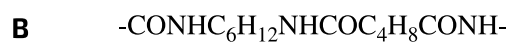
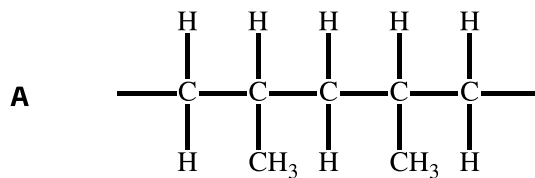


## Polymerisation Types

**Subject & topics:** Chemistry | Organic | Polymers      **Stage & difficulty:** A Level P2

**A** and **B** show parts of two industrial polymers.



**Figure 1:** Industrial polymers **A** and **B**

### Part A

#### Polymerisation A

State the type of polymerisation reaction that produced polymer **A**.

### Part B

#### Polymerisation B

State the type of polymerisation reaction that produced polymer **B**.

**Part C**

**Monomer A**

Draw the full structural formula of the monomer that produced polymer **A** using the [structure editor](#) and enter the SMILES string below.

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

[Using the structure editor](#)

**Part D**

**Monomer B**

Draw the full structural formula of the nitrogen-containing monomer that produced polymer **B** using the [structure editor](#) and enter the SMILES string below.

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

[Using the structure editor](#)

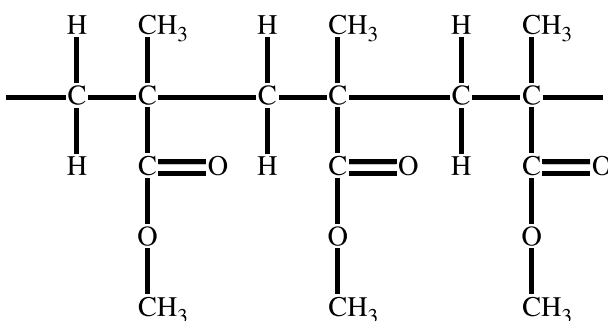
## Poly(methyl Methacrylate)

**Subject & topics:** Chemistry | Organic | Polymers     **Stage & difficulty:** A Level P1

### Part A

#### Poly(methyl methacrylate)

Poly(methyl methacrylate) is used to make hard contact lenses. Part of its polymer chain is shown.



**Figure 1:** Poly(methyl methacrylate)

Which statements about poly(methyl methacrylate) are correct?

- 1 It is an addition polymer.
- 2 Its monomer is  $\text{CH}_2=\text{C}(\text{CH}_3)\text{COOCH}_3$ .
- 3 It is an ester.

- ☐ 1, 2 and 3 are correct
- ☐ 1 and 2 only are correct
- ☐ 1 and 3 only are correct
- ☐ 2 and 3 only are correct
- ☐ 1 only is correct
- ☐ 2 only is correct
- ☐ 3 only is correct

Part B  
Perspex

The structure of the plastic *Perspex* is shown below.

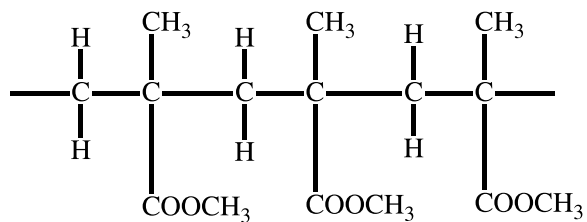


Figure 2: *Perspex*

What is the molecular structure of the monomer from which this plastic is formed?

