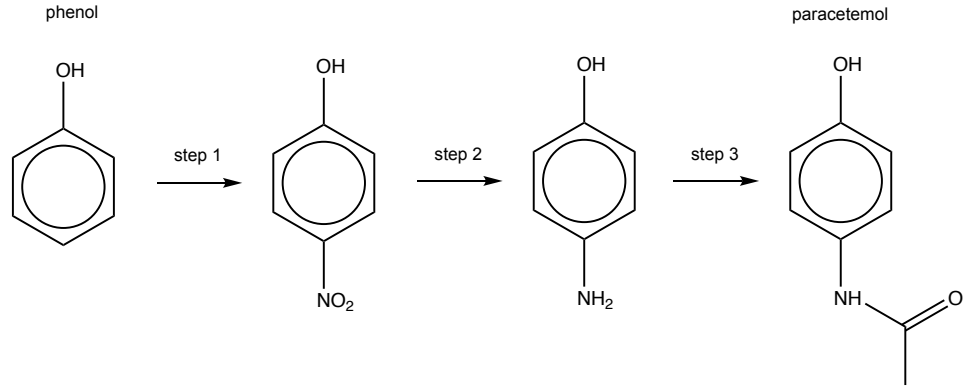
1) Paracetemol can be made in a 3-step synthesis from phenol.

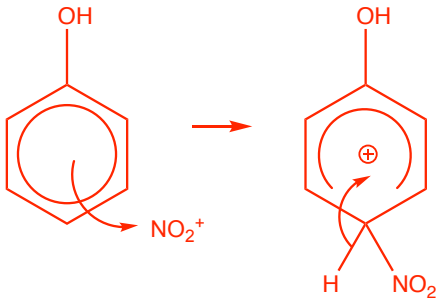


a) Complete the table about the steps shown.

Step	Reagents & conditions	Reaction type
1	**conc HNO_3 & conc H_2SO_4 warm / 50ºC**	**nitration or electrophilic substitution**
2	**Sn & HCl (followed by NaOH)**	**reduction**
3	**ethanoyl chloride or ethanoic anhydride**	**acylation or nucleophilic addition-elimination**

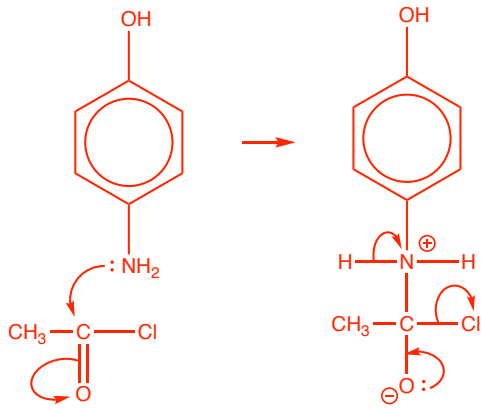
b) Name and outline the mechanism for step 1.

$HNO_3 + 2\,H_2SO_4 \longrightarrow NO_2^+ + 2\,HSO_4^- + H_3O^+$



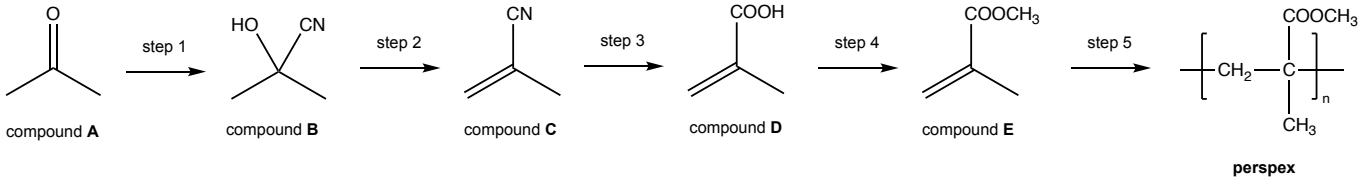
electrophilic substitution

c) Name and outline the mechanism for step 3.



nucleophilic addition-elimination

2) Perspex can be made by the following synthetic pathway.



compound **A** compound **B** compound **C** compound **D** compound **E** **perspex**

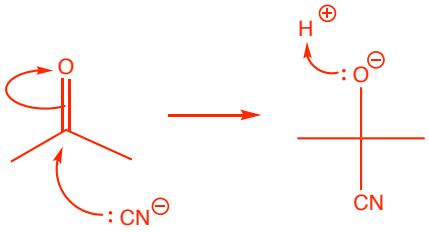
a) Give the IUPAC name of each compound.

