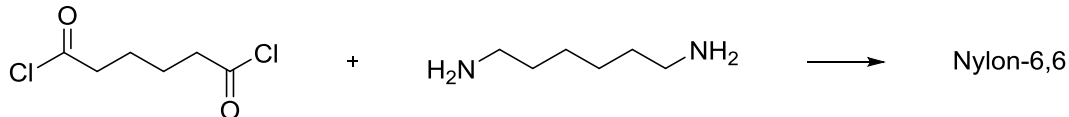
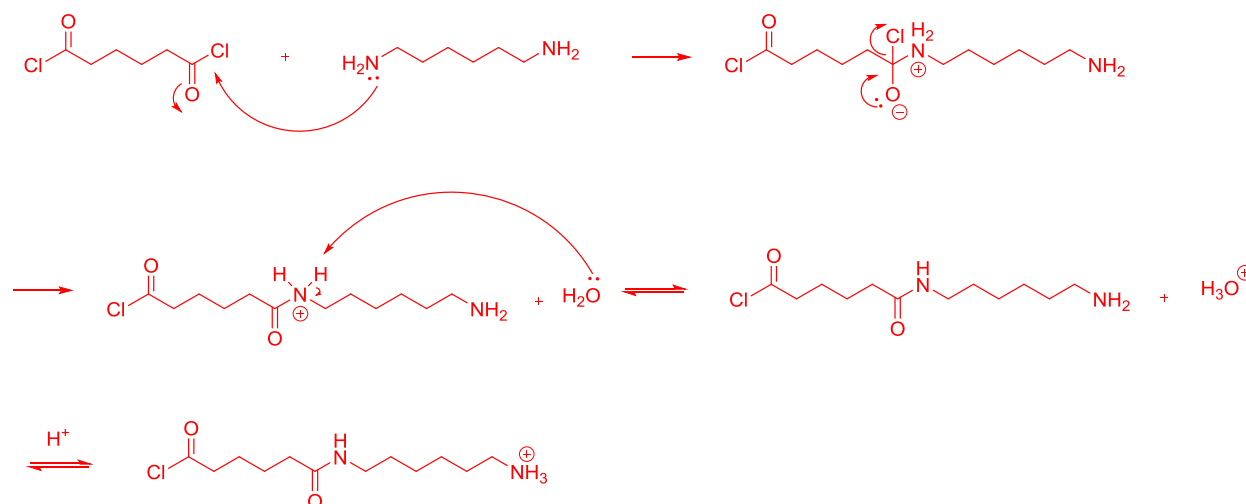


CHM2123 Problem Set #4 – The Synthesis of Organic Polymers

1. While performing the synthesis of Nylon-6,6, a student mixes adipoyl chloride and hexanediamine in dichloromethane and water. He observes that no nylon is formed. What reagent is he missing? Using a mechanism, explain why no nylon was formed.

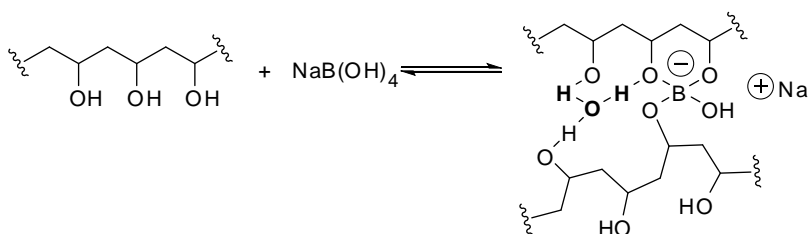


The student forgot to add a base (in the experiment, Na_2CO_3 was used). Without a base, the reaction solution becomes acidic protonating the free amine, rendering it non-nucleophilic and thus stopping the polymerization.



2. With the aid of structures, explain how borax is used to convert polyvinyl alcohol to Slime?

Borax, or sodium borate ($\text{Na}_2\text{B}_2\text{O}_7$) cross-links multiple chains of polymers through covalent and hydrogen bonding, giving the polymer its increased strength.



3. During the lab period, a distracted student added too much maleic anhydride in part A of the experiment. What type of polymer will she observe?

