

4 Compounds **P** and **Q** are structural isomers.



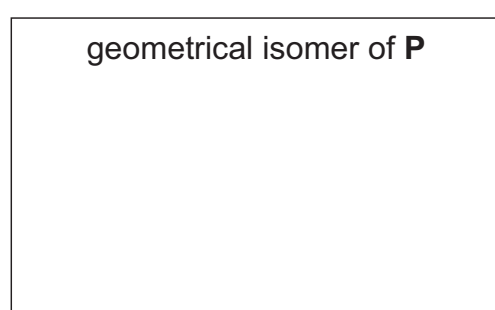
Fig. 4.1

(a) (i) Define structural isomerism.

.....
 [2]

(ii) **P** shows geometrical isomerism.

Draw the geometrical isomer of **P**. Explain why the two isomers are **not** identical.



explanation

 [2]

(iii) Both **P** and **Q** react with aqueous bromine.

Name the mechanism of this reaction.

..... [1]

(iv) **Q** is oxidised by hot concentrated acidified $\text{KMnO}_4(\text{aq})$, forming two different organic products.

Construct an equation for this reaction. Use $[\text{O}]$ to represent an atom of oxygen from the oxidising agent.

$(\text{CH}_3)_2\text{C}=\text{CHCH}_3$ [2]

(v) **Q** reacts with $\text{HBr}(\text{g})$ to produce two structural isomers, **R** and **S**, as shown in Fig. 4.2.

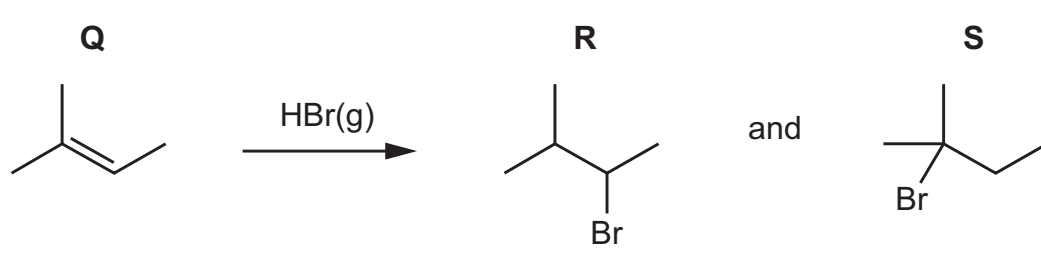


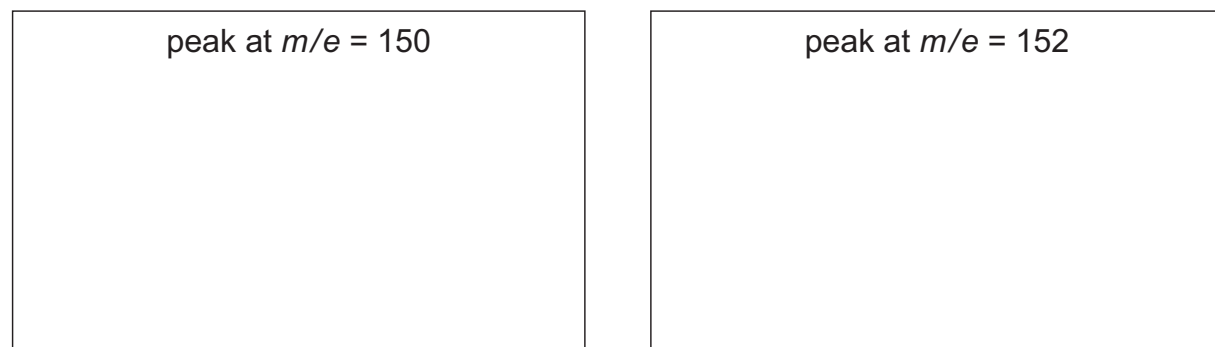
Fig. 4.2

State and explain why isomer **S** is the major product of the reaction.

.....
 [2]

(vi) The mass spectrum of **R** shows peaks at $m/e = 150$ and $m/e = 152$.

Suggest structures for the ions responsible for these peaks.



[2]

(b) Fig. 4.3 shows a synthesis starting from **T**, a different isomer of **R** and **S**.

