Cambridge AS & A Level

CHEMISTRY

Paper 1

Topical Past Paper Questions

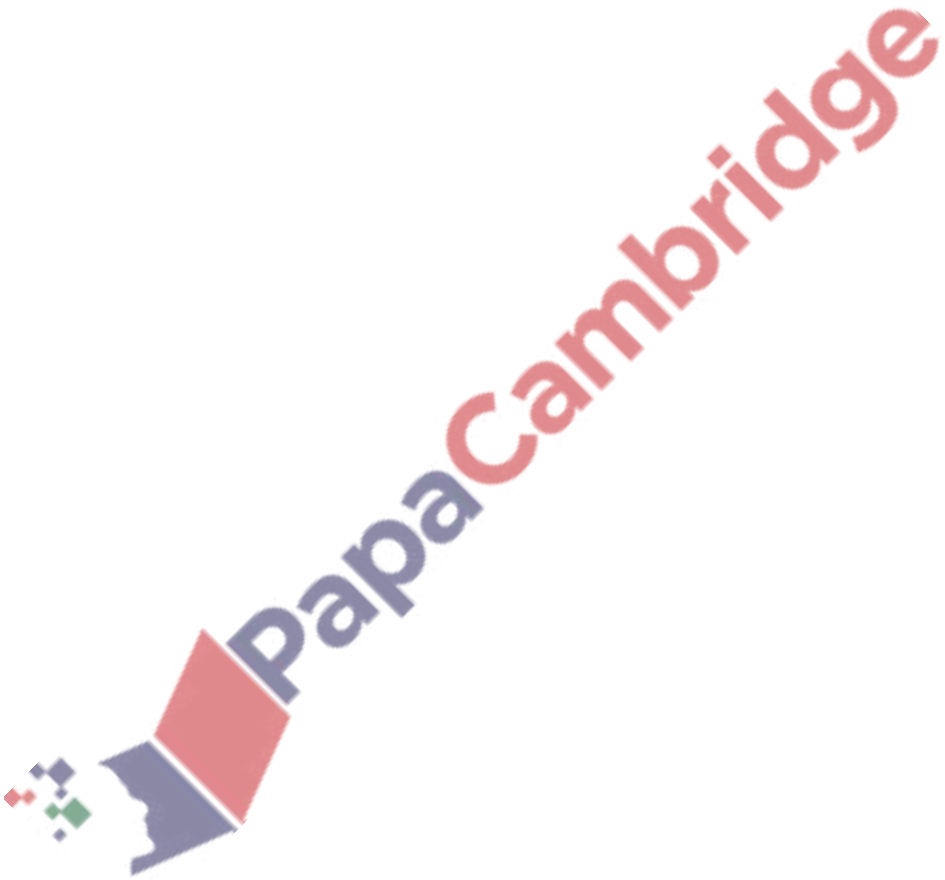
+ Answer Scheme

2015 - 2021

PapaCambridge

Chapter 21

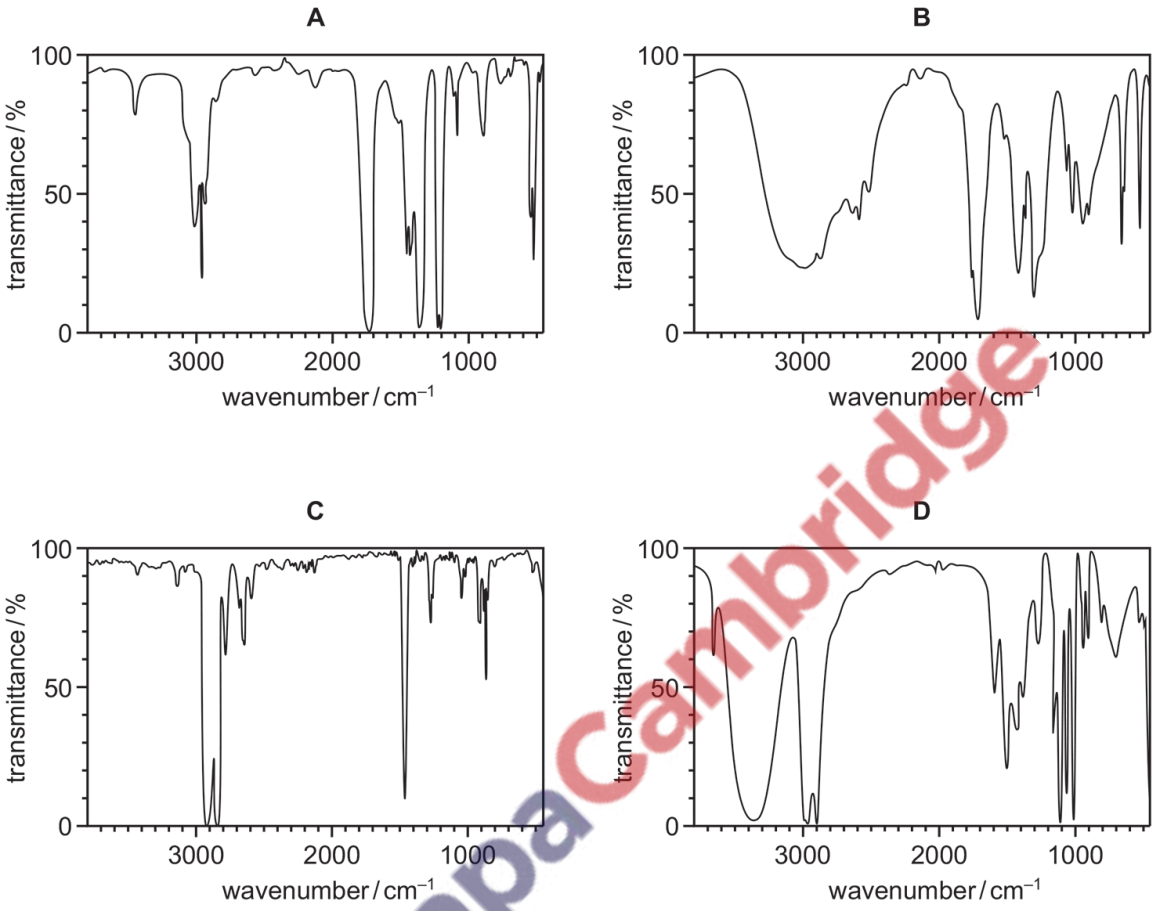
Analytical techniques



21.1 Infrared spectroscopy

1188. 9701_m22_qp_12 Q: 40

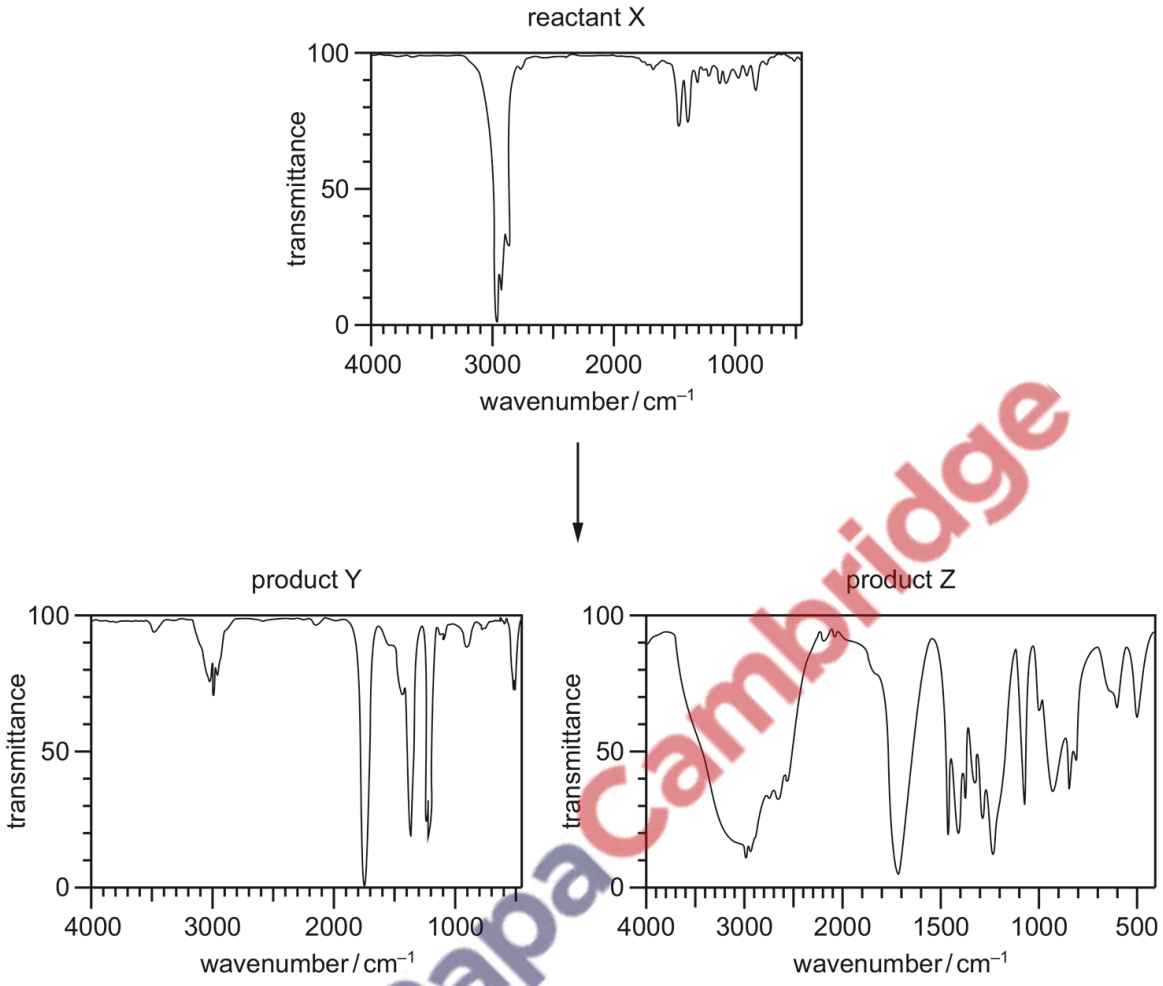
Which diagram shows the infrared spectrum of a compound that contains both a C=O and an O–H group?



bond	functional group 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	2850–3100
N–H	amine, amide	3300–3500
O–H	carboxyl hydroxy	2500–3000 3200–3650

1189. 9701_m21_qp_12 Q: 30

When reactant X is treated with a suitable reagent, products Y and Z are formed. Infrared spectra of X, Y and Z are shown.

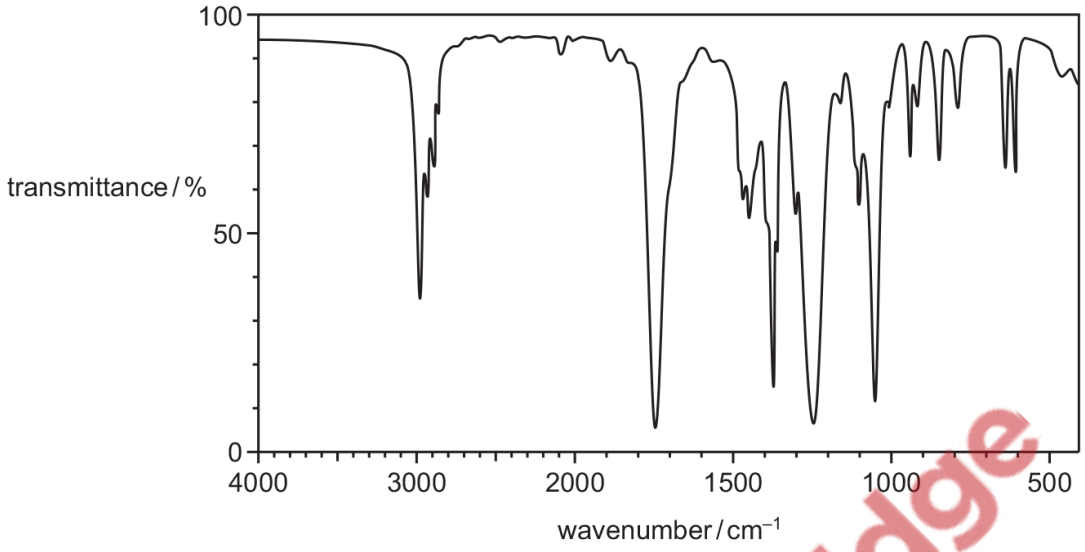