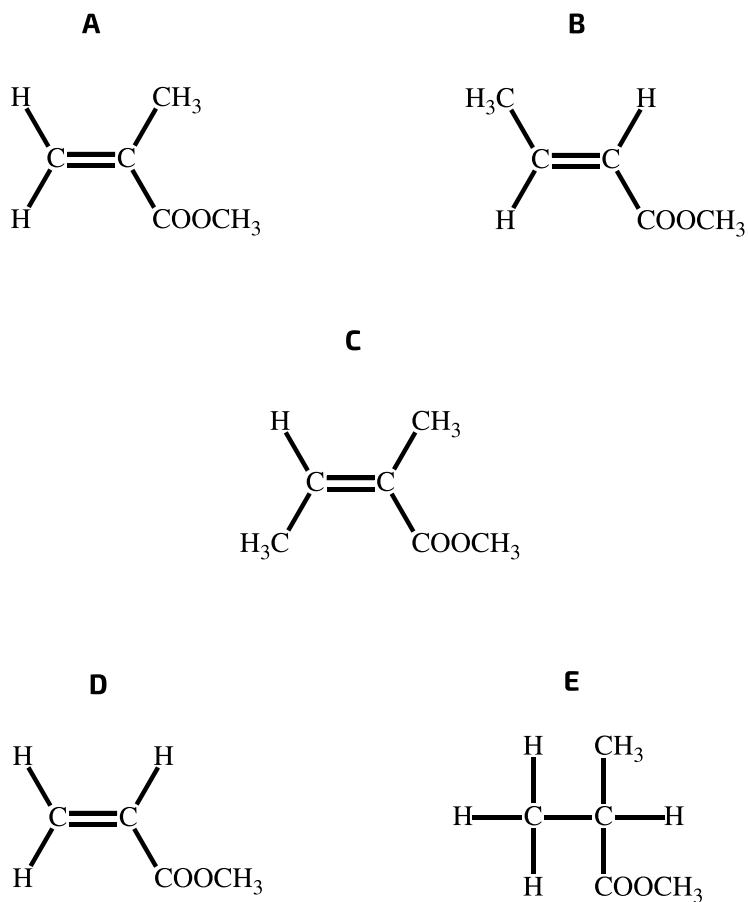


Figure 3: Possible monomers of *Perspex*

- ☐ A
- ☐ B
- ☐ C
- ☐ D

☐ E

Part A adapted with permission from UCLES, A-Level Chemistry, November 1996, Paper 4, Question 40;

Part B adapted with permission from UCLES, A-Level Chemistry, June 1993, Paper 4, Question 24

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Question deck:

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## Cyano Acrylate

**Subject & topics:** Chemistry | Organic | Polymers      **Stage & difficulty:** A Level P1

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Part A  
Superglue

'Superglue' contains the compound

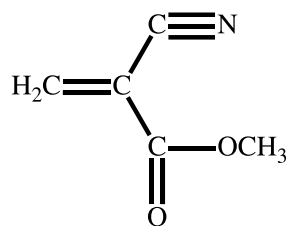


Figure 1: 'Superglue' compound

It is rapidly polymerised by traces of bases on the surface of the objects to be stuck together. Which of the following represents the repeat unit of the polymerised form?