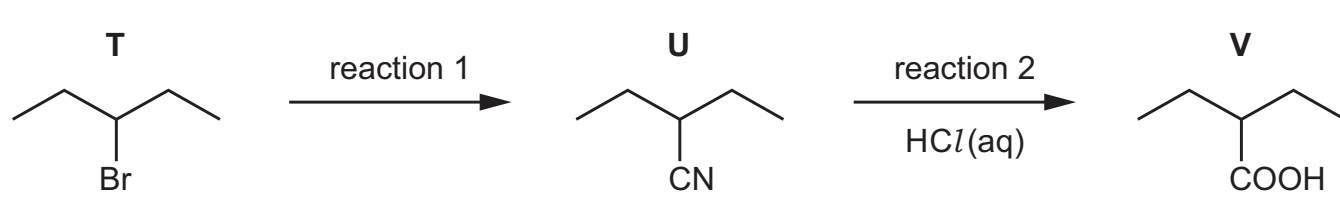


Fig. 4.3

(i) Identify the reagent and conditions for reaction 1.

..... [1]

(ii) Reaction 2 is a hydrolysis reaction.

Construct an equation for reaction 2.

$(\text{C}_2\text{H}_5)_2\text{CHCN}$ [1]

(iii) **V** reacts with propan-2-ol in the presence of a catalytic amount of H_2SO_4 to form organic compound **W**.

Complete Table 4.1 to give details of this reaction.

Table 4.1

	reaction of V with propan-2-ol
type of reaction	
functional group formed	
molecular formula of organic product W	

[3]

[Total: 16]

Important values, constants and standards

molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Faraday constant	$F = 9.65 \times 10^4 \text{ C mol}^{-1}$
Avogadro constant	$L = 6.02 \times 10^{23} \text{ mol}^{-1}$
electronic charge	$e = -1.60 \times 10^{-19} \text{ C}$
molar volume of gas	$V_m = 22.4 \text{ dm}^3 \text{ mol}^{-1}$ at s.t.p. (101 kPa and 273 K) $V_m = 24.0 \text{ dm}^3 \text{ mol}^{-1}$ at room conditions
ionic product of water	$K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ (at 298 K (25 °C))
specific heat capacity of water	$c = 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$ (4.18 $\text{J g}^{-1} \text{ K}^{-1}$)

The Periodic Table of Elements

Group																																	
1		2		3												10		11		12		13		14		15		16		17		18	
H hydrogen 1.0				Key												Ne neon 20.2		Ar argon 39.9		Kr krypton 83.8		Xe xenon 131.3		Rn radon —		Og oganeson —							
Li lithium 6.9		Be beryllium 9.0		atomic number name atomic symbol relative atomic mass												F fluorine 19.0		Cl chlorine 35.5		Br bromine 79.9		I iodine 126.9		At astatine —		Ts tennessine —							
Na sodium 23.0		Mg magnesium 24.3		3												10		11		12		13		14		15		16		17		18	
K potassium 39.1		Ca calcium 40.1		3												10		11		12		13		14		15		16		17		18	
Rb rubidium 85.5		Sr strontium 87.6		3												10		11		12		13		14		15		16		17		18	
Cs caesium 132.9		Ba barium 137.3		3												10		11		12		13		14		15		16		17		18	
Fr francium —		Ra radium —		3												10		11		12		13		14		15		16		17		18	
La lanthanum 138.9		Ce cerium 140.1		3												10		11		12		13		14		15		16		17		18	
Pr praseodymium 140.9		Nd neodymium 144.2		3												10		11		12		13		14		15		16		17		18	
Sm samarium 150.4		Eu europium 152.0		3												10		11		12		13		14		15		16		17		18	
Gd gadolinium 157.3		Tb terbium 158.9		3												10		11		12		13		14		15		16		17		18	
Dy dysprosium 162.5		Ho holmium 164.9		3												10		11		12		13		14		15		16		17		18	
Er erbium 167.3		Tm thulium 168.9		3												10		11		12		13		14		15		16		17		18	
Yb ytterbium 173.1		Lu lutetium 175.0		3												10		11		12		13		14		15		16		17		18	
Ac actinium —		Th thorium 232.0		3												10		11		12		13		14		15		16		17		18	
Pa protactinium 231.0		U uranium 238.0		3												10		11		12		13		14		15		16		17		18	
Am americium —		Cm curium —		3												10		11		12		13		14		15		16		17		18	
Bk berkelium —		Cf californium —		3												10		11		12		13		14		15		16		17		18	
Lr lawrencium —		No nobelium —		3												10		11		12		13		14		15		16		17		18	