Which row could be correct?

	X	Y	Z
A	2,3-dimethylpent-2-ene	propanone	butanone
B	2-methylpent-2-ene	propanone	propanoic acid
C	pent-2-ene	ethanoic acid	propanoic acid
D	propyl propanoate	propan-1-ol	propanoic acid

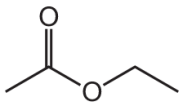
1190. 9701_s21_qp_11 Q: 17

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

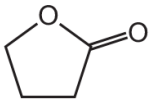


What could be the skeletal formula of compound X?

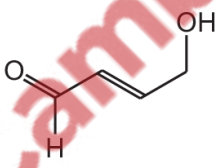
A



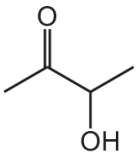
B



C

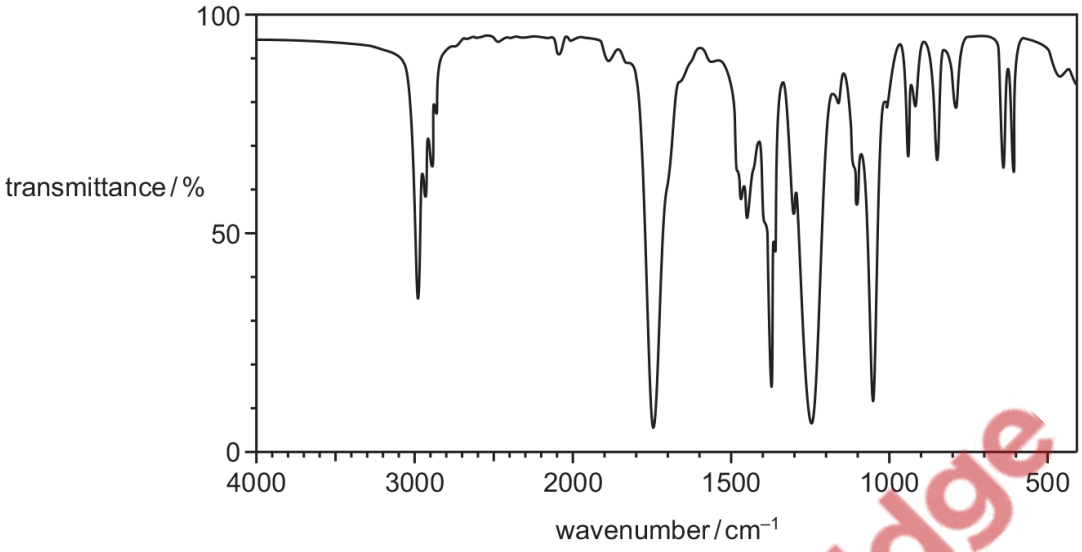


D



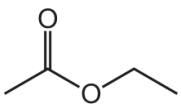
1191. 9701_s21_qp_11 Q: 26

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

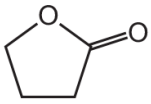


What could be the skeletal formula of compound X?

