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THE RELATION OF OTHER SCIENCES TO CHEMISTRY.

The age of theoretical science is fast passing away and a more practical one is taking its place. This change comes from the fact that everywhere all forms of education are being adapted to our everyday needs. The classroom is to a certain degree being changed into a laboratory and workshop, and all branches of sciences are being placed on an experimental basis. The lines of demarcation which separate the different sciences are rapidly disappearing, as we become more familiar with their underlying principles. The correlation of different sciences will play a large part in their future development. The principles which underlie one branch are used to explain those of another; and we find running through the scientific world a large number of facts which are common to all sciences and can be applied to one as well as to another. I shall take you through experiment after experiment in the different sciences and show that the fundamental principles of chemistry are interwoven through all of them and that a knowledge of these principles is indispensable to any teacher engaged in teaching a science.

During the last few years a large number of branches of science have been added to the courses of study in our public schools. The demand made on a teacher of science nowadays is much greater than it was even a decade or so ago. What was taught then is taught now; but in addition to that we have physiology, hygiene, botany, zoology, sanitation, nature study, domestic science, and agriculture. Not all of these are taught at present in our common schools, but a large part of the subject matter contained in the above subjects is required in one form or another, as in nature study, household arts, and agriculture.

First let us turn our thoughts to physiology and hygiene, two subjects which have been taught in the common schools of our country for the last few years, and see what laboratory study will do in bringing about a clearer conception of many important facts. Now the human body is composed of fourteen different elements arranged to form many different compounds, some of which are gases, others liquids, and still others solids; while it is not entirely necessary to illustrate the properties of all the elements and the different classes of compounds, yet it is not out of place and is in fact very helpful to perform experiments on the more important ones, as sulphur, phosphorus, carbon, oxygen, hydrogen, and nitrogen, besides the carbohydrates, the fats, and the proteids. The burning of wood, coal, or charcoal will not only illustrate a property of carbon and oxygen, but it will show oxidation as the process which is carried on in the human body to supply it with energy. To show that the product of combustion is the same in each case, it is necessary to pass the resulting gas from the burning wood into lime water, and then exhale through a glass tube into another vessel of lime water, and note the similarity in the results. Again it can be easily shown that animal bodies contain carbon, by burning a piece of meat in a test tube, and then suspending a drop of lime water on a glass rod in the tube. The presence and properties of the other elements also may be detected by easy methods.

In studying the different foods, it is always well to illustrate by experiment the distinguished properties of fats, carbohydrates, and proteids. Each of these tests can be performed in a few minutes, and after the tests there will be no mistake in the pupils' mind as to the different characteristic properties of these compounds. In testing for proteids, boil the substance with nitric acid until it is dissolved. The yellow color which results from the action of the acid on proteid, changes to orange if neutralized by ammonia. If a test for glucose is to be made, treat the dissolved substance with Fehling's solution; a red deposit of metallic copper should appear if glucose is present. The test for the other foods can be made by very simple experiments. In teaching physiology or hygiene it is often necessary to show pupils the difference between pure and impure air. This may be done by blowing exhaled air from the lungs into a bottle of lime water, and also inhaling pure air which has been drawn through another bottle of the same solution, and comparing the resulting conditions of the lime water. From the greater precipitate of calcium carbonate, the student sees at a glance which bottle contains the larger amount of carbon dioxide. In taking up the study of bones if one wishes to test for the presence of mineral matter in them in order to show the class that it is this which gives them their rigidity, all that is necessary is to place a calf's rib in a 20 per cent. solution of hydrochloric acid and allow it to remain there for a few days. The hydrochloric acid will dissolve the mineral matter and as a result the bone will become very flexible. Evaporate to dryness the solution, and examine the residue for the mineral matter.

Fermentation presents many interesting points, since there are so many illustrations going on even about the home; for instance, the souring of milk, the fermenting of preserves, the making of bread, and in the case of the human body the digestion of food. In these processes is clearly shown the importance of yeast and bacteria, both of which are micro-organisms and have a very important relation to man. It is hoped that these few experiments will be sufficient to suggest the close relation which exists between experimental physiology and chemistry. A knowledge of chemistry will greatly aid in the interpretation of many facts as well as in the performing of the experiments.

How is chemistry related to physiography and geology, and of what value is it in accounting for the changes which have taken place in the earth's crust? Are there any topographical conditions existing at the present time which have resulted from chemical changes, and are there any geological phenomena which are chemical in their nature? These questions can best be answered by calling attention to several physiographical changes and geological phenomena and by applying experiments which will illustrate each point. Caverns are formed by water which has been saturated with carbon dioxide and has run over great beds of limestone. This combination of water and carbon dioxide forms an acid, which dissolves the carbonate and forms with it a soluble bicarbonate which runs off. After this erosion has been going on for ages, great caves, such as the Mammoth Cave in Kentucky, and Wyandotte Cave in Indiana, are formed. In these caves, as in many others, the beautiful crystalline columns known as stalactites and stalagmites are often formed; they result from the decomposition of the bicarbonate when exposed to the air. To illustrate this, pass carbon dioxide gas into lime water until the precipitate which is formed dissolves, and then allow the solution to stand for sometime or become heated. In either case, the carbon dioxide is liberated, causing the lime to re-appear. This same experiment can be used to illustrate how minerals are brought to the surface by geysers and hot springs. Certain gases in solution in water help to dissolve the mineral matter with which they come in contact. If water contains much gas and if the gas escapes, as it is likely to when it is heated or comes into the air, some of the dissolved mineral matter held may be deposited. Warm spring water, when it is cooled, often gives up some of the dis ovled mineral matter which was held in solution. This is shown by making a saturated solution of saltpeter or of common salt in hot water, and allowing it to cool; the excess crystallizes out. The cause of the continuous geysers may be explained by pouring water on a piece of fresh, unslacked lime. The chemical combination which takes place between the lime and water produces heat enough to raise water to the boiling point to evolve steam.

The chemical changes which result from atmosphere agencies are mostly due to oxygen. The chief among the rock substances with which oxygen unites is iron. This process is known as oxidation and is illustrated familiarly by the rusting of iron objects in damp weather, the rust being a chemical combination of iron, oxygen, and water. The brick-red and yellow colors of many soils and rocks are due to the oxidation of the iron. Thus rocks are disintegrated and gradually transformed into soil by the process of oxidation.

Many facts of great interest in the study of botany have been worked out in the chemical laboratory. These same experiments are almost as interesting to the beginner as to the teacher, and they explain many things which otherwise have no meaning to the pupil. The value of applying chemistry to the study of plants can be shown by a few illustrations. Some seeds are mostly starch, others proteids, and still others contain a large percentage of oil; as is shown in the case of corn, peas, and the castor bean. Corn, wheat, and rice can be shown to contain starch by pulverizing a few kernels and then making a paste by adding hot water; after an iodine solution is added, the blue color indicates starch. Grind up a few peas or beans and add a few drops of strong nitric acid and then a small amount of strong ammonia. The orange color indicates proteid material. To show whether or not the castor beans contain oil, mash a few of them, place the contents in a test-tube and treat with benzene. Shake well and pour the solution on a sheet of glazed paper and notice the change when held to the light.

The fact that starch is being changed to grape sugar in the germination of corn, can be easily shown if we cut lengthwise through the embryos of half a dozen kernels that have just begun to germinate, place them in a test tube, treat with Fehling's solution, and heat almost to the boiling point. The product will be found to give a re-action for the presence of sugar along the edge of the cotyledons and between them and the endosperms. In order to show in what form food passes through the stem of the plant, use the following experiment. Two thistle tubes are partly filled, one with starch and water, the other with sugar and water, and a piece of parchment paper tied over the end of each. The lower ends of both tubes are placed in a glass dish under water. After twenty-four hours the water in each dish is tested for starch and sugar. We find that only the sugar which has been dissolved by the water can pass through the membrane.