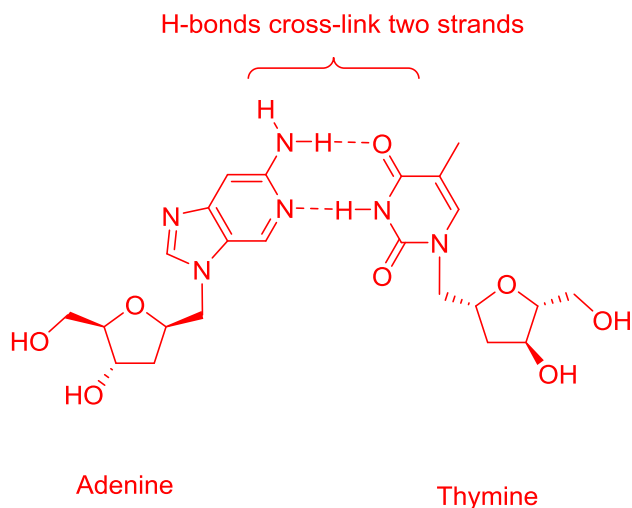
She will observe a random co-polymer. Without a 1:1 mixture of maleic anhydride and polystyrene, the order in which the monomers add is random.

4. What is the difference between HDPE and LDPE?

Polyethylene is created from polymers of ethylene gas and can result in branching of the polymer. HDPE (high density) has minimal amount of branching, creating stronger intermolecular forces, which results in closer polymer chains. LDPE (low density) has more branching, which minimizes the amount of intermolecular forces, creating a polymer with more space between the chains.

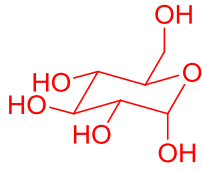
5. What type of polymer is DNA? Explain how cross-linking occurs within two strands of DNA. Draw the cross-linking between adenine and thymine.

DNA is an alternating co-polymer, with an alternating sugar (ribose) and a nucleotide base. Cross-linking between the two strands is possible through hydrogen bonding between the base pairs.

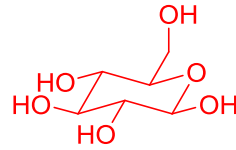


6. Starch and cellulose are two polymers of glucose. Explain the difference between them.

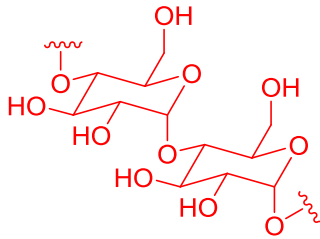
Glucose can exist in two forms: α or β . Starch a polymer created of monomers of glucose joined by 1,4- α linkages and cellulose is created of monomers of glucose joined by 1,4- β linkages.



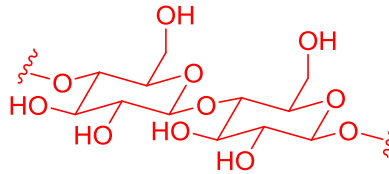
α -Glucose



β -Glucose



Starch



Cellulose

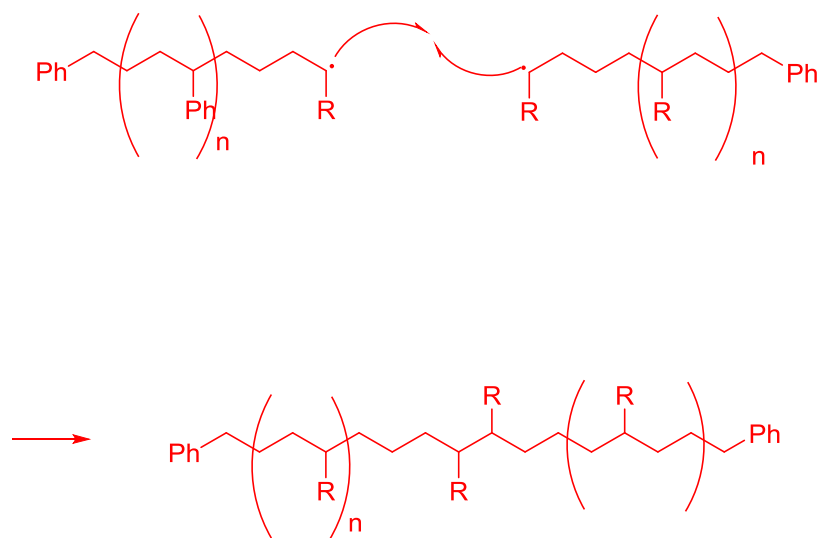
7. What is vulcanization?