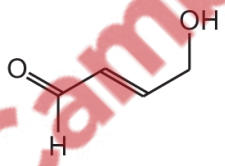
A



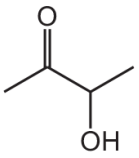
B



C



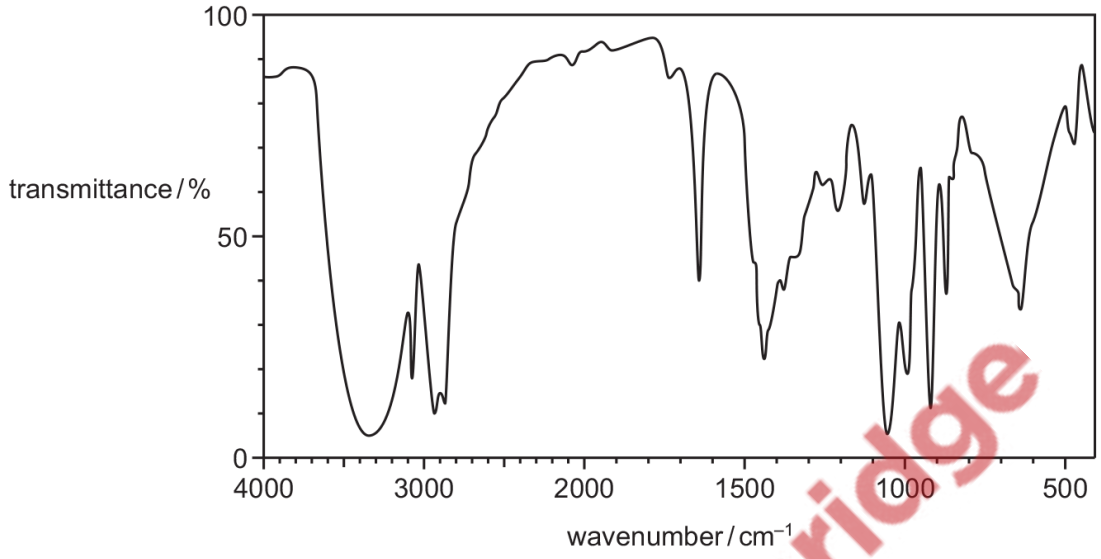
D



1192. 9701_s21_qp_12 Q: 30

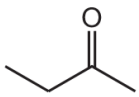
The molecular formula of Z is C_4H_8O.

The infra-red spectrum of Z is shown.

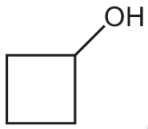


What could be Z?

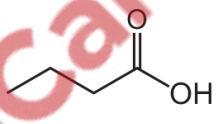
A



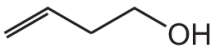
B



C

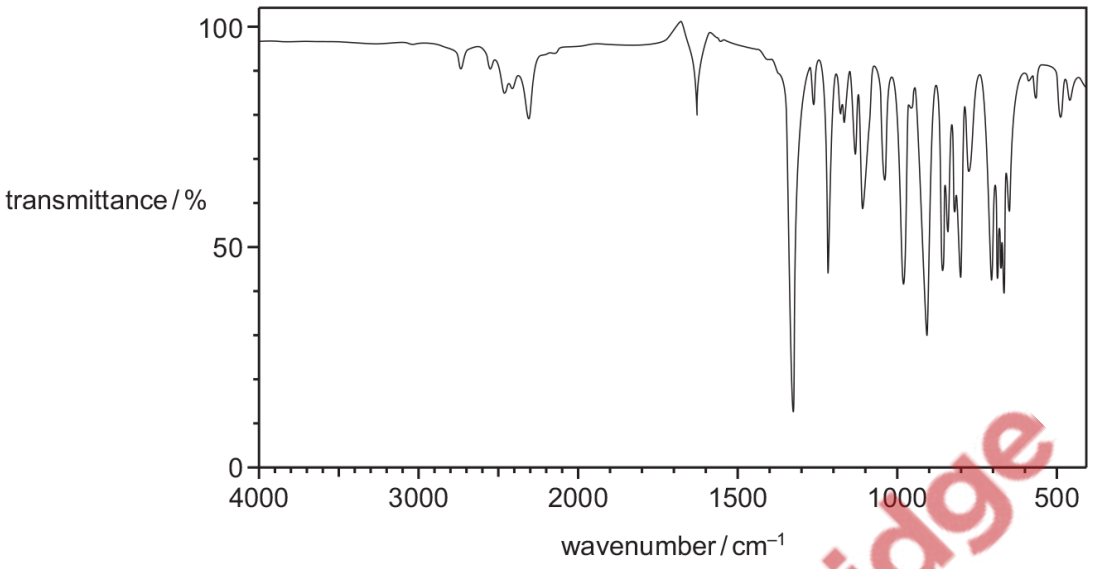


D



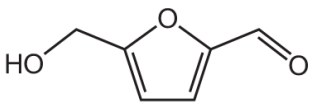
1193. 9701_s21_qp_13 Q: 30

The infra-red spectrum of molecule Z is shown.



What could be the identity of Z?

A



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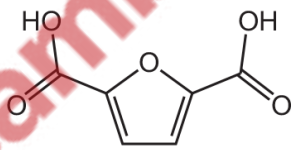

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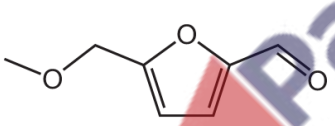
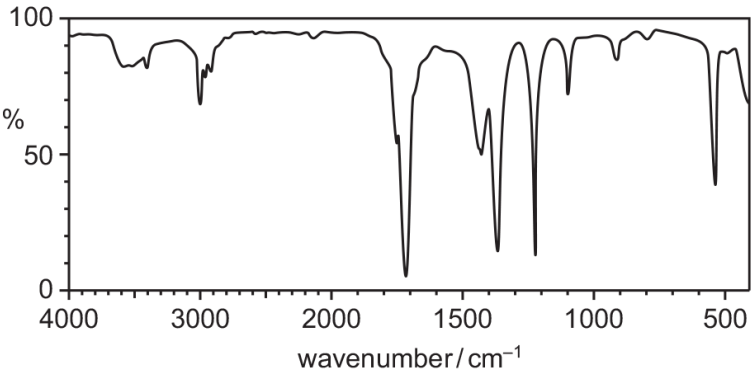


