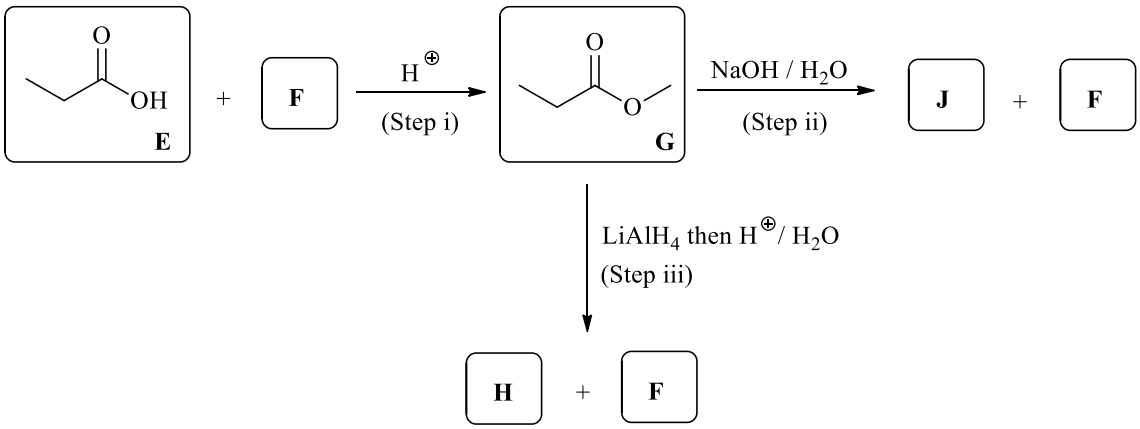
Marks 6

- Consider the following reaction sequences beginning with the carboxylic acid, **E**.



Name compounds **E** and **G**.

E:
G:

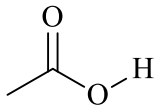
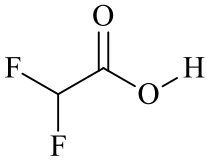
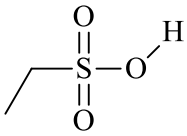
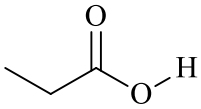
Propose structures for compounds **F**, **H** and **J**.

F	**H**	**J**

Propose a mechanism for step (ii).

Marks 5

- Draw the conjugate bases for the following acids.

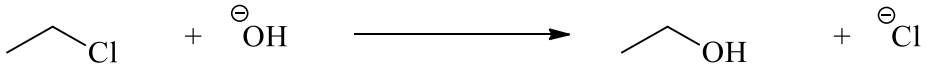
S	**T**	**U**	**V**
			
Conjugate base of **S**	Conjugate base of **T**	Conjugate base of **U**	Conjugate base of **V**

Which of **S** and **T** is the stronger acid? Give a reason for your answer.

Which of **U** and **V** is the stronger acid? Give a reason for your answer.

Marks 7

- The hydroxide anion can react with chloroethane via a mechanism that is abbreviated S_N2, as shown below. Add curly arrows to the reaction scheme to complete a mechanism for this reaction.



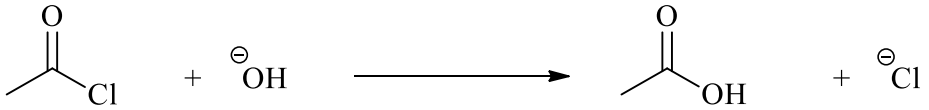
Explain what each part of the abbreviation S_N2 means.

S =

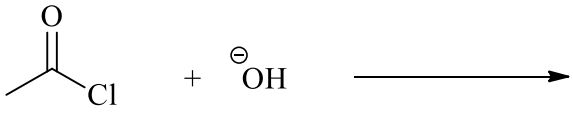
N =

2 =

The hydroxide anion undergoes an apparently similar reaction with ethanoyl chloride:



Draw a mechanism (using curly arrows) for this reaction, thereby demonstrating how it is fundamentally different to the reaction of chloroethane above.



