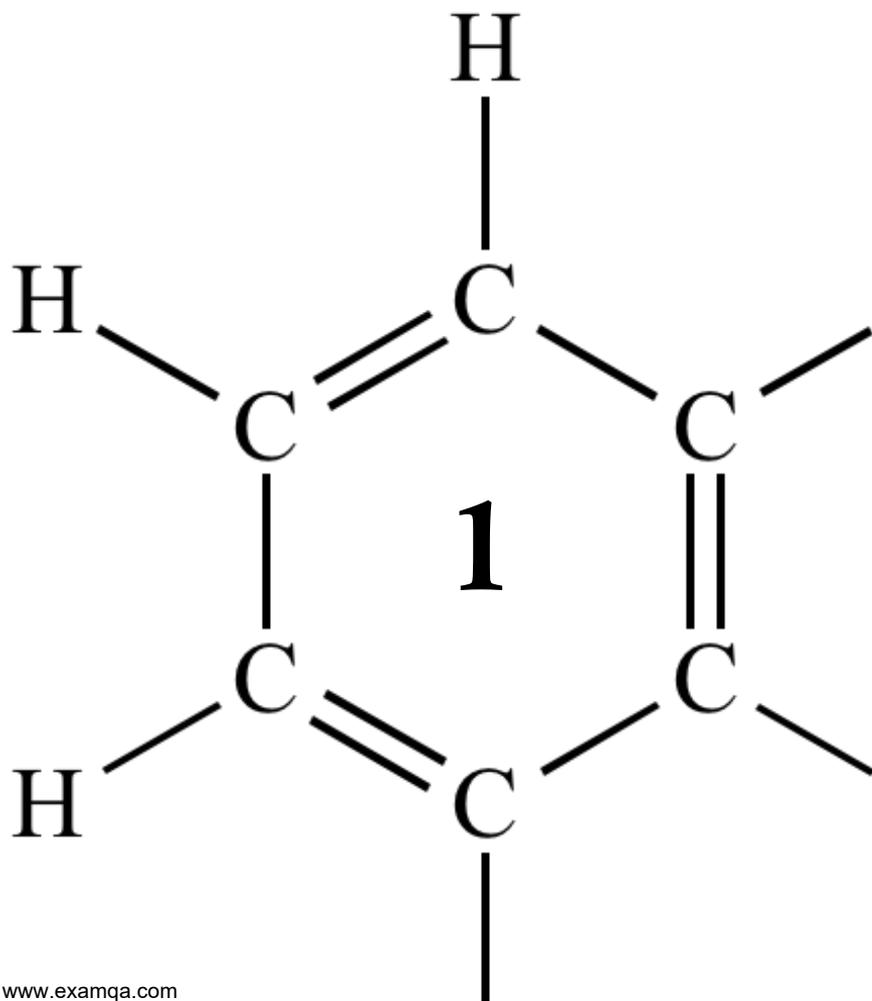


OCR A2 CHEMISTRY

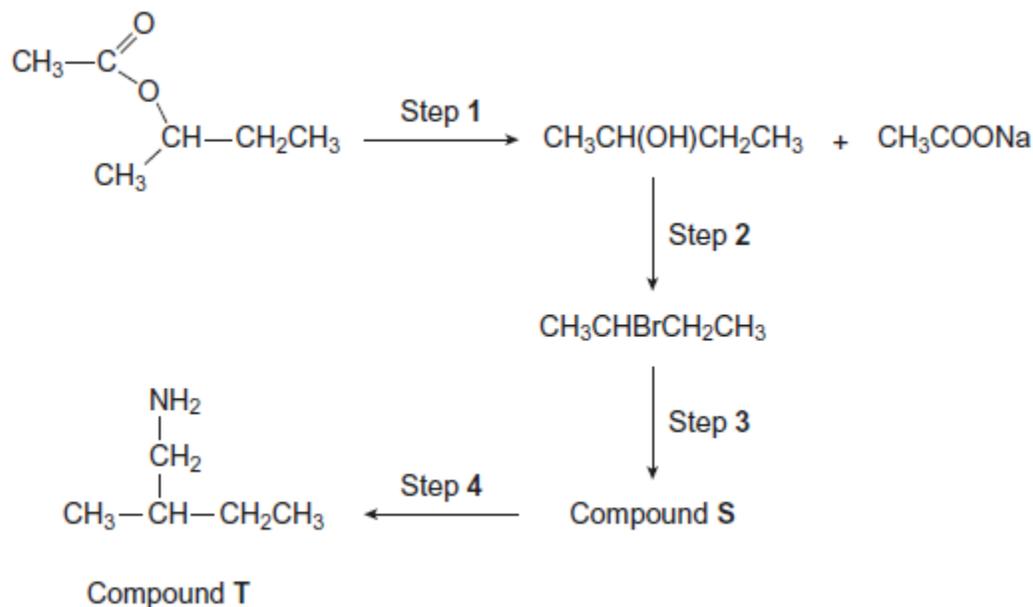
MODULE 6.3

ORGANIC SYNTHESIS
PRACTICALS



1

A four-step synthesis of compound **T** is shown.



- (a) Give the reagent and conditions for Step 1.
State how you could obtain a sample of the alcohol from the reaction mixture formed in Step 1.

.....
.....
.....
.....
.....

(3)

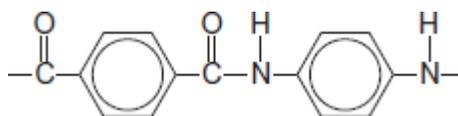
- (b) Draw the structure of compound **S**.
For each of Steps 3 and 4, give a reagent and one condition, other than heat.

(5)

(Total 8 marks)

2

Kevlar is a polymer used in protective clothing.
The repeating unit within the polymer chains of Kevlar is shown.



- (a) Name the strongest type of interaction between polymer chains of Kevlar.

.....

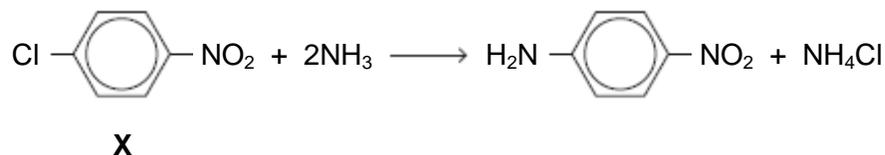
(1)

- (b) One of the monomers used in the synthesis of Kevlar is

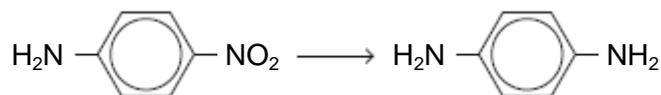


An industrial synthesis of this monomer uses the following two-stage process starting from compound **X**.

Stage 1



Stage 2



- (i) Suggest why the reaction of ammonia with **X** in Stage 1 might be considered unexpected.

.....
.....
.....
.....

(2)

- (ii) Suggest a combination of reagents for the reaction in Stage 2.

.....

(1)

- (iii) Compound **X** can be produced by nitration of chlorobenzene.

