SI Organic Chemistry - Full Discipline Demo

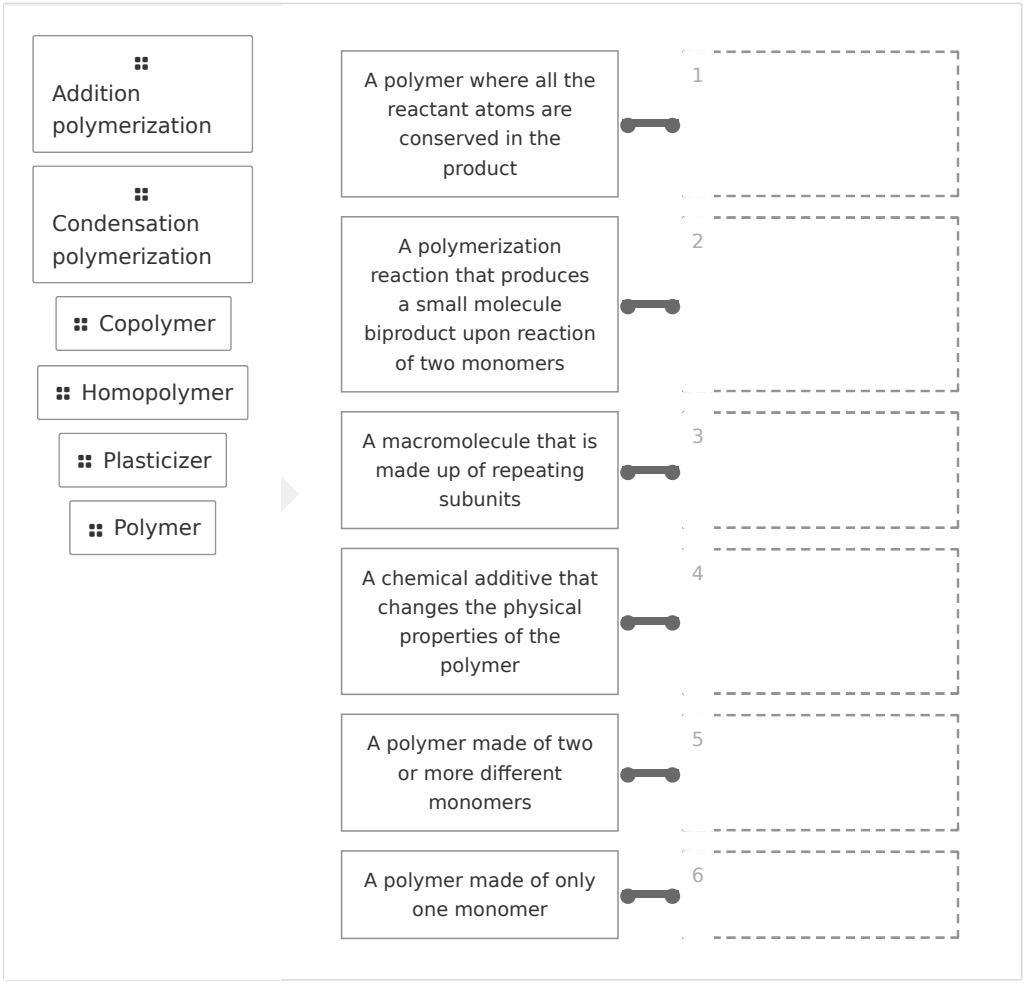
Polymers

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Organic Chemistry - Full Discipline Demo
Course	SI Organic Chemistry - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Match the definition with each term that fits the best description.

