

CHAPTER 15	Investigation 15.B: Modelling and Making Polymers	BLM 15.2.2
HANDOUT		

Polyvinyl alcohol (PVA) is used to make a special type of plastic bag. In the first part of this investigation, you will build a structural model of a short strand of PVA. In the second part of this investigation, you will use PVA to make a different polymer product, “Slime.” You will prepare “Slime” by *cross-linking* long strands of polyvinyl alcohol using borax, sodium tetraborate decahydrate,  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}(\text{aq})$ . Cross-linking means that bonds form from one strand to another at several points along the polymer strand.

### Questions

- What can you learn about the properties of PVA from building a model of it? What polymerization reaction appears to be responsible for the formation of PVA? What is the structure of this polymer?
- How are the polymers PVA and “Slime” similar? How are they different? How might these compounds be used?

### Prediction

Use the model of PVA you build in Part 1 to predict whether PVA forms from an addition reaction or a condensation reaction. Use your observations from Part 1 to predict whether a piece of PVA will dissolve easily in water.

### Safety Precautions



- Wear an apron, safety glasses, and gloves while completing Part 2 of this investigation.
- Wash your hands thoroughly after this investigation.

### Materials

#### Part 1

- molecular model kit (1 per group)

#### Part 2

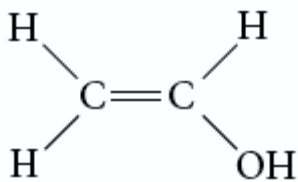
- pieces of polyvinyl alcohol bags (totalling about  $20\text{ cm}^2$ )
- 10 mL of very hot water
- food colouring
- 5 mL of 4% borax solution
- kettle or hot plate
- 10 mL graduated cylinder
- 50 mL beaker
- stirring rod

### Procedure

#### Part 1

1. Working in a group of four, use your molecular model kits to build four ethenol monomers, as illustrated on the following page:

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ethenol  
(vinyl alcohol)

2. Examine the models you have built.
  - (a) Decide whether they will react in an addition polymerization or a condensation polymerization reaction to form polyvinyl alcohol.
  - (b) Predict and draw the structure of PVA.
3. Use the four monomers to build a short strand of PVA with four repeating units.
4. Examine the polymer model.
  - (a) What intermolecular force(s) might operate between two strands of this polymer?
  - (b) Use your knowledge of the force(s) to predict whether this polymer would dissolve in water or not.

## Part 2

1. Work with a partner. Before starting, examine the pieces of the polyvinyl alcohol bag. Record your observations.

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2. Place 10 mL of near-boiling water into a 50 mL beaker. **Caution:** Be careful to avoid burning yourself.
  3. Add the pieces of the polyvinyl alcohol bag to the hot water. Stir and poke the mixture using a stirring rod until the compound has dissolved.
  4. Add a few drops of food colouring to the mixture, and stir again.
  5. Add 5 mL of the borax solution and stir.
  6. When it has cooled so it can be comfortably handled, examine the “Slime” you have produced.
  7. Record your observations.
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8. Manipulate the “Slime” sample. For example, roll it into a ball and drop it on the lab bench. Slowly pull it apart between your hands. Pull it apart quickly. Let the ball of “Slime” sit on the bench while you clean up. Record your observations.

## Analysis

1. Does PVA appear to be formed by an addition reaction or a condensation reaction? Give reasons to support your answer.
2. Explain why PVA dissolves in water, even though it is a very large molecule.

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- What happened when you manipulated the “Slime” in various ways? Suggest an explanation for what you observed.

### Conclusions

- How do you think a bag made of polyvinyl alcohol might be useful **(a)** in a hospital? **(b)** as an adhesive? **(c)** in the cosmetics industry?
- How could you tell that changes to the polymer occurred when you added the borax solution to the dissolved solution of polyvinyl alcohol? Explain your observations.
- Compare the properties of the polyvinyl alcohol polymer and the “Slime” cross-linked polymer you observed in this investigation. Were there any similarities? How were they different?

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### Application

- Although polyvinyl alcohol appears to form by a simple polymerization reaction of vinyl alcohol monomers, it does not. Vinyl alcohol is unstable and rearranges to form ethanal. Draw the structure of ethanal. Do library or electronic research to find out how polyvinyl alcohol is synthesized.

### Extension

- Construct a four-monomer strand of a condensation polymer of your choice. Next, take the model apart and use it to build four monomers. What additional atoms are required from the model kit to build the monomers? What does this tell you about a condensation reaction?