

## Experiment 26B

### POLYMERS

#### Materials:

Resorcinol, formalin (40% formaldehyde), 3 M NaOH, 400 mL beaker, large test tube, thermometer, 10 mL graduated cylinder, weighing boat.

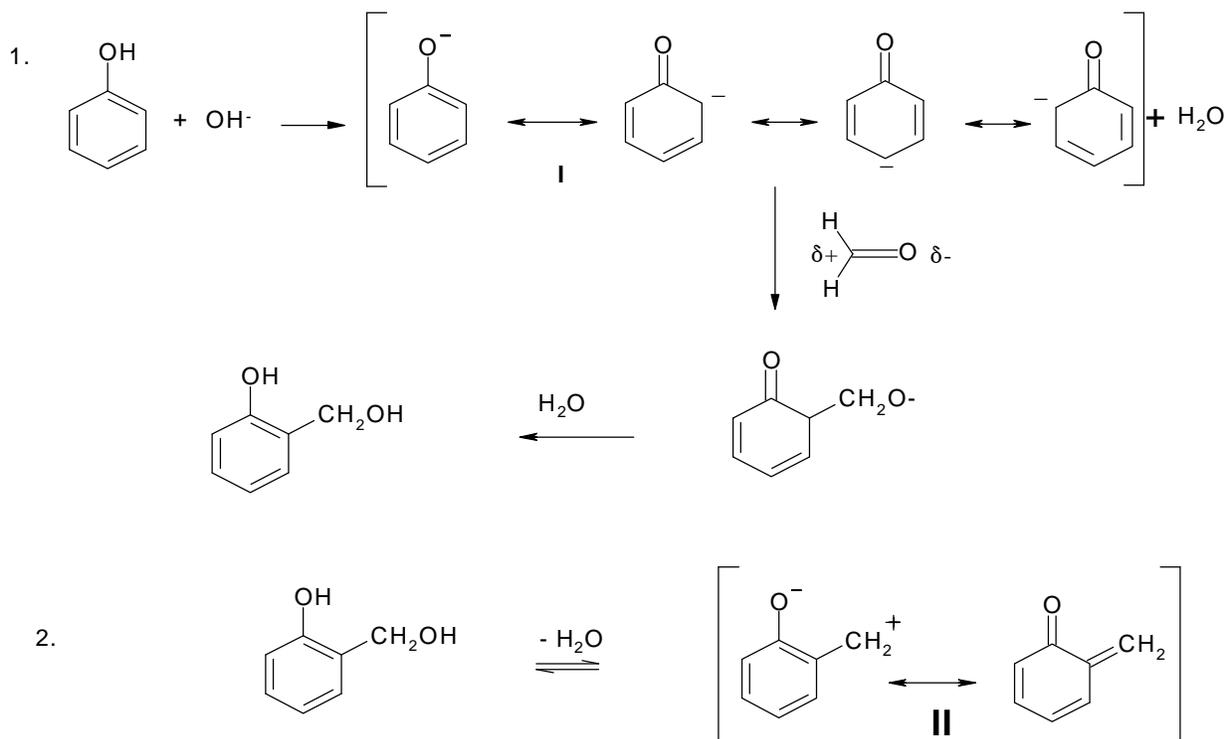
#### Purpose:

In this experiment you will prepare a polymer by condensation and observe its properties.

