eminence, thinks fit to be superior or sarcastic or condescending—then small wonder if our young scientist returns gladly to his laboratory, thinking with savage glee as he completes his analysis how hopelessly lost his English master would be inside those sacred walls.

All this does scant justice to those few young scientific boys who have been among my own keenest and best-informed English pupils in the past few years. But it must be confessed they were the exception, and that both in quantity and quality the essays on political or general subjects shown up to me by my Science VIth have compared badly with those from the Classical or Modern sides. There are three stages through which young writers normally pass: that in which their essays are too short, because they have little to say; that in which they are too long because they cannot control their material; and that (reached only by the few) in which they have suited their length to their subject, having learnt to select and arrange both their thoughts and their words. Too often I find that, while I have to wade through vast compositions by young historians and modern linguists who have reached the stage of verbosity and cannot emerge from it, the comparative brevity of their scientific brethren is due more often to their having failed to pass out of stage one than to their having graduated into stage three.

Training in the appreciation of literature is a chancy business; it depends more than almost any other co-operative activity upon the nature of the two parties to the operation and upon the *rapport* between them. But if the pupil is to make our great heritage of literature his own he must both be sensitive himself and sit—at some stage in his career—at the feet of one of the chosen votaries of Apollo. All too often he enters upon his specialist course in none too congenial a mood. He may well have suffered under the meticulous dissection of a play of Shakespeare and the minor poems of Milton by a teacher whose horizon was bounded by contexts and classical allusions and the percentage required for a credit. In this teaching the teacher must be sincere, both in judgment and in enthusiasm. The teacher must also be sincere in criticism, such as frank recognition of Shakespeare's ludicrous failures as well as his triumphs. Such teachers win respect, and respect for them is half-way to interest in their enthusiasms. The second suggestion I would make is that here as in the earlier stage much can be done by asking questions which excite a desire to know the answer.

It is not for everyone to find in literature their chief delight. But we shall do our pupils wrong if we do not endeavour to reveal to them all what abiding happiness can be found in the company of great writers. This is after all the crowning achievement of the English teacher. To ensure moderately clear expression is much, and the first step to creating an intelligent electorate. To awaken interest in social, political and moral questions, this is more, and an enrichment of the life of man. But to open the doors of the imagination, this is best of all. For we are all of us, scientist and humanist alike, citizens of two worlds; and nothing that happens in this unhappy, tortured planet where man is at enmity with man can altogether overwhelm one who has heard the lute of Orpheus, or thrilled to the passion of Romeo, or looked with startled eyes through Keats's casements upon the foam of perilous seas.

THE SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING AT RUGBY

THE first full annual meeting the Science Masters' Association has been able to arrange since the outbreak of war was held at Rugby School during April 8–10, under the presidency of Mr. Hugh Lyon, headmaster of the School. The success of the meeting justified the venture; more than two hundred members were resident in school Houses, and many others made daily visits. The lectures were stimulating, discussions fruitful even when they developed unexpected trends, visits of particular interest, and the members' exhibition as good as any of its predecessors.

A liberal education draws its energy from many sources. It is a narrow kind of humane education which neglects the study of natural science; but it is a sterile form of scientific training which takes little regard of human relationships. The presidential address on "English in the Science Course" (see p. 454) and the biennial Science and Citizenship Lecture on "Biological Instruction and Training for Citizenship" given by Prof. Lancelot Hogben left the mind open to the wider views of life.

Biology and Citizenship

Prof. Hogben aimed high. He endeavoured to approach the great national and political problems caused by the impact of science on society. At the start of his lecture he cleared the air for what followed by examining the ideal of knowledge for its own sake.

Knowledge for its own sake presumably means knowledge for the sake of the individual, the pursuit of knowledge for the satisfaction of personal curiosity; and it goes without saying that individual curiosity is a necessary condition for the growth of knowledge. To that extent knowledge for its own sake is a formula which directs attention to a legitimate aspiration and to a sound educational principle. Most of us, including those alert to social agencies which provide scope for personal curiosity, would readily concede that personal interest in a particular line of inquiry or instruction depends on circumstances which do not necessarily or commonly have a close connexion with its social usefulness. Few of us imagine that precocious concern for the remediable evils of malnutrition determines the choice of a career in biochemistry. What we do assert is that a society more alert to the problems of malnutrition would furnish more ample opportunities for biochemical research and instruction. We find it difficult to understand why biochemistry should suffer from the efforts of those who wish to promote greater public esteem for the work which biochemists carry out; and we are not convinced that a person who professes supercilious indifference towards the welfare of his fellow-citizens is on that account a better biochemist.

