



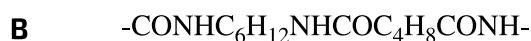
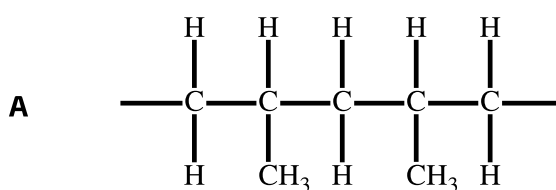
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# Polymerisation Types



**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.

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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](#)

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**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.

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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.

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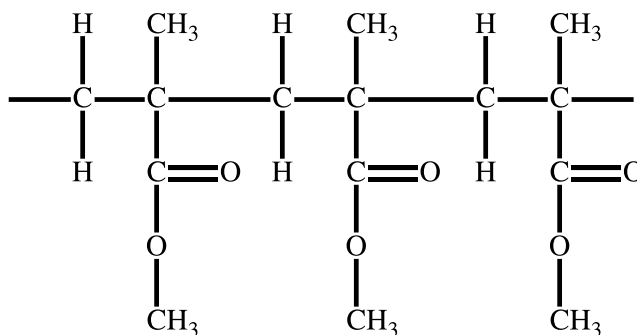
# Poly(methyl Methacrylate)

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**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)

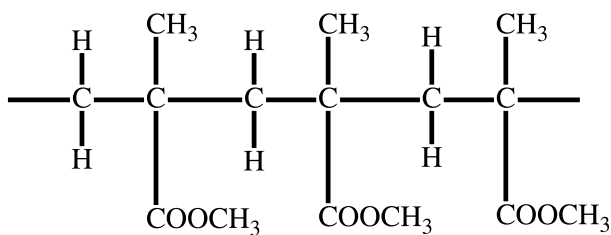
Which statements about poly(methyl methacrylate) are correct?

- 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

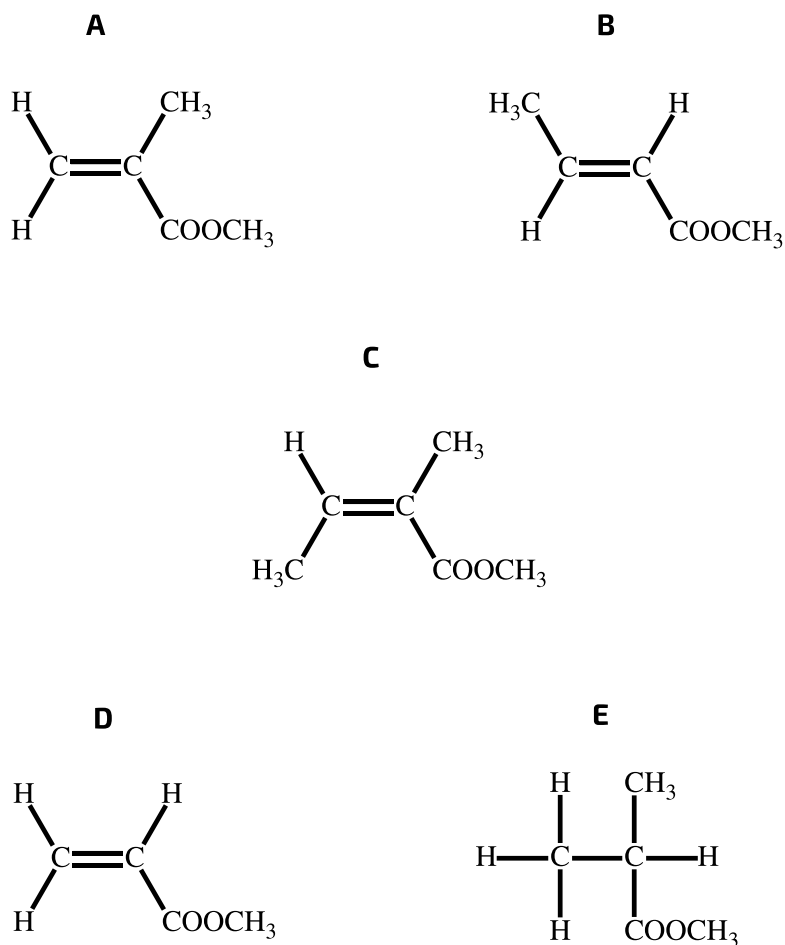
**Part B Perspex**

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**



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# Cyano Acrylate



## Part A Superglue

'Superglue' contains the compound

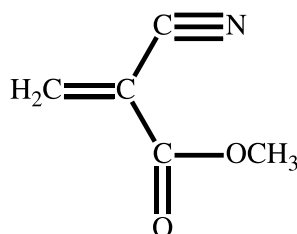
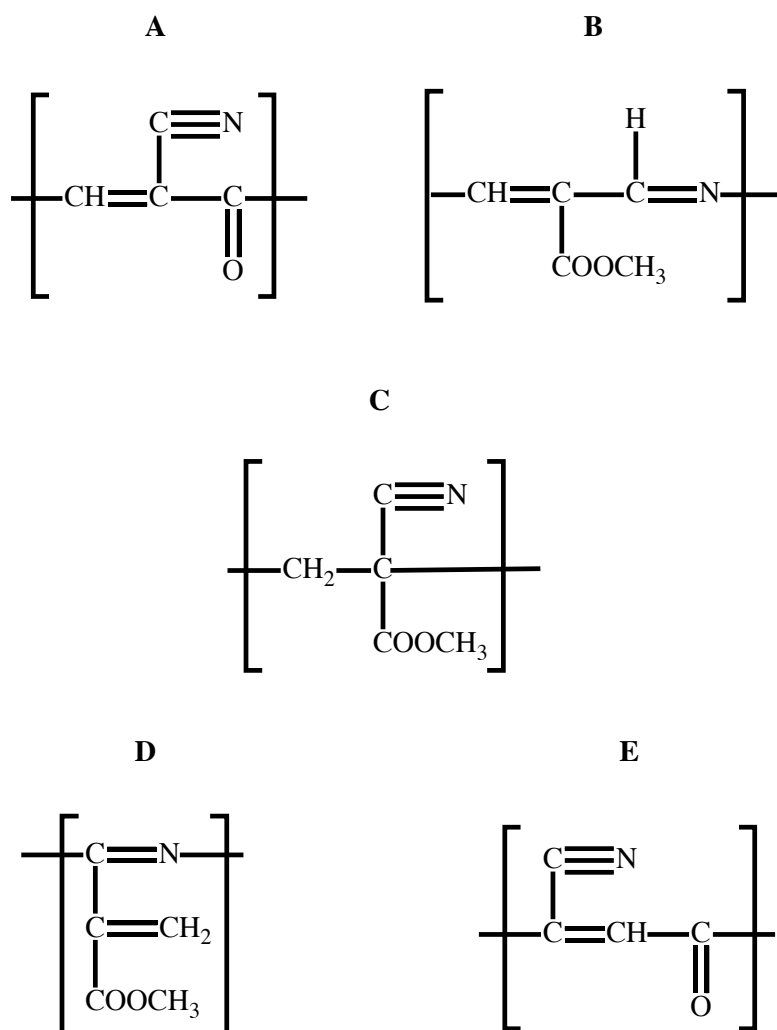


Figure 1: 'Superglue' compound

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?

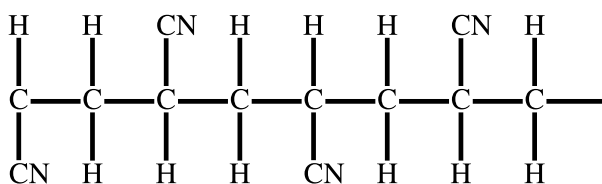


**Figure 2:** Possible repeat units in 'superglue'

- ☐ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**
- ☐ **E**

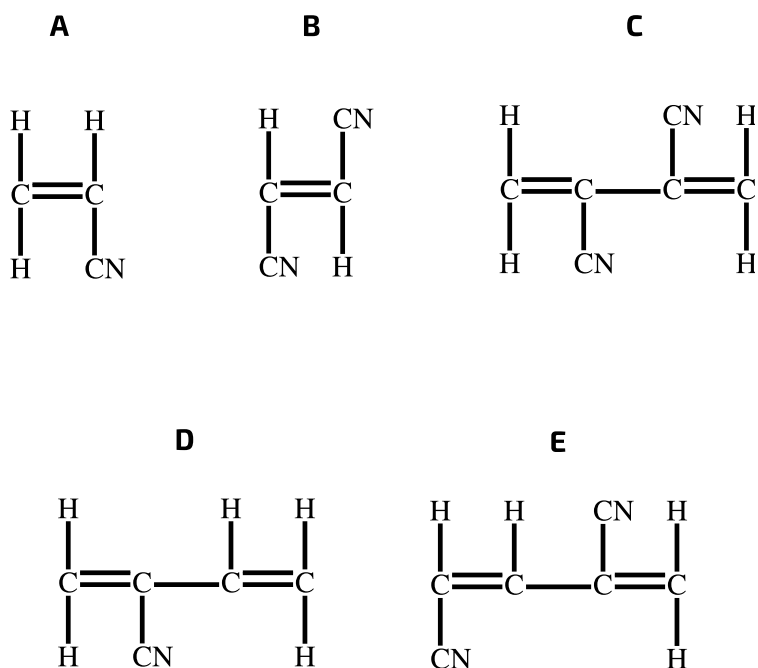
## Part B Acrylic fibre

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**





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# Condensation Polymers



## 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?

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

---

**Part B**    **Condensation polymer**

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

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

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# Nylon 66



## 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,  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ .

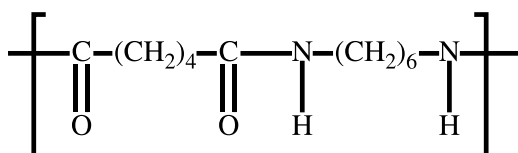


Figure 1: Nylon 66

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

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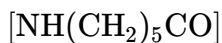
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# Polyamides



## Part A Nylon 6

Nylon 6 has the following formula and undergoes acidic hydrolysis.

