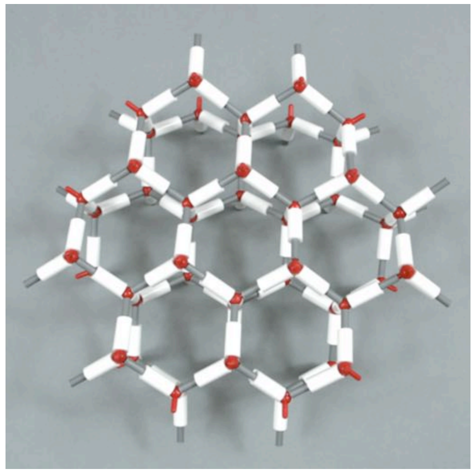
Super Models



Ice Molecular Model Kit

Ryler Enterprises, Inc.

Recommended for ages 10-adult

⚠ **Caution:** Atom centers and vinyl tubing are a choking hazard. Do not eat or chew model parts.

Kit Contents:

50 red 4-peg oxygen atom centers (2 spares)
98 white tubes (hydrogen atoms) (2 spares)
98 gray hydrogen bonds (2 spares)

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Ice Assembly Instructions

PLEASE NOTE: THROUGHOUT THE ASSEMBLY OF THE ICE CRYSTAL, A RED PEG WILL ALWAYS BE INSERTED INTO A GRAY TUBE.

IF TAKING APART THE MODEL IS NECESSARY, ALWAYS PULL A GRAY TUBE FROM A RED PEG.

1. Insert two gray tubes into two white tubes (hydrogen atoms) so that their ends are flush (See Fig. 1). Then insert the pegs of a red oxygen atom into the white-tube-ends of the gray tubes (See Fig. 2). This represents a covalently bonded water molecule. Repeat this process with 47 more red oxygen atoms, gray tubes, and white tubes.

Fig. 1 Gray tube ends flush with white tube ends.

Fig. 2 Covalently bonded water molecule.

2. Line up six water molecules as you see in Fig. 3. Pick up the leftmost water molecule in your left hand and the second water with your right hand. Make sure that the water in the right hand has a red peg pointing up and a gray tube pointing away. (See Fig. 4).

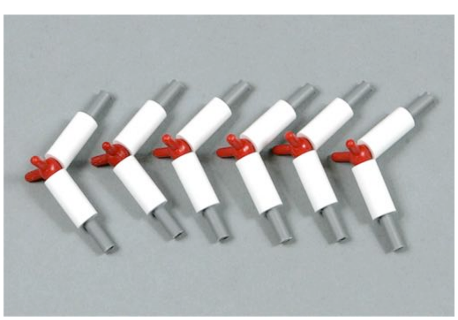


Fig. 3 Arranging six water molecules.

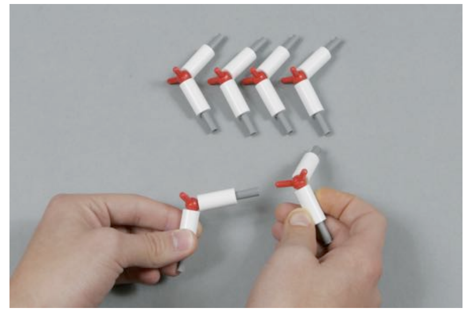


Fig. 4 Putting a second water on the first.

3. Add a third water molecule (See Fig. 5)

Fig. 5 Adding water 3 to water 2.

4. Join the fourth and fifth water molecules in the same way. Finally, bond the last of the six water molecules to the chain (See Fig. 6).

Fig. 6 Putting the last water molecule in place.

5. Now turn the first water molecule that you used to start the chain so that one red peg is upright and the gray tube is pointing away from you. Push the red peg of water number one into the gray tube of water number six. This will form the chain into a ring (See Fig. 7).

Fig. 7 Making the water chain into a ring structure.

6. The completed ring of six waters should have three red pegs pointing up and three white tubes pointing down (See Fig. 8).

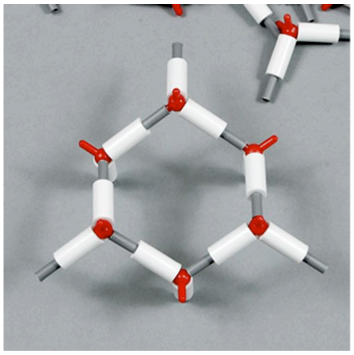


Fig. 8 A completed hexagon of water molecules.

7. To make a layer of the ice crystal, attach water molecules so that you duplicate the picture in Fig. 9. Note that the ring that you have just made, shown in the lower right hand corner, has been moved to the center of the picture.

Remember: ALWAYS PLACE A RED PEG INTO A GRAY TUBE.