If they mean anything at all, this seems to be what people suggest when they make knowledge for its own sake a battle cry in the discussion of science teaching in relation to citizenship. There is nothing particularly scientific about the egocentric attitude which refuses to recognize social relations as data relevant to personal conduct. That we are members of a social group is an inescapable fact. To what extent we get opportunities and encouragement to

pursue our own interests depends on whether the pursuit of our interests harmonizes with the interests of others. In a democratic society this depends partly on whether we can convince our fellow-citizens that the pursuit of our own interests will benefit them. To conceal these simple considerations behind fine phrases such as 'knowledge for its own sake' merely shows lack of imagination and common sense. If personal curiosity is the only justification for the study of biology, there are no sufficient reasons for promoting its study as a school subject. Biology can justify its claim to a place in universal instruction if, and only if, it can establish its credentials as a branch of humane scholarship, that is to say, as an essential part of the intellectual equipment of the individual for the responsibilities of citizenship. This presupposes a common basis of agreement concerning civic obligations and privileges.

As a definition sufficient for the purpose of constructive discussion Prof. Hogben suggested the following. Those of us who subscribe to the democratic process believe in promoting social adjustment by rational assent of those concerned. Specialists need educating to a rational appreciation of the social value of professional work they perform. During the past twenty years the Fascist and Nazi regimes have systematically reorganized education to promote and consolidate totalitarian values and institutions. During the same period can any single country claim to have an educational system designed with equal singleness of purpose to encourage the survival of democracy ? The pioneers of British democracy did have definite views about the type of education which democratic government calls for ; but the curriculum of our educational institutions has not kept in step with the changing functions of democratic government. What views about education for government are widely prevalent in influential circles are a 'hangover' from a period when the functions of democratic government were very different from what they are to-day.

To a large extent the change is due to the impact of scientific discovery on human society. If the functions of democratic government were still as when Milton claimed the right to know, to utter and to argue freely according to conscience, they would be equally important assets to-day. They are not. Our outlook is necessarily different from that of Milton's contemporaries. Meanwhile, we have patched up an educational system which served the needs of democracy well enough in the eighteenth century by making provision for the training of specialists for industry. There has been no radical change of the practice of education for government. What units of government are most suitable to changing conditions, and what new tasks Government can undertake in the interests of citizens increasingly become technical issues for which historical erudition supplies no precedent. Intelligent social decision depends on understanding what technical possibilities are realizable.

The fact that scientific knowledge can discipline human beings to cease striving for what they cannot have is not the only way in which it affects social values. Diffusion of scientific knowledge has a more positive role. To say that public health is now one of the major preoccupations of Government is to say that scientific discovery, and diffusion of knowledge by its implications, have enlarged the scope of human co-operation by enlisting us in a common struggle. Out of this new awareness of common dangers is coming to birth a new social phenomenon, the rational recognition of common needs which transcend our conflicting wants. We are learning to discuss whether people have the vitamins they need and to ensure that they get them. To the extent that we do so, the virus of scientific rationality is infecting politics.

The demand for biological teaching in the school is a new thing, and there is a widespread sentiment in favour of providing biological instruction of a sort suitable to the needs of pupils not destined to become professional biologists. There is much to be said for the provision of a more flexible curriculum in the universities and for the introduction of a general science degree for teachers ; but the administrative difficulties are great, while too many professors approach the issue with more concern for departmental prestige than for the civic value of what they can contribute. Biological instruction which can justify its claim to a place in a curriculum designed to promote intelligent citizenship must give prominence to aspects of biology which are most relevant to human needs. A comprehensive treatment of the field would emphasize the following themes :

(*a*) Animal parasitology, mycology and insect pests, that is, pests and parasites of man and of domestic animals or cultivated plants.

(*b*) Genetics in relation to plant and animal breeding.

(*c*) Bacteriology, serology and chemotherapeutics.

(*d*) Soil conditions and plant nutrition.

(*e*) Animal nutrition in relation to animal husbandry ; human nutrition, respiration and excretion *vis-à-vis* occupational diseases, and animal husbandry.