#### Discussion:

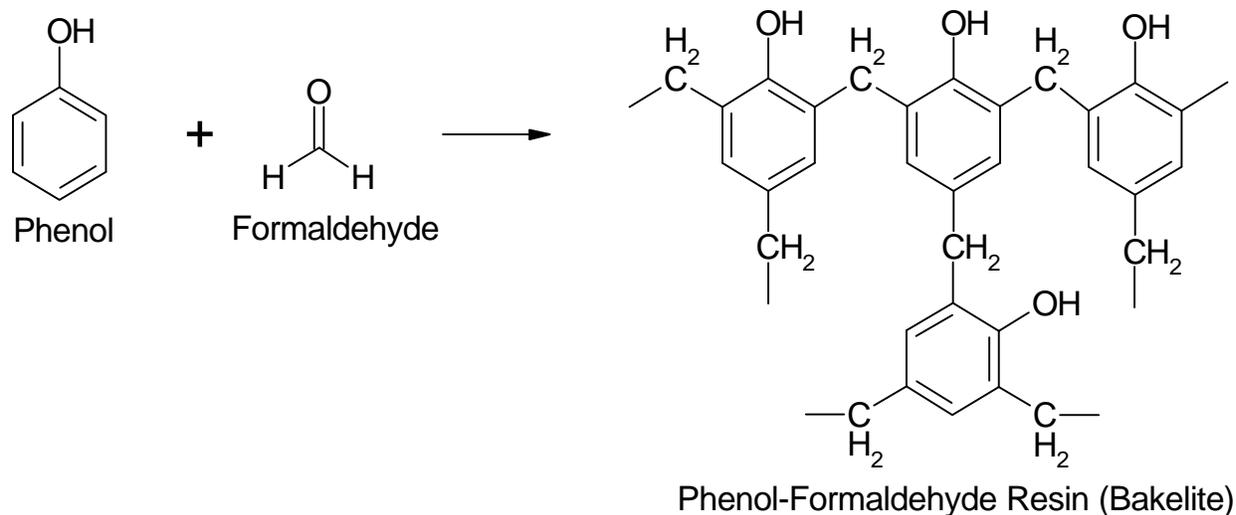
In polymerization relatively small molecules, known as monomer units, join chemically to form polymers which are huge complex molecules with molar masses ranging up to several million grams/mole. Changes in properties accompany this process. Ordinary liquids and solids may become plastics or rubbers. For example, gaseous ethene becomes a solid known as polyethylene. Many polymers occur naturally while others like the one you are about to prepare are made synthetically.

In this experiment you will prepare a Bakelite-type plastic. Bakelite-type plastics are very strong and are often used as the binder for carborundum in high speed grinding wheels.



The initial sequence of steps, starting with phenol are shown below:

3. Following this initial condensation, II can react with I to form a dimer.
4. Eventually, a trimer will form, followed by a tetramer, etc. The overall reaction to form the final cross-linked polymer may be represented as:



The reaction rates and properties of the polymer can be altered by using different phenols as starting materials.

**PROCEDURE:** (Work individually)

To 5 g of resorcinol in a large test tube, add 1 mL of 3 M NaOH and 5 mL of formalin (40% formaldehyde) and mix thoroughly. Keep the temperature at 45-50°C in a water bath and swirl the test tube until all the crystals are dissolved. When everything is in solution, check to be sure the solution is homogenous, then raise the temperature of the water bath to 55°C and maintain this temperature for at least 10 minutes. Finally, set the reaction aside to slowly cool (still in the water bath)\*. Be sure the thermometer is at all times in the water bath and **NOT** in the polymer solution. If the polymer solution were to "set" to a hard plastic with the thermometer imbedded in it, an expensive thermometer would be lost.

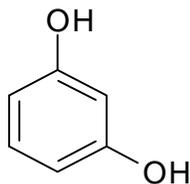
\***Note:** If the polymer is cooled too quickly it will not anneal and will probably crack into several pieces due to internal stress and strain.

Name \_\_\_\_\_ Section \_\_\_\_\_

Partner \_\_\_\_\_ Date \_\_\_\_\_

**QUESTIONS**  
**Experiment 26B**

The formula for resorcinol is:



1. Write equations for reasonable steps in the polymerization of resorcinol with formaldehyde accompanied by the successive elimination of at least two molecules of water, i. e., the formation of at least a trimer. Use the phenol reaction on page 2 as a guide to the product formed.

2. Resorcinol is a better reactant than phenol in this type of polymerization. Why?

