THE DEPARTMENT OF THE AMERICAN ASSOCIATION OF COLLEGES OF PHARMACY

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"The following papers on 'Content of the Course in Pharmaceutical Arithmetic' and 'Problems Confronting the Teacher of Dispensing Pharmacy' were presented at the Teacher's Conferences last year. They are called to the attention of the teachers who are in charge of these courses. Both subjects are very important and discussion of these papers is invited.—C. B. JORDAN, *Editor*."

PHARMACEUTICAL ARITHMETIC: CONTENT OF THE COURSE.

BY J. L. KLOTZ.*

With the advent of the minimum four-year curriculum in Pharmacy, some schools are planning to add technical courses in pharmacy; others are giving practically the same curriculum as heretofore with the addition of certain cultural subjects; while a third group will add courses in the allied sciences. To all of these, however, the disposition of the course in pharmaceutical arithmetic is of vital importance. Although in the past a knowledge of the fundamental arithmetical principles has always been a necessity to the pharmacist, we are fast approaching the time when the pharmacist will be required to know far more than has ever before been expected of him. Just as it was requisite for him to calculate the dosage of prescription ingredients, it will soon be necessary for him to conduct the analyses of drugs and chemicals, thus demanding a knowledge of a field of mathematics with which the average graduate of to-day is totally unfamiliar. So, when we consider the changes which are rapidly affecting the profession of pharmacy, it becomes evident that in order to meet these new conditions it is necessary that we alter old procedures and construct newer, more comprehensive courses of study on the solid foundations of the past.

Our first concern in the construction of a course in Pharmaceutical Arithmetic is, of course, where to begin. Although we are entitled to believe that our students are familiar with all fundamental arithmetical principles on their entrance into our colleges and universities, it is the exception rather than the rule for the pharmacy student to demonstrate a mastery of the required subject matter. It becomes necessary for us then, to spend a minimum amount of time in an effort to prepare the student for the simplest pharmaceutical arithmetical procedures. In recognizance of this fact, numerous authors of textbooks on the subject of Pharmaceutical Arithmetic, notably Stevens (1), have devoted a part of their text to a review of the simpler arithmetical procedures. It is evident, therefore, that the first step in the construction of the course must be adequate review in the fundamentals.

Just as the subject of Pharmacy is based upon the Pharmacopœia, the subject of Pharmaceutical Arithmetic is based on the various tables of weights and measures which must be taken up at this point along with sufficient laboratory work to supply the student with a thorough understanding of the principles involved. The

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teaching of various conversion factors for expressing units of one system in those of another is a practice to be discouraged as a knowledge of a few common figures enables the student to conduct these conversions in logical fashion without memorized factors.

The subjects of specific gravity and specific volume follow the weight and measure instruction in the usual arrangement of the course. The science of pharmacy is so integrally held with these two factors that although the subject matter is rather too difficult to be taken up at such an early date, it is almost impossible to undertake further study until this branch has been thoroughly developed. The subjects are usually divided into the following sub-heads: Hydrometers, pycnometers, plummets, hydrostatic weighing, etc., and no attempt can well be made along this line without the addition of laboratory work. At all costs, it is necessary to spend sufficient time both upon the theory and practical applications of this subject to insure a working knowledge of the principles involved.

At some point, preferably as early as possible, it is desirable to include a short consideration of the various devices used to measure temperature. In addition to the three forms of thermometers, *i. e.*, Fahrenheit, Centigrade and Reamur, which are usually considered, a brief discussion of the "absolute scale" as well as the thermocouple and the radiation pyrometer might be of advantage.

We have now progressed to the point of consideration of percentage solutions and alligation, having omitted only one subject, "reduction and expansion of formulas" a topic which is usually developed along with the science of metrology.

Percentage solutions, one of the most important of the various sub-heads of the course, is unfortunately a subject around which a great deal of controversy revolves. Burt (2) has reviewed the various methods of calculation and has recommended the discontinuance of all weight to weight calculations for extemporaneous practice. Regardless of the confusion existing as regards this subject it is of the utmost importance for us to teach all methods to the best of our ability and to emphasize those practicable for use and those which may be prevalent in our respective localities. At this point it is also of value to consider briefly the preparation of percentage solids as well as percentage solutions and it will be found that almost as much confusion exists as regards percentage solids as that surrounding percentage solutions.

Alligation, divided into medial and alternate by most texts on the subject, needs very little discussion. It is a type of calculation peculiar to pharmacy and as such is of as much if not of more value to the pharmacist of the future as to the pharmacist of the present.

Thus, we have briefly considered the majority of the calculations now taught in the course "Pharmaceutical Arithmetic." However, when we consider that our fields of research are constantly broadening and our duties are becoming more diverse, it is evident that these subjects represent only the elements of the desirable course of study. The following paragraphs represent brief discussions of subjects which in the future we shall undoubtedly find it advisable to include either as integral parts of our present course of study, or as the essentials of a new course "Advanced Pharmaceutical Arithmetic."