(*f*) Physiology of reproduction.

(*g*) Interpretation of vital statistics.

Prof. Hogben then dealt in detail with the broad background required, and the framework of specialized studies to be erected on it.

Biology as a Social Science

The lecture by Prof. Lancelot Hogben lent strong support to the main points raised by Mr. L. J. F. Brimble during the previous afternoon, when in a lecture entitled "Biology as a Social Science" he not only pleaded for a more definite realization in schools of the sociological implications of biology but also dealt with the practical ways in which teachers could put these to effect. At this lecture Mr. H. P. Ramage (Gresham's School) was in the chair.

There is a widespread feeling that the study of man should have a larger share in all general biology courses. This has, however, been wrongly interpreted by some. For example, certain biologists, especially in the universities, have expressed the fear that this might lead to man being used as a biological 'type'. Mr. Brimble dissociated himself from this view. In any event he gave reasons which he amplified later for considering man as an undesirable type in biological teaching because in certain fundamentals he is the exception rather than the rule. Another reason for emphasizing the sociological impact of biology is the strong movement which is now taking place in favour of the development of the social sciences, both in research and in education.

Mr. Brimble expressed his concern over the tendency of many teachers to make their science teaching too heuristic, in that they lean too much towards teaching science in the spirit of research and discovery. This may be all right in the universities but in the

schools it leads to the students missing other aspects of their studies which are of equal importance. There is considerable danger involved in pressing for more practical work in schools. It is true that practical work well taught is of inestimable value, but it runs the risk of becoming biased in favour of the potential scientists. Practical work cannot, of course, be abandoned altogether since it is essential in order to drive home basic scientific facts and to satisfy the fundamental instincts of the pupil. To inculcate in the average schoolchild the spirit of discovery is, of course, very desirable, but by far the majority have no intention of taking up science as a profession in later life and many of them in any event have no leaning that way, yet those young students can derive as much benefit from a properly organized course of school science as any student who proposes entering the university as a science student. It is difficult to say what cultural benefit any boy or girl can derive in later life from an empirical knowledge of the analytical tables or of the structural formula for soap. On the other hand a knowledge of the everyday applications of chemical analysis can have certain cultural repercussions.

In biology as in any other science one must realize that though there is a minority who intend following careers which demand some detailed knowledge of biological science or medicine, and although these must receive consideration for the sake of the advancement of science, on the other hand much more consideration must be given to the fuller education of all students including the potential science specialists, in which historical background, the philosophy of science and the impact of science upon society have a full share of consideration.

One important factor, however, must be taken into consideration in all stages of the student's school life, and that is the time factor. Teaching hours are comparatively short—about thirty hours a week. If the ideal educational syllabus is to be achieved, however, one must decide what shall be taught and how much of what, and in coming to this decision the dead wood must be cut out and new shoots encouraged. This applies not only to the subjects themselves but also to the content of each individual subject, as emphasized also by Mr. Lyon. In other words, a more balanced curriculum is desirable and this must be periodically revised. In spite of the time factor, if it can be agreed that any subject, no matter what it is, shall be taught in schools, then time should be found for it, and in Mr. Brimble's opinion biology, which after all is the science of life, should be taught in all schools.

Mr. Brimble also discussed the dominating and destructive effect of the examination syllabuses as they are at present constituted. The attitude of many biologists and educationists towards biology teaching in schools leaves much to be desired. Their attitude can be ascribed to at least two things, namely, the lack of knowledge of the principles and importance of biology by those educationists, sociologists and even politicians who have had no training in the subject and also the attitude of a number of authoritative academic biologists themselves. This is evidenced to-day by the remark one is too often hearing that there is not much use for biologists as such in the war effort. How far this is true can be gauged from the successful formation and activity of the Biology War Committee (see NATURE of Feb. 28, pp. 227 and 234). If biology can be utilized in this way in wartime, how useful then could it prove itself, given the chance in peace-time. Biology is not just botany plus zoology; it is the science of life, and if it is going to win the place in the educational system of the country which it deserves then it must be treated as such.

Mr. Brimble then gave one or two examples in more detail of how present-day biological teaching could be so modified as to make the science more interesting and useful and to bring it to bear more directly on the study of man and mankind. He did not plead for a complete reorganization of the syllabus, since the most important factor is the frame of mind of the teacher himself. The biology syllabus even if it remains unchanged is seething with opportunities for dealing with sociological implications.

