D propan-2-ol

- 12 Substance T was analysed and found to contain 62.07% carbon, 10.34% hydrogen and 27.59% oxygen.

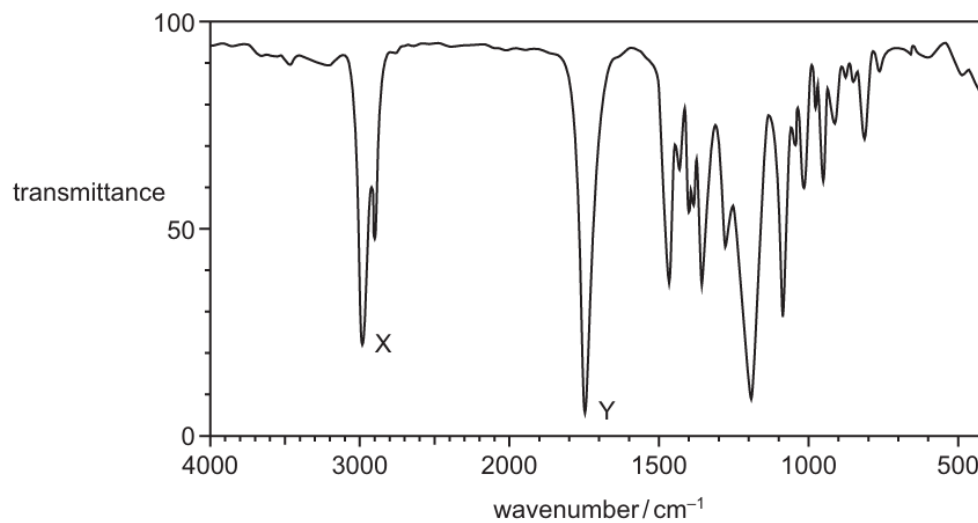
The infra-red spectrum of substance T is shown.



Which substance could be T?



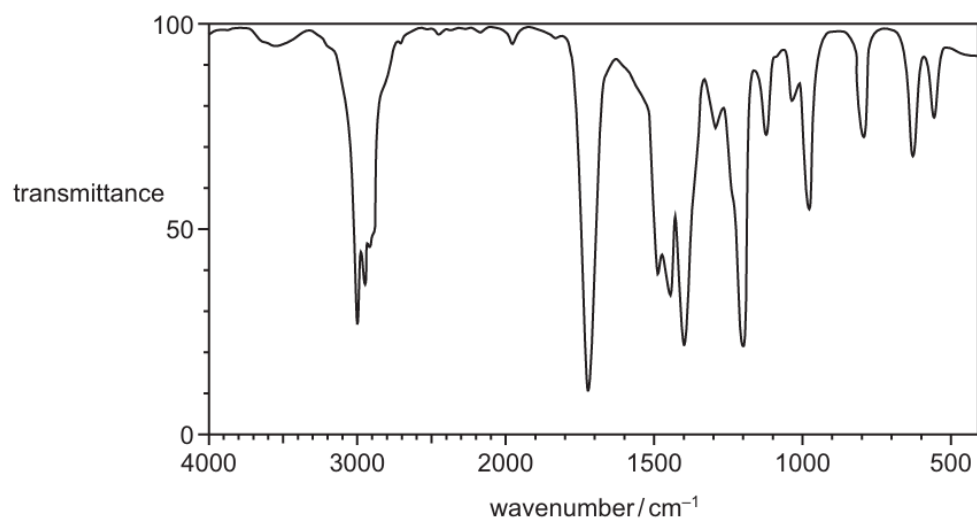
- 13 The infra-red spectrum of a substance with empirical formula C_2H_4O is shown.



Which bonds are responsible for peak X and peak Y?

	peak X	peak Y
A	C-H	C=C
B	C-H	C=O
C	O-H	C=C
D	O-H	C=O

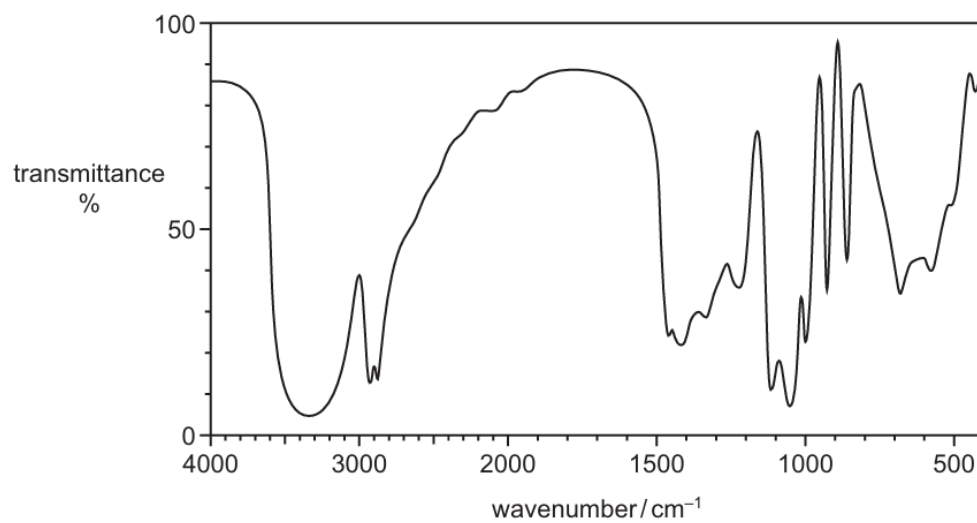
14 The diagram shows the infra-red spectrum of Q.



