of solutions in the range of a concentration of 0.01 per cent. was decidedly increased, whereas in a concentration above 0.1 per cent. it was decreased, and finally the speed of cataphoretic mobility of the colloid particles, when measured in solutions of gelatin and egg albumin, was practically doubled after freezing.

The fact that the values of viscosity determinations were decreased in some cases, but the values of surface tensions, however, showed a thoroughgoing increase, may be understood if we recall that, for instance, a zymase solution or a gelatin solution may be considered as in every respect a more heterogeneous system, when compared with a solution, for instance, of egg albumin. It is necessary, therefore, to assume that under the effect of freezing, lyophilic colloids not only may undergo a disaggregation of the colloid particles, but also an aggregation of the same.

In so far as the values of surface tension measurements are concerned, we noticed that the reapproachment to the value of the surface tension of conductivity water was the greater, the more the respective solutions were diluted. In order to understand this fact we may assume, in accordance with the considerations of Gortner and coworkers[3] concerning the bound $\leftrightarrows$ free water equilibrium, that the surface tension of a lyophilic colloid solution is a resultant of three factors. namely, (a) the surface tension of colloid particles, and (b) the surface tension of the aforementioned two parts of the water system. Under the assumption that the increase of the value of surface tension of a frozen and afterwards thawed solution of lyophilic colloids, if not caused by dehydration of the particles, is due to a decrease of the radius of the colloid particles and subsequent increase of the surface of the same, then the bound $\leftrightarrows$ free water equilibrium is shifted in disfavor of the free water component. Accordingly, the surface tension increases only to the extent of the difference between the surface tension value of the particles and the value of surface tension of the water system. The diluted solutions on the other hand contain less particles, and accordingly the additional amount of bound water, when the surfaces are increased on account of freezing, as well as the difference between the value of the particles and the value of water, is smaller. The increase of the value of the surface tension is therefore greater in the case of diluted solutions. It was noticeable in this connection that sodium oleate solutions showed a decided diminution of volume in frozen state, compared to the unchanged volume of frozen proteins or gum arabic. This observation may be due to the possibly much less material rôle of the bound water in the case of colloidal electrolytes.

[3] R. A. Gortner, "Outlines of Biochemistry," p. 230, New York, 1929.

The disaggregation-aggregation hypothesis is supported also by the results of the measurements of conductivity and cataphoretic mobility of the particles, since we assume that the conductivity of dispersoid systems, containing the same amount of substance in dispersion of different degree, is reciprocally related to the square of the radius of the particles. The conductivity itself is based on the particles of highest dispersion of the system. The increased cataphoretic mobility on the other hand may be due to the fact that on account of increased dispersion, electrolytes went into solution out of the proteins, causing an electrical charge of the particles, which again causes an increase in their mobility.

Since, according to our present knowledge, proteins have to be considered not only as the substance of crystalline enzymes, but also as being responsible for the properties of the so-called carriers, so we may consider the results of our measurements as the first exact proof of the colloidal carrier's dependence of functioning on its physical state. At the same time it may be also mentioned that the biochemical behavior of physically transformed lyophilic colloids is distinctly different from the original systems.

It is intended to report in detail the experiments in the *Kolloid Zeibschrift*.

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SEX DIFFERENCES IN THE STUDY OF GENERAL SCIENCE

THE purpose of this study is to investigate sex differences in the difficulty of the course in ninth-grade general science, and variations in difficulty from one part of the course to another.

Since competent writers of general science text-books do not agree upon what to include in the course, the selection of material for investigation must necessarily be arbitrary. Seven hundred forty-eight statements were chosen from text-books commonly adopted, the intention being to obtain a varied and random sampling of material sometimes used. To validate the use of these statements, ten text-books were surveyed to discover the extent to which these statements were incorporated into the course. A statement was counted as being in a book if found stated directly or if material was found from which it could be readily deduced. Table I summarizes these findings.