In considering the growth and the source of the foods of plants, it is necessary to describe the function of the green parts (leaves and young shoots) for it is through these that the work is carried on. The simple fact that the air and the soil are the chief sources and that the sun furnishes the energy, is not enough. The pupil must learn by experiments in order to appreciate the actual condition which exists. If we clasp strips of black cloth or card-board over a portion of several leaves of a geranium or bean, place the plant in a sunny place for two days, and then remove the covered leaves after a bright day of sunlight, we find, after extracting the chlorophyll by placing the leaves in alcohol, that the part of the leaf excluded from the sunlight does not give a test for starch. This shows very plainly that in order to grow, plants must have sunlight. To see a certain fact worked out by experiment is worth more than a library of books on the subject. Children are not old enough to appreciate the writings of the best authorities on the subject.

The plant's need of air can be shown by coating parts of the leaves with vaseline, which prevents the air from coming into contact with the leaf. These coated portions give no test for starch, showing that the air must furnish a large part of the food. Upon seeing this experiment performed, the class might raise the question as to whether or not plants used the same kind of air that animals do. The teacher might call their attention to the different constitutents of the air, which they had previously studied, or may perform some experiments to show the difference between oxygen, nitrogen, and carbon dioxide. After showing the difference between the properties of carbon dioxide and oxygen, the teacher may perform a simple experiment to prove to the class which of the two gases is used by plants. Over some small green water weeds in a glass jar, place a funnel upside down, and invert a test tube full of water over the neck of the funnel; bubbles will rise and, if the jar stands in the sunlight for a few days, enough bubbles may be collected to test for oxygen. The pupil will see for himself that plants and animals differ in what they take from the air and give out to it.

Every one is aware of the fact that our markets have been flooded with adulterated foods of all kinds. There has been adulteration not only in foods, but also in drugs and even in dry goods. Much has been done by Dr. Harvey W. Wiley and his assistants, to rid the markets of articles sold under false claims, but the work has had only a beginning. The only way in which the country will completely eradicate this gross evil from American markets is by drilling into every boy and girl in every state of the union a knowledge of the injurious effects of poor foods and by showing them by repeated experiments conducted before the class that many articles of food and even of clothing are not just what they are supposed to be.

One does not need to go far for illustrations. Take, for instance, tea and coffee, both of which are used in great quantities by all civilized countries, and see how easily we may test for many common impurities. The substitutes for coffee are roasted cereals or bread with or without the addition of ground coffee. Their extracts may not be entirely free from caffein and tannin, but in any case will contain less than genuine coffee. The bitter taste and dark color are both due to caramel, the substitute mentioned above. The directions for testing are as follows. Spread the coffee out on a piece of clean white paper, examine it with a small hand lens; if any cereal grains are present, they may be distinguished by their shiny appearance; while if chicory is present, it will be recognized since it has a dark gummy appearance. Another way to test coffee is to take a teaspoonful of ground coffee and shake it up thoroughly with water; after standing for a few minutes most of the coffee will float, while the chicory and cereals will sink, coloring the water a strong brownish tint. Of course it is to be expected that a few coffee grains will sink also, but not many. In order to test for starch, all that is necessary is to add a teaspoonful of the ground specimen to be tested, to a cup of warm water, to boil for three minutes, and to filter through bone black to decolorize the solution. Now test the filtrate with iodine solution. The blue color should be absent; if present, the sample contains cereal or bread. To apply a chemical test for chicory, boil some of the sample to be tested, in water to which a little sodium carbonate has been added, decant, wash, and treat the residue with weak solution of bleaching powder for half a day. It will be observed that the chicory will form a light layer on the surface, while the coffee forms a dark layer at the bottom.

In testing for tea it is only necessary to test for tannin and caffein, two constituents of tea which are obtained from a variety of plants known as thea. Make an infusion by steeping the leaves in boiling water for about five minutes, and decant off the clear solution. Now add a few drops of the solution to a weak starch solution faintly colored with iodine; if tannin is present the color will fade, thus showing the presence of tea. To some of the tea extract add about one-tenth its volume of chloroform and shake; after settling, draw off the water and evaporate the chloroform solution to dryness on a water bath. The residue should be a clear, crystalline, bitter substance, which is the caffein of the tea.

Milk is sometimes adulterated with formaldehyde and boric acid, which are no more nor less than embalming fluids. Both of these are very harmful, especially the former. The untimely death of many babies has resulted from no other cause. To test for these is a very simple process, which can be carried out by any teacher who is familiar with laboratory experiments. Place in a test tube about eight cubic centimeters or about 10 grams of milk to be tested and add an equal volume of strong oil of vitriol or hydrochloric acid, and a piece of iron alum about the size of a pinhead. Now mix the liquids very carefully by rotary motion. Next place the test tube in a vessel of boiling water, after it stands a few minutes a purple-colored mixture will appear if the formaldehyde is present. If any coal-tar coloring had been added to the milk, it will be shown by the pinkish color upon the addition of the acid alone. To detect boric acid or borax in milk, dissolve one gram of alum in one and a half ounces or fifty grams of water and then add about one ounce or thirty grams of milk; after shaking vigorously, filter, pour a small amount into a test-tube and add a few drops of hydrochloric acid. Now saturate a piece of turmeric paper with this mixture and hold over a flame to dry. The color should be cherry-red, but will turn to a dark green color on the addition of a drop of ammonia, if boric acid is present.

Sometimes artificial coloring matter is put in candies and jellies instead of the juice of fruit. The test for the adulterants may be conducted as follows. Place some of the sample in a small amount of water. While the solution is boiling, place in the liquid a few pieces of white woolen cloth and continue to boil for ten minutes, now remove the cloth and wash in hot water. If the cloth is brightly colored, the presence of artificial dyes is shown. If one wishes to make the test more certain, boil the colored cloth in dilute ammonia for five minutes, and the coloring matter will be dissolved.

One way of adultering black pepper is by coating tapioca with lamp black. Since the topioca is largely starch, it is only necessary to grind a few kernels to a powder, treat with hot water to make a paste of it, and then apply the iodine solution test.

Existing almost everywhere about us, in water, food, air, and the soil, are millions of bacteria or germs, which play a tremendous part in shaping the destiny of man. They cause fermentation, decay, and over one half of the diseases of the human race. Tuberculosis, typhoid fever, diphtheria, pneumonia, blood-poisoning, and syphilis will serve as illustrations of dreadful germ diseases which occasion the greater part of the present misery of this world. This condition might almost be eradicated if the world was made cleaner and better through the co-operation of all young persons, who are now growing up to be our future home-makers. The death of over 3,000,000 of people yearly in Europe and America can be directly traced to bacteria. The sad thing of it all, is that a very large proportion of these deaths results from preventable diseases which might be eliminated if people were sufficiently educated to take proper care of their civic and domestic life.

In order to test for the presence of bacteria of any kind, it becomes necessary to give favorable conditions for growth in what is known as a pure culture. This is done by first growing the bacteria in some medium such as beef broth, gelatin, or potato, and then examining them under a high power microscope. As the beef broth may be slightly acid, a little baking soda or some other alkali must be added to make it feebly alkaline; test it with litmus paper so that an excess is not added. This liquid should be carefully sterilized before use, by heating to such a temperature as to kill all life that might be there. To prepare the gelatin medium it is only necessary to add gelatin to the above beef broth or bouillon. The gelatin is much better suited to tests for specific kinds of bacteria; since in a liquid the bacteria are constantly moving and hence mixing, but in the gelatin, which is a solid, a bacterium is fixed at one spot. Next run a thin layer of the gelatin medium into the bottom part of some Petri dishes, cover, and sterilize for a half hour. This sterilization should be repeated for three days in succession. Be careful that the gelatin does not touch the cover. Then allow it to cool so as to form a plate in the bottom of the dishes. Instead of Petri dishes, small bottles, test-tubes, or even tumblers may be used with as good success.