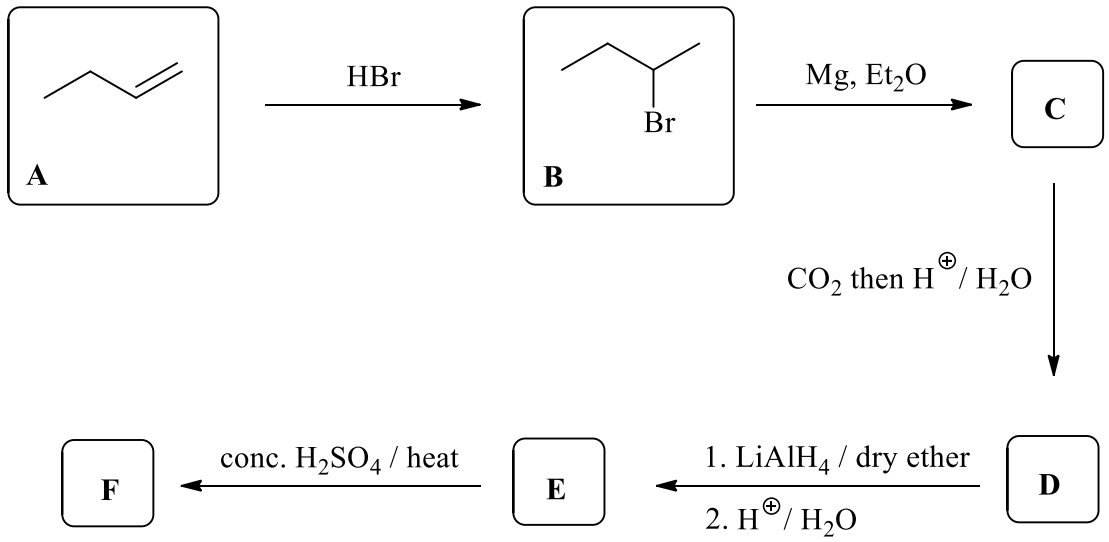
In each of these reactions, a full molecular orbital of the hydroxide anion (the HOMO) interacts with an empty molecular orbital of the organic halogen compound (the LUMO).

Which orbital is the LUMO in chloroethane?

Which orbital is the LUMO in ethanoyl chloride?

Marks 6

- Consider the following reaction sequence beginning with the alkene **A**.



Suggest structures for compounds **C** – **F** in the reaction sequence above.

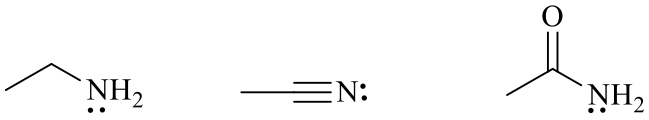
C	**D**
E	**F**

Describe the selectivity observed, and briefly explain the reasons for it, in the conversion of alkene **A** to compound **B**.

Marks

5

- Consider the three nitrogen-containing compounds **P**, **Q** and **R**.



P **Q** **R**

What is the hybridisation at *N* in compound **P**?

What is the hybridisation at *N* in compound **Q**?

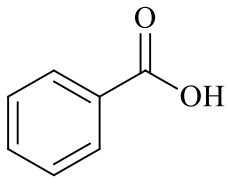
Use this information to decide which of **P** or **Q** is more basic. Explain your reasoning.

Show curly arrows and another structure to show how compound **R** is stabilised by resonance.

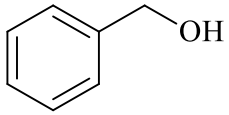
Which is more basic, compound **P** or compound **R**? Why?

Marks 6

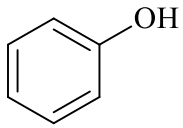
- Benzoic acid **H**, benzyl alcohol **I** and phenol **J** are shown below. The pK_a values of these three compounds are 15.2, 9.9 and 4.2, but not in that order.



H



I



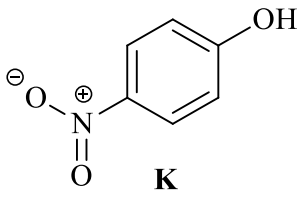
J

Assign the correct pK_a to each of these three compounds.

pK_a values:	**H** =	**I** =	**J** =

Draw resonance structures to explain your answer.

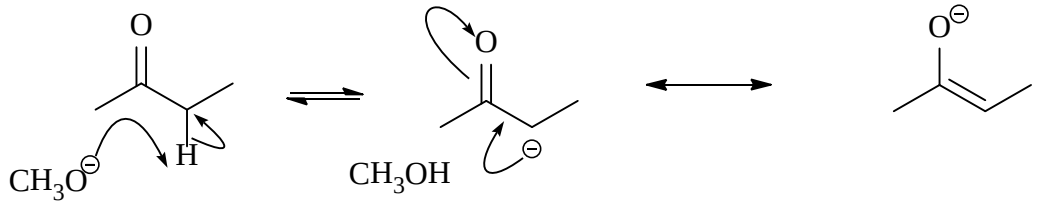
Would you expect 4-nitrophenol, **K**, to be more or less acidic than phenol, **J**? Explain your answer.



K

Marks 6

- Protons next to a carbonyl group can be removed by alkoxide bases as shown below.

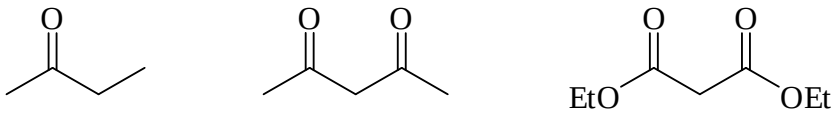


J **K** **L**

Apply your understanding of resonance to propose a structure **L** that explains how the carbonyl group increases the acidity of these hydrogens.

Add curly arrows to the reaction scheme above to complete a mechanism for the deprotonation of **J** to give **K**, and the stabilisation of **K** by resonance.

The pK_a values of compounds **J**, **M** and **N** are 9, 13 and 19, but not in that order. Match each compound with the correct pK_a, and explain your answer.

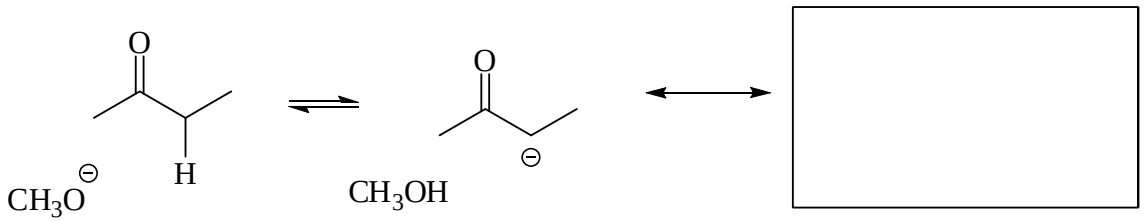


J **M** **N**

pK_a values:	**J** =	**M** =	**N** =

Marks 6

- Protons next to a carbonyl group can be removed by alkoxide bases as shown below.

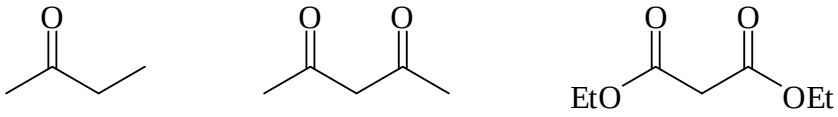


J **K** **L**

Apply your understanding of resonance to propose a structure **L** that explains how the carbonyl group increases the acidity of these hydrogens.

