Part B

Materials (per group)

- molecular models of monomers from Part A

Recording Predictions and Observations

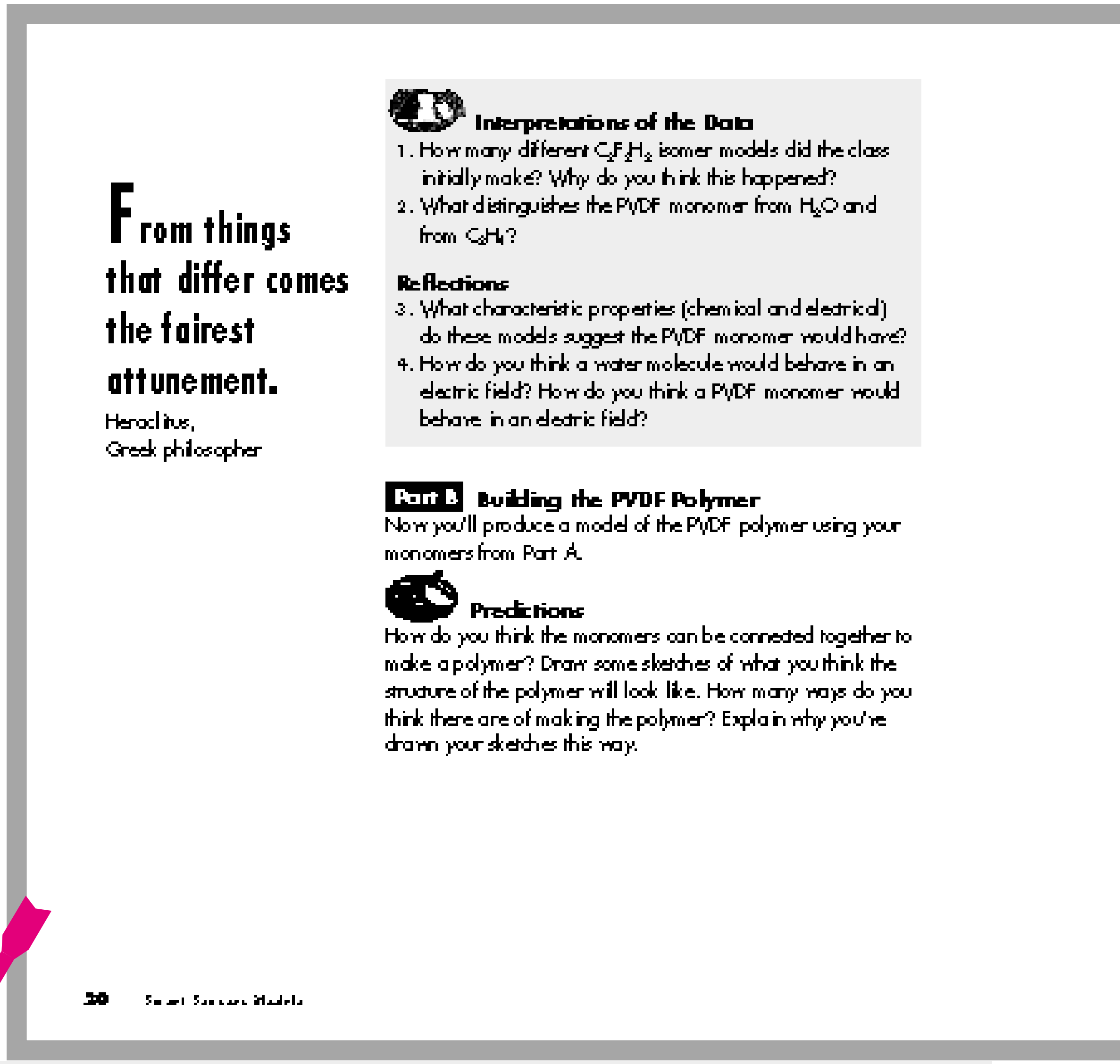
Activity-Log Sheet 6 contains space for students to record their predictions, sketch the polymer they propose, and sketch the polymer they build in their groups.

Discussing the Quote

Ask students to identify the “things that differ” in their monomer models (the atoms) and suggest how the differences might influence the monomer's behavior in a polymer.

For More Information . . .

The polymerization of PVDF is discussed in detail on pages A13 of the Minipedia.



From things that differ comes the fairest attunement.

Heraclitus,
Greek philosopher

Interpretations of the Data

1. How many different $C_2F_2H_2$ isomer models did the class initially make? Why do you think this happened?
2. What distinguishes the PVDF monomer from H_2O and from C_2H_4?

Reflections

3. What characteristic properties (chemical and electrical) do these models suggest the PVDF monomer would have?
4. How do you think a water molecule would behave in an electric field? How do you think a PVDF monomer would behave in an electric field?

Part B Building the PVDF Polymer

Now you'll produce a model of the PVDF polymer using your monomers from Part A.

Predictions

How do you think the monomers can be connected together to make a polymer? Draw some sketches of what you think the structure of the polymer will look like. How many ways do you think there are of making the polymer? Explain why you've drawn your sketches this way.

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Interpretations of the Data

1. Students will probably create at least the three isomers of difluoroethylene (1,1-difluoroethylene, 1,2-*cis* difluoroethylene, and 1,2-*trans* difluoroethylene) and may create other arrangements, as illustrated on page 19.

2. The PVDF monomer is a halogen substituted hydrocarbon. While students will probably not use this terminology, they will observe that PVDF differs from both H_2O and C_2H_4 in its constituent atoms. Two fluorine atoms have replaced two of the hydrogen atoms in ethylene; this is the halogen substitution (fluorine is a halogen).

Reflections

3. From their sketches based on electronegativity, students can see that the PVDF monomer molecules are polar. If your students have studied chemistry, they may be able to explain that this is because the atoms do not share electrons equally in the carbon-fluorine bonds. You may wish to point out that the entire molecule might participate in polar covalent bonds. Students may also suggest that the monomers are stable because of their carbon-carbon double bonds. You might also point out that the carbon-carbon double bond (in both C_2H_4 and CF_2CH_2) can be opened up and the freed electrons used in two new single bonds. This will prepare students for performing an addition polymerization in Part B.

4. Water is a polar molecule, and in an electric field it arranges itself with its positive ends closer to the negative charges of the field and its negative ends closer to the positive charges of the field. Students should realize that the polar PVDF monomer will react similarly in an electric field. Ask them to imagine an electric field with negative charges at the “top” and positive at the “bottom,” then have them rotate their monomer models to show where the fluorine and hydrogen atoms would line up in relation to those charges.

Predictions

Have willing students share their sketches with the class. You might discuss the predictions as a class and reach a consensus on a single prediction for all the groups to test first.

Students who have studied organic chemistry may suggest that the double bond between carbon atoms must be broken for the monomers to join. If this happens, encourage students to try building their polymers by breaking this double bond. (The polymerization of 1,1-difluoroethylene occurs with the opening of the double bond between the carbon atoms.)