The teacher may now select for use some receptacle in which the gelatin plates have remained sterile for several days. If she wants to demonstrate to the class the fact that dirt contains bacteria, she may select some boy who is accustomed to come to school with dirty hands and face and have him rub his dirty finger across the gelatine. The cover is now put on quickly and the dish set aside for several days. The bacteria will grow rapidly in this medium, and in a few day's time if a small particle is mounted on a slide and examined under a high power microscope, it will be found to contain colonies of several different kinds of bacteria. Each member of the class or school may be allowed to look at the bacteria which were collected from the finger of a dirty boy. Seeing great numbers of germs moving about in the gelatin, and knowing that they come from the dirt on his hands, will so impress the boy that he will try his best to keep clean. The teacher can now explain that all dirt contains thousands of disease germs which may cause death, if proper precautions are not taken. Again the teacher can show the difference between a dirty and clean home or street by exposing a dish for five minutes in each place and then following out the above experiment. The same experiment can be used to show the advantage of dusting a living room or school room with a damp cloth rather than with a feather duster, which has a tendency to stir up millions of germs in the room. A comparison of the results in each case will be most impressive.

No other subject is demanding so much attention at the present time as the study of agriculture. Schools for this purpose are springing up in many parts of the country. It has been placed upon the list of required subjects in this and many other states. Now comes the call for teachers who can handle the subject effectively, not only in the high school, but in the rural school as well. To this end it is quite necessary that a fair knowledge of its principles should be thoroughly acquired by all teachers. This subject is even more beneficial to the rural school teacher, for it is in these communities that its teaching will be of greatest value. To be able to show how two bushels of wheat or corn can grow where one grows now, to show how two people can get a good living off the same piece of land that produces hardly a living for one, and then to show that this gain results from economic principles which any one may apply, is a noble mission well worthy of the time and energies of our best American teachers. Prof. G. F. Warren says, "The teaching of agriculture will make better money. It will lead more boys to choose farming as a profession, because it will open up a field for intellectual life whose existence they never suspected. But the great reason for this work is that it is one of the best means of training a student's mind, and it is one of the best means because it studies the things that come within his experience—the things with which and by which he lives." "Then, in the next place," says Prof. C. W. Pourkett, "agriculture is the most practical of the sciences; the knowledge acquired from it can at once be applied to life. It is also practical in that it shows the relation between cause and effect. It is not sufficient that a man should know that clover increases the fertility of the land. He should know how it does this, just as he knows how the earth rotates on its axis. It is not enough for a man to be told that good plowing makes better crops. He must know why it does this, just as he knows how his multiplication table is made. Both as an intelligent and as a practical being he is interested in knowing how bacteria cause milk to sour; why ashes are helpful to plants; why drainage is good for the soil; and countless other things that are as easily taught as the facts of arithmetic and of geography, and are far more interesting and useful."

"In order to understand more perfectly the nature of the substances dealt with so as to make the most intelligent use of them," says Prof. Harry Snyder, "it is necessary to have a practical knowledge of some of the laws of chemistry and of the properties of some elements and compounds which enter into the composition of plant and animal bodies." Not all the elements found in the soil are beneficial to plant life, and so it is necessary to know which ones are essential and how they affect the growth of plants. Potassium is a very common element, found in all land plants. The alkalinity of the ashes of oak, maple, etc., is due to it, and it is from this source that the potash was obtained to make the soft soap that our grandparents used. The f. action of potassium is apparently to aid in the production and transportation of the carbohydrate compounds ,as starch and sugar, and thus indirectly in the formation of organic matter. Weak and sickly plants are always deficient in potash. This fact is in accord with the known stimulating effect of potassium on the formation of cellulose in plant growth, since it has been shown that lodging is due in some cases to lack of cellulose compounds in the cell walls of the plant.

No new plant cells can be produced without the aid of calcium. Many investigators have found that whenever it is withheld the growth of the plant is restricted. Some plants, after their growth has been checked by withholding calcium, will show increased vigor within a few hours after it is supplied. This seems to show that it is practically essential to the metabolic processes in plants. Nine-tenths of the calcium found in plants occur in the straw, and it is for this reason that there is generally enough present, since most of the straw is returned to the soil as manure. Potassium and phosphorus differ from calcium in this respect, for 45 to 80 per cent. of the ash of seeds of all grains is composed of compounds of these two elements. So in order to retain a constant supply in the soil it is necessary to feed the grain to the stock and then return these elements to the soil in the manure or to supply some artificial fertilizer. The function of phosphorus is to aid in the production and transformation of proteids of all plants. It is essential to all plants, especially in the early stages of their development, for 80 per cent. of the total amount of it is assimilated by wheat, for instance, in the first fifty days.

To the agricultural student nitrogen plays a most important part in the role of plant and animal economy. It forms many essential compounds that take an important part in all organic life. Humus, the organic matter of the soil, which results from decayed vegetable matter, is composed of 6-10 per cent, of nitrogen. This is in the form of organic nitrogen and must be transformed into nitrates, as potassium or sodium, before it is taken up by plants. Plants growing on soil which is rich in nitrates have a luxuriant foliage, and it is quite easy to tell when they are lacking. Since the straw contains most of the nitrogen, it is removed very rapidly from the soil, especially in the case of fodder. Manure, artificial fertilizers, or leguminous plants are means by which it can be replaced in the soil. One of the most interesting phases of soil life is the process called nitrification, which is due to the activity of very minute germs or bacteria. The principal food of these small vegetable germs is the humus of the soil. They are capable of restoring the free nitrogen of the soil into the roots of leguminous plants. This process, known as fixation of nitrogen, replenishes the soil with a good supply of nitrogen.

Sometimes the soil may be too alkali or too acid in re-action for some plants. To determine this, all that is necessary is to mix some soil in water, decant the suppernatent liquid, and test with litmus paper. If it is acid, lime should be added; if alkali, it should be drained. Deep plowing aids wonderfully and should be carried on in all soils that are more or less alkali, as it lessens the rate of evaporation and hence lessens the rate of salt deposit on the surface. In this way great quantities of land have been reclaimed in many parts of the United States. This is a simple method but it proves very effective. To know just what the need is, is a greater task than to apply the remedy. With a knowledge of these facts it is possible to give considerable help to farmers in backward communities.

After this brief discussion of the correlation of chemistry with the different sciences, I think you will agree that a knowledge of its fundamental principles is indispensable to a teacher engaged in teaching science. Almost all the experiments which have been taken to illustrate the different sciences, can be understood by the upper grades, and the first year high school student can even perform many of them for himself. Then, too, if many of these common principles were drilled into the pupils of the upper grades and in the first year high school, it would not be such a difficult task to teach chemistry in our secondary schools. The amount of chemicals for any one branch of science is very small and the apparatus simple and inexpensive. The cost for equipment in all cases will not amount to much and the money could not be expended for a better purpose.

In closing let me quote from Prof. Harry Snyder, in order to give you his conception as to the place which chemistry should have among the sciences. "The laws of nature, as far as they are known, are set forth in the various sciences, among which chemistry occupies a prominent place. In every day life, chemistry takes an important part because it is the science which treats of the composition and use of substances found in nature. Plants and animal foods which are essential for life are simply mechanical mixtures of various forms of matter which are constantly undergoing changes and exemplifying the laws of chemistry. Although not all of the laws relating to the chemistry of plant and animal life have been discovered, many of those relating to soils and foods, are known and can be applied to every day affairs."