Add curly arrows to the reaction scheme above to complete a mechanism for the deprotonation of **J** to give **K**, and the stabilisation of **K** by resonance.

The pK_a values of compounds **J**, **M** and **N** are 9, 13 and 19, but not in that order. Match each compound with the correct pK_a, and explain your answer.



J **M** **N**

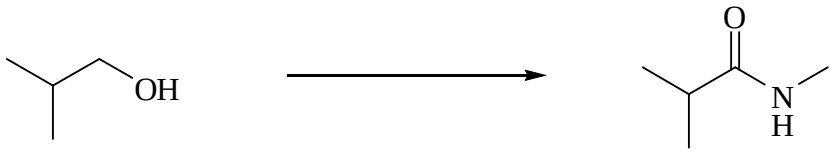
pK_a values:	**J** =	**M** =	**N** =

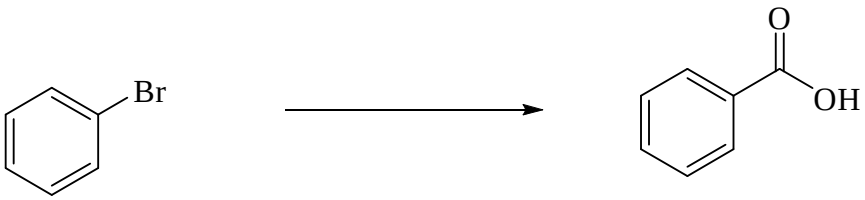
Reasoning for above assignments

Page Total:

Marks 6

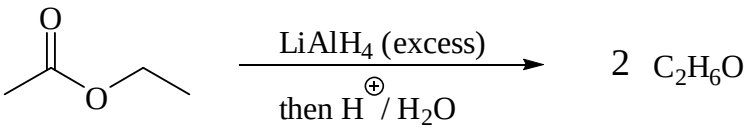
- Suggest reagents to accomplish the following transformations. More than one step is required in all cases.





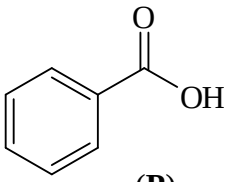
- Propose a structure for the product of the following reaction. Outline a mechanism for its formation. Show all curly arrows and any intermediates.

Marks 4



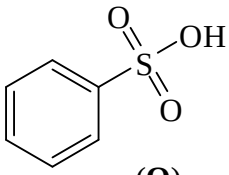
Marks
3

- For each of the following pairs of compounds, identify which is the stronger acid and give reasons for your choice.



(**P**)

and



(**Q**)

(**R**)

and

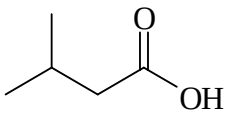
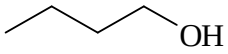
(**S**)

CF_3CO_2H and CH_3CO_2H

(**T**) (**U**)

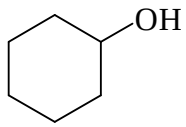
Marks 4

- Complete the following table by drawing the structures of the intermediate and final organic product(s) as required. The intermediate product is formed when the starting material is treated with Reagent 1. The final product is formed when the intermediate product is treated with Reagent 2.

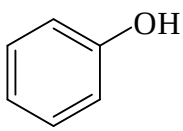
Starting material	Intermediate product	Final product
	Reagent 1: $SOCl_2$	Reagent 2: CH_3NH_2
	Reagent 1: $K_2Cr_2O_7$ / $H^{\oplus}$	Reagent 2: CH_3OH / $H^{\oplus}$

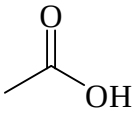
- For each of the following pairs of compounds, identify which is the stronger acid and give reasons for your choice.