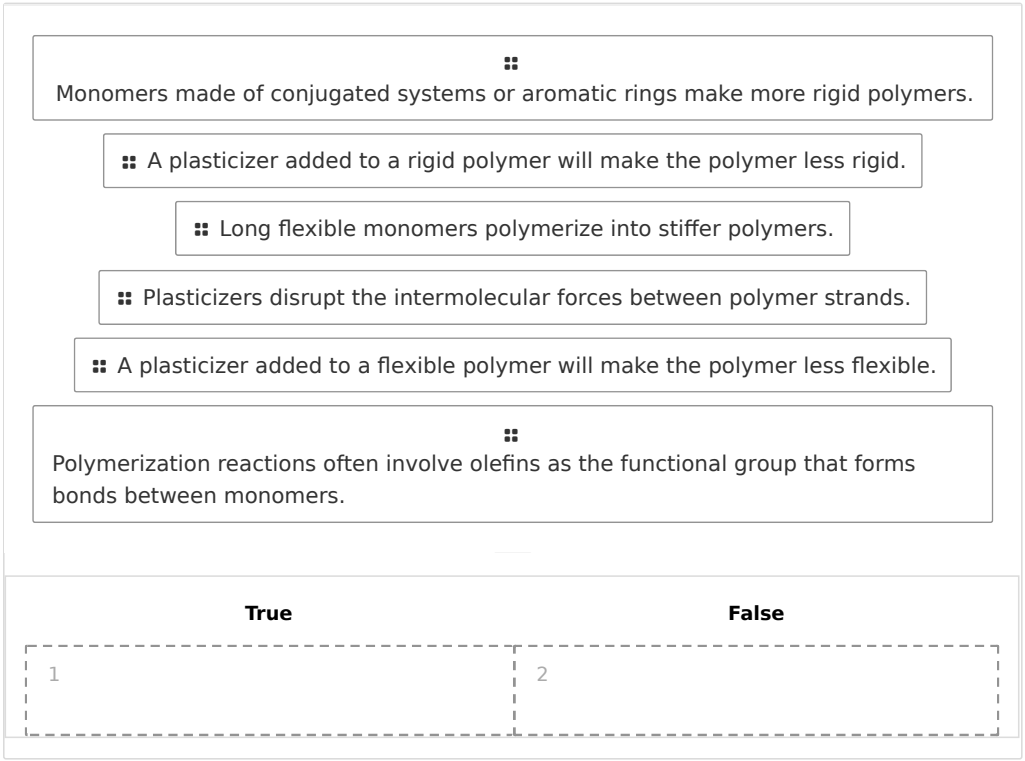


Correct answers:

1 Addition polymerization 2 Condensation polymerization 3 Polymer

4 Plasticizer 5 Copolymer 6 Homopolymer

Classify the following compounds as either a polymer or small molecule.



Correct answers:

1

Polymerization reactions often involve olefins as the functional group that forms bonds between monomers.

A plasticizer added to a rigid polymer will make the polymer less rigid.

Plasticizers disrupt the intermolecular forces between polymer strands.

Monomers made of conjugated systems or aromatic rings make more rigid polymers.

2 Long flexible monomers polymerize into stiffer polymers.

A plasticizer added to a flexible polymer will make the polymer less flexible.

Exploration

Polymers are macromolecules that have repeating subunits called monomers.

- True ✔
- False

Plasticizers are chemical additives that change the _____ properties of a polymer and make them more _____.

- physical; flexible ✔
- molecular; ridged
- chemical; elastic
- None of the above

Nylon, a polyamide, is synthesized by reacting a dicarboxylic acid with a diol.

- True
- False ✔

A longer reaction time between polyvinyl acetate and sodium tetraborate will make the polymer _____.

- more fluid
- more flexible
- less flexible ✔
- None of the above

The role of glycerol when mixing starch-glycerol is to ___.

- act as a plasticizer ✔
- remove water
- make the polymer crystalline
- None of the above

Exercise 1

Explain what happened chemically that caused the differences between the initial flexibility and texture of the polymer with a short reaction time compared to the polymer with a long reaction time?

The short reaction time polymer is initially soft and highly flexible because it has had only a short amount of time for the sodium tetraborate to integrate into the polymer structure. After long exposure to sodium tetraborate, the polymer becomes harder and less stretchy as the tetraborate molecules bind the polymer strands together.