Hugh Allen Murta.

PRIMITIVE ARITHMETIC AND NUMBER SYSTEMS.

In the high state of civilization which had grown up in Greece about the third century before Christ, the sciences of astronomy, geometry and trigonometry were fairly well established, while arithmetic, though included among the branches of learning of the period, had not been advanced nearly so far. The study of geometry, with its close relation to logic and with the range it affords to the imagination in its search for the infinite, seems to have been more congenial to the Greek mind. So what knowledge the Greeks had of arithmetic is thought to have been obtained largely from others, chiefly the Phoenicians and the Egyptians, though the earlier development of mathematics is surrounded with more or less uncertainty.

The commercial interests of Sidon, Tyre, and other Eastern Mediterranean cities naturally developed a certain knowledge of the art of calculation. This probably consisted only of the fundamental processes, performed mechanically and acquired mostly by observation and experience, with little or no knowledge of the theory of arithmetic or of the science of numbers. But the Phoenicians were only the traders of the time, not its thinkers; and so we look elsewhere for the real beginnings of this science. Now the Phoenicians had important trading relations with the Chaldeans—the astronomers of the time—who undoubtedly were somewhat advanced in the processes of calculation. Consequently there had grown up in Chaldea a kind of practical arithmetic, including possibly a few of the properties of numbers; and whatever knowledge they had thus gained was transmitted by them, through the Phoenicians, to the Greeks.

In Egypt, also, there had grown up, probably earlier even than among the Chaldeans, a form of mathematical science which may perhaps be called arithmetic. The knowledge which we possess of their progress in this line is contained in a treatise by a certain priest, Ahmes, known also as the first man to have used the equation in solving problems. This treatise gives a number of rules for the solution of arithmetical problems, but the processes by which the results are obtained are in general not given. The treatise is important, however, because it shows that the Egyptians expressed all fractional values as the sum of two or more fractions, each of which had the numerator equal to unity. For example, the fraction 7-12 would be given in the form, 1-3 plus 1-4. The Babylonians had the same method of expressing fractions except that in their scheme all the denominators were either factors or multiples of 60. The Greeks seem to have followed the example of the Egyptians, and this form of writing fractions continued in practice far into the Christian era, the advantage being that in their reduction only the denominators need be considered. In multiplication, the Egyptians resorted to the scheme of repeatedly doubling the number to be multiplied and them adding it a certain number of times until the desired product was obtained. Thus to multiply any number **n** by 11, they would first double it, getting **2n**; double this result. obtaining **4n**; double again, getting **8n**; and then add **2n** and **n** to the result, and in this way arrive at the produce of **n** by **11**.

Though the subject of arithmetic is thus seen to have made a little progress among several of the nations—China and India should also be included in this list—yet in every one it failed to reach the same state of development to which the other branches of learning had attained. This retarded growth of a study which the common people of today consider, perhaps, of greatest practical value, was due in large measure to the number systems which generally prevailed at that time. Very little was known about the science of numbers, and methods of numeration and notation were extremely clumsy. Even the simplest processes of arithmetic, such as addition or substraction, were impossible without some mechanical device. All primitive people had to depend, therefore, upon some kind of counting board for all calculations. Thus the abacus, or swan-pan, was invented and used in nearly the same form by peoples so widely separated as the Chinese, Hindoos, Greeks, Egyptians, Romans, and Aztecs; and it is in common use even today in Russia, China, and Japan. Since there is, then, so close a relation between a number system and the processes of calculation, it seems worth while to note a few of the main stages in the development of the present system.

In learning to count the child instinctively uses his fingers to represent numbers. In so doing he is merely living over the experience of the race. For, so far as records go, all early races and the uncivilized tribes of the present do the same. It is natural that this should have been the case, for the fiingers are always convenient for use and are of about the right number; for primitive man, just as the child, could not think numbers much above ten. In fact, many of the early languages have words for only the first three or four numbers, and all numbers above three or four are represented by a word meaning heap or many. Moreover, the word which is used for this first number is usually derived from the name of the finger which was used to designate that number.

As the tribes advanced in intelligence and their power of comprehending number increased, they began generally to reckon things in tens and multiples of ten. This was true of nearly all early people, though there were a few exceptions. For the natives of Java and the Aztecs of Mexico probably counted in multiples of five, and the latter seem to have used the number twenty also for this purpose. This would seem to indicate that they had probably used both fingers and toes in counting. Only two tribes, one in Africa and the other in New Zealand, are known to have s system not based upon multiples of either five, ten, or twenty. The former are said to count in multiples of seven, and the latter in multiples of eleven. But generally the digits of the two hands were used in counting.

and thus ten came to be the base of numeration wherever a system was developed. This is shown by the fact that in nearly all languages the words for the numbers above ten are either derived from, or are compounds of, the number from one to ten. For example, in English the number fifteen represents five and ten, while twenty represents twice-ten. The numbers eleven and twelve, though at first thought to be exceptions, are found to be derived from Anglo-Saxon roots meaning respectively one-and-ten and two-and-ten.

In a general way, we have now seen how our system of numeration came to be built upon a decimal basis. But the early methods of expressing these numbers in writing were of such nature that the processes of calculation, even among the progressive races, still remained a matter of great difficulty. A better system of notation had to be found by which numbers could be represented briefly by means of symbols before facility in processes could be possible.

Few primitive people could count much beyond ten with ease, or think in terms of larger numbers. When they had need to represent such numbers, it was done by having one man count the things or units on his fingers, while a second man would raise a finger every time the first man counted ten, until all his fingers had been raised, thus indicating one hundred. If it was necessary to count higher, a third man would tally the hundreds on his fingers in the same way. Unconsciously they were using the decimal system in which the fingers of the first man represented the units, those of the second man the tens, and so on. By thus representing concretely these larger numbers they became able gradually to comprehend and use such numbers. Soon the more progressive races invented an instrument to do the work of the three men, and we have the abacus, or swan-pan, referred to above. The abacus was a board in which grooves had been cut, or one covered with sand in which grooves could be made with the finger. Pebbles were used as counters. As many of these were placed in the first groove as the number of units counted. When ten had been thus counted, one would be placed in the second, or tens, groove and the others removed, and this process repeated as often as necessary. Sometimes, as among the Chinese or Mexicans, the grooves were represented by parallel wires stretched in awooden frame on which beads or discs were strung, ten on each wire. As many beads on the first wire were pushed to one side of the frame as there were units to be represented; on the second wire, the number of beads used represented the number of tens; and so on. The instrument in this form was generally called a swan-pan, and when certain improvements had been made in it by which two numbers could be represented on it at one time, the processes of addition and subtraction could be performed by skilled operators with remarkable facility. This scheme was based upon the idea of a place or local value for each of the digits; and it would seem that among a people as ingenious as the Greeks, it would, by the use of symbols, have been developed into a similar system of notation. But the absence of the zero by which place value alone could be represented seems to have been a handicap, and civilization had to wait centuries yet before such a symbol came into use, first among the Hindoos, and then centuries longer before the system was perfected by the Arabs and by them introduced into Europe.

Until that time various means of writing numbers were used. The most primitive people simply used scratches or notches made in wood for this purpose; and as they rarely counted much above ten, this probably supplies their needs fairly well. But as civilization advanced, better systems were devised, even though these, too, were rather crude. In Egypt unity was represented by a vertical stroke, or straight line. This symbol was repeated as often as necessary up to ten. Later they invented a symbol for 10 and another for 100, and used these in the same way. Thus 235 would be represented in this scheme by the hundred's symbol used twice, the ten's symbol used three times, and the stroke five times, all written in succession.