Marks 4

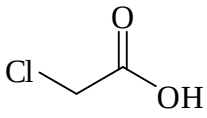


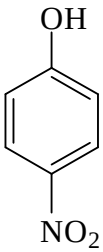
and



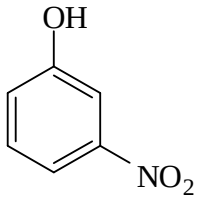


and



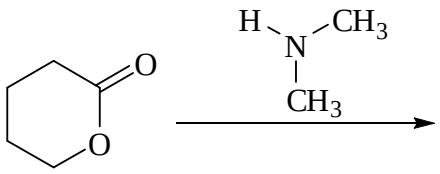


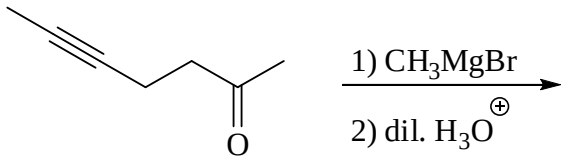
and



Marks 3

- Draw the structure(s) of the major organic product(s) formed in each of the following reactions. Give the names of the products where requested.



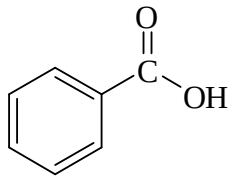
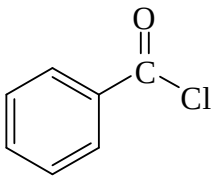
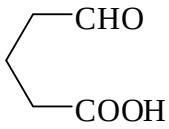


Name(s):

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

Marks 3

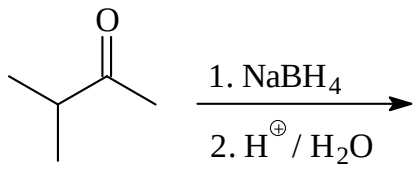
- Complete the following table.

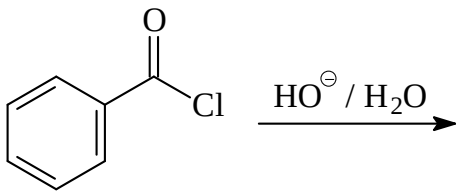
Starting material	Reagents / Conditions	Major organic product(s)
		
	1. $NaBH_4$ 2. $H^{\oplus}$ / H_2O	

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

- Draw the structure(s) of the major organic product(s) formed in each of the following reactions. Give the names of the products where requested.