D

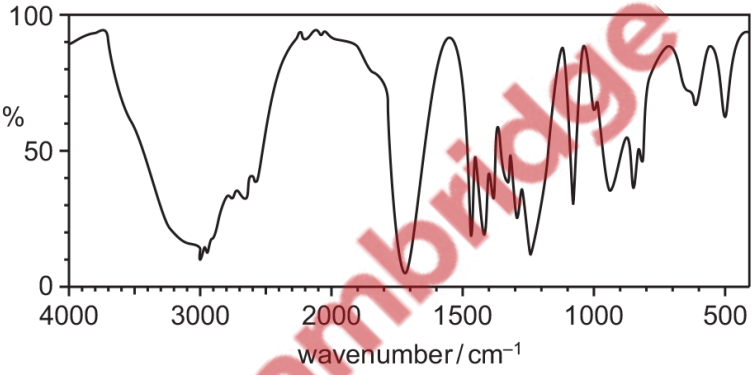
1194. 9701_w21_qp_11 Q: 30

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

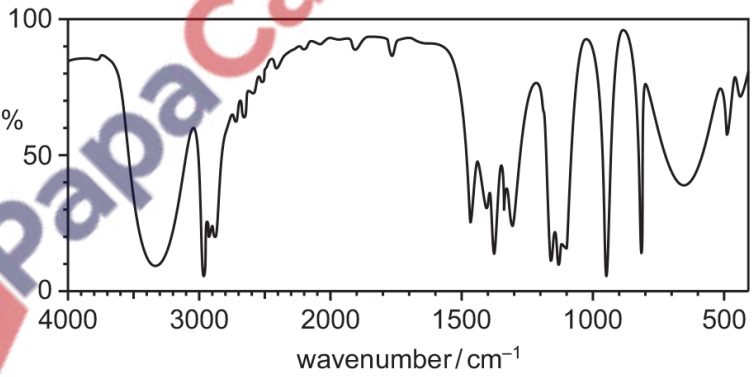
spectrum 1



spectrum 2



spectrum 3

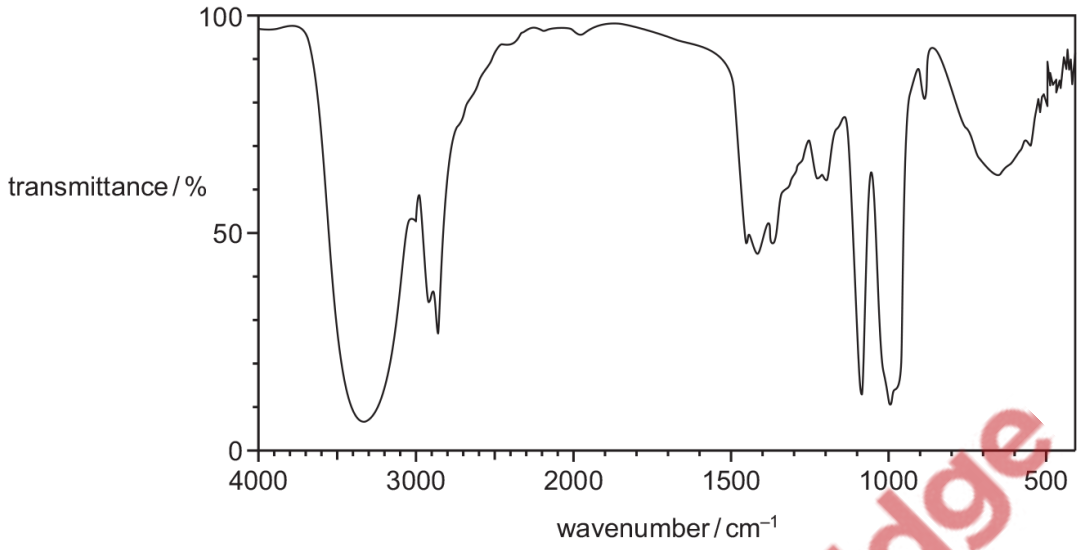


What could the three compounds be?

	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

1195. 9701_w21_qp_12 Q: 30

The infra-red spectrum of Y is shown.



What could Y be?

A $CH_3CO_2C_2H_5$

B $CH_2(OH)CH=CHCH_2OH$

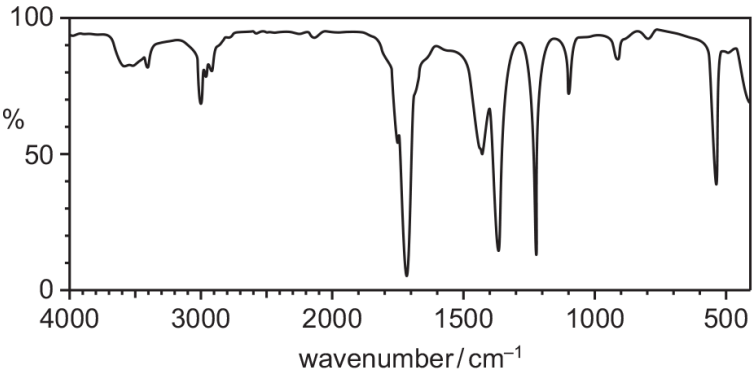
C $CH_3(CH_2)_2CO_2H$

D $CH_2(OH)(CH_2)_2CHO$

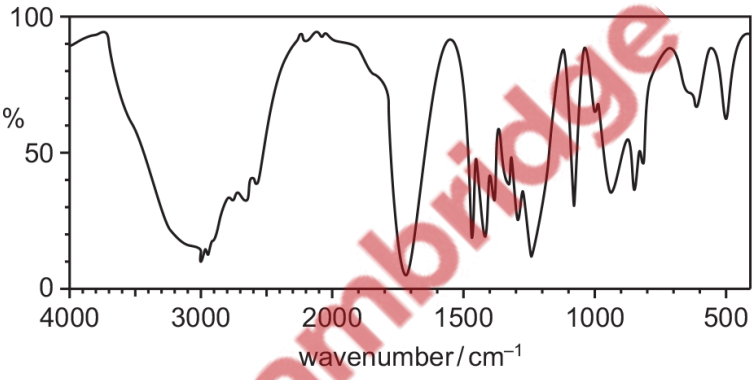
1196. 9701_w21_qp_13 Q: 30

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

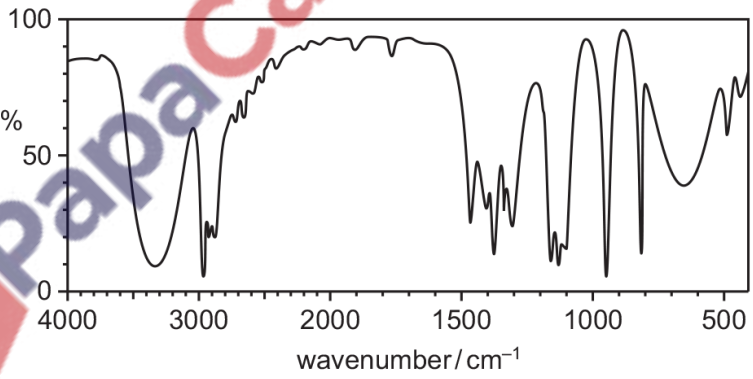
spectrum 1



spectrum 2



spectrum 3

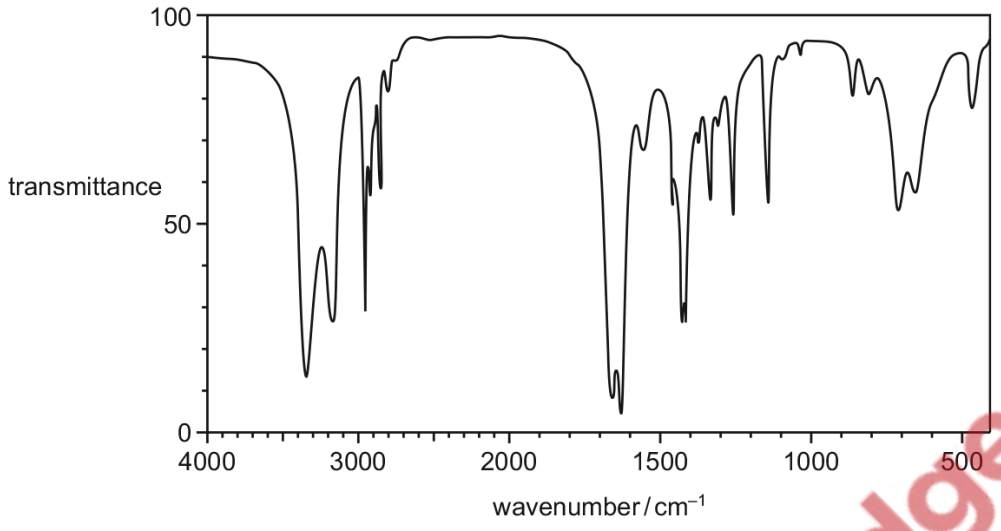


What could the three compounds be?

	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

1197. 9701_m20_qp_12 Q: 23

The infrared spectrum shown was obtained from a compound J.



Which statement about J is correct?

A Both C=O and C≡N are present.