The early Greeks are believed to have had a similar system, though no record of it exists. The Romans also used symbols for these numbers, but added others for five, fifty, five hundred, and a thousand. The symbol V for five is thought to have come from the shape of the open hand with the thumb extended, the sign among primitive men for that number, and the symbol X is believed to represent two V's written vertex to vertex. However this may have been, the Romans perfected the Egyptian system, and with the additional symbols, and the bar written over a character by which its value was multiplied by a thousand, were able to express all numbers as high as they wished to go. They also used the subtractive feature by which a symbol written before one of larger value decreased it by its own value. Thus IV represented four and XL stood for forty. This is the Roman system of numerals which we have today but which is now used chiefly for ordinal purposes, as the numbering of pages, paragraphs, etc.

Whatever system the early Greeks had was abandoned about the third century B. C., for a new system based upon the use of the letters of their alphabet as symbols. They used the first nine letters for the numbers from one to nine, the next nine letters for the numbers 10, 20, ...90, and the remaining letters together with three additional characters for the hundreds. Thus by the use of the letters and certain prefixes they were able to write all numbers as high as one hundred million. Though complete and logical, the system was of such nature that it was almost impossible to use it in computations; even the simple processes could be performed only by those of exceptional genius. Arithmetical operations were, therefore, performed on the abacus and by means of tables committed to memory, and the results only written in this system. Without doubt the adoption of this cumbersome system of notation was unfortunate for the progress of arithmetic. And consequently all the sciences in which arithmetical computations were necessary were retarded in their development until the adoption of the so-called Arabic system, the origin and growth of which will now be briefly traced.

The Arabs were traders, and in the course of their commercial relations with the Hindoos, they became interested in certain works of the latter on mathematics. These treatises were largely on algebra and trigonometry, but contained also much that is at present embraced in arithmetic. The following subjects are among those treated: the fundamental processes of addition, subtraction, multiplication, and division; involution and evolution; the reduction of fractions; the "rule of three," or proportion; interest, discount, and exchange; progressions; and mensuration. But the Arabs were especially interested in the decimal system of notation which they found in use among the Hindoos. This was in the eighth century and is the earliest record of our system of notation, though it must have been in use for at least a century before this time. It contained symbols to represent the numbers from one to nine and also the very important symbol for zero. It was a well-thought-out scheme, in which each symbol had not only its own value but also a place or local value, a feature found in no other early system. Thus each character represented a certain number of units, tens, or hundreds, according to the place in which it stood, and absence of value in any of these positions was represented by the zero. It was in general use among the Hindoo merchants; and as the Arabs had no system of their own, they forthwith adopted this one, symbols and all, and soon became familiar with it and its use in arithmetical computations. Thus by the end of the eighth century, they were in possession of a good system of notation, understood the Hindoo works on algebra and arithmetic, and so were well equipped for the great advance they were to make in mathematics during the celebrated period when the Mohammedan caliphs ruled at Bagdad.

The introduction of the new system of notation into Europe followed, but only after a lapse of several centuries. From Bagdad, Arabian learning was carried to Spain, then under Mohammedan rule. Here great schools were founded and flourished during the eleventh and twelfth centuries, and knowledge of the Hindoo system was obtained by European scholars in attendance at these schools. But the chief impulse toward its introduction came from Italy, whose merchants had learned of the system and its use from their commercial relations with the East. They soon recognized its superiority over the Roman system, and it rapidly came into general use among the merchant class, and later among the merchants of Europe generally. The Arabic notation was also used in the almanacs and calendars of this period, was generally used in works on science, and astronomical tables and computations were in the new system; and so by the middle of the fifteenth century, aided by the invention of printing, it had completed its conquest of Europe.

The Arabic characters or symbols which were introduced with the system were probably the first letters of an early Hindoo alphabet. The origin of the zero, however, is unknown, but it may represent a closed hand, the sign used among primitive men for the absence of number. On account of the lapse of time since the Arabs adopted the system, many changes have taken place in the characters, and they now bear little resemblance to their original form. Only the 1, 7, and 0 would perhaps be recognized in the original, though the early symbols for 5 and 6 look much like the present 4 and 5 respectively. The forms which the Italian merchants of the thirteenth century used, however, are readily recognized, and are practically the same as we have them today. Variations have developed in the forms of several of the figures from time to time, but these have all been discarded. On the other hand, the evolution of the characters still used in the East has been of such nature that there is now no resemblance whatever between the two sets of symbols with the exception of the characters 1 and 9. Chas. R. Shultz.

THE TEACHING OF PHYSIOLOGY IN THE GRADES.

The real object of the study of physiology in the public schools is to teach young people how to keep well and strong and to avoid evil habits that destroy character as well as health. Ill health is the result of our ignorance of the laws of hygiene, and health may be secured and guarded by knowledge gained during our school life.

It will not be found profitable or practical to attempt much in the matter of teaching physiology before the fourth year of school life. If anything is done, it should be by way of familiar talks on the most common things about health, such as dental sanitation, care of skin, care of ears and eyes, importance of fresh air, catching of diseases and colds, mouth-breathing. It might be well to make mention of the evils of alcoholism, the tobacco and the patent-medicine evils. Hygiene should be so taught that children will cultivate habits of health and see clearly the relation of health and vitality to present happiness and future efficiency.

The subject of the care of the teeth of children in the public schools should enlist every force of society, private and public, as bad condition of the teeth is only a symptom of general physical ill-being and indicates other deficiencies in the body of the child and of his parents as well. Scientists in many branches have recently pointed out and demonstrated in a striking manner the close relation existing between sound teeth and sound minds and bodies. The bacteriologist has found the uncared-for mouth the best possible place for the cultivation of bacteria. It has been aptly called the prize bacterial ground of the world. Disease germs lose their strength and activity when the mouth is kept clean. A clean mouth and clean teeth furnish the best and surest safeguard against disease.

The main factors entering into this problem of caring for the teeth of school children are:

1. The general health of the individual: good health favors sound teeth and poor health favors decay of teeth.

2. Character of oral secretions: secretions which are normal in quantity and re-action favor sound teeth; secretions abnormal in quantity and re-action favor decay of the teeth.

3. The use of the teeth: teeth which are regularly exercised are less liable to decay than those insufficiently exercised.

4. The presence of bacteria in the mouth: bacteria play an important role in the destruction of the teeth; by controlling the life of the oral bacteria decay is limited.

5. The general cleanliness of the teeth and the mouth: if the teeth can be kept clean, decay can be reduced to very small proportions.

The following is a suggestive outline to be used in developing the subject of Dental Sanitation:

Hygiene of mouth and teeth.

1.—Conditions favorable to growth of bacteria.
- a. Warmth.
- b. Moisture.
- c. Organic matter.

2. Results of bacteria in the mouth.
- a. Gumboils.
- b. Decay.
- c. Changed condition of the saliva.
- d. Tartar.
- e. Chemical poisons.

3. Precautions.
- a. Proper food.
- b. Cleansing.

4. Kinds of fool.
- a. Bone-forming food, such as eggs, meat, and bread.
- b. Lime salts.

5. Care of the teeth.
- 1. Time to use tooth brush.
- 2. How to use it.
- 3. Additional safeguards.
  - a. Powder.
  - b. Floss.
  - c. Tooth-picks.
- 4. Visits to dentists at stated intervals.

3. Results of neglect.
- 1. Insomnia.
- 2. Melancholia.
- 3. Eye trouble.
- 4. Ear trouble.
- 5. Swelling of glands.
- 6. Neurasthenia.

Other subjects might be developed in a similar manner.