Experimental work can also utilize man as a subject. There is a tendency towards this to-day but it could be taken much further with advantage. At the same time it would be dangerous to centre the biology syllabus completely around man himself because in a considerable number of aspects he is the exception rather than the rule. For example, the conception of the survival of the fittest would be very difficult to teach if man were the main centre of interest. The question of reproduction raises several important issues which must be faced by the teacher. There seems to be little doubt that human reproduction should be given its logical place in the biology syllabus but teachers must realize that it is a delicate subject and one which must be dealt with very carefully, preferably after consultation with parents. Mr. Brimble expressed the view that it would be better that the subject be omitted than dealt with clumsily.

Principles of social biology confront us at every turn in the school curriculum; for example, individual and public health, nutritional standards, housing, population movements, race and nation, problems of family life, relations and responsibilities of one person to another, social policy of the State. Make social biology an academic discipline; then it will follow that in later life our schoolchildren will give effect to it as citizens in public administration and national policy. How deeply involved social biology becomes in national policy was illustrated by Mr. Brimble in his comparison of the attitude of Fascist powers towards social biology with that of the democracies.

Dealing with the teaching of biology in the Higher School Certificate, Mr. Brimble emphasized the deplorable domination at this stage of the requirements of the universities. The same point of view was expressed by a speaker in the discussion on "Science in Post-War Schools" (see p. 459). At present Higher School Certificate biology centres around the requirements of the first M.B. examination and the university intermediate and scholarship examinations. There can be little argument in favour of this. Indeed it is in the Higher School Certificate that biology might be treated more directly as social biology, though Mr. Brimble stressed the desirability of approaching it as such throughout the school, having once based the general precepts of biology in the lower forms of secondary schools and in the junior and senior schools more on observational science—especially natural history. In the Higher School Certificate stages sociology, civics and citizenship are often taught, and the biology course could be brought into line with these subjects or perhaps even be absorbed by them. In fact, after the School Certificate stage, a

course of a year or probably two might well be based almost solely on cultural values. This, from the point of view of biology, was compared with remarks made by Mr. Hugh Lyon in his presidential address with reference to English.

In the discussion which followed, several valuable contributions were made, giving the general impression that the science master of to-day is anxious to emphasize more the social relations of the subjects he is teaching. Several speakers gave indications of what they were doing in their biological teaching along the lines discussed by Mr. Brimble. In the view of Mr. E. L. Walker (Caterham School), who gave several examples of his own teaching in social biology, there should be no difficulty in emphasizing the social impacts of biology. Mr. E. Lucas (Winchester College) also gave examples of his own methods and expressed the view that the social impact of biology should be brought out in the Higher School Certificate forms. Mr. Richard Palmer (lecturer in education, University of Liverpool, now seconded to the B.B.C.) made some very constructive remarks in favour of social biology and illustrated them with some excellent examples of what he and others are doing in school broadcasts. The method of teaching nutrition as practised by Mr. Palmer in school broadcasts followed closely those which Mr. Brimble would encourage; in fact Mr. Brimble used Mr. Palmer's method as an illustration of his own point of view.

Mr. Palmer and Mr. R. Weatherall (Eton College) did not agree with Mr. Brimble that man should not be treated as a central type. Mr. Bibby (Central Council for Health Education) made several valuable suggestions in favour of biology as a social science and expressed his disagreement with Mr. Lucas that social biology should be confined to the Higher School Certificate stage. Mr. Weatherall also expressed the view that Mr. Brimble's suggestions were too modest even at this stage, and considered that present-day biology teaching should be discarded in favour of social biology "from the cradle". Mr. Brimble replied that the course which he recommended teachers should adopt was probably not so modest as tactful. It is not possible in a democracy to get things done by revolution but rather by evolution, and he emphasized the fact that to put biology teaching on the basis which he and most of his audience desired depends chiefly on gradual modification of the teacher's attitude rather than wholesale discarding of the present principles and practice of teaching.

In his reply to Messrs. Palmer and Weatherall suggesting that man should be considered the central type, Mr. Brimble emphasized the pitfalls, giving the example of bacteriology. A knowledge of bacteria must come from a study of bacteria themselves and not from a study of man, otherwise there is the risk of giving the impression that bacteria only cause disease, whereas it should be remembered, of course, that there are as many useful and even essential types of bacteria as there are undesirable types. This can best be done by treating the bacterium as the type.