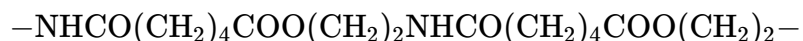


What is the product of the acidic hydrolysis of Nylon 6?

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

**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

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# PMPS Polyester



Part of the structure of the biodegradable polyester PMPS has the structure shown below.



## Part A Monomer structures

Draw the structures of the monomer units which can be used to make this polymer.

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

Enter your answer in the format "A, B" (space after comma).

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 B % mass of carbon

Calculate the percentage by mass of carbon in PMPS to the nearest 0.1%.

---

**Part C**    % mass of hydrogen

Calculate the percentage by mass of hydrogen in PMPS to the nearest 0.1%.

---

---

**Part D**    % mass of oxygen

Calculate the percentage by mass of oxygen in PMPS to the nearest 0.1%.

---

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# More Condensation Polymers

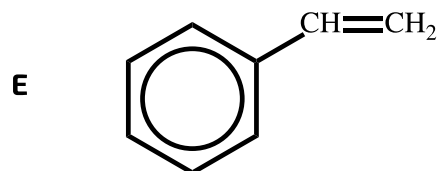
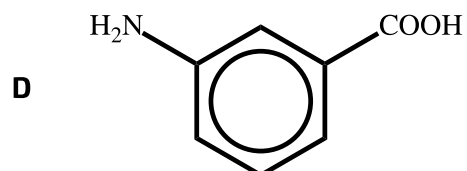
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## Part A Single monomers

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

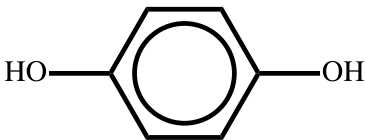
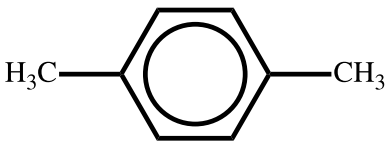



**Figure 1:** Possible condensation polymer monomers

- ☐ **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**

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# Monomer Units



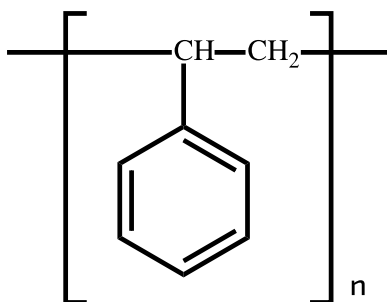
What are the respective monomer units that can be used to form the following polymers?

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

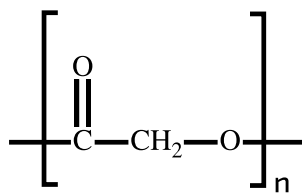
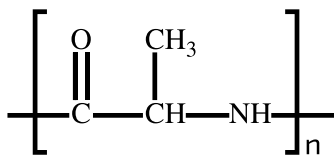
In the editor, after drawing your structure, click on the round, yellow smiley face to generate a SMILES string. Copy the SMILES string and paste it in the answer box.

[Using the structure editor](#)

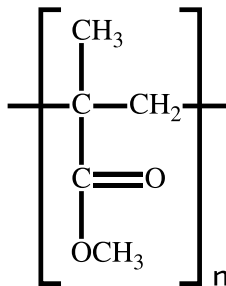
**Part A**  $[\text{CH}(\text{C}_6\text{H}_5)\text{CH}_2]_n$



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

**Part B**  $[\text{COCH}_2\text{O}]_n$ **Figure 2:** Structure of  $[\text{COCH}_2\text{O}]_n$ **Part C**  $[\text{COCH}(\text{CH}_3)\text{NH}]_n$ **Figure 3:** Structure of  $[\text{COCH}(\text{CH}_3)\text{NH}]_n$

**Part D**  $[\text{C}(\text{CH}_3)(\text{COOCH}_3)\text{CH}_2]_n$



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

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# Addition Polymers

A Level



## Part A Chloro-polymer 1

A molecule of a polymer contained the sequence shown.

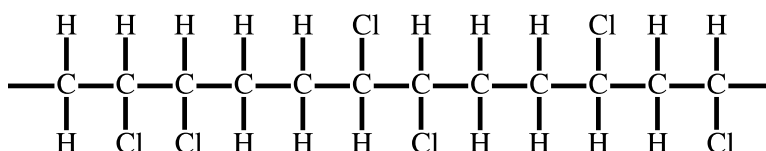


Figure 1: Polymer sequence

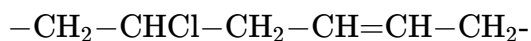
What could be the monomer from which this polymer is obtained?

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

---

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

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