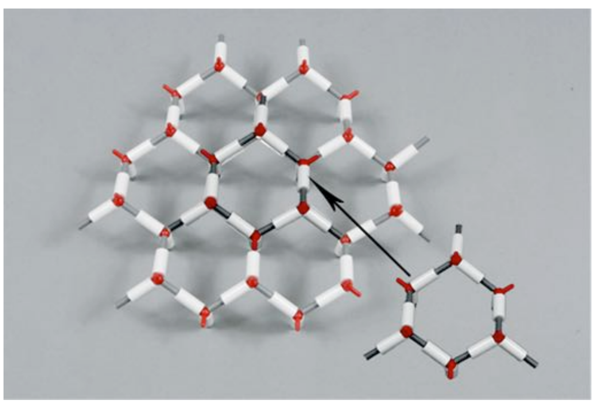
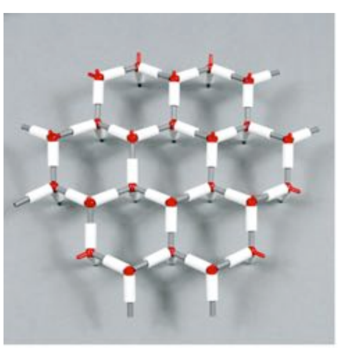
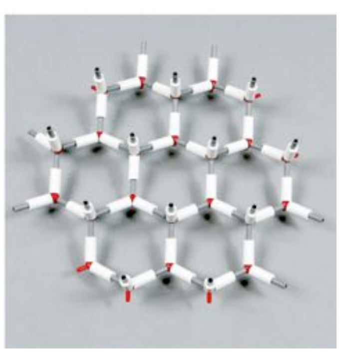


Fig. 9 Completing one ice crystal layer.

Your single layer should now appear as you see in Figs. 10, a and b.



a.



b.

Fig. 10 Two views of a completed ice layer.

8. Repeat steps two through seven to make a second layer, and then attach it to the first layer (See Fig. 11).

Fig. 11 The completed ice crystal.

Teaching Activities for the Ice Model

Activity 1: Making ice crystals

Give one kit to a team of two students. Modify the instructions for assembly by using the following rules:

1. Each oxygen must have two hydrogens covalently bonded to it.
2. Each oxygen may have up to two hydrogen bonds also.
3. Six water molecules combine to form a ring.
4. Assemble your own ice crystal.

Allow the students about 15 minutes to assemble their own miniature snowflakes. Evaluate their results based on if they followed rules 1-4 above.

Compare each groups final product and discuss why there is such diversity in the shapes of snowflakes. Ask the question: Do you think every snowflake is unique? If a single snowflake is made of a small drop of water with a mass of about 0.01g, then there would be about 3×10^{20} water Molecules in one snowflake. The odds of two being exactly the same would be astronomically small.

Note that ice crystals may also be shaped like rods or tubes.

Activity 2: Expansion of water when it freezes.

Fill a small paper cup to the brim with water and put it into the freezer. Take it out the next day and observe. Have students assemble water molecules by connecting two hydrogens (white) to one oxygen (red). Place the assembled water molecules in a pile and make a note of how much space (volume) they occupy. Assemble the ice structure by connecting the water molecules. Note and describe the amount of space (volume) the structure now occupies. Compare this with the space occupied by the water molecules when they were in a pile. What are some observations in nature of this phenomenon? Answers: ice floats on water (ice cubes, frozen lakes), ice expands in water pipes and can cause them to break: one inch of rain is equal to approximately 10 inches of snow.

Activity 3: 6 Sided Symmetry
Weather permitting: Go outside on a day when it is snowing and observe snowflakes. Leave some glass plates outside to use for catching snowflakes.

Count the number of sides on typical snowflakes. Assemble the ice model. The water molecules form rings with how many sides? Answer: six. Turn the model, and look at it from different angels. Rings of six atoms are apparent.

Activity 4: Pykrete.

In the early 1940's Britain and the U.S. were making plans to construct a super-aircraft carrier made of ice. Two Americans invented a method of making ice extremely strong by adding sawdust to water and then freezing it. The mixture was called pykrete to honor the Englishman who proposed the idea of boats made of ice. Experimental ice-boats were actually made and sailed on some Canadian lakes.

You can make and test pykrete for strength quite easily. Wash out a 64 ounce milk carton, add nine ounces of sawdust, and then add about seven cups of water. Freeze the concoction along with an equal volume of plain water in another container. After freezing compare the properties of the contents of both contaianers.

Activity 5: Does ice evaporate (sublimate)?

Allow water in an open container to freeze. Then mark the level of the ice before letting the ice to stay in the freezer for about one week. Reexamine the level of the ice. The best results occur when the freezer is free of humidity, i.e. self defrosting The amount of evaporation will depend of the humidity of the freezer and the length of time allowed for the effect to take place.

Activity 6: Freezing point depression.

Compare the freezing temperature of solutions of 5.8 g of sodium chloride, 34.2 g of sucrose, and if possible 6.2 g of antifreeze (ethylene glycol), each dissolved in 100 g of distilled water.

Fill a 400 mL beaker (or a 10 oz styrofoam cup) ¾ full of ice and enough water to form a layer ½ inch above the top of the ice. Stir to mix. The temperature of the bath should be about -10º C. Put 100 mL of distilled water in a test tube, place the tube in the bath and look for the first sign of ice crystal formation.

Do the same with the three test solutions, and record the freezing temperatures.

Activity 7: Growing snow crystals.

Log onto the following website for details on Making snow crystals: www.its.caltech.edu/~atomic/snowcrystals/project/project.htm.