Give the combination of reagents for this nitration of chlorobenzene.

Write an equation or equations to show the formation of a reactive intermediate from these reagents.

Reagents

.....

Equation(s)

.....

(3)

- (iv) Name and outline a mechanism for the formation of **X** from chlorobenzene and the reactive intermediate in part (iii).

Name of mechanism

Mechanism

(4)
(Total 11 marks)

3

Use the data given on the back of the Periodic Table (PT) to help you answer this question. Compounds **A** to **G** are all isomers with the molecular formula $C_6H_{12}O_2$

- (a) Isomer **A**, $C_6H_{12}O_2$, is a neutral compound and is formed by the reaction between compounds **X** and **Y** in the presence of a small amount of concentrated sulphuric acid. **X** and **Y** can both be formed from propanal by different redox reactions.

X has an absorption in its infra-red spectrum at 1750 cm^{-1} .

Deduce the structural formulae of **A**, **X** and **Y**. Give suitable reagents, in each case, for the formation of **X** and **Y** from propanal and state the role of concentrated sulphuric acid in the formation of **A**.

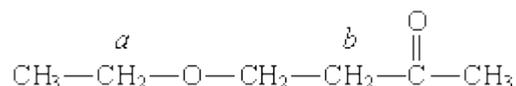
(7)

- (b) Isomers **B**, **C**, **D** and **E** all react with aqueous sodium carbonate to produce carbon dioxide. Deduce the structural formulae of the three isomers that contain an asymmetric carbon atom.

