

MAKING A CHEMICAL COLLECTION.

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It has been the privilege of the writer during the past ten years to formulate and carry out definite plans for a large, comprehensive, and systematically arranged collection of substances that are of interest to students of chemistry. Since it has recently come to his notice that several other teachers of chemistry in secondary schools are establishing chemical collections, a few words may not be out of place in regard to the experience of the writer in this school where the conditions have been rather favorable for the work and where several schemes have been developed with gratifying results. Our collection at present numbers about seventeen hundred specimens, and it is hoped that it will eventually reach twenty-five hundred specimens, this latter number being considered a reasonable limit to the amount of illustrative material which can be used to advantage in the department of chemistry in a secondary school.

For convenience the collection is divided into three parts: (1) the elements, (2) the compounds, and (3) specimens to illustrate the chemical arts and manufactures. The first two divisions are mainly of theoretical interest, because the elements and compounds are arranged according to their scientific classification. Much, however, of practical value and of technical interest is interwoven, for the substances stand side by side on the shelves as they are made in the laboratory, as they occur in nature, and as they are used in technical processes. The third division of the collection is of practical interest primarily, showing how the substances classified in the other two divisions are used in the various industries. This division naturally covers a very wide field. Already several firms have donated specimens to illustrate the manufacture of their special lines of goods. These samples often include specimens of the raw material, specimens of material during the different stages in the process of manufacture, side products, residues, and finished products.

For further convenience this article will consider the following topics: cases, bottles, labels, classification, sources of material, gases, minerals and head pieces; these will be followed by a brief consideration of the separate groups of elements and compounds, giving such results of our experience as may possibly be helpful to others engaged in this line of work.

CASES.

The most convenient form of exhibition case for the elements and compounds is one at least seven feet and eight inches high, outside measurement. The base need not be over six inches high, and for the molded top seven inches may be allowed, though of course this will depend upon the style of molding used. This leaves about six feet and a half for the height of the door, that is, for available exhibition space. Cupboards and drawers are omitted entirely because all the specimens should, of course, be constantly exposed to view. The door sashes and parting beads should be cut down to the smallest possible dimensions consistent with strength and stability. Much can be gained in this respect by attention to small matters; for instance, if the doors are hung so that each parting bead carries only one pair of butts, these beads may be narrowed appreciably. The case should present the maximum of glass surface and the minimum of surrounding wood frames. We have found that a door six feet and six inches high by twenty-six and a half inches wide, both outside dimensions, will take four lights of glass, each twenty-four by eighteen inches; this being a trade size of glass, no cutting is required. A suitable depth for the case is eleven inches outside; this will leave about nine inches for the width of the shelf. The case should contain eight shelves, the base being called the first one. Alternate shelves should be the full depth of the case, and these shelves should come directly behind the cross-bars of the sashes. The other shelves should be about five inches and a half in depth and should come about midway between the other shelves. This arrangement exposes all specimens to full view without obstruction from cross-bars and so on. The advantage of this style of case over a deep case containing narrow shelves arranged as a flight of steps is that all the specimens are brought much nearer the glass door and it is therefore much more convenient to examine them; furthermore, these shelves are particularly well adapted for both the minerals and the two sizes of bottles which will be mentioned below. The cases may be made with any number of doors, from two to twenty, according to the size of the space allotted to the cases. The doors should be supplied with good, non-corroding locks, and one key should fit all locks.

The cases for the third division of the collection may well be, for consistency's sake, of the same dimensions as those just described, but the depth may very properly be doubled.



The cases should be built of some wood, such as white pine, that will not warp or check after standing some months. The outside may be finished to correspond with the rest of the finish in the room. The inside should be painted; pure white is not a desirable color on account of the large number of white salts that the collection will eventually contain; some tint should be chosen that will not be conspicuous in itself but should form a good background for not only the white salts but also the variously colored minerals. The writer has found a light drab, dull finish, a satisfactory color.

Some of the cases, preferably those containing the first two divisions of the collection, should be placed in the hall and in as good a light as possible. This brings the collection permanently before the students of the department and increases their interest as well as the value of the collection itself for reference.

BOTTLES.

All chemicals should be exhibited in bottles of uniform size, but these should be of two sizes, four-ounce and twelve-ounce. They should be made of a good grade of glass, absolutely free from color and as free from bubble imperfections as possible. Wide-mouth, glass-stoppered bottles can be used throughout, for liquids as well as for solids. The bottles should be bought by the gross, in order to ensure uniformity. We were fortunate in getting a bottle blown in an iron mold; this left a horizontal mold mark just below the neck, and this mark was exceedingly helpful, because when the tops of the labels were put even with this mark the labels were brought to a uniform height above the shelf.

LABELS.

For use on the bottles a plain white label two and a half inches by one and three eighths inches is a good size. This may have a double light-rule border near the edge to improve its appearance, but as much free space as possible should be left for the writing. The name of the school and the words "CHEMICAL COLLECTION" should be printed near the top of the label. For use with minerals and other unbottled specimens a white, stiff card, three and three quarters inches by two and one eighth inches should be used. This should be bordered and printed to correspond with the sticker labels. For supporting these cards beside specimens when it is not desirable to lay the cards on the shelf beside the specimens, Dennison's ticket pins and card holders are exceedingly convenient. It is often helpful to have a large label card to indicate the different subdivisions of the collection. These cards may be as large as three by five inches if desired, and should, of course, be printed to correspond with the smaller labels. The ruled border, however, may be a little heavier.