The regular study of physiology should begin about the fourth year of the child's school life. A good-text book should form the basis of this work. A great variety of exercises must be undertaken to fasten the facts in the pupil's memory. The text-book is only a helper, a basis on which to do good work. Every topic in the text should be more fully explained and illustrated. The teacher should gradually and systematically accumulate a certain amount of supplementary material. In a note book she should keep outlines of each topic taught, quotations from collaterial reading, a list of general and special topics of practical experiments and their explanation; test questions for review, practical questions of all kinds; blackboard sketches, original or suggested by one's reading. Newspapers and magazines abound in curious bits of information, odd and interesting facts, and other instructive matter pertaining to physiology and hygiene, which should be culled and put into a scrap book.

In order to do good work in the teaching of physiology, it is well to have charts and models which should be used every day in recitation, as whatever we see with our eyes and feel with our fingers and our hands in the way of experiment and illustrations in physiology, is worth far more than merely trying to master the printed page. It is also important to emphasize the fact that physiological processes can never be understood unless the pupil is given some idea of at least some of the simpler principles of chemistry.

While physiology is one of the biological sciences it should be clearly recognized that it is not, like botany or zoology, a science of observation and description; but rather, like physics or chemistry, a science of experiment. The pupil must become more or less familiar with carbon, hydrogen, oxygen, and nitrogen; he must know how to test for carbon dioxide, for acids, for alkalis. He must learn something of the common processes of oxidation and evaporation. Unless these lessons are taught early in the course and taught by experiment, the pupil will find his foundation weak when he attacks the more difficult processes involved in digestion, respiration, and excretion. Most of these simple lessons can be taught with common matches, a few chemicals, and some pieces of glassware. In the subject of foods the pupil should familiarize himself by laboratory experiment with nutrients found most commonly in foods, such as carbohydrates, proteids, and fats. Most of the experiments in food analysis can be carried on successfully at home if necessary chemicals and test tubes are provided for children. After testing several foods for presence or absence of proteids, fats, mineral matter, and water, at home or in school and after a comparison of results obtained, each pupil has a concrete idea of some of the most important compounds he is to meet continually as ingredients of his food, as components of blood, or as essential constituents of his body. It is impossible to demonstrate the uses of the various nutrients, so with laboratory study there must be combined a considerable amount of class-room instruction. Laboratory work must always be supplemented by vigorous questioning in order to keep clear in the mind of the pupil the essential points in each experiment and the relation of the various facts learned.

The study of half a dozen of the common tissues should next be undertaken because they are met with again and again in considering the processes of digestion, circulation, and respiration. In the study of the bony tissue we can obtain a piece of bone from the butcher and from the specimen learn the essential characteristics of bone, cartilage, connective tissue, and fatty tissue. If we wish to take up the study of muscle and are aiming to lead the pupil to get clear ideas of its structure, we can do so by studying pieces of beefsteak; this study should explain muscle tissue and serve to review fat and connective tissue. If we wish to study the action and the position of the muscles of the arm, for instance, we can do so by some very simple experiments. To show how biceps muscles relax and contact, lay your left fore-arm on a table, and grasp with the right hand the mass of flesh on the front of the upper arm. Now gradually raise the fore-arm, keeping the elbow on the table; note that the muscle thickens as the hand rises. The pupil can make out, too, that the tendon of this muscle is attached in the region of the fore-arm; and, after grasping this tendon between the thumb and forefinger, he can by turning the fore-arm satisfy himself that his muscle is joined to the radius and not to the ulna. Similar study of the fleshy party of the fore-arm reveals to the pupil the fact that some of the muscles controlling the fingers are located in this region. By opening and closing his fingers he can trace the long tendons which pull on the fingers, from the fore-arm along the wrist and the palm or the back of the hand to the bone of the fingers.

The essential points in the structure of the skin, of the nails, and of the hair, of the action of blood vessels, sweat glands, and nerves in the hand can also be found by individual pupils.

The study of cell structure can now be introduced, and a few days spent on the study of the amoeba. The pupil should be led to see that these single-celled animals carry on processes essentially the same in kind as those performed by the highest animals. It is well to consider some of the most important functions carried on by animal cells, such as locomotion, taking in of food, digestion, circulation, and assimilation, the taking in of oxygen, and oxidation.

In the study of the separate bones the pupil should be trained to examine his own body with a skeleton before him. Better still, two friends should work thus together, each serving as a model to the other. The habit of looking at the living body with anatomical eyes and the eyes, too, at our fingers' ends, cannot be too highly estimated. The following are exercises which might be used in the study of the spine, the shoulder, and the arm.

1. Run fingers up and down the middle of the back. Tell what you feel. Notice the knobs all in a row. How many? Twenty-four little bones, like beads strung on a string; each bone has sharp points sticking out, and each has hooks, with which it holds on to the other, and which help tie each to its mate.

2. Let each one bend over and then back very far and very fast. Notice that this pile of twenty-four bones neither rattles nor cracks as they sway to and fro. Little soft cushions of fat-elastic, like a rubber ball, and tiny drops of oil are between the bones so that they cannot rub or grate on each other.

3. Move your shoulder joint. Notice that you can turn it round

and round, up and down, backward and forward. The end of the arm-bone has a ball on it, which fits into a kind of cup; this cup is made by two bones touching each other at the shoulder. What are these two bones? Feel one, a large three-sided bone (shoulder blade) back of your shoulder. The other, the collar-bone, is plainly seen and felt running across the top of the chest from the breast bone to the shoulder. These two bones join at the shoulder, making a cup-like place in which the end of the arm-bone turns, like a ball in a socket.

4. Turn the hand over with the palm upwards and the edge of the fore-arm bone (ulna) can be felt from the olecranon to the prominent knob at the wrist. Turn the fore-arm over with the palm down, and the head of the ulna can be plainly felt and seen projecting at the back of the wrist.

Many other exercises might be employed in the teaching of this same thing. If you wish to teach cleanliness most effectively, devote a half dozen lessons to the study of bacteria. Let the children experiment at home with milk and with a hay infusion. Expose culture dishes containing nutrient agar to the air in a room before and after sweeping, and let the pupils note the growth of the colonies of bacteria day by day. Emphasize the filthiness and the danger of expectoration in public places, and call attention to the splendid work done by boards of health.

It will add greatly to the success of a teacher in physiology to be able to compare interesting facts and bits of information about common animals, birds, fishes, and insects, with the anatomy of the human structure. Children are by instinct comparative anatomists and physiologists, and the study of the human body offers rare opportunities to develop this instinct. Teeth are wonderfully interesting where studied comparatively and in relation to the food which the animal eats. Show them how the teeth of cows, horses and sheep differ from those of human beings, either by comparison with models or the real thing. Teach in what way the covering of man's body is different from that of horses, birds, fishes, and lobsters. Compare the digestive apparatus in sheep and birds; respiration in fishes, insects, and birds. Other profitable subjects for comparative study are the various methods of locomotion employed by vertebrates, also their method of getting food, and the ways in which they are protected.

Much of this observation can be done at home by the individual if once he asquires the habit of noting resemblances and differences. It may take longer to acquire these facts by observation than from text-book lessons, but the laboratory method is far better as the children manifest more interest and describe with greater clearness and accuracy. Physiology, indeed, need not be uninteresting and unprofitable if taught by laboratory method.

Ina C. Pratt.

The Normal Review

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There is a time to copy and a time not to copy. Copying—or imitation, as the social psychologist is more likely to say—results from a deep-rooted instinct that helps to keep civilization from slipping back. But it helps only, it doesn't do all; it must pull in harness—as evenly as possible—with innovation. Imitation may do much in retaining and handing on what is best of the achievement of humanity; but a good thing meant to feed the mind or soul, if only handed on, is likely to become "flat, stale, and unprofitable." Some one must come to humanity's need and make ideas and life both fresh and effective; that is, some one must initiate, must bring to us a new outlook and inspire us to a new response. Which sort of individual in the big mass of humanity do you want to be? Will you imitate only? Or will you sometimes lead, sometimes make a new beginning?