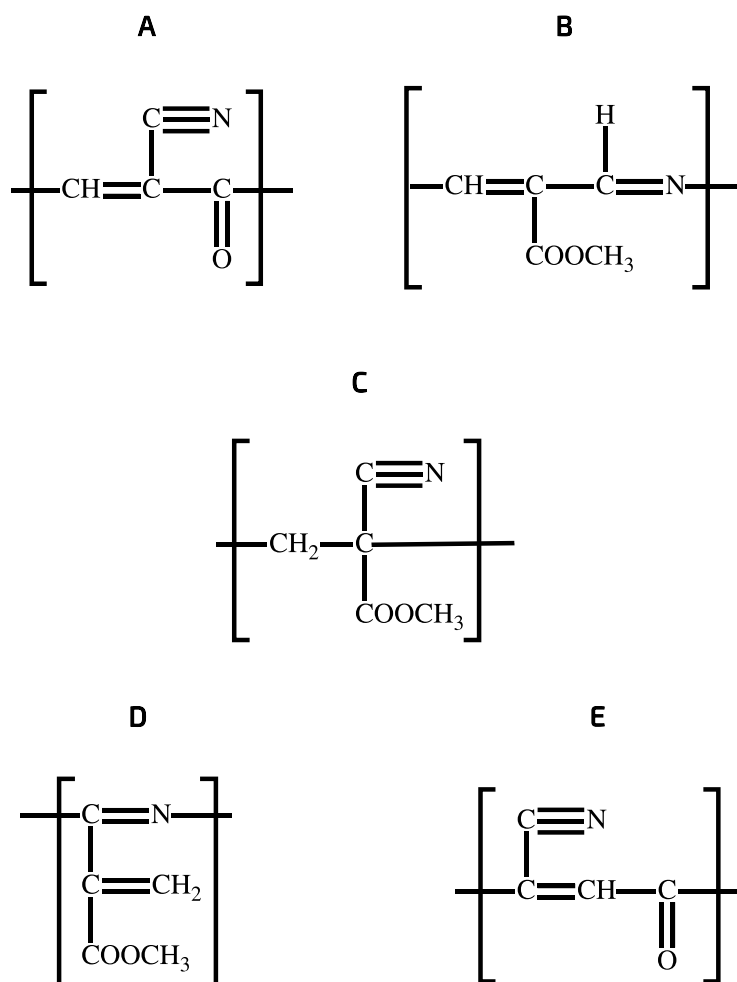


Figure 2: Possible repeat units in 'superglue'

☐ A

☐ B

☐ C

☐ D

☐ E



Part B

Acrylic fibre

Acrylic fibre is an addition polymer. Part of this polymer chain is shown below.

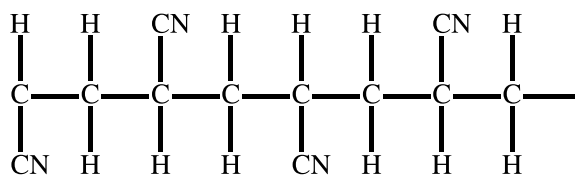


Figure 3: Acrylic fibre polymer

Which monomer would form this polymer?

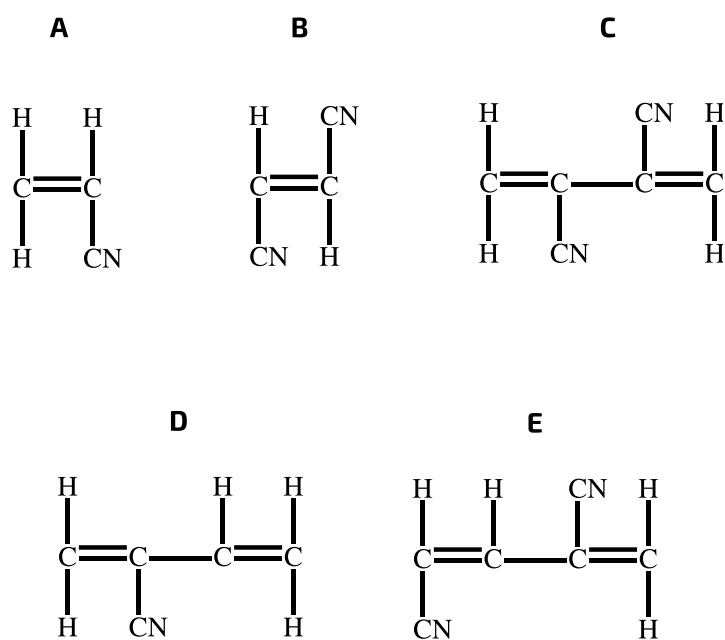


Figure 4: Possible monomer units for acrylic fibre

- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ E

Part A adapted with permission from UCLES, A-Level Chemistry, June 1990, Paper 1, Question 23;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1991, Paper 1, Question 25

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## Condensation Polymers

**Subject & topics:** Chemistry | Organic | Polymers    **Stage & difficulty:** A Level P1

### Part A

#### 6-aminohexanoic acid

A common type of nylon is made by the self-condensation of 6-aminohexanoic acid,  $\text{NH}_2(\text{CH}_2)_5\text{COOH}$ .

What is the repeat unit of the polymer?

- ☐  $[\text{NH}_2(\text{CH}_2)_5\text{COOH}]$
- ☐  $[\text{NH}_3(\text{CH}_2)_5\text{NHCO}(\text{CH}_2)_5\text{CO}]$
- ☐  $[\text{NH}(\text{CH}_2)_5\text{CO}]$
- ☐  $[\text{NH}_3(\text{CH}_2)_5\text{COO}]$

### Part B

#### Condensation polymer

Which of the following is a repeat unit in a condensation polymer?

