TEACHERS' HANDBOOK TO ACCOMPANY FOUNDATIONS OF CHEMISTRY

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TO ACCOMPANY

FOUNDATIONS OF CHEMISTRY

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PREFACE

THIS handbook has been prepared as a guide to the use of the authors' textbook, *Foundations of Chemistry*. Although it is obvious that the experienced teacher will find much of the detailed suggestion and answers to questions superfluous, nevertheless it is probable that even for such a teacher this handbook will be of value in showing the authors' point of view. Furthermore, it is to be hoped that maturer persons, who may be studying the main textbook from interest in the subject and without the advantage of class instruction, may derive a good deal of help from the use of the handbook.

The authors realize that some matters are explained very fully in the textbook, much being stated that might be left to the pupils' imagination, or be brought out in classroom discussion. They believe, however, that it is better to treat few topics thoroughly than many superficially. The questions given at the end of each chapter will be of service in developing the pupils' imagination and suggesting lines of class discussion. Furthermore, countless facts and experiences of everyday life, of which the few treated in the book are fairly typical, may be studied in the light of the principles developed from the selected topics. The pupil may thus grow to a deeper realization that all happenings in the universe occur in obedience to natural law, and that the more fully he can understand the laws of nature, the better he will be able to apply the knowledge he possesses to the problems of his daily life.

This handbook follows the order of the textbook, chapter by chapter. In many cases it is suggested that the teacher use extra matter to enrich the content of the course on the historical, the industrial, or other side of the subject. Trips to industrial plants are suggested at appropriate places. Such trips are profitable in increasing interest, in demonstrating the practical importance of chemistry, and especially in securing better acquaintance between pupils and teacher.

Excursions undertaken in school time are usually more profitable than those taken after school hours or on Saturday.

A number of brief quotations from the original papers of men who have made great advances in chemistry have been given. Some of these have been translated from the less accessible originals.

The answers to most of the questions are here given very fully. The authors hold that monosyllabic answers from the pupils should not be tolerated, but that the answers should show an appreciation of the purpose of the question. To this end they have given the answers in such a full and thoughtful manner as they would endeavor to have their pupils attain. In many instances they have gone beyond the knowledge which the pupil could reasonably be supposed to possess in order to suggest elaborations of the topic which could serve, at the teacher's discretion, to make the classroom work of more value. In the solution of the numerical problems possibly an excess of detail in the steps of the process is given, but the authors believe it is better to err on this side. The mere numerical correctness of the answer from the pupil is of secondary importance to the understanding of the application to the problem, of scientific principles.

If experiments precede the classroom and textbook work and embody in part at least the spirit of the discovery method, if classroom discussion follows, and lastly, if the use of the textbook supplements and arranges the material in orderly fashion, it is believed that good results will be obtained.

TEACHERS' HANDBOOK

CHAPTER I

CHEMICAL AND PHYSICAL CHANGES

Pages 9–14

As a first experiment in chemistry to give a concrete illustration of the nature of chemical change, something likely to be of intense interest to the pupil should be selected. The material used should be familiar to the pupil. We would suggest the lighting of a small pinch of black gunpowder placed on a piece of paper. This will show the principal features of chemical change and at the same time awaken interest in the pupils. The evolution of heat and light are obvious. The new products formed are easily seen and smelled, both those that are scattered in the smoke and those that remain on the paper. A word about the objectionable character of smoke from black gunpowder when used in war, and a hint to the effect that smokeless powder produces only invisible gases as new products, may add to the interest.

A physical change can be illustrated by melting a bit of ice, boiling the water thus obtained, condensing some of the steam on the under side of a watch glass, and freezing the dew thus formed by rapidly evaporating ether in the watch glass. Use a current of air to assist the evaporation of the ether.

Answers to Questions on Chapter I

Page 14

1. Different chemical substances are distinguished by their different properties. Physical properties are evident to us through our senses of sight, feeling, smell, taste, and hearing. Chemical

properties are shown in the ability of substances to undergo chemical change, the latter always being accompanied by changes of physical properties.

2. Chemical changes differ from physical changes in the following respects:

(1) A chemical change involves a complete change of properties, that is, the disappearance of the properties of the substance or substances entering the change, and the appearance of new properties which are the properties of the substance or substances produced in the change.

Physical changes do not involve a complete change of properties. The changes are caused by the application of some physical force, and when the force is removed the substances are free to return to their original condition.

(2) Chemical changes are accompanied by a heat effect, often a very marked one accompanied by the evolution of light. Physical changes do not necessarily involve any heat effect.

(3) Another distinction was hinted at in the statement on page 11 that the carbon dioxide produced by burning charcoal weighs 3⅔ times as much as the charcoal. This statement in connection with the law of the conservation of matter shows that the same definite proportion must always exist between the weights of the substances entering this chemical change. If two substances are mixed physically, for example sugar and sand, they may be mixed in any proportion.

3. Five examples of physical change are:

(1) Crushing of rock in a stone crusher.

(2) Hammering of gold into gold leaf.

(3) Compressing air in an automobile tire.

(4) Careful mixing together of powdered charcoal, powdered sulphur, and powdered saltpeter, in making the mixture called gunpowder.

(5) The shortening of a steel rail on a cold day and its lengthening on a hot day.

4. Five instances of chemical change and points that distinguish them from physical changes are:

(1) Sugar is scorched during cooking: The new properties of a

brown or black color and a burnt taste appear and remain permanently even after the sugar has cooled to ordinary temperature.

(2) Bleaching of cloth: The property of color is changed, indicating that some highly colored substance in the cloth is changed chemically.

(3) Ripening of fruit: Unripe fruit tastes sour; ripe fruit tastes sweet, indicating that a sour substance has disappeared in the forming of a sweet substance.

(4) Explosion of gunpowder: Heat and light are produced. A large quantity of gases is formed, and the solid substance left bears no resemblance to the original gunpowder.

(5) The spoiling of eggs: During this process the eggs acquire a very offensive odor, a new property which indicates the formation of a new substance.

5. Three instances of chemical change in which the heat effect is so intense as to cause the emission of light:

(1) Burning of wood.

(2) Explosion of gunpowder.

(3) Explosion of photographic flash-light powder.

6. Three instances of chemical change in which the heat effect is noticeable, but not so intense as to cause emission of light:

(1) Slow combustion of food materials within the body.

(2) Fermenting of a manure pile.

(3) The action which results from mixing lime and water.

7. Three instances of chemical change in which the heat effect is not noticeable:

(1) Rusting of iron.

(2) Ripening of fruit.

(3) The tarnishing of silver, as when a silver spoon is used in eating an egg.

8. A substance hotter than its surroundings cools off more or less rapidly because the heat escapes into the surroundings. When wood burns, so much heat is produced within a short time by the chemical change that it cannot all escape at once. Therefore the heat becomes very intense within the body of wood and amid the gases of the flame. If the same amount of wood decays completely, the same amount of heat is produced, but so slowly that it can escape