If you are going to be the innovator, the leader, the man who makes his world new, you might well begin now—but never with mere copying. To be sure the varieties of copying are unnumbered; in school and out, we copy hats, manners, voice, ideas, phraseology, somebody else's solution of a problem, and many another thing. Some of these are wholly bad, and of them there is no need to say more. Of the desirable kinds of copying most of us will instinctively do quite enough. The remainder, the kind of copying not recognizable at once as bad or as advisable, is the kind that tests the people who are fairly good or somewhat better. It tests you and me. This is the kind of copying that makes the distinction between the unquestioning henchman and the leader. If one has no care to be more than an imitater, he can find much that is good to copy; if he wants to count as much as possible as an individual, he must find some other path than copying.

To our sister institution at Lock Haven we extend our heartfelt sympathy as we record its loss in the death of its head. Dr. J. R. Flickinger, principal of the State Normal School, died a few weeks ago from heart disease. He was an able man, a graduate of Princeton, a lawyer, legislator, and teacher, The office of Principal of the Lock Haven Normal School he had filled for thirteen years. He had been, also, a member of the American Historical Association and of the Academy of Political and Social Sciences.

Faculty Notes.

Miss Thomas was one of the instructors at the Institute at Leisenring No. I., Dunbar Township, February 10.

Miss Mary Noss and Mrs. Fraser attended the Institute held at the Filbert School, Fairbank, Redstone Township, February 3. Miss Noss gave much pleasure by her playing on the piano, and Mrs. Fraser had an instructive talk on "Teaching Reading in the Primary Grades." Professor I. H. Hess is Supervising Principal. Mrs. Fraser was an instructor in the Institute held at Footedale, February 17; here, also, her subject was reading and she demonstrated her methods by work with a class of children.

Mr. Adams addressed the Institutes at Pricedale, Rostraver Township, February 3, and at Footedale, February 17.

Mr. Nethaway spoke on the subject of Physical Training at the following district institutes;—Centerville, Pa., January 20; New Salem, January 27; Hickory, Pa., February 2. After each address Mr. Nethaway spent a half hour in playing games with the children present, in order to demonstrate methods and types of games. Finally an appeal was made to school-boards, ministers, parents, and teachers to use their utmost endeavor to provide play and recreational facilities, and to plan for occasional picnics and festivals.

Miss Etta Lilley left California February 28 for Atlantic City, to spend a few days with her brother, Dr. Lilley of Brownsville, who is in ill health.

Miss Buckee has left for a short visit to the Normal School at Montclair, New Jersey, where Dr. Will S. Munroe is principal. From Montclair she goes to New York to attend a banquet given in honor of Mr. William Dean Howells, and a reception at the home of Mrs. Kate Douglas Wiggin Riggs.

During the last week of February Dr. Davis was present, as a delegate from Clark University, Worcester, Mass., at the celebration of the 125th anniversary of the founding of the University of Pittsburg. On the twenty-ninth the program included an address by Dr. Davis on "The Reciprocal Relations of Normal and High Schools."

Sara Penrod, 1912.

The Winter Meeting of the American Chemical Society.

During the Christmas holidays, from Tuesday, Dec. 26, to Saturday, Dec. 30, the American Chemical Society held its winter meeting in Washington, D. C. The society made its headquarters in the New Raleigh hotel and conducted the general program in the McKinley Manual Training High School. The attendance was the largest in the history of the society, over 500 members being present. Tuesday afternoon and evening, meetings were held for the eletion of officers and the discussion of some miscellaneous business. The first session of the general program took place in the McKinley High School, Wednesday forenoon. This was a joint meeting of the sections of the Chemical Education and Inorganic Chemistry Divisions; and in this session three papers on the teaching of physical chemistry were presented by A. A. Noyes, Massachusetts Institute of Technology; W. D. Bancroft, Cornell University; and H. C. Jones, Johns Hopkins. The reading of these papers was followed by a general discussion, in which several teachers of general chemistry, representing different universities, made severe criticism on the character of the work done in our secondary schools. In the afternoon three addresses were delivered, one by G. B. Frankfort, University of Minn., on "The Resins and Their Chemical Relations to the Terpenes"; another by H. P. Talbot, Massachusetts Institute of Technology, on "The Privileges and Responsibilities of the Chemical Analyst" and the third by Dr. A. T. Vage on "Oswald's Proposed International Institute of Chemistry." Thursday morning and both Friday morning and afternoon were given over to the presentation of papers on subjects relating to the following different divisions of chemistry,—Agriculture and Food, Biological, Physical and Inorganic, India Rubber, Pharmaceutical, Industrial, and Engineering, Organic and Fertilizer. The total number of papers presented, including all divisions, was 248. On Thursday afternoon the members of the society were taken on excursions to the Department of Agriculture, the Bureaus of Standards and Mines, and the Geophysical Laboratory of the Marine Hospital Service.

In the general assembly room of the McKinley High School on Thursday evening, Prof. Alexander Smith, Columbia University, the retiring President, gave his address before the members of the society on "An Early Physical Chemist." This was followed by a lecture by Prof. F. B. Kenrick, Toronto University, Toronto, Ontario, aided by Mr. H. E. Howe of the Bausch and Lomb Optical Company, on "Lantern Experiments on Reactions in Heterogeneous Systems." The annual banquet occurred Friday evening in the New Raleigh Hotel. A few business meetings were held Saturday morning and the society adjourned.

Before closing this paper I wish to present one point brought out by several university teachers of general and physical chemistry in regard to the amount and character of the chemistry taught in our secondary schools. They charge the teachers in the secondary schools with teaching erroneous ideas about the fundamental principles underlying chemistry. They made the statement that a student who knows nothing about chemistry will make better progress than one who has had a course in elementary chemistry, which consists of statements many of which are out of harmony with the modern conception. One instance will suffice. Nearly all elementary chemistries on the market, many of which are written by university men, defines an atom as the smallest particle of matter or the smallest indivisible particle of matter. Yet a few years ago Rutherford showed conclusively that radium atoms were transmuted into helium, thus proving the instability of the atom. Also, Sir J. J. Thompson in his work on electrons has proved atoms to be composed of a large number of positive and negative electrons. Since all lines of science are going forward with leaps and bounds, a text-book on any one division is almost out of date one year after publication, and this condition makes it necessary for a teacher to do considerable outside reading to keep abreast of the times.

Hugh Allen Murta.

Piano Recital by Mr. Mongino.

In the Normal Chapel, February 15th, Mr. S. Monguio, the eminent Spanish pianist, gave a recital which for display of virtuosity, real musicianship, and remarkable powers of tone and interpretation, was one of the most brilliant imaginable. A program of great variety and charm was presented. One of the serious numbers played was Mr. Monguio's Sonata in E major. This composition, which is written in the strict classic form, has themes of distinct musical value and an intensely strong structural and dynamic development. It abounds in passages which make difficult demands upon the performer. The complete program was as follows:

1. Debussy—Prelude .... A Minor
2. Monguio—Sonata .... E Major
   Allegro Vivo
   Andante.
   Allegretto.
   Allegro Maestoso.
3. Schumann—Intermezzo .... E Minor
4. Rossi
   Andantino .... G Major
   Allegro .... G Major
5. Schubert—Impromtu .... E Flat
6. Chopin
   a Mazurka .... C Sharp Minor
   b Study .... F Minor
7. Brahms—Hungarian Dances
   a D Minor
   b G Minor
   c D Minor

The Washington's Birthday Celebration.