The fourth isomer has only three singlet peaks in its proton n.m.r. spectrum. Deduce the structural formula of this isomer and label it **E**.

(4)

- (c) Isomer **F**, $C_6H_{12}O_2$, has the structural formula shown below, on which some of the protons have been labelled.



A proton n.m.r. spectrum is obtained for **F**. Using Table 1 at the back of the Periodic Table (PT), predict a value of δ for the protons labelled *a* and also for those labelled *b*. State and account for the splitting patterns of the peaks assigned to the protons *a* and *b*.

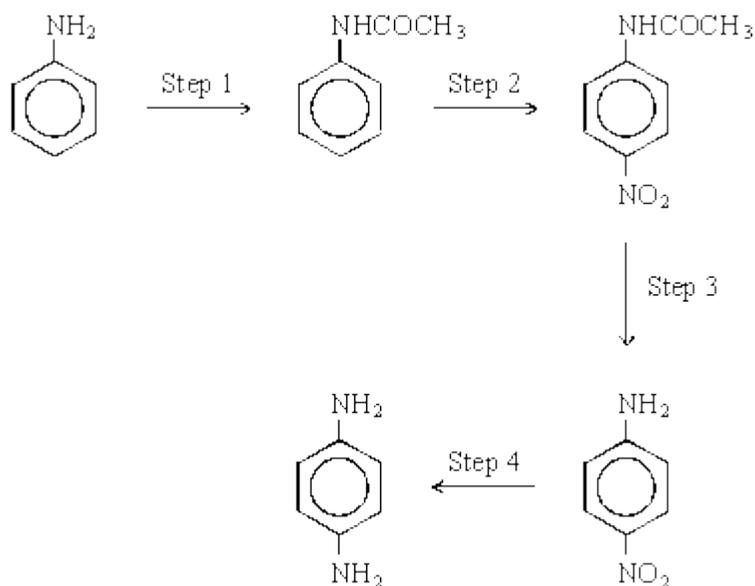
(6)

- (d) Isomer **G**, $C_6H_{12}O_2$, contains six carbon atoms in a ring. It has an absorption in its infra-red spectrum at 3270 cm^{-1} and shows only three different proton environments in its proton n.m.r. spectrum. Deduce a structural formula for **G**.

(2)
(Total 19 marks)

4

A possible synthesis of 1,4-diaminobenzene is shown below.

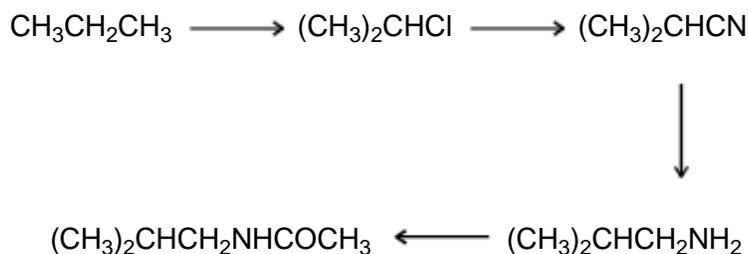


- (a) Identify a suitable reagent or combination of reagents for Step 1. Name and outline a mechanism for the reaction.
- (b) Identify a suitable reagent or combination of reagents for Step 2. Name and outline a mechanism for the reaction.
- (c) Identify a suitable reagent or combination of reagents for Step 4. Draw the repeating unit of the polymer formed by reaction of 1,4-diaminobenzene with pentanedioic acid.

(6)
(6)
(3)
(Total 15 marks)

5

Which one of the following types of reaction is **not** involved in the above sequence?

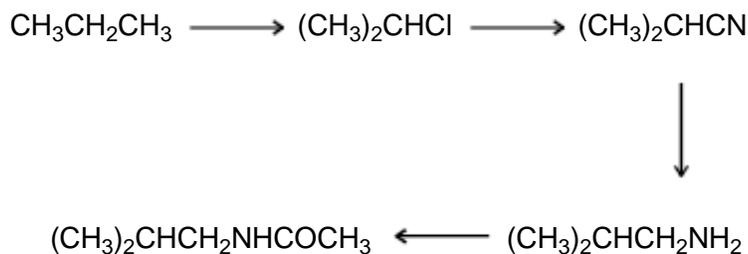


- A halogenation
- B acylation
- C reduction
- D oxidation

(Total 1 mark)

6

Which one of the following types of reaction mechanism is **not** involved in the above sequence?