It should be remembered that fully-described and well-written labels enhance the value of a collection immensely and that many valuable specimens may be comparatively worthless for

collection purposes if not accompanied by proper labels. The curator of the collection should therefore see to it that all specimens be accompanied by proper labels. He should even suggest to prospective donors the advisability of supplying additional label information. Some one has said that a museum is a collection of descriptive labels illustrated by suitable specimens. The spirit of this definition might well be the underlying principle governing the development of a secondary school collection.

CLASSIFICATION.

The elements may be subdivided into metals and non-metals. The compounds may be divided into oxides, hydroxides, hydrides, chlorides, bromides, iodides, fluorides, cyanogen compounds, sulphides, carbonates, sulphates, silicates, oxalates, chromates, nitrates, phosphates, and miscellaneous compounds. The specimens in the arts and manufactures division will naturally vary to some extent with the locality and with the interest that manufacturers may show in the collection. But they should consist primarily of specimens illustrating those industries which are most clearly dependent upon chemical reactions.

SOURCES OF MATERIAL.

If the funds of the school allow it many substances may be obtained by direct purchase. In nearly every school the stock-room contains a supply large enough to allow samples to be transferred from the stock-room to the collection. Many substances can be made by the students themselves from stock on hand, and this work can be arranged either as regular advanced work or as voluntary work for the better scholars. In all cases, substances so made should have on the label the name of the student who made them. This device will always bring about fresh additions from other students. Many manufacturers are ready and glad to donate samples of their products to such collections, but for obvious reasons it is not advisable to mention the names of any such firms in this article.

Lastly, of course, friends of the school may become interested enough in the collection to donate specimens or money for their purchase. It should be emphasized here that the instructor should have some well-formed plan in mind toward which he is constantly working; this will enable him to recommend judiciously in case of prospective donations.

GASES.

The gaseous elements, oxygen, hydrogen, nitrogen, and chlorine, may be prepared in the laboratory, purified if necessary, dried and stored in sealed glass bulbs. The writer has used for this purpose an inexpensive modification of gas-collecting tube; this modification consists of a thin glass bulb about three inches in diameter with two small bore glass tubes about six inches long fused into opposite sides of the bulb; these are very convenient because the straight tubes may be bent at right angles close to the bulb, and after the bulb has been filled with gas the ends of the glass tubes can be drawn off in the blast lamp and hermetically sealed. The main advantage of bending the tubes is that the bulbs will then lie in any position in which they are placed and there is no danger of their rolling around. A small label with the symbol of the gas should be pasted upon one of the straight tubes and a larger card label with complete information should be laid beside the bulb. Bromine, both in liquid and in vapor form, may well be similarly shown.

Of the gaseous compounds, ammonia gas, phosphine, hydrogen sulphide, hydrochloric acid gas, three oxides of nitrogen, two oxides of carbon, and two oxides of sulphur, may be exhibited in glass bulbs. In preparing sulphur trioxide the bulb should be immersed in a freezing mixture and the sulphur trioxide gas passed into it for some time, care being taken, of course, to have all apparatus perfectly dry; when enough of the snow-like oxide has collected, the ends of the glass tubes should be drawn off while the bulb is still in the freezing mixture; after standing several weeks the amorphous sulphur trioxide vaporizes and condenses on the side of the glass in long, beautiful, needle crystals, sometimes two inches long. For collecting carbon monoxide gas the bulb described above cannot be used because the gas ignites spontaneously and explosively during the drawing off of the glass tubes; instead, a separatory funnel with stem cut off close to the lower stop-cock may be used.

In this connection it is of interest to note that sulphur dioxide and nitrogen tetroxide may both be liquified at ordinary temperature by passing the gases into the bulbs packed in freezing mixture; the bulbs might well be sealed before being removed from the freezing mixture.

MINERALS.

Minerals have a distinct place in such a collection as is being

here described, because so many chemical compounds appear as minerals and it is desirable to show these compounds in as many different forms as possible. If the school has practically no minerals already on hand, by far the best beginning is to purchase from a reliable dealer a collection of a hundred and seventy-five to two hundred specimens especially prepared for high schools and academies. Such a collection has usually been made up with considerable care, and though it illustrates only the common or important species and varieties, these come from widely-distributed localities. Such a collection is much more representative than any collection of minerals that the secondary school teacher has time or opportunity to assemble personally. Specimens in such a prepared collection are usually well labeled with mineral name, variety name, chemical name, formula, and locality. Since these specimens are for cabinet use instead of for individual study, they should be of pretty good size, say from four to five inches long and from three to four inches wide. Such a collection of minerals makes a substantial beginning for a chemical collection, and as other minerals are desired subsequently they can be obtained separately. A smaller mineral collection than the one just described would not be consistent with the size of the chemical collection as outlined, and a larger one would not give students and other interested friends an opportunity to donate additional specimens. It goes without saying that extremely rare minerals and specimens showing but slight variations in the same mineral are out of place in a secondary school collection. It should constantly be borne in mind that the collection is not to confuse the mind of the student by multiplicity of specimens, but rather to leave sharp impressions of the groups of compounds and the more characteristic and common specimens within each group.

HEAD PIECES.

The cases themselves, particularly if they are large, receive a finishing touch if a very large specimen is placed on top of each case. Substances that serve this purpose well are large masses of gas-retort carbon, say about two feet long; large cross sections of petrified wood, showing the complete trunk from center to bark; a huge mass of gypsum and a large lump of commercial fibrous salammoniac, such as is used in iron industries. Other specimens will suggest themselves to the teacher.

(To be continued.)