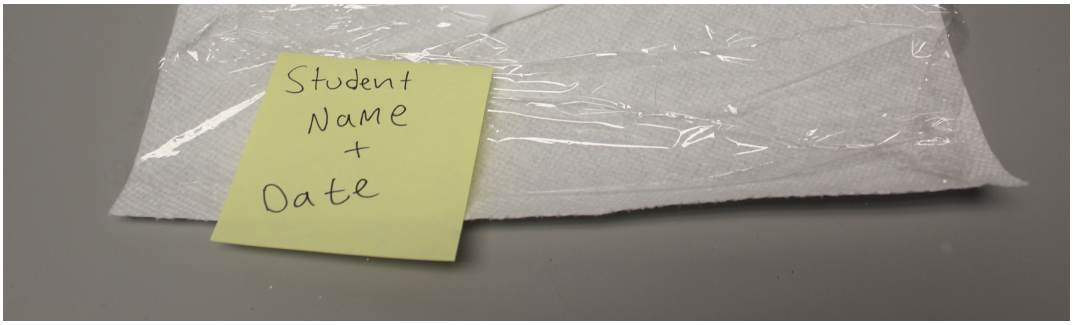
Based on your results in this exercise, what chemical was causing the change in the physical properties of the polymer over time?

Sodium tetraborate was the chemical that resulted in a change in the physical properties of the polymer. A longer reaction time allowed more tetraborate to displace the acetate in the polymer, making it more rigid.

Panel 1: Observations of Polymer with Brief Reaction Time
(SAMPLE ANSWER BELOW)

Polymer is watery, barely holds together, a "goop," highly flexible.

Photo 1: Polymer with Brief Reaction Time
(SAMPLE ANSWER BELOW)



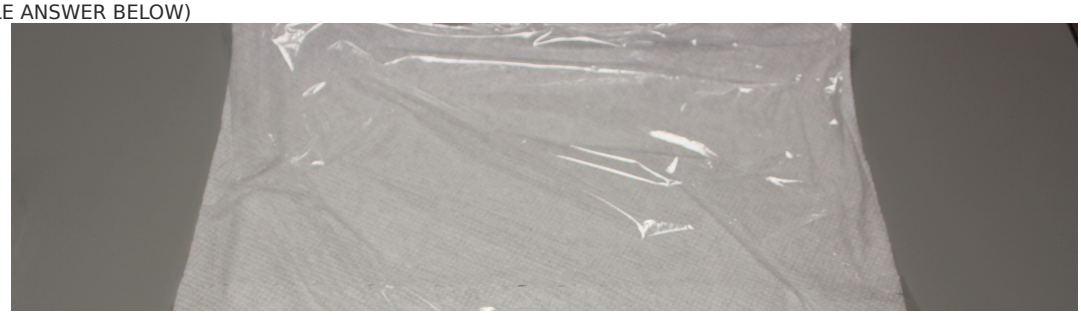
Panel 2: Observations of Polymer with Long Reaction Time

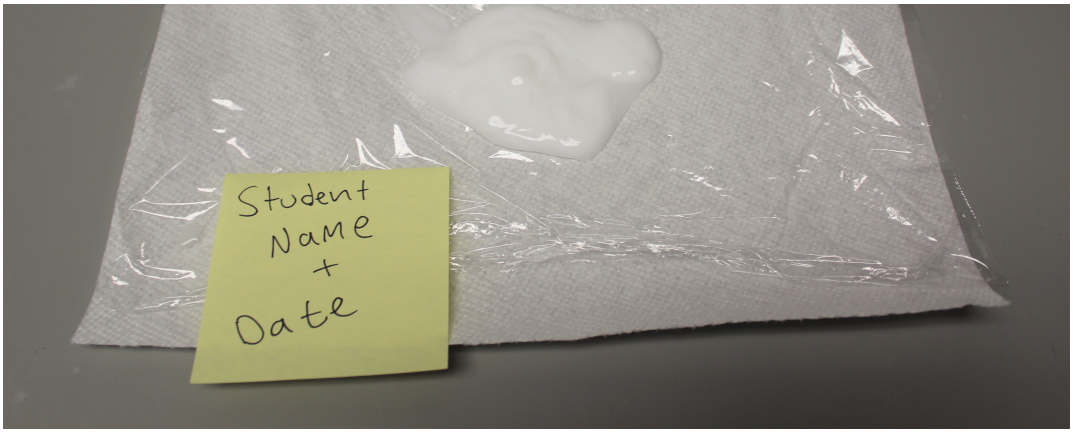
(SAMPLE ANSWER BELOW)

Consistency of "gak"--more rubbery than watery, still moldable but holds its form better. Firm, can bounce, can "break" if quickly pulled apart.