- A free-radical substitution
- B nucleophilic substitution
- C elimination
- D nucleophilic addition-elimination

(Total 1 mark)

7

(a) **P**, **Q** and **R** have the molecular formula C_6H_{12}

All three are branched-chain molecules and none is cyclic.

P can represent a pair of optical isomers.

Q can represent a pair of geometrical isomers.

R can represent another pair of geometrical isomers different from **Q**.

Draw one possible structure for one of the isomers of each of **P**, **Q** and **R**.

Structure of **P**

Structure of **Q**

Structure of **R**

(3)

(b) Butanone reacts with reagent **S** to form compound **T** which exists as a racemic mixture. Dehydration of **T** forms **U**, C_5H_7N , which can represent a pair of geometrical isomers.

(i) State the meaning of the term *racemic mixture* and suggest why such a mixture is formed in this reaction.

Racemic mixture

.....

Explanation.....

.....

.....

- (ii) Identify reagent **S**, and draw a structural formula for each of **T** and **U**.

Reagent **S**

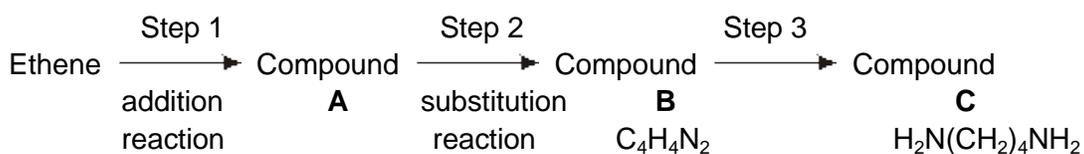
Compound **T**

Compound **U**

(6)
(Total 9 marks)

8

- (a) Compound **C**, $\text{H}_2\text{N}(\text{CH}_2)_4\text{NH}_2$, can be synthesised from ethene in three steps as shown below.



Name compound **C** and draw a structure for each of compounds **A** and **B**.
State the reagent(s) required for each step and name the type of reaction involved in the conversion of **B** into **C**.

(7)

- (b) Draw the repeating unit of the polyamide formed when **C** reacts with hexanedioic acid.
Discuss the interactions between the chains of the polyamide.

(4)

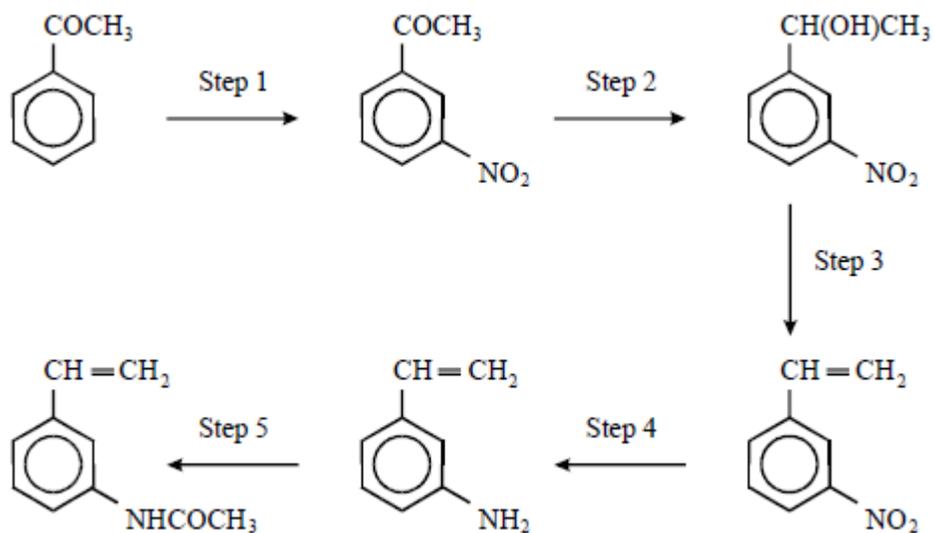
- (c) Explain why polyamides are degraded by sodium hydroxide whereas polymers such as poly(ethene) are not.