- ☐  $-\text{CH}_2\text{C}(\text{CH}_3)=\text{CHCH}_2-$
- ☐  $-\text{CH}_2\text{CHCl}-$
- ☐  $-\text{OCH}_2\text{CH}_2\text{O}-$
- ☐  $-\text{CH}_2\text{CH}_2\text{CH}_2\text{O}-$
- ☐  $-\text{OCH}_2\text{CH}_2\text{OOCCH}_2\text{CH}_2\text{CO}-$

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## Nylon 66

**Subject & topics:** Chemistry | Organic | Polymers     **Stage & difficulty:** A Level P2

### Part A

#### Preparation method

Nylon 66 is a condensation polymer derived from hexane-1,6-diamine,  $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ , and hexanedioic acid,  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ .

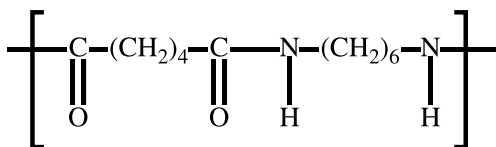


Figure 1: Nylon 66

Which of the following, reacting with the diamine, would provide the most rapid method of preparing the polymer?

- ☐ diethyl hexanedioate
- ☐ hexane-1,6-diol
- ☐ hexanedioic acid
- ☐ hexanedioyl chloride
- ☐ sodium hexanedioate

**Part B**

**Polymerisation reaction**

Nylon 66 has the repeat unit:



When it is made from hexanedioic acid and hexane-1,6-diamine,

1. condensation polymerisation takes place.
2. amide linkages are formed.
3. ammonia is eliminated.

- ☐ 1, 2 and 3 are correct
- ☐ 1 and 2 only are correct
- ☐ 1 and 3 only are correct
- ☐ 2 and 3 only are correct
- ☐ 1 only is correct
- ☐ 2 only is correct
- ☐ 3 only is correct

Part A adapted with permission from UCLES, A-Level Chemistry, June 1990, Paper 1, Question 26;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1991, Paper 1, Question 40

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## Polyamides

**Subject & topics:** Chemistry | Organic | Polymers      **Stage & difficulty:** A Level P2

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### Part A

#### Nylon 6

Nylon 6 has the following formula and undergoes acidic hydrolysis.



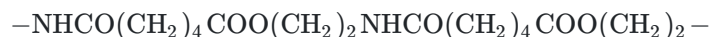
What is the product of the acidic hydrolysis of Nylon 6?

- ☐  $\text{HO}(\text{CH}_2)_5\text{COOH}$
- ☐  $\text{HO}(\text{CH}_2)_5\text{OH}$
- ☐  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$
- ☐  $\text{H}_3\text{N}^+(\text{CH}_2)_5\text{COOH}$
- ☐  $\text{H}_3\text{N}^+(\text{CH}_2)_5\text{OH}$

**Part B**

**Polyamide**

Part of the structure of a polymer is shown below.



Which of the following statements about this polymer are correct?

**1** It could be made from  $\text{ClCO}(\text{CH}_2)_4\text{COCl}$  and  $\text{HOCH}_2\text{CH}_2\text{NH}_2$ .

**2** It is both a polyamide and a polyester.

**3** It would be resistant to alkaline hydrolysis.

☐ **1, 2 and 3** are correct

☐ **1 and 2** only are correct

☐ **1 and 3** only are correct

☐ **2 and 3** only are correct

☐ **1** only is correct

☐ **2** only is correct

☐ **3** only is correct

Part A adapted with permission from UCLES, A-Level Chemistry, June 1992, Paper 3, Question 29;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1993, Paper 3, Question 40

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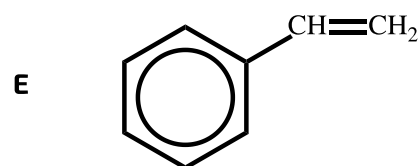
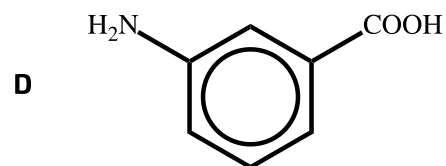
## More Condensation Polymers

**Subject & topics:** Chemistry | Organic | Polymers    **Stage & difficulty:** A Level P1

### Part A

#### Single monomers

Which of the following compounds could be used by itself to form a condensation polymer?