Photo 2: Polymer with Long Reaction Time

(SAMPLE ANSWER BELOW)





Exercise 2

Describe the physical properties of the two polymers. Use descriptor words such as bendable, rigid, stretch, elastic, firm, shapeable, etc.

The first polymer is flexible and has plastic properties. You can bend and prod it using the glass rod. It is firm but not brittle. The rigid, brittle polymer made without glycerol doesn't have a plasticizer present to give it plastic properties.

What effects did glycerol have in the formation of the polymers? Reference Photos 3-4 and Panel 3 in your explanation.

Glycerol acts as a plasticizer in the formation of the polymer--it allows the polymer to be more flexible instead of brittle.

Photo 3. Starch-glycerol polymer
(SAMPLE ANSWER BELOW)

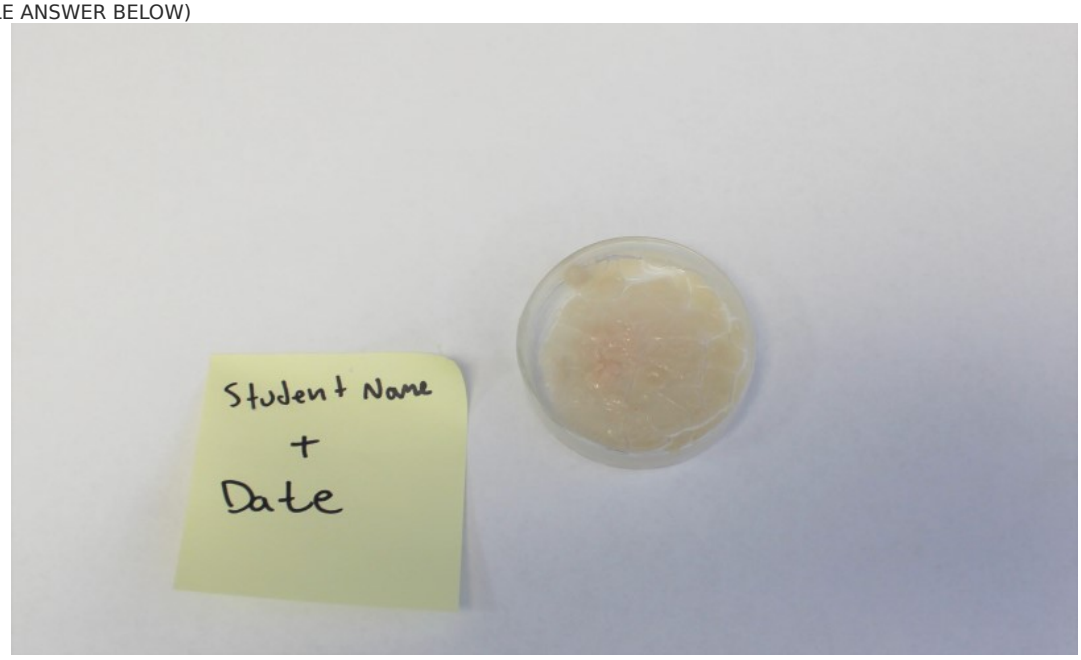
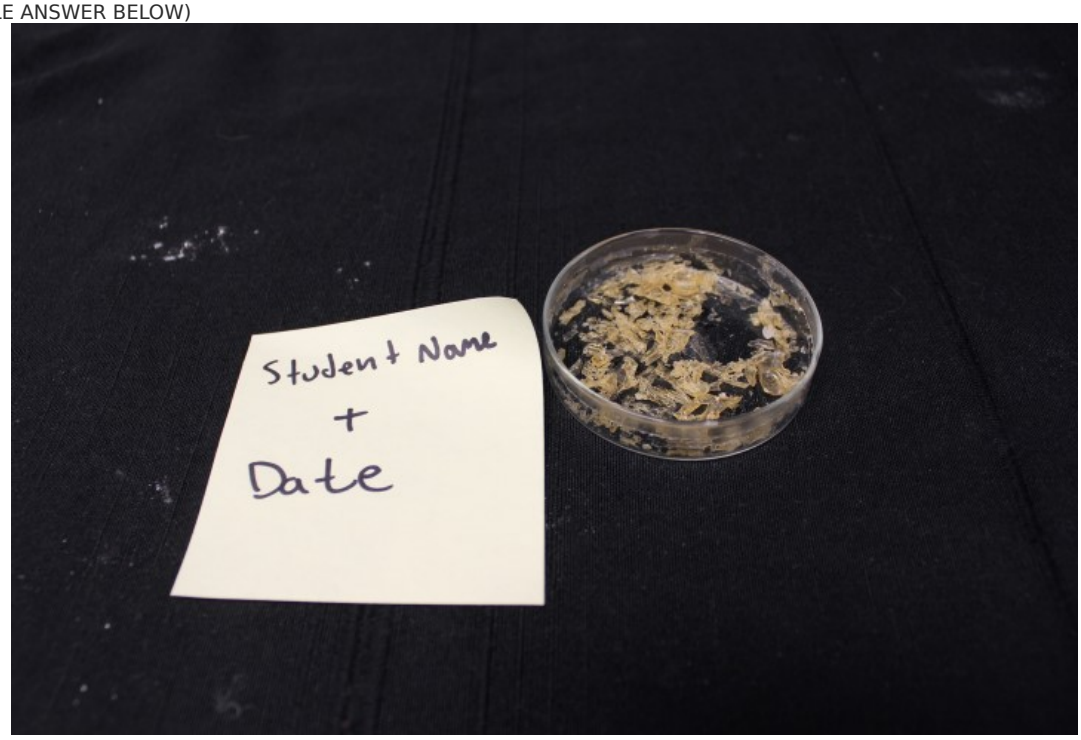