The general impression given by the discussion which followed Mr. Brimble's lecture was that teachers agree that biology should be treated more as a social science than it is, and that now is the time for educationists and teachers to approach the problem, since a golden opportunity is now at hand for making the subject of more comprehensive, cultural and therefore human interest.

Science in Post-War Schools

The discussion "Science in Post-War Schools" was opened by Mr. E. G. Savage, education officer to the London County Council, who was followed by Mr. S. V. Brown (Liverpool Institute). Mr. Savage foresees the danger that, at the end of the War, science in schools might be relegated to its previous position. He suggested that peace claims for science as the core of educational studies are even more exacting than those in war-time. Present curricula are conventional rather than rational, and both subjects and ways of teaching are dominated by examinations. He outlined seven aims of secondary education:

(1) Production of physical fitness and maintenance of health.

(2) Acquisition and practice of certain fundamental skills: speech, writing, calculation and capacity to think clearly;

(3) Production of qualities and development of aptitudes valuable in home life.

(4) Training for citizenship in a European democracy.

(5) Development of high ethical standards.

(6) Acquisition of knowledge and skills for proper use of leisure.

(7) Subjects as tools for probable vocations.

Mr. Savage examined the part which could be played by science teaching in all these aims.

Mr. Brown was more concerned with the work of the master. He pointed out that, of every hundred pupils who enter a secondary school, eighty-three take the School Certificate examination and sixty pass the examination. Fourteen enter for the Higher School Certificate of whom ten pass, and five, at the very most, go on to the university. He believes that what the teacher does, he does badly in the main, since he pays more attention to Higher School Certificate candidates than to the School Certificate forms; that the standard of a pass in School Certificate is too low, and that no pupil should sit for the School Certificate examination until he is at least 15½. The Higher School Certificate examination should be divorced from scholarship awards.

In the discussion which followed, many points of view were expressed. Nearly forty years ago Anatole France, an arch-apostle for Latin as the core of school-work, wrote: "Secondary education tends to strip itself more and more of that incomparable splendour which it derived from its apparent uselessness. Since such a transformation is necessary, since it corresponds to the change in customs, it is not very philosophical to lament it overmuch. Nations have an instinct for what suits them best, and the new France will doubtless find the teaching which her children need." France did not. Let us see that we do.

Atomic Structure in Chemistry

The chemistry discussion "Should an Outline of Atomic Structure be taught in the School Certificate Chemistry Course?", initiated by Mr. A. W. Wellings (Leamington College) and Dr. E. J. F. James (Winchester College), provided lively debate and stimulating discussion. It was evident that chemistry teachers are aware of the need of making the atom problem more rational, and appreciate the part to be played by chemical studies in a coherent scheme of science teaching, in giving, not the conceit of knowledge, but an intellectual humility that recognizes that all their pupils learn and do is primarily to open up fresh horizons.

Teaching of Physics

The joint discussion with the Physical Society on "The Teaching of Physics", with Prof. Allan Ferguson in the chair, was divided into two parts : (*a*) "Fundamental Laws and Definitions"; Mr. C. W. Hansel (Bedford School) tackled the problems of the concepts of mass and weight and the systems of units involved, already familiar in his papers to the Physical Society ; (*b*) opening the second half of the discussion, Mr. P. Woodland (Bedford School) stressed "The Need for a Permanent Standardisation and Guidance Committee for Elementary Physics". The main objects of such a committee would be (i) to introduce such a measure of standardization of definition, statement of laws, notation and conventions as would save teachers, students and examiners much wasted effort, and (ii) to issue each year reports on the work done in physics in schools and similar institutions, and to give advice on any changes in syllabus or technique which might be helpful both to those concerned in the teaching or organization of physics and to those who employ students who have learnt physics for a vocational purpose.

Many members followed the opening speakers in both sections and some differences of opinion were evident. The constitution of such a committee proposed by Mr. Woodland and the ways of enforcing its recommendations were then examined.

Visits were paid to the British Thomson-Houston Co. and to the English Electric Co. The Members' Exhibition was one of the successes of the meeting. Such trends as could be discerned were in the greater attention given to alternating current, the production of wireless and aerodynamical apparatus for A.T.C. instruction and in the use of small-scale apparatus in chemistry. A valuable exhibition of scientific books and publications was well attended.