Logarithms, known as mathematical short cuts, are of inestimable value to the student working in any scientific field. Hours of calculation and tedious multipli-

cations and divisions can invariably be shortened into simple tabulations by logarithmic figures. Many chemical formulas, particularly those of "Physical Chemistry," can be greatly simplified and in fact require a knowledge of logarithms. All gravimetric calculations are greatly simplified by the use of logarithms and in fact few principles of mathematics are more practicable for every-day use than this type of mathematical device. So in broadening our courses, one of the most important of our additions can profitably be made by the inclusion of adequate explanation and application of logarithms to scientific data.

Many courses in Chemistry have at some time in their course of study, exercises in the use of the slide rule. All of the advantages listed in the use of logarithms apply equally well to the slide rule which offers in addition many other convenient types of calculations with little time and effort involved. To the student who is far enough advanced and well enough versed in the fundamentals, the slide rule is a very helpful device in mathematical work. Care must be used, however, to make certain that the student does not learn by imitation the various slide rule settings, but that he thoroughly understands the principles involved before he is introduced to its uses. It is for this reason that the slide rule is not to be recommended for use early in the course but is of advantage to the advanced student.

Since assay work is becoming such an important part of the newer pharmaceutical curricula, it is necessary that some consideration of the calculations involved be given it in "Pharmaceutical Arithmetic." Before a thorough understanding of these calculations can be obtained, the student must be well versed in chemical arithmetic and for this purpose a short review should be given in that subject. All types of gravimetric analysis calculations should be discussed in detail as well as their factors and logarithms. Volumetric analysis reactions, factors, etc., should also be considered and in this connection mathematical factors influencing the choice of indicators would be of great value to the student and facilitate the progress of the various assay courses. Likewise, an elementary consideration of the "Partition Law" as applied to the distribution of a substance between two solvents would simplify the work of the assay course.

The additions to the course which we have herein suggested will undoubtedly call to mind the question "Where will we get time to cover this additional material?" The only available solution to the difficulty is of course the continuance of the subject throughout the year rather than only one semester. Thus we might call the first term "Pharmaceutical Arithmetic," required of all students and the second "Advanced Pharmaceutical Arithmetic" elective for those students intending to go into commercial work or research. In view of the importance of the course, there should be no objection to devoting a full year to its study.

OUTLINE OF PROPOSED COURSE OF STUDY.

1. Review of Fundamentals:
   - *a.* Fractions
   - *b.* Decimals.
   - *c.* Percentage.
   - *d.* Ratio and Proportion.
2. Metrology:
   - *a.* Tables of weights and measures.
   - *b.* Conversion from one system to another.
     - *1.* Factors and their derivation.
   - *c.* Calculations involving metrology.
     - *1.* Reducing and enlarging formulas.
3. Specific Gravity:
   - *a.* Determination methods.
   - *b.* Applications.
     - *1.* Weight to volume.
     - *2.* Volume to weight.

4. Specific Volume:
   a. Determination methods.
   b. Applications.
5. Thermometry:
   a. Thermometer scales.
   b. Thermocouples, radiation, pyrometer, etc.
6. Percentage Solutions:
   a. Weight to weight.
   b. Weight to volume.
   c. Volume to volume.
   d. Calculation from weight of solute.
7. Alligation:
   a. Medial.
   b. Alternate.
      1. Percentage strength.
      2. Specific gravity.
8. Logarithms:
   a. Simple procedures.
   b. Formula application.
9. Slide Rule:
   a. Simple procedures.
   b. Roots.
   c. Logarithms.
   d. Formula settings, etc.
10. Review of Chemical Arithmetic:
   a. Quantities of substances necessary for reaction.
   b. Quantities of substances formed in reactions.
11. Assay Procedures:
   a. Gravimetric factors and their logarithms.
   b. Volumetric solution factors.
   c. Adjustment of volumetric solutions.
   d. Indicator constants.
   e. Choice of indicators.
   f. Distribution of substances between solvents.
      1. Washing of precipitates.
      2. Shaking out alkaloids.

SUMMARY.

1. Suggestions made as to addition of logarithms to course in Pharmaceutical Arithmetic.
2. Suggestion made as to addition of slide rule exercises.
3. Suggestion made as to addition of Gravimetric and Volumetric analysis procedures and calculations involved.
4. Suggestion as to consideration of "Partition Law," methods of measuring heat, theories of indicator choice, etc.
5. Suggestion made as to adding to length of course.
6. Outline of course offered.

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PROBLEMS CONFRONTING THE TEACHER OF DISPENSING PHARMACY.

BY LOUIS WAIT RISING.*

The subject of problems is an age-old one in any field. A number of them are gone over again and again at various annual or more frequently convened gatherings, but because the human mind is what it is—individual—they are never completely threshed out and settled. The points for and against each one are as old and stabilized as the problems themselves, but never can there be obtained a unanimity of opinion for either side.

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