**Figure 1:** Possible condensation polymer monomers

- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ E

Part B

Monomer pairs

Which of the following pairs of compounds are the monomers of a condensation polymer?

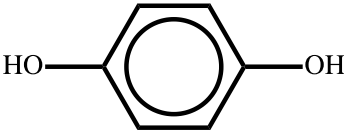
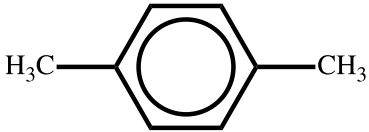
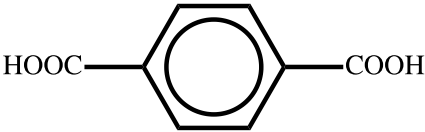
- A**       $\text{CH}_3\text{OOCCH}_2\text{CH}_2\text{COOCH}_3$       and       $\text{CH}_2=\text{CHCH}=\text{CH}_2$
- B**            and       $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$
- C**       $\text{O}=\text{CHCH}_2\text{CH}_2\text{CH}=\text{O}$       and      
- D**            and       $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$

Figure 2: Possible pairs of monomers of a condensation polymer

- ☐ A
- ☐ B
- ☐ C
- ☐ D

Part A adapted with permission from UCLES, A-Level Chemistry, June 1993, Paper 4, Question 30;

Part B adapted with permission from UCLES, A-Level Chemistry, June 1994, Paper 4, Question 30

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## Monomer Units

**Subject & topics:** Chemistry | Organic | Polymers    **Stage & difficulty:** A Level P1

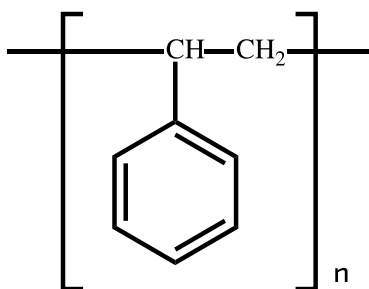
What are the respective monomer units that can be used to form the following polymers?

Use the [structure editor](#) to generate SMILES strings as your answers.

In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

[Using the structure editor](#)

### Part A



**Figure 1:** Structure of  $[\text{CH}(\text{C}_6\text{H}_5)\text{CH}_2]_n$

Part B

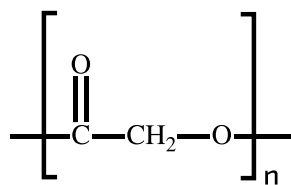


Figure 2: Structure of  $[\text{COCH}_2\text{O}]_n$

Part C

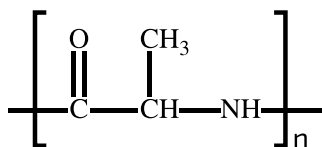


Figure 3: Structure of  $[\text{COCH}(\text{CH}_3)\text{NH}]_n$

Part D

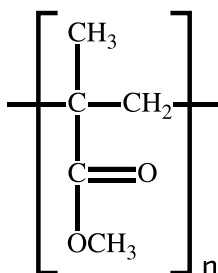


Figure 4: Structure of  $[\text{C}(\text{CH}_3)(\text{COOCH}_3)\text{CH}_2]_n$

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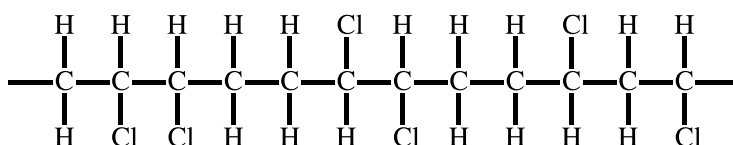
## Addition Polymers

**Subject & topics:** Chemistry | Organic | Polymers      **Stage & difficulty:** A Level C1

### Part A

#### Chloro-polymer 1

A molecule of a polymer contained the sequence shown.



**Figure 1:** Polymer sequence

What could be the monomer from which this polymer is obtained?

