SOME UNSOLVED PROBLEMS

By the time you have progressed in a perusal of the manual to this page, several interesting ideas have no doubt come to mind. One, perhaps, is that all the problems on the preceding pages have already been solved and your task was really to solve them all over again—a somewhat unprofitable occupation. However, several problems for which the answers are not known are listed below. These problems are only a few of very, very many. They have been selected for inclusion here on the basis of their simplicity of presentation. (There are many other problems, some more interesting, no doubt, than the ones posed here, that cannot be easily described to the beginner in science.) Also, because of their simplicity, we do have a loose sort of explanation for a few of the problems in this list. You may even be aware of some of these explanations. But they are not solved in any real sense; that is, for those for which we have a hypothesis, the hypothesis is doubted by at least some of those who have conducted tests in their laboratories. Hence they are, all of them, unsolved.

Later on, you may be the one to conceive of an acceptable explanation for a few of these. Let this be your challenge!

1. To 200 ml of boiling water, add, with stirring, 0.5 g of each of the following dyes: Sudan red, sulfanil blue, aniline yellow. When the dyes have dispersed, add small swatches of cotton, silk, wool, and acetate rayon to the hot liquid. After a few minutes remove the pieces of cloth and rinse in tap water.
   Why are the pieces of cloth dyed different colors?

2. Wash an article soiled with greasy and with nongreasy dirt in a soap or detergent solution.
   Why is the article cleaned?

3. Put about 500 ml of water in a large beaker and heat it to boiling. Continue to boil the water vigorously; note that the bubbles form from fixed spots on the bottom, or sides, of the beaker.
   Why do bubbles form from particular spots when the water is boiled vigorously?

4. Add 5 ml of a 0.1-N silver nitrate solution to 5 ml of a 0.1-N KBr solution. Filter off the precipitate which is formed and expose it to a strong light.
   Why did the silver bromide darken?

5. Clean 1 ml of mercury by shaking it vigorously for one minute in a test tube containing 10 ml of 1-M nitric acid. Discard the acid and wash the mercury with distilled water. Put the mercury on a clean watch glass and add enough 5-N sulfuric acid to cover the mercury completely. Add 1 ml of 0.1-M potassium permanganate solution to the acid and stir gently. (If the mercury at this point is broken up into several globules, collect it into one globule.) With a steady hand, put the point of a steel sewing needle under the surface of the aqueous solution and lightly touch the side of the mercury globule, a few degrees above its "equator." Hold the needle steady. Rhythmic action will continue for several seconds.
   Why does the mercury pulsate?
6. Prepare a collodion bag similar in size and shape to a test tube. Half-fill the bag with a solution containing 0.1 g of potato starch and 0.1 g of sodium chloride per 100 ml. Suspend the half-filled bag in a beaker of distilled water. From time to time test the distilled water for the presence of Cl⁻ ions and for the presence of starch.

   Why does the electrolyte diffuse through the collodion membrane, whereas the starch does not?

7. In the hood, pass a little phosphorous trihydride (or arsenic trihydride or antimony trihydride) into a 0.1-M solution of silver nitrate. A yellow precipitate which turns black in a few hours or less is formed.

   What is the nature of the yellow precipitate?

8. Mix 2 g of finely divided Pb₃O₄ with 2 g of finely divided clean sand. Put 50 ml of water and 50 ml of paraffin oil in a tall glass cylinder. (A graduate will do, but the good chemist uses a graduate only for measuring volumes, not for the purpose outlined here.) Add the lead oxide-sand mixture, and with the palm of your hand over the mouth of the cylinder, shake vigorously for several minutes. Then let the cylinder and its contents stand undisturbed for a few minutes.

   Why is the lead oxide separated from the sand?

Every chemistry class includes a few students interested in subjects other than chemistry. In recognition of these nonchemists, here are a few problems from other disciplines.

From geology: What caused the deformation of the outer layers of the earth and the consequent formation of mountains?

From a subdivision of biology, embryology: The nerve cells which are distributed throughout the body of an animal were originally, in the very young embryo, all collected together in one place. During the subsequent growth of this embryo, many of these cells left the site of their origin and migrated to remote places in the body, where they grew into functioning cells.

   What factors initiated this migration? What directed the migratory cells to certain specific locations? What was their mode of locomotion?

It is remarkable to realize that only 100 years ago almost every question listed in this manual as an exercise for the student (and many others, not listed, for which the answers are now fairly well established) would have been put in the list in this part of the manual. At some future time the answers to the questions now listed here will be reasonably well established and other questions not as yet even conceived (!) will take their place in a list such as this one.

Your duty and pleasure, as a scientist, will be to move questions from the unsolved list to the solved list (and occasionally back again). You will learn to note with awe that for every question removed from the list of unsolved problems two or three will arise to take its place. And yet, for all this, our knowledge of what is true gets closer and closer to Truth, and this is the wonder of wonders.