This list of statements agrees as well with the text-books as they do with each other and is better justified than a list of statements found in all text-books, since

TABLE I

Author	Text	Edition	Statements found
Hessler	First Year of Science	1925	615
Hunter and Whitman	Problems in General Science	1930	612
Van Buskirk and Smith	Science of Everyday Life	1928	598
Wood and Carpenter	Our Environment—How We Use and Control It	1927	567
Caldwell and Curtiss	Introduction to Science	1929	566
Webb and Didcoct	Early Steps in Science	1924	552
Snyder	General Science	1925	532
Pieper and Beauchamp	Everyday Problems in Science	1925	508
Hodgdon	Elementary General Science	1928	442
Clark	New Introduction to Science	1928	364

only 150 of the 748 statements were used by every author. Text-book writers agree least on plant and animal biology, on biographical material and on foods and clothing. They agree best on heat, electricity and weather. Some authors omit entirely large bodies of material included by most of the others.

The statements were converted into completion or recall questions. C. I. Hull (Aptitudes Testing, New York, World Book Co. Page 313) reports that the self correlation of various forms of tests is: true-false r equals .507, multiple-choice r equals .556, completion r equals .618. Completion also lessens the chance of neighboring questions affecting the test item by eliminating needless words used as alternates in multiple-choice questions. Completion questions can not be answered by eliminating the wrong answers.

Subjects tested were chosen by the selected sampling method from six widely scattered states, all in the North except Virginia. School enrolments ranged from less than one hundred to more than two thousand in a single building. Farming communities and one select city residential district supplied the pupils tested. Three hundred boys and three hundred girls supplied the material used for calculating the difficulty of the questions. The tests were given at the end of the year, after a period of review, by the class teachers under uniform conditions. The papers were scored uniformly by the experimenter.

Since the content of general science is not standardized, the questions were classified in terms of the science from which they were originally derived. An adequate classification is difficult because a single statement may be used in any one of several contexts. For instance, carbon dioxide is discussed under atmosphere, chemistry, foods, fire extinguishers, respiration, ventilation, oxidation and geology. Questions were finally classified on the basis of their occurrence in other secondary science books, as physics, chemistry, physiography, etc.

The per cent. of pupils who missed each question was calculated separately for boys and girls. For each question the per cent. of boys missing the question was subtracted from the per cent. of girls missing the question. That is, a question missed by 84 per cent. of girls and 76 per cent. of boys would yield a *difference* of plus 8, indicating the question is easier for boys than for girls. Minus differences indicate the questions are easier for girls.

Table II shows the distribution of the 748 questions arranged in order of the difference in difficulty for boys and girls. Only 14 questions were equally difficult for both, 187 were from 0 to 4.9 per cent. easier for boys, etc. The median question in this distribution has a difficulty difference of plus 5.06.

TABLE II

Distribution of Differences in Difficulty for Boys and Girls

Minus class intervals										
34–30	29–25	24–20	19–15	14–10	9–5	4–0	0			
N1	1	2	7	11	42	107	14			
Plus class intervals										
0–4	4–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54
N187	170	78	58	31	18	8	7	5	0	1

Table III shows the median difficulty of the questions when arranged in groups. Of the twelve questions on clothing, the median question was 3.3 per cent. points easier for girls than for boys. Read downward the topics become increasingly difficult for girls and increasingly easy for boys, relatively.

The differences are significant when the median is three times its probable error. Only three subdivisions of material fail to show significant differences, while thirteen of eighteen favor boys.

The mean of the 748 differences is 6.1 per cent. points, counting as minus differences favoring girls.