Compound	IUPAC name
A	**propanone**
B	**2-hydroxy-2-methylpropanenitrile**
C	**2-methylprop-2-enenitrile (or methylpropenenitrile)**
D	**2-methylprop-2-enoic acid (or methylpropenoic acid)**
E	**methyl 2-methylprop-2-enoate (or methyl 2-methylpropenoate)**

b) Complete the table about the steps shown.

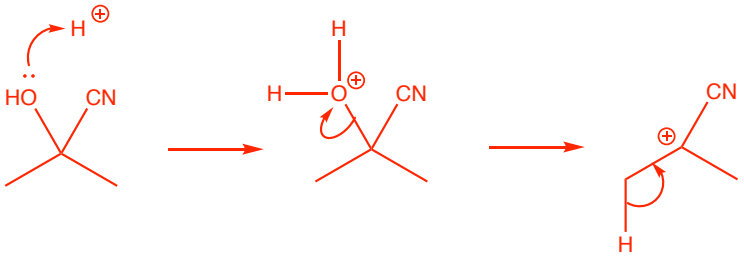
Step	Reagents & conditions	Reaction type
1	**HCN (or KCN then acid)**	**nucleophilic addition**
2	**conc H_2SO_4 at 180ºC**	**elimination / dehydration**
4	**ethanol & conc H_2SO_4**	**esterification**

c) Name and outline the mechanism for step 1.



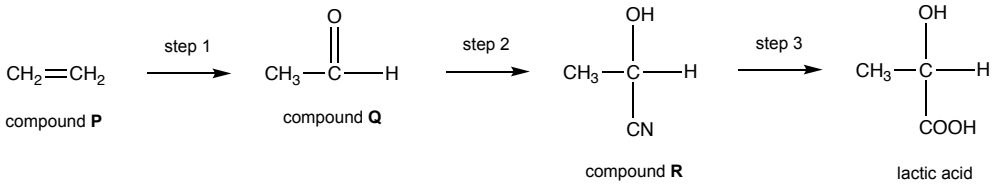
nucleophilic addition

d) Name and outline the mechanism for step 2.



elimination

3) Lactic acid can be made by the following synthetic pathway.



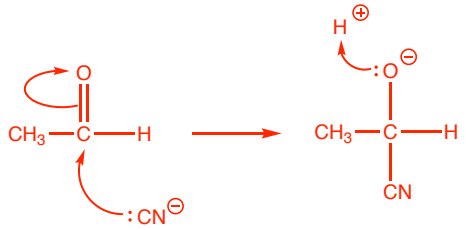
a) Give the IUPAC name of each compound.

Compound	IUPAC name
P	ethene
Q	ethanal
R	2-hydroxypropanenitrile

b) Complete the table about step 2.

Step	Reagents & conditions	Reaction type
2	HCN (or KCN then acid)	nucleophilic addition

c) Name and outline the mechanism for step 2.



nucleophilic addition

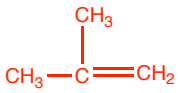
d) Explain why the lactic acid is formed as a racemic mixture.

C=O is planar
so equal chance of attack by CN^- from above or below
produces a 50/50 mixture of the two enantiomers

4) The conversion of 1-bromo-2-methylpropane into 2-bromo-2-methylpropane via compound **X** can be achieved as shown.

The infrared spectrum of compound **X** has a signal at 1650 cm^{-1}

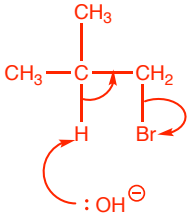
a) Give the structure of compound **X**.



b) Complete the table about the synthesis.

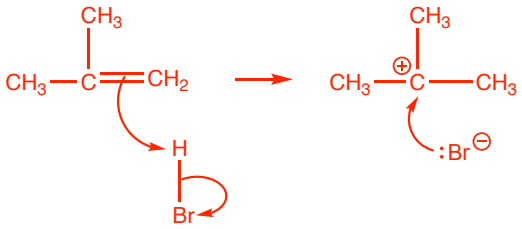
Step	Reagents & conditions	Reaction type
1	**KOH in ethanol, hot**	**elimination**
2	**HBr**	**electrophilic addition**

c) Name and outline the mechanism for step 1.



elimination

d) Name and outline the mechanism for step 2.



electrophilic addition

e) Explain why 2-bromo-2-methylpropane is formed predominantly rather than 1-bromo-2-methylpropane in step 2.

it is formed from a 3^{y} carbocation
that is more stable than the alternative 1^{y} carbocation
due to greater inductive effect of 3 alkyl groups rather than 1 alkyl group