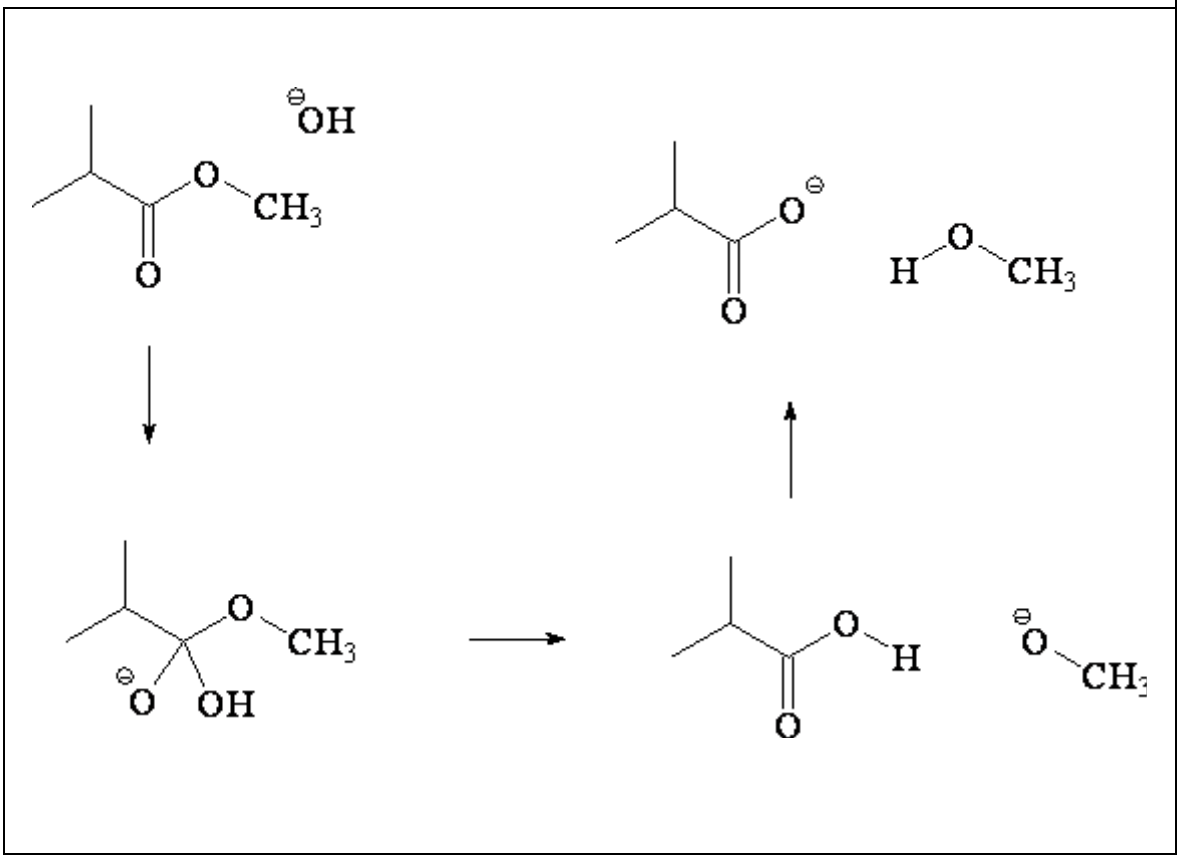
Marks 2





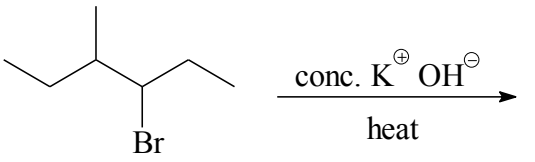
- Complete the mechanism for the reaction given below. Draw partial charges and curly arrows as appropriate to illustrate the bonding changes that take place.

Marks 3

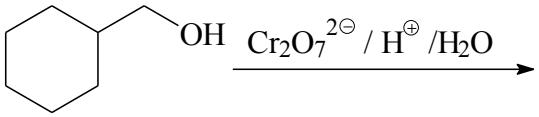


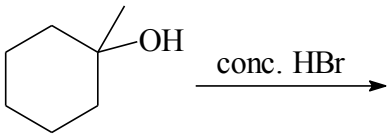
Marks 6

- Draw the structure(s) of the major organic product(s) formed in each of the following reactions. Give the names of the products where requested.

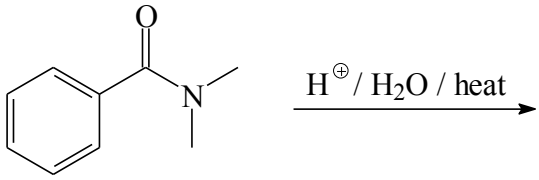


Name(s):

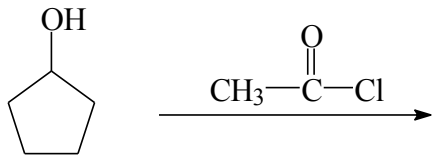


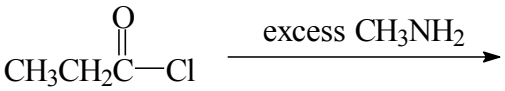


Name(s):



• Draw the constitutional formula(s) of the major organic product(s) formed in each of the following reactions.	**Marks 2**

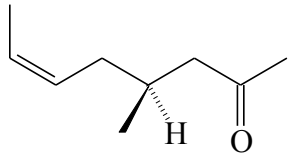




Marks 6

- Compound **X** was isolated as a derivative of a natural product.