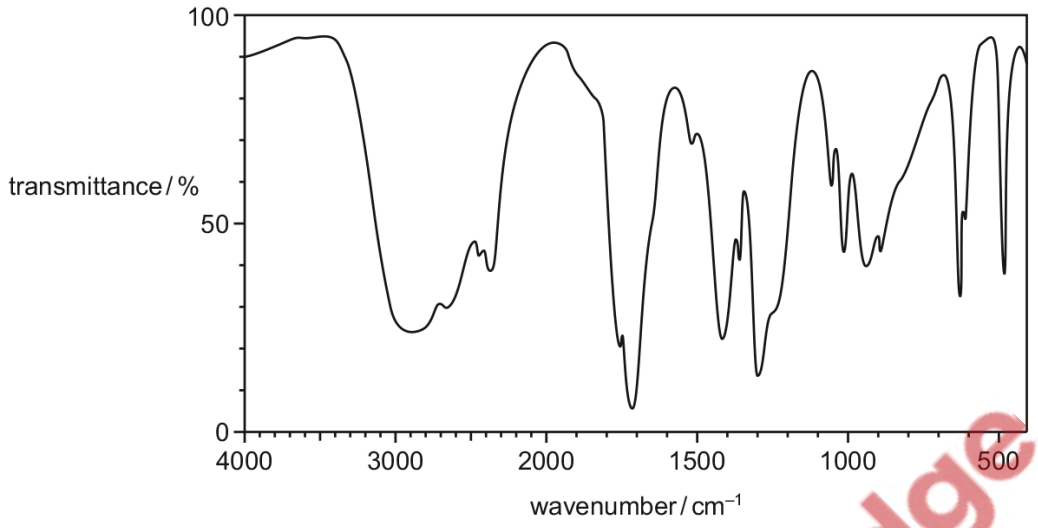
B Neither C=O nor C≡N are present.

C C=O is present but not C≡N.

D C≡N is present but not C=O.

1198. 9701_s20_qp_11 Q: 29

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

1199. 9701_s20_qp_12 Q: 21

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

1200. 9701_s20_qp_13 Q: 7

The element sulfur produces a mass spectrum with the following peaks.

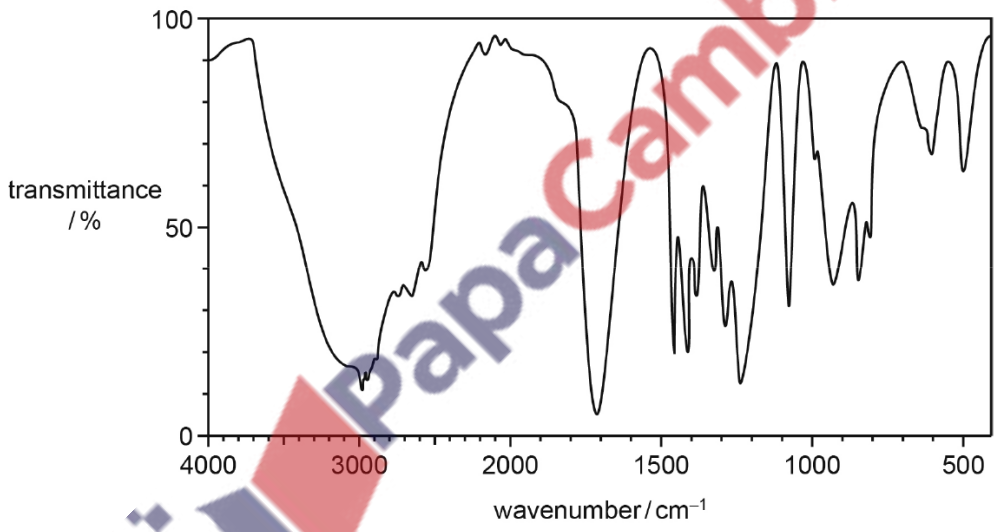
m/*e* value of peak	relative abundance
32	95.02
33	0.76
34	4.20
36	0.02

Which relative atomic mass of sulfur can be calculated from these data, given to four significant figures?

A 32.07 **B** 32.08 **C** 32.09 **D** 32.10

1201. 9701_s20_qp_13 Q: 25

The diagram shows the infrared spectrum of an organic compound.



What could be the identity of this compound?

A propan-1-ol

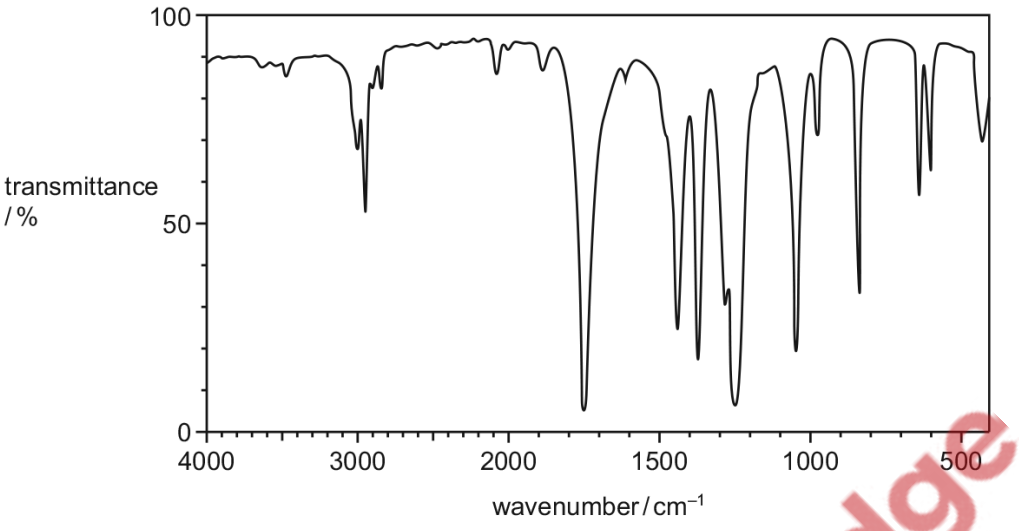
B propanal

C propanoic acid

D propanone

1202. 9701_w20_qp_12 Q: 30

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



What could be compound G?

A CH_3COCH_2OH

B $CH_3CH_2CO_2H$

C $CH_3CO_2CH_3$

D $CH_3CHCHCH_3$

1203. 9701_m19_qp_12 Q: 30

An infra-red spectrum shows a broad peak at 3000 cm^{-1} and a strong peak at 1710 cm^{-1}.

Which substance could have produced this spectrum?

A methyl propanoate

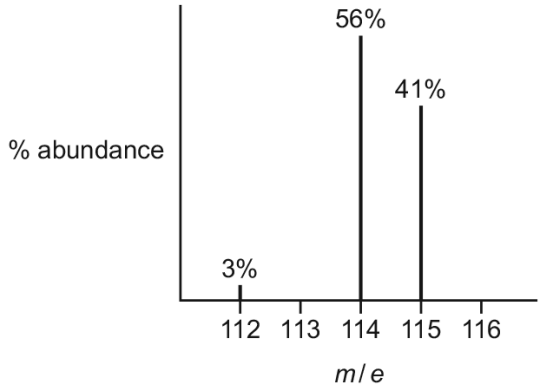
B propan-2-ol

C propanoic acid

D propanone

1204. 9701_s19_qp_11 Q: 2

A sample of element X is analysed using mass spectrometry. The mass spectrum obtained is shown.

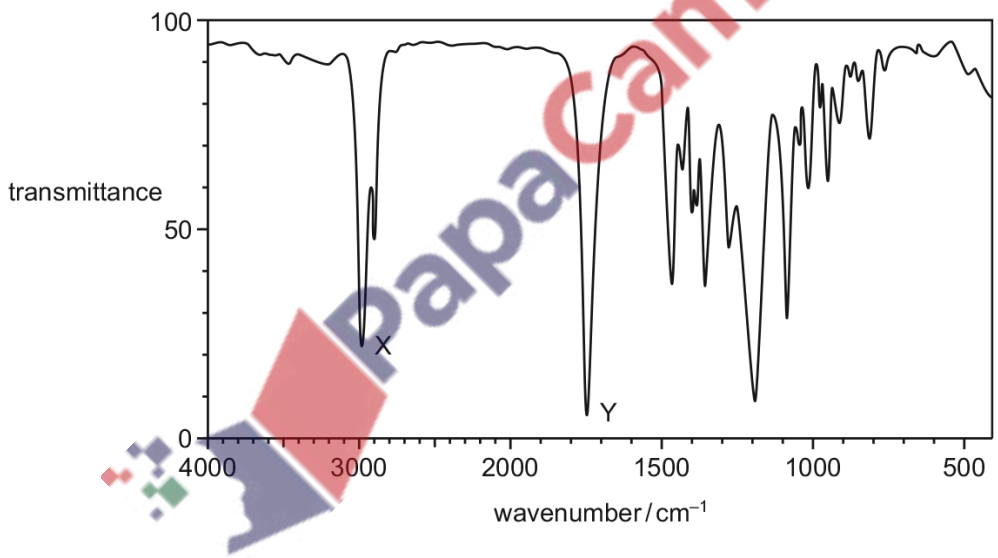


What is the relative atomic mass of this sample of element X?