Photo 4: Starch polymer without glycerol
(SAMPLE ANSWER BELOW)



Panel 3: Physical properties of polymers

(SAMPLE ANSWER BELOW)

The polymer that is made from the hydrolysis of starch and added glycerol is an opaque white semi-solid. It is more flexible than the other polymer made in Exercise 2. It has a waxy and malleable property.

The polymer that is made from just the hydrolysis of starch is crystalline and very brittle. It cannot be molded without breaking.

Competency Review

A polymer _____.

- is a macromolecule
- has repeating subunits
- is made of monomers
- All of the above. ✔

Polystyrene is a _____ made from styrene in a(n) _____ polymerization reaction.

- copolymer; addition
- homopolymer; addition ✔
- copolymer; condensation
- None of the above

A polymer with monomers linked by long alkyl chains will be more _____than a polymer linked together by aromatic rings.

- rigid
- flexible ✔
- stable
- crystalline

Plasticizers change the physical properties of a polymer to _____.

- increase elasticity
- increase flexibility
- decrease brittleness
- All of the above ✔

The white polymer with variable reaction times was synthesized by a reaction between _____ and _____.

- polyvinyl acetate; sodium tetraborate ✔
- starch; glycerol
- styrene; vinyl chloride
- None of the above

The polyvinyl acetate-Borax polymer became more _____ due to the loss of _____ during its synthesis.

- transparent; carbon dioxide
- flexible; water
- rigid; acetate ✔
- viscous; glycerol

The addition of glycerol to starch prior to reaction changed the physical properties of the polymer formed to be more _____ compared to the polymer prepared without glycerol.

- plastic ✔
- crystalline
- viscous of a liquid
- None of the above.

The flexibility of a polymer linker directly affects the flexibility of the polymer.

- True ✔
- False

The polymer synthesized from acid hydrolysis of starch without glycerol has a _____ structure.

- flexible
- rigid ✔
- viscous
- None of the above

Extension Questions

Like starches, proteins are a biological polymer. Research the bonding involved in forming a protein polymer:

1. **Are they homopolymers or copolymers?**
2. **Are they addition polymers or condensation polymers?**
3. **What type of intermolecular forces hold together the protein "secondary structures" known as alpha-helices and beta-sheets?**
4. **Do these secondary structures make the polymer more or less flexible?**

(SAMPLE ANSWER BELOW)

Proteins are made up of various amino acid monomers that bond together by amide bonds.

1. Copolymers (some students may argue homopolymers because they are all amino acids, but amino acids are different from each other)

2. Condensation--they lose water when the amide bond forms.

3. Alpha helices and beta sheets are intermolecularly hydrogen bonded to keep their shape.

4. While the amide bonds themselves allow amino acids to rotate freely, the secondary structures' intermolecular hydrogen bonds make them more rigid.