Vulcanization is the process of converting rubber into a more durable polymer by the addition of sulfur. Sulfur creates cross-links between the polymers of rubber, changing their physical properties.

8. What is an elastomer?

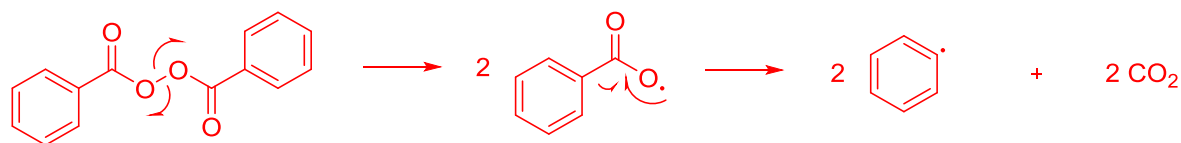
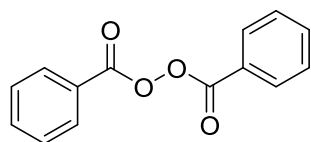
An elastomer is a flexible polymer that is easily stretched, molded or otherwise pulled into a different shape without breaking. The most common example is rubber, but others include neoprene and plastic seals or adhesives.

9. Give the mechanism of the termination of a growing polymer chain.

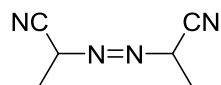


10. Give the mechanism for the initiation using:

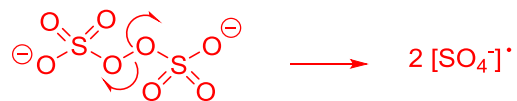
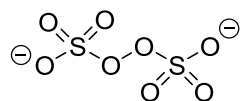
a. Benzoyl chloride



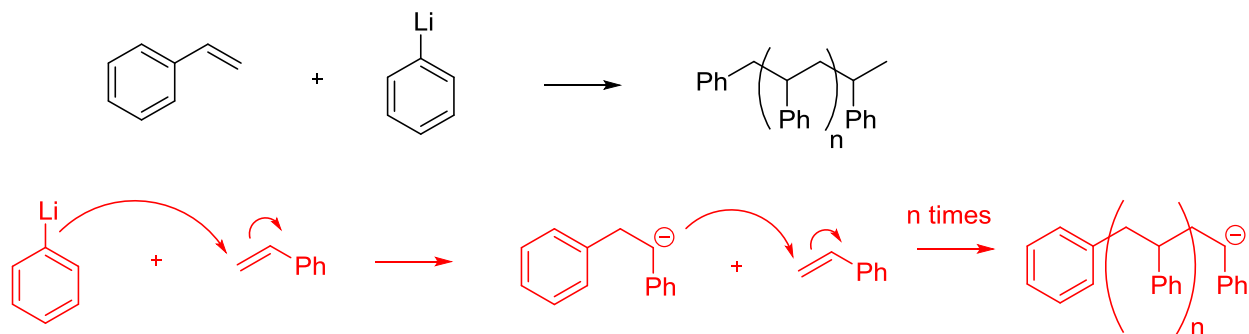
b. AIBN



c. Ammonium persulfate



11. Polymers can also be made via anionic chain growth. Give the mechanism for the growth of the polymer shown below (show initiation and growth of at least 1 additional monomer):



12. How would you quench the growth of an anionic polymer?

Anionic polymers polymerize rapidly due to the instability of the negative charge on the carbon. Quenching with a protic source is necessary, however, use of a strong acid can be dangerous since it can react quite vigorously, creating fires. Typically, weakly protic solvents such as isopropanol are used. Anionic polymers can also self-terminate via spontaneous hydride elimination.

13. Give the structure of the polymer created by these two starting materials:

