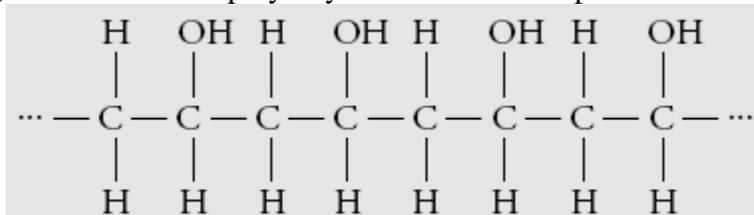


Investigation 15.B: Modelling and Making Polymers Answer Key

Answers to Part 1 Procedure Questions

2. (b) The structure of polyvinyl alcohol can be represented as follows:



4. (a) Since each strand has hydroxyl side groups you would expect to see some amount of hydrogen bonding between two strands of the polymer.

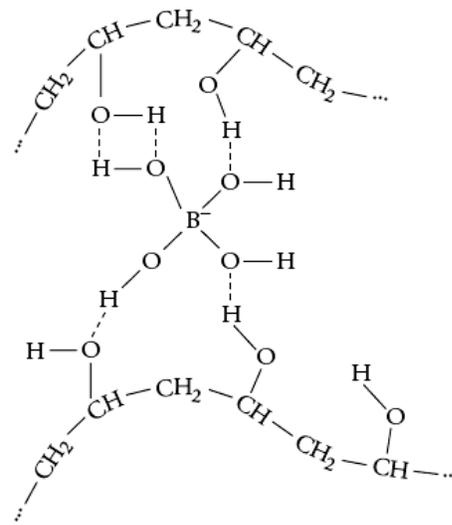
(b) Since the hydroxyl side groups are present, you would also expect to see interactions with water molecules, making this polymer soluble in water.

Answers to Analysis Questions

- PVA is formed by an addition reaction, since there is no side product formed in the reaction of the vinyl alcohol monomers. In addition, since the vinyl alcohol monomer only has one functional group it will not undergo condensation polymerization.
- PVA dissolves in water because the presence of many hydroxyl side groups allows the water to form hydrogen bonds with the PVA strands.
- You should observe the following properties:

Action of ball of slime	Observations
Dropped onto bench top	Ball of slime bounces (or shatters depending on how much borax was reacted with PVA)
Pulled slowly apart	Slime stretches
Pulled quickly apart	Slime snaps into two pieces
Left to sit on the bench top	Slime spreads out into a layer

In each case the reason is due to how the PVA chains are cross-linked. When sodium tetraborate is dissolved into water it quickly reverts to boric acid ($\text{H}_3\text{BO}_3(\text{aq})$), which then accepts hydroxide groups from the water to form a boron ion complex, $\text{B}(\text{OH})_4^-$. Hydrogen bond cross-links are formed between the hydroxide groups of the boron ion complex and adjacent strands of the PVA to produce the polymer (see diagram to the right). This type of crosslinking gives the polymer elasticity.

**Answers to Conclusion Questions**

4. (a) Polyvinyl alcohol bags could be used as water soluble containers to store used hospital linens and garments for relatively safe handling. The bag and contaminated contents can both be added to a washing machine, where

Investigation 15.B: Modelling and Making Polymers Answer Key (cont'd)

the bag would dissolve in the hot water, leaving only the items to be washed.

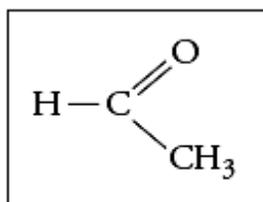
(b) Polyvinyl alcohol is used either as a compounding agent or as a direct binding agent with cellulose, depending on the adhesive and application use. One common use is for the quick-setting adhesive on the back of postage stamps.

(c) Polyvinyl alcohol is used as an emulsifier and thickener for makeup products.