- ☐  $\text{CHCl}=\text{CHCl}$
- ☐  $\text{CH}_3\text{CCl}=\text{CH}_2$
- ☐  $\text{CH}_3\text{CCl}=\text{CHCl}$
- ☐  $\text{CH}_2=\text{CHCl}$

Part B

**Chloro-polymer 2**

A polymer has the following repeat unit.



Which pair of monomers could be used to make this polymer?

- ☐  $\text{CH}_3-\text{CH}_2\text{Cl}$  and  $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$
- ☐  $\text{CH}_2=\text{CHCl}$  and  $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$
- ☐  $\text{CH}_2=\text{CCl}-\text{CH}=\text{CH}_2$  and  $\text{CH}_2=\text{CH}_2$
- ☐  $\text{CH}_2=\text{CHCl}$  and  $\text{CH}_2=\text{CH}_2$

Part A adapted with permission from UCLES, A-Level Chemistry, June 1996, Paper 3, Question 30;

Part B adapted with permission from UCLES, A-Level Chemistry, June 1995, Paper 4, Question 30

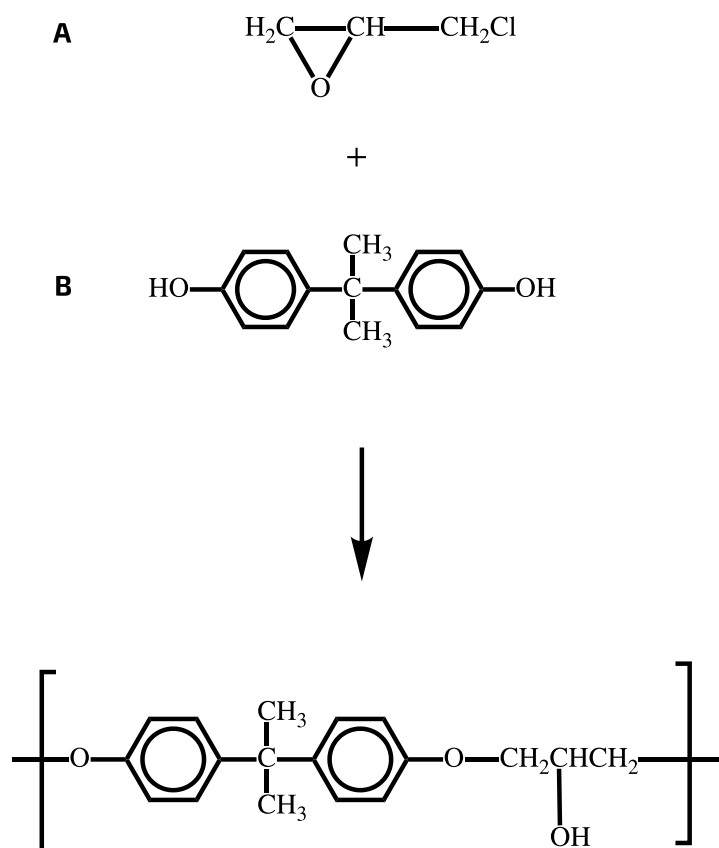
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## Epoxy Resins

**Subject & topics:** Chemistry | Organic | Polymers    **Stage & difficulty:** A Level C1

Monomer **A** reacts with the diphenol **B** below to give a polymer as shown in the reaction scheme below:



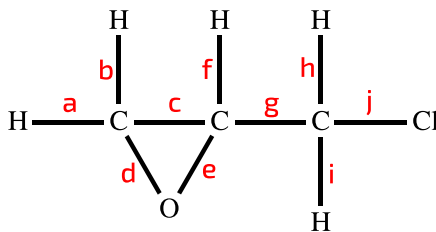
**Figure 1:** Epoxy resin polymer reaction



**Part A**

**Which bonds broken?**

From the displayed formula below, state in alphabetical order (e.g. **ab**) which bonds must break for the polymer to be formed.



**Figure 2:** Structure of epoxy monomer unit

**Part B**

**What is condensed out?**

This is an example of condensation polymerisation.

State which small molecule is condensed out.

**Part C**

**How many molecules removed?**

How many of these molecules are removed per repeat unit of the polymer?