What could be Q?

- A butan-1-ol
- B butanoic acid
- C butanone
- D 3-hydroxybutanal

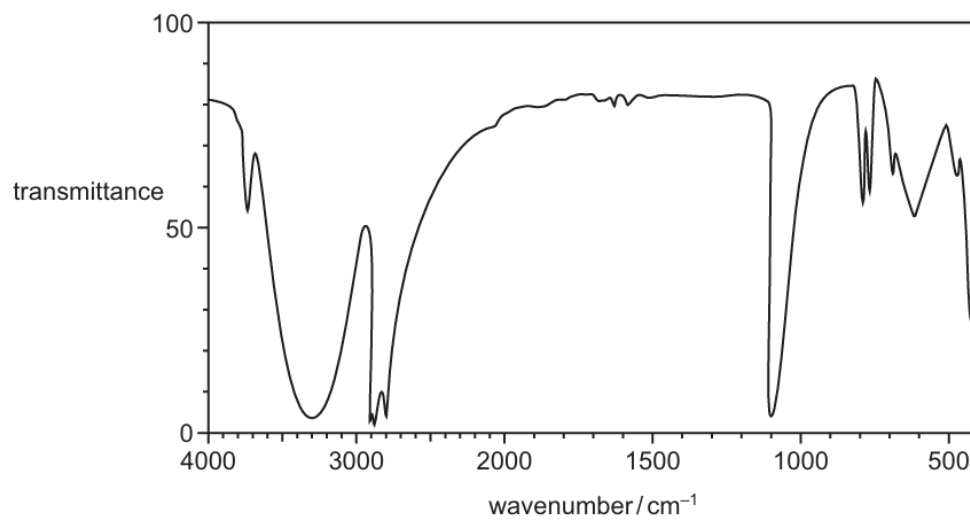
15 The infra-red spectrum of compound **L** is shown.



What could be the structure of **L**?

- A HOCH₂COCH₂OH
- B HOCH₂CH(OH)CHO
- C HOCH₂CH(OH)CH₂OH
- D HOCH₂CH₂COOH

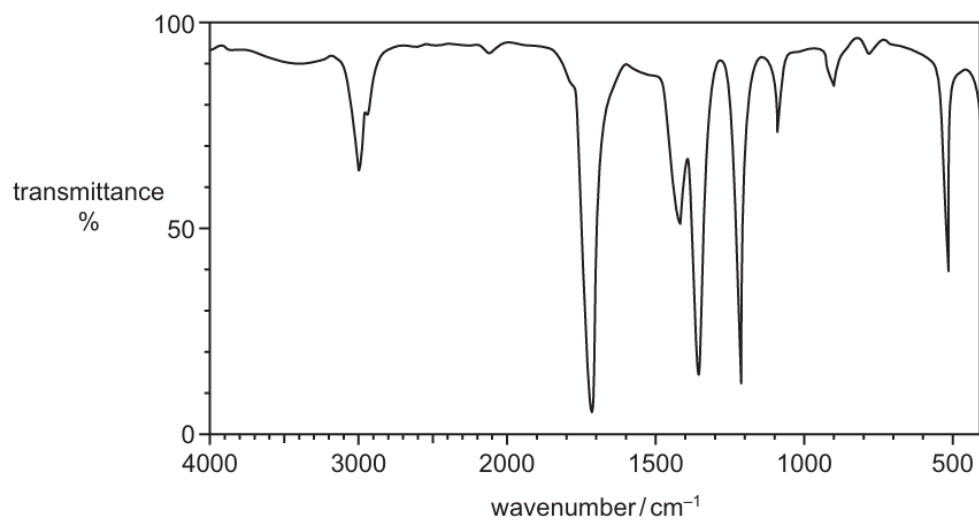
- 16** Compound X contains three carbon atoms. Part of a simplified infra-red spectrum of compound X is shown.



Which compound could be X?

- A** $\text{CH}_3\text{CH}_2\text{CHO}$
- B** $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
- C** $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- D** $\text{CH}_3\text{CO}_2\text{CH}_3$

17 The infra-red spectrum of an organic compound is shown.



Which compound could give this spectrum?

- A $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
- B $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
- C CH_3COCH_3
- D $\text{CH}_3\text{COCH}_2\text{OH}$