X



Carbon 4 of X **is a stereogenic centre. List the substituents attached to C4 in descending order of priority according to the sequence rules.**

highest priority			lowest priority

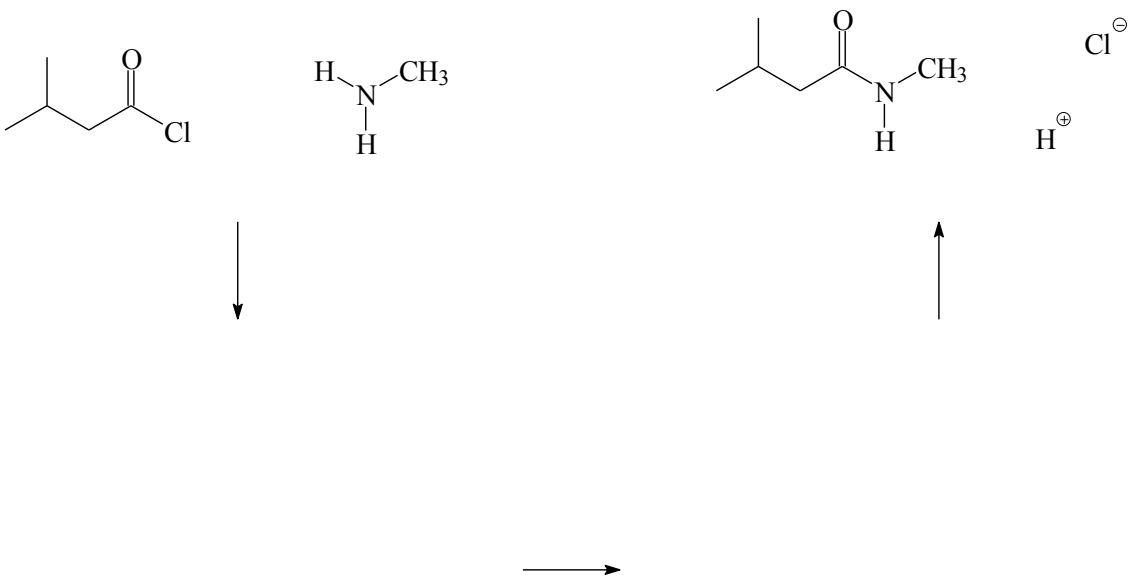
What is the systematic name for compound **X**? Make sure you include all relevant stereochemical descriptors.

Reduction of **X** with sodium borohydride ($NaBH_4$) followed by quenching the reaction with dilute acid gives **Y**. Give the constitutional formula for **Y**.

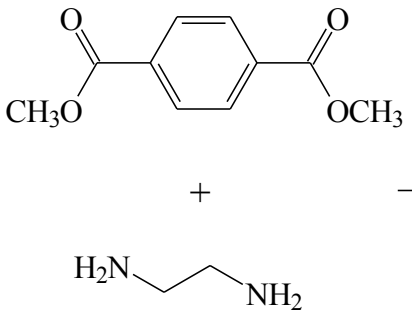
Product **Y** can be separated into two isomers. Explain.

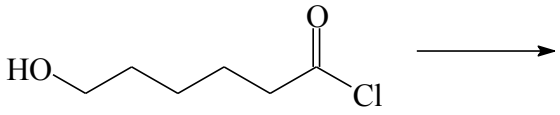
4

- Complete the three step mechanism for the reaction given below. Draw intermediate structures, curly arrows and partial charges as appropriate to illustrate the bonding changes that take place.



	Marks
• Draw the repeating unit of the polymer formed in the following reactions.	2





• Show clearly the reagents you would use to carry out the following chemical conversion. Draw constitutional formulas for any intermediate compounds. NOTE: More than one step is necessary.	4