A 113.7 **B** 114.0 **C** 114.2 **D** 114.4

1205. 9701_s19_qp_11 Q: 24

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

1206. 9701_s19_qp_12 Q: 2

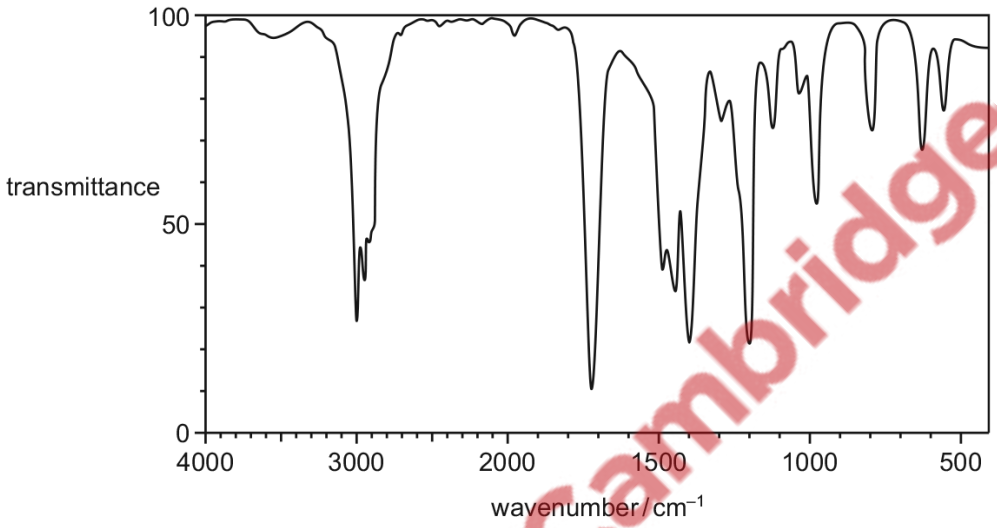
Oxygen has three stable isotopes, ^{16}O, ^{17}O and ^{18}O. All three isotopes are present in a sample of oxygen gas, O_2, which was analysed using a mass spectrometer.

How many peaks associated with the O_2^+ ion would be expected?

A 3 **B** 5 **C** 6 **D** 9

1207. 9701_s19_qp_12 Q: 30

The diagram shows the infra-red spectrum of Q.



What could be Q?

A butan-1-ol

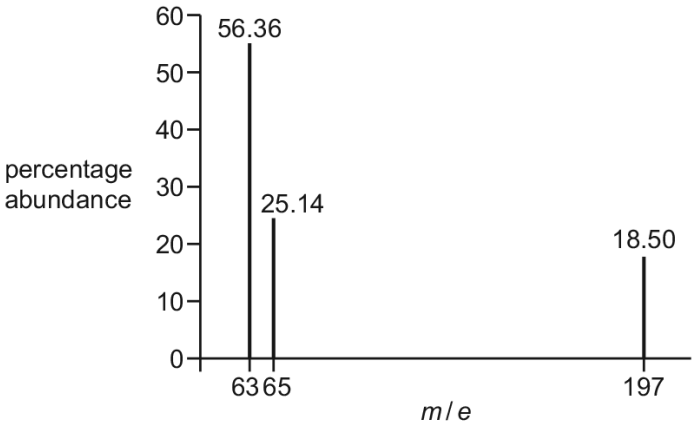
B butanoic acid

C butanone

D 3-hydroxybutanal

1208. 9701_s19_qp_13 Q: 2

The mass spectrum of an alloy of copper and gold is shown.



Which expression can be used to calculate the relative atomic mass, A_r, of copper present in this sample?

A $\dfrac{(56.36 \times 63) + (25.14 \times 65)}{(56.36 + 25.14 + 18.50)}$

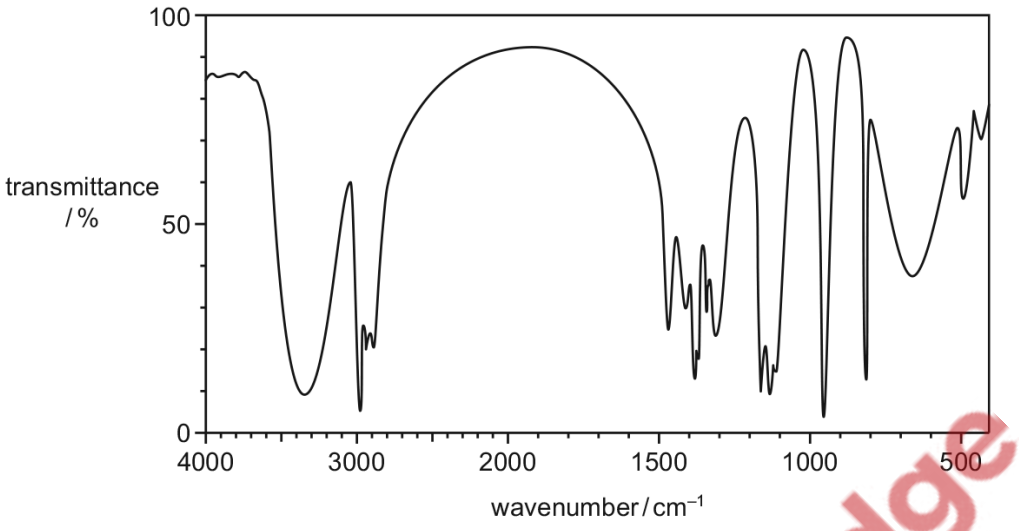
B $\dfrac{(56.36 \times 63) + (25.14 \times 65) + (18.50 \times 197)}{(56.36 + 25.14 + 18.50)}$

C $\dfrac{(56.36 \times 63) + (25.14 \times 65)}{(56.36 + 25.14)}$

D $\dfrac{(56.36 \times 63) + (25.14 \times 65)}{(63 + 65)}$

1209. 9701_w19_qp_11 Q: 30

The infra-red spectrum of compound P is shown.



What could be compound P?

A methyl ethanoate

B propanal

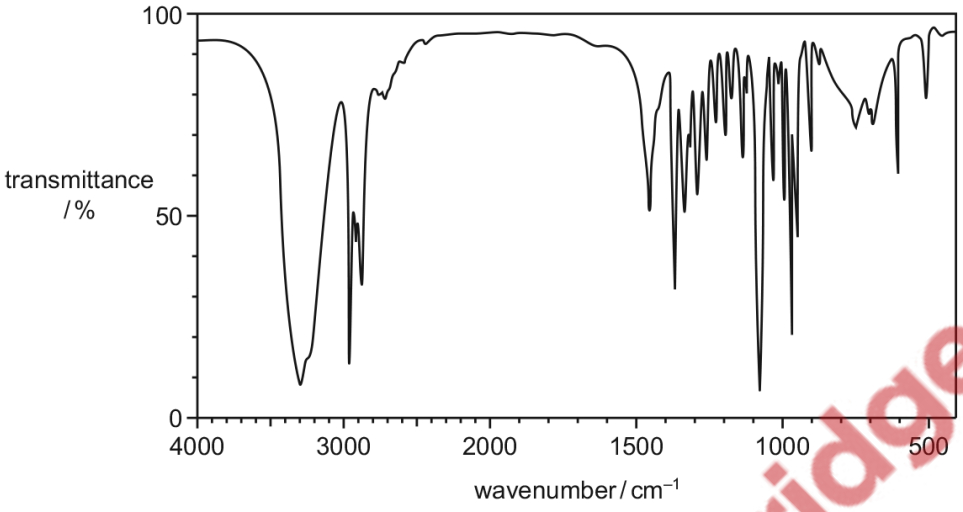
C propanoic acid

D propan-2-ol

1210. 9701_w19_qp_12 Q: 30

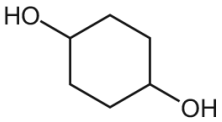
Substance T was analysed and found to contain 62.07% carbon, 10.34% hydrogen and 27.59% oxygen.