(3)

(Total 14 marks)

9

Refer to the following reaction sequence:

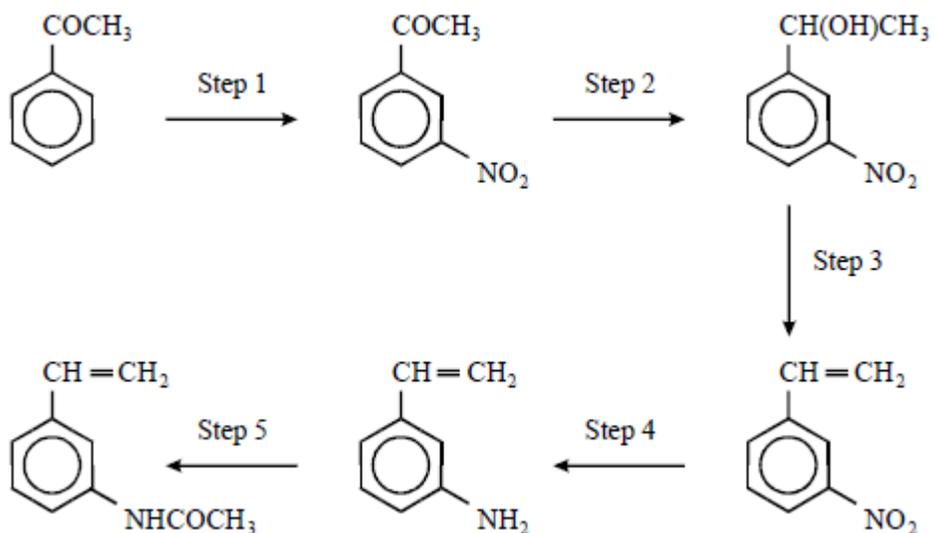
Which one of the following types of reaction is **not** involved in the above sequence?

- A acylation
- B oxidation
- C reduction
- D dehydration

(Total 1 mark)

10

Refer to the following reaction sequence:

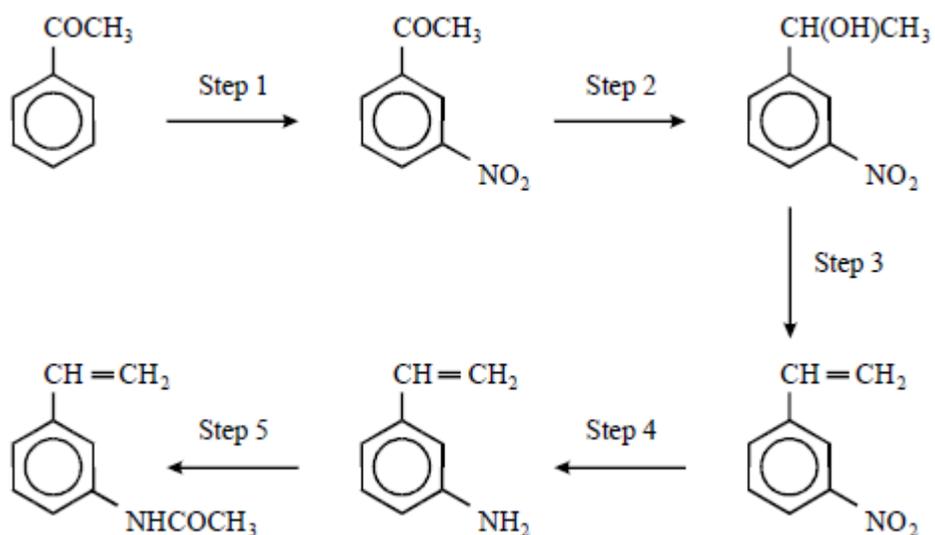
Which one of the following types of reaction mechanism is **not** involved in the above sequence?

- A electrophilic addition
- B electrophilic substitution
- C addition-elimination
- D elimination

(Total 1 mark)

11

Refer to the following reaction sequence:



Which one of the following would be the most appropriate to carry out Step 2?

- A H_2 / Ni
- B Sn / HCl
- C NaBH_4
- D Fe / HCl

(Total 1 mark)