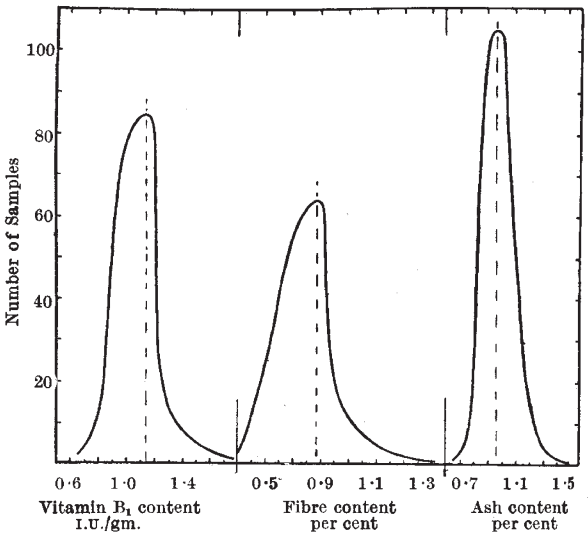
NATIONAL BREAD

By the Staff of the Research Association of British Flour-Millers

THE Medical Research Council in its second memorandum on bread[1] described in general terms the specification for 85 per cent National wheatmeal. It should contain 85 per cent of the weight of the clean wheat and in the case of a reconstituted meal should include all the white flour, all the reduction roll tails, mill finish and purifier tails and sufficient fine bran to reach the 85 per cent extraction figure. Analyses were given of meals prepared on the experimental plant in these laboratories, from which it was deduced that National meal should not contain less than 1 I.U. of vitamin B_1 per gm., and the fibre should not exceed 0·9 per cent.

The report further stated that improvers facilitate the work of the baker and lead to a more attractive loaf. Those normally used in the milling industry have been shown to have no effect on the vitamin B_1 content of flour or meal, and there is no evidence at present, on nutritional grounds, to justify their prohibition.

A few months ago the Ministry of Food arranged for a survey of the quality of the National wheatmeal being produced throughout Great Britain. Samples from more than 200 mills, large and small, were examined for vitamin B_1, fibre, ash, granularity and baking quality ; in all, 303 samples have so far been examined, some of them being repeat samples from millers who had modified their methods.



Quality of Meals. The accompanying curves show the analytical results expressed as frequency curves. The modes and medians in the three curves correspond to the following figures :

	Mode	Median
Vitamin B_1	1·15 I.U./gm.	1·05 I.U./gm.
Fibre	0·85 per cent	0·70 per cent
Ash	0·95 ,,	0·95 ,,

Average figures for whole wheat are 1·3 I.U./gm., 2 per cent and 1·8 per cent respectively. The vitamin B_1 estimations were carried out by the thiochrome method[2] and could be duplicated with an accuracy of ± 5 per cent. The fibre was estimated by a method based on the Fertiliser and Feeding Stuffs Regulations 1932, with certain modifications. This method is routine in these laboratories and duplicate determinations on wheatmeals in general agree to within 0·05. The ash was determined on 5 gm. ignited in a muffle at 600° C., for six hours or overnight.

In view of the Medical Research Council's analytical criteria for wheatmeal, it is of interest to note that out of the 303 samples examined 253 had a B_1 content equal to or greater than 1 I.U. per gm. and 256 had a fibre content equal to or less than 0·9 per cent.

Quality of Breads. A meal conforming to analytical standards does not, however, always give a good loaf, and from the consumer's point of view the proper baking of National wheatmeal is just as important as its careful milling.

The absorption of each meal was determined by physical tests on doughs using special apparatus designed in these laboratories.

The moisture contents of the meals as received varied between 12·8 per cent and 16·1 per cent (5 hours at 100° C., in an electric oven) :

18 per cent of the samples had moisture contents of 15 per cent or more
27 ,, ,, ,, ,, ,, ,, ,, ,, ,, 14½–15 per cent
28 ,, ,, ,, ,, ,, ,, ,, ,, ,, 14–14½ ,, ,,
27 ,, ,, ,, ,, ,, ,, ,, ,, ,, less than 14 ,,

The water absorptions varied between 14·9 and 17·8 gallons per sack.

This variation in absorption was only partly affected by the variations in moisture content, since