The infra-red spectrum of substance T is shown.

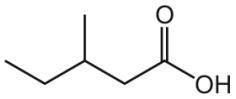


Which substance could be T?

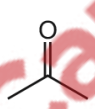
A



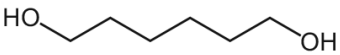
B



C



D



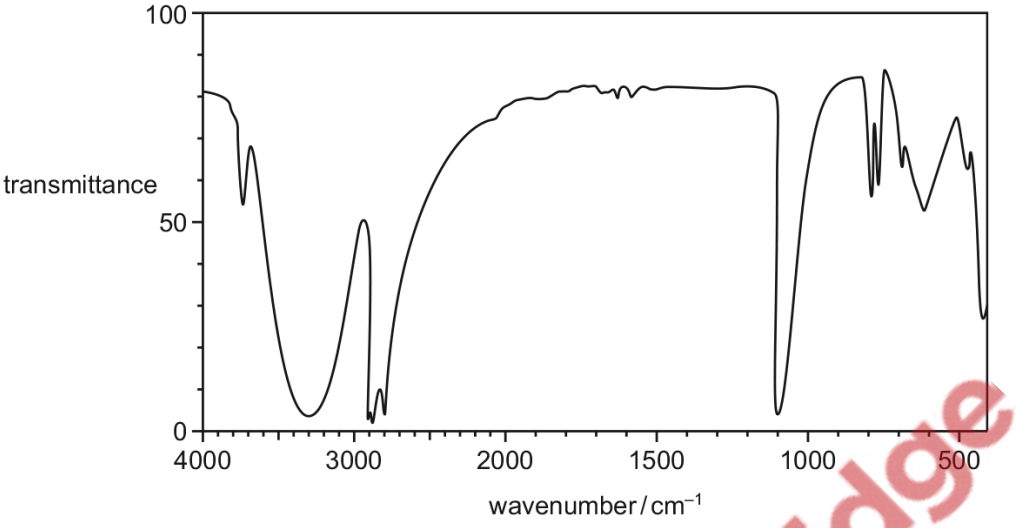
1211. 9701_m18_qp_12 Q: 30

How many **structural** isomers with the molecular formula $C_4H_{10}O$ give infra-red absorptions both at approximately 1200 cm^{-1} and at approximately 3400 cm^{-1}?

A 2 **B** 4 **C** 6 **D** 7

1212. 9701_s18_qp_11 Q: 30

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



Which compound could be X?

A CH_3CH_2CHO

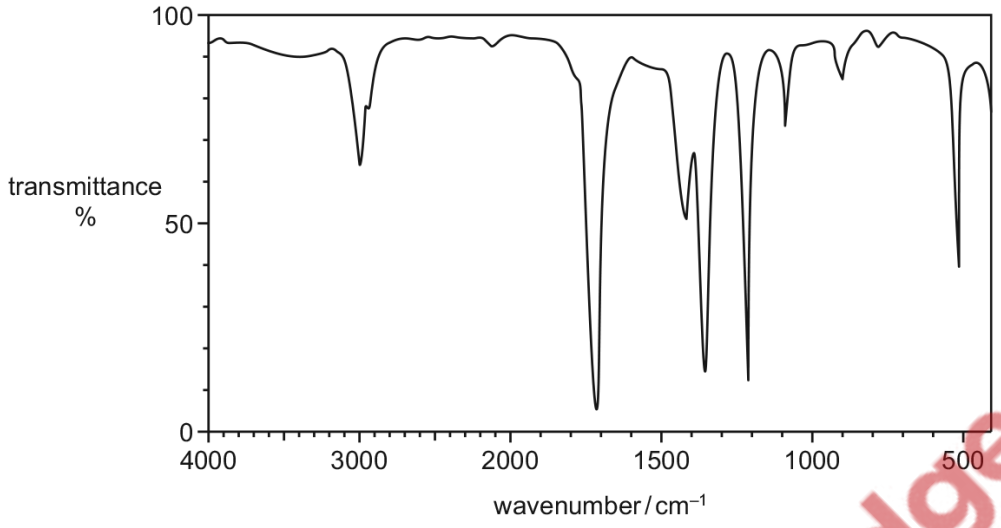
B $CH_3CH_2CO_2H$

C $CH_3CH_2CH_2OH$

D $CH_3CO_2CH_3$

1213. 9701_s18_qp_12 Q: 30

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



Which compound could give this spectrum?

A $CH_3CH_2CO_2H$

B $CH_3CH(OH)CH_3$

C CH_3COCH_3

D CH_3COCH_2OH

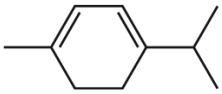
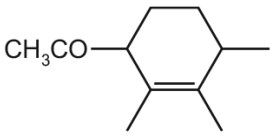
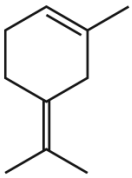
1214. 9701_s18_qp_13 Q: 30

Compound **S** can be extracted from natural compounds. Reacting **S** with hot, concentrated $KMnO_4$ produces the organic product, **T**. Some of the absorptions found in the infra-red spectra of **S** and **T** are described.

S has no strong absorption between 1670 and 1740 cm^{-1}.

T has a strong absorption at 1720 cm^{-1} but has **no** strong, broad absorption between 2500 and 3000 cm^{-1}.

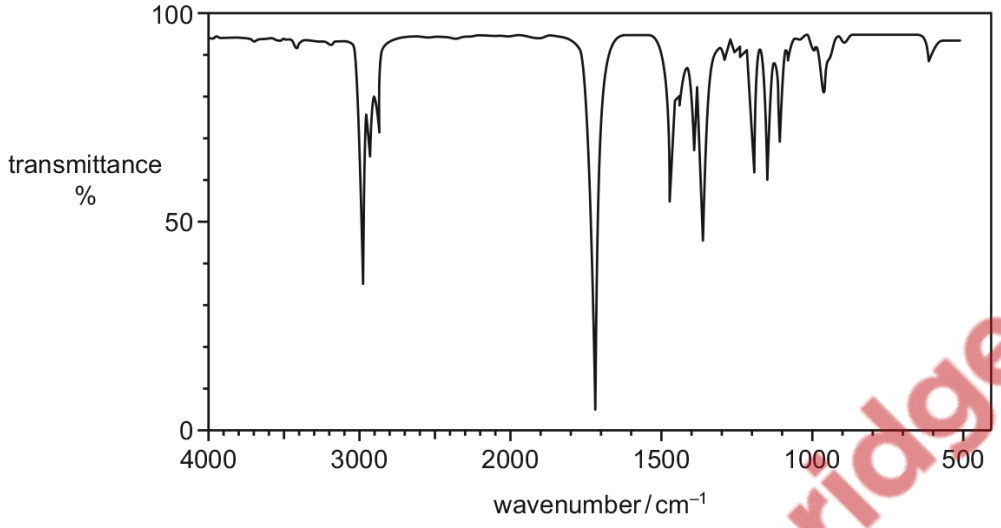
From this information, what could be the formulae of **S** and **T**?

	S	T
A	$CH_3(CH_2)_5CH{=}CH_2$	$CH_3(CH_2)_5CO_2H$
B		$CH_3COCH_2CH_2COCH(CH_3)_2$
C		$CH_3COCH(COCH_3)CH_2CH_2CH(COCH_3)CH_3$
D		$HO_2CCH_2CH_2COCH_2COCH_3$

1215. 9701_w18_qp_11 Q: 30

J is a branched-chain alcohol, $C_5H_{12}O$. **J** is heated under reflux with an excess of $Cr_2O_7^{2-}/H^+$ until no further reaction occurs. An organic compound **K** is formed in good yield.