Typical questions on which girls excel are: Artifi-

TABLE III

MEDIAN DIFFICULTY OF QUESTIONS UNDER SUBDIVISIONS

Type of material	Number of questions	Median difference	$P.E._{md}$
Clothing	12	– 3.3	.5
Food	27	– 2.8	.9
Earth, weather, geology	79	.1	.4
Human biology, health	60	.6	.5
Life processes and development	20	1.9	.7
Properties of matter	8	2.5	.8
Plant and animal biology	49	2.8	.7
Biography	34	2.9	.6
Astronomy	19	3.2	.8
Light	51	4.0	.8
Chemistry, air, water, matter fuels	115	4.4	.4
Heat	48	6.0	.7
Simple machines, work, laws of mechanics	50	6.4	.9
Sound	19	9.9	1.8
Measurement, introductory method	19	11.2	1.6
Fluids, barometers, pumps	32	11.9	1.1
Electricity	68	12.0	.9
Applied mechanics, engines, etc.	38	22.2	1.3

cial silk made from wood pulp is called rayon; iodine mixed with starch gives a dark blue color; a disk one third red and two thirds yellow appears to be orange when rotated rapidly.

Boys are superior to girls in answering these: Lamp cords are insulated with cloth and rubber; a dry cell is contained in a zinc can; an airplane with two sets of wings is a biplane.

Apparently a large part of the differences can be explained by environmental factors differing in the experience of boys and girls. These factors may or may not explain the much greater interest of boys in mechanics. At any rate, sitting in the same classes, reading the same text-books, receiving instruction from the same teachers do not operate effectively in eliminating sex differences.

This study brings out more questions than it solves. Should we shift emphasis on the course for boys and for girls to attempt to equalize their achievement? Is one course over mechanics adequate for a girl who must live in houses and offices dominated by machines? Do sex differences carry over to teachers of general science? What advanced sciences should be provided for girls, since they are so obviously handicapped in physics? Should boys and girls be taught separately since their interest as manifested in achievement is considerably different? Should boys and girls be graded on the same distribution?

CONCLUSIONS

General science is far from standardized in text-book treatment, the range of completeness being from 48 per cent. to 82 per cent. of a random checklist of items.

Material in general science is not arranged in either uniform or logical manner.

Material generally covered in biology shows no sex difference in general, but the subdivisions show slight differences.

Physiography material shows no sex differences.

Chemistry material shows significant differences in favor of boys.

Physics material is much easier for boys than for girls, the median differences on subtopics ranging from 4 to 22 per cent.

The subject as a whole is much easier for boys than for girls.

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PROGRESS IN WESTERN DUCK SICKNESS STUDIES

A RECITAL of the events and experimental work that have led to a new concept of western duck sickness, formerly attributed to the toxic action of certain soluble salts of "alkali," was published in SCIENCE late in 1930.[1] The findings there chronicled strongly suggested that a type of botulism was involved. A supplementary contribution by Drs. Giltner and Couch,[2] appearing at the same time, set forth the fact that the bacillus of *Clostridium botulinum*, Type C, was present in mud obtained at Tule Lake, California, as well as in the tissues of wild mallards, pintails and ring-billed gulls that had died of or were killed while afflicted with duck sickness.

Despite the highly suggestive character of these circumstances and other facts revealed, including the striking similarity of the syndrome of duck sickness and that of botulism as manifested in "limberneck" of domestic ducks, there still remained the necessity of demonstrating actual toxin production under field conditions, and in media or associated with food or water likely to be ingested by birds. With an organism as prevalent and widely distributed as *Clostridium botulinum*, the need for such added evidence is obvious. As expressed by Geiger, Dickson and Meyer,[3] "the

[1] E. R. Kalmbach, "Western Duck Sickness Produced Experimentally." SCIENCE, lxxii, 1878, 658–659, Dec. 26, 1930.

[2] L. T. Giltner, J. F. Couch, "Western Duck Sickness and Botulism." *Ibid.*, 660.

[3] J. C. Geiger, E. C. Dickson and K. F. Meyer, "The Epidemiology of Botulism," U. S. Public Health Bulletin No. 127, pp. 1–119, September, 1922.