- You could tell that changes occurred with the addition of the borax solution because the physical elasticity and stiffness of the cross-linked polymer are noticeably different. In addition, careful observation should indicate that an endothermic chemical reaction has occurred since the slime becomes noticeably cooler to the touch.
- Your answer will depend on the observations made. The polyvinyl alcohol polymer and “slime” polymer are both fluid-like substances. However, polyvinyl alcohol is significantly less viscous than the “slime” polymer.

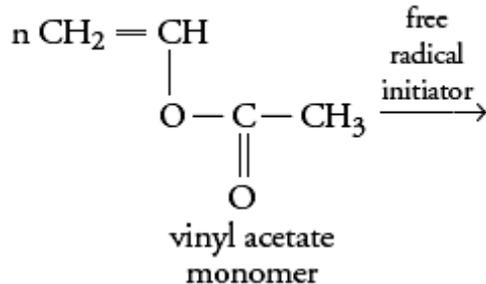
Answer to Application Question

- The structure of ethanal is indicated below. Polyvinyl alcohol is obtained by the saponification of polyvinyl acetate, which is in turn obtained from the polymerization of vinyl acetate monomers.

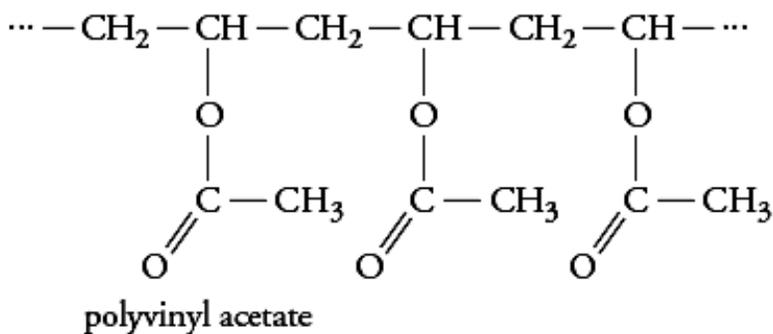


ethanal

Step 1.

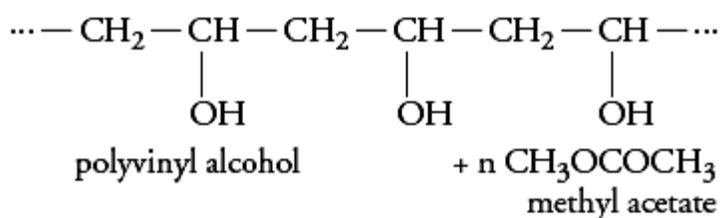
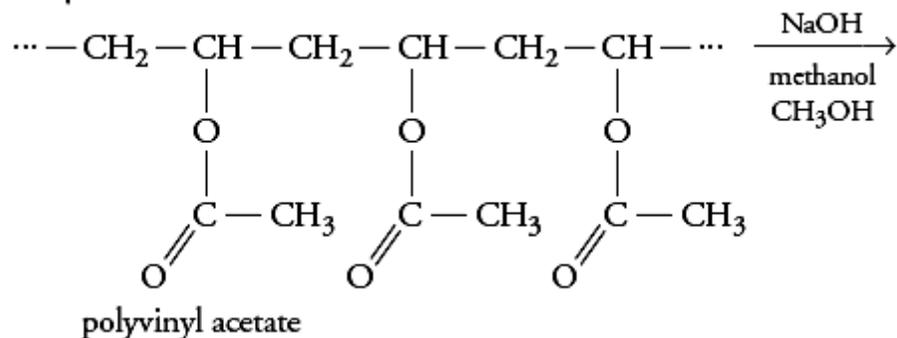


free radical initiator



Investigation 15.B: Modelling and Making Polymers Answer Key (cont'd)

Step 2.



Answer to Extension Question

8. You should find that hydrogen and oxygen atoms are needed to build the monomers. From this, you should conclude that condensation reactions require the removal of a functional group (hydroxyl for many polymerization reactions).