The infra-red spectrum of **K** is shown.

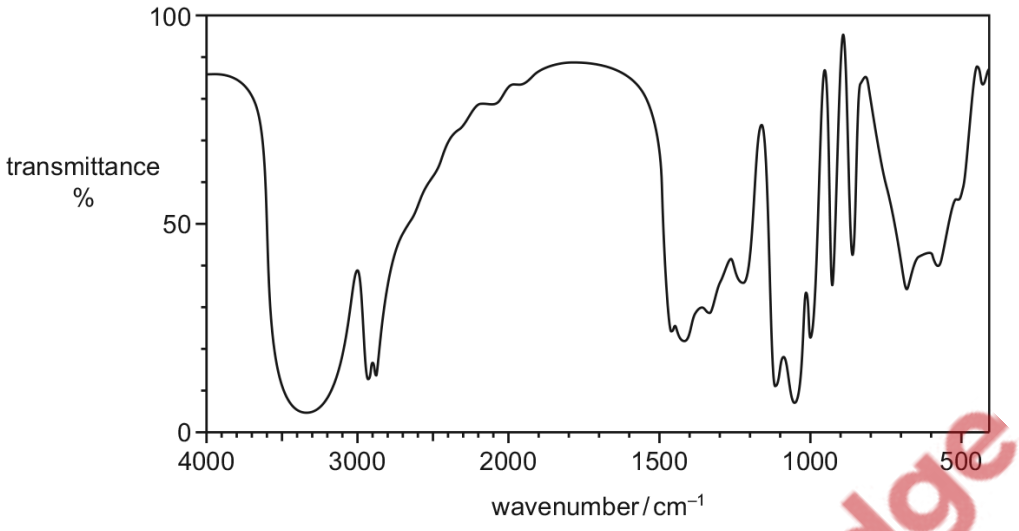


What are the structures of the branched-chain alcohol **J** and compound **K**?

	J	K
A	$CH_3CH(CH_3)CH_2CH_2OH$	$CH_3CH(CH_3)CH_2CHO$
B	$CH_3CH_2CH(OH)CH_2CH_3$	$CH_3CH_2COCH_2CH_3$
C	$CH_3CH(CH_3)CH(OH)CH_3$	$CH_3CH(CH_3)COCH_3$
D	$CH_3CH(CH_3)CH_2CH_2OH$	$CH_3CH(CH_3)CH_2COOH$

1216. 9701_w18_qp_12 Q: 30

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



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

A $HOCH_2COCH_2OH$

B $HOCH_2CH(OH)CHO$

C $HOCH_2CH(OH)CH_2OH$

D $HOCH_2CH_2COOH$

1217. 9701_s17_qp_11 Q: 2

The mass spectrum of a sample of lithium shows that it contains two isotopes, ^6Li and ^7Li.

The isotopic abundances are shown in the table.

isotope	isotopic abundance
^6Li	7.42%
^7Li	92.58%

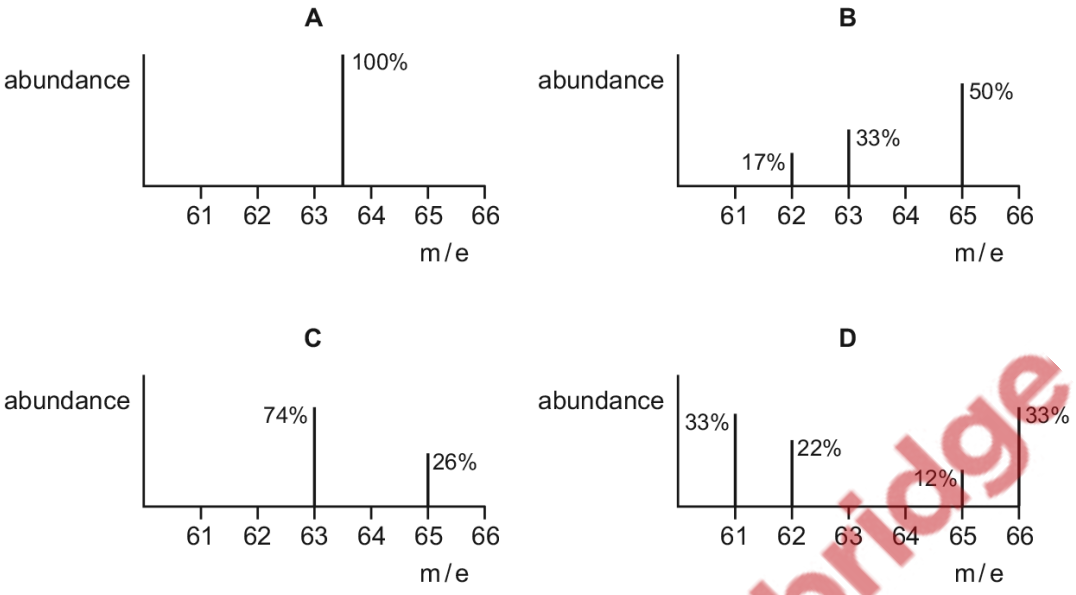
What is the relative atomic mass of this sample of lithium, given to three significant figures?

A 6.07 **B** 6.50 **C** 6.90 **D** 6.93

1218. 9701_s16_qp_13 Q: 4

The relative atomic mass of copper is 63.5.

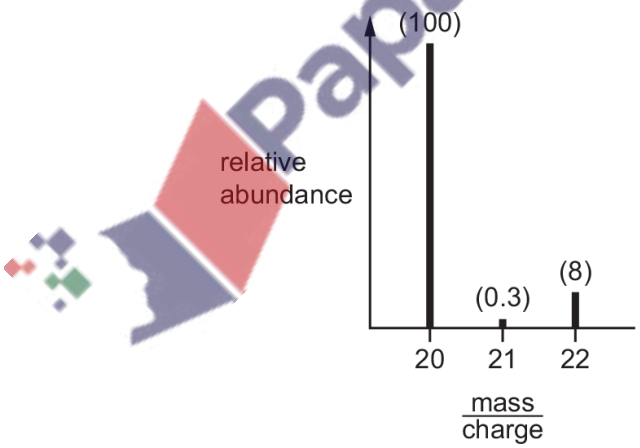
Which chart is a correct mass spectrum that would lead to this value?



21.2 Mass spectrometry

1219. 9701_w21_qp_11 Q: 1

The mass spectrum of a sample of neon is shown. The relative abundance of each peak is written in brackets above it.



What is the relative atomic mass, A_r, of this sample of neon?

A 20.15 **B** 20.20 **C** 21.00 **D** 21.82

1220. 9701_w21_qp_12 Q: 1

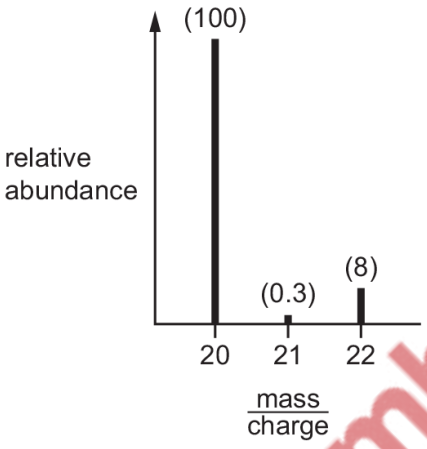
Compound X consists of 40.0% carbon, 6.7% hydrogen and 53.3% oxygen by mass.

What is the empirical formula of compound X?

A CH_2O **B** C_2H_2O **C** C_2H_4O **D** CHO

1221. 9701_w21_qp_13 Q: 1

The mass spectrum of a sample of neon is shown. The relative abundance of each peak is written in brackets above it.



What is the relative atomic mass, A_r, of this sample of neon?

A 20.15 **B** 20.20 **C** 21.00 **D** 21.82