On ye two and twentieth day of February, in ye year of our Lord nineteen hundred and twelve, ye students and pedagogues of ye California State Normal School celebrated in a very fitting way ye anniversary of ye birthday of our own George Washington, ye father of his countrie.

Countless fair lassies and brave laddies, attired mostly in ye Sunday-go-to-meeting clothes, crowned with mounds of powdered fluffiness and becurled periwigs vied with each other as tho' 'twere a beauty show. Ye beautiful flowered overskirts and filmy fichus set off ye girlish figures, while ye stocks and befrilled laces of ye youthful gallants presented them in ye latest colonial style.

Ye merrie assemblage gathered in ye spacious dining hall. Here under ye artistic and generous direction of Mr. Craven, ye business manager of ye school, ye hall was appropriately decorated with our national colors, and an elaborate banquet, consisting of all ye fruits of a bountiful harvest, was served. In ye centre at a circular table, covers were laid for twelve people.

All personal adornment was forgotten when, to ye notes of soul-stirring music, ye President and his dignified Cabinet together with their wives were ushered in and seated at ye centre table. 'Twould seem vain to claim ye skill to describe ye grandeur, ye glittering splendor of these personages.

Mr. Adams, Vice-President to his Excellency, presided as host. After ye banquet he presented in a pleasing and impressive way ye members of ye Cabinet. They severally spoke such thrilling words that ye patriotic soul of every American citizen was stirred. Justly are we proud of such capable and proficient men as his Honor, ye President, has selected for his Cabinet.

After a formal reception to General Washington and his Cabinet in ye library, ye enthusiastic company adjourned to ye chapel, where their patriotic spirit became further excited by ye stirring drama, "Soldiers Brave and Maidens Fair," enacted by ye worthy Middler class of ye aforesaid school.

Ye most pleasurable evening ended with the dancing of ye Minuet be ye President and Cabinet and the Ladies. Bess V. Minerd, 1912.

Toasts.

Toastmaster, (Frank J. Weigle) .... John Adams
Washington, the Citizen Ruler, (Campbell Yothers) .... Thomas Jefferson
Washington, the Statesman, (Oscar J. Reckard) .... Alexander Hamilton
Washington, the Great General, (J. Earl Long) .... General Knox
Washington, the Leader, (Harry E. Hackney) .... Edmund Randolph
Response, (S. E. Cowell) .... George Washington

The wives of the members of the cabinet were impersonated by Misses Prosser, Butts, Crossett, Gibson, Whyte, and McClintock.

The following was the cast for the play, "Soldiers Brave and Maidens Fair:"

John Tallmadge, Captain of Washington's Body-Guard...Joseph Stewart
Capt. Armstrong, a British Officer,....................Randolph Wycoff
Reuben Adamson, a Staunch Loyalist,...............Ernest R. Boucher
General George Clinton, Commanding the British Army at Philadelphia, Ben Crago
Marshall and Tarpo, Negro Servants Belonging to Mr. Adamson Jesse Wade and Otto McDonough
Ruth Adamson, Daughter of a Loyalist but Herself a Colonist Miss Margaret Decker
Patience Powell, Ruth's friend, a Faint-hearted Sympathizer with Both Sides, ... Miss Kate Craven

Soldiers, Neighbors, Friends, Children

Time of Play, 1777—Clinton's Evacuation of Philadelphia.

A period of three weeks elapses between Acts I and II.

Scene—Act I., Parlor in house of Reuben Adamson. Act II, The same.

The Model School.

Grade I.	Song	School
	Hurrah for Washington.	
	Our Flag.	
	Recitation.	
Grade II.	Song	Washington
	Flag Drill	School
	Three Soldier Boys.	
	Recitation	Frances Lamb
	Recitation	John Ludwick
	Dramatization	
Grade III.	Making a Flag.	
Grade IV.	Dialogue, Making of the First American Flag.	
	Exercise, Showing the Development of the United States Flag.	
	Song, Liberty.	
Grade V.	Washington and His Fortunes	Seven Girls
	A Washington Flag Salute.	
Grade VI.	Minuet.	
Grade VII.	Flag Drill.	
Grade VIII.	Honor to Washington.	

Physical Training Department.

The intra-class basket ball leagues have proved a thorough success, in so far as the conditions of the school would permit. In order that each of the fifteen teams might play one game each week, the schedule was arranged for Wednesday and Saturday afternoons. So many special examinations were held on these afternoons during the first hour and a half after lunch that league games, as such, both in the Junior and Senior classes were rendered impossible. The leagues were a positive success, however, in that from eighty to ninety students have played basket ball each week, many of whom never had handled a basket ball before and now have become devotees of the game. Another year the formation of such leagues will be demanded, and by a re-adjustment of the time of play the difficulty referred to above may be overcome. The Middlers and Academic schedules were the only ones carried out. The standing of teams in these leagues follows:

Middlers	Won	Lost	Percent.
W. & J.—Captain, Crago,	4	2	.666
State—Captain, Mankey	3	2	.600
Waynesburg—Captain, Stewart	2	3	.400
Pitt—Captain, Wycoff,	2	4	.333

Note: State and Waynesburg have a tie game to play off.

Academics	Games	Won	Lost	Tie	Percent.
California Normal—Capt., Humphries,	12	7	4	1	.636
Slippery Rock Normal—Capt. ,Glunt,	13	8	5	0	.615
Indiana Normal—Capt., Durston	11	2	8	1	.200

In addition to the league games a number of inter-class contests have been held. The inter-class series promises to be hotly contested.

On the evening of Feb. 21, the Senior basket ball team won a closely contested game from the Methodist Church League team which won the Church League series. The visitors were unfamiliar with the A. A. U. rules and fouled frequently as a consequence. The line-up follows:

Methodist Team		Senior Team
Edwards	Forward	Griffith
Croner	Forward	Howard
Coatsworth	Center	Cowell and Hay
Paxton	Guard	Dannels
Tumglazer and King	Guard	Hackney

Score: Seniors 17, Methodists 9.

Field goals—Coatsworth 2, Edwards 1, Paxton 1, Howard 2, Dannels 1, Griffith 1. Free throws—Coatsworth 1, Dannels 9.

Among Magazines and Books.

In this little volume * of selections from the poetry and prose of Emerson Dr. Tappan has done much to give the high school boy and girl a pleasing introduction to Emerson and to his works. The short introduction of five pages should make them realize that Emerson was once a boy like others, mischievous and full of fun. The pupil is made to sympathize with the boy Emerson in his relations to his peculiar aunt, who was "full of whims and oddities. To test a young girl's moral courage, she once invited her to carry a broom stick across Boston Common." Such is one glimpse we get of the person who had a marked effect on the life of the future writer. Her influence helped him to become what he afterward was, for she was very careful lest he should develop some trait of character which she did not consider consistent with perfection. It was she who impressed upon him such mottoes as, "Be generous and great." and "Scorn trifles." The short introduction makes us feel very well acquainted with the writer whose works are to be taken up for consideration and study.

The edition includes three essays: "Compensation," "Self Reliance," and "Manners." The questions found at the bottom of each page will help the reader to a better comprehension of Emerson's thought. Such suggestions as "Explain, The best way to repeal a bad law is to execute it strictly", stimulate independent thinking. Appreciative notes follow the essays. In addition to the three essays, the volume includes several poems. Miss Tappan's notes on the poems must help the student to see more fully the beauty of "Snow Storm," "Concord Hymn," "The Humble Bee," "Forbearance," "Rhodora," Each and All," "Forerunners," and "Woodnotes."

This book, while especially well adapted to the use of high school pupils, would be valuable to other readers of Emerson. It is of a convenient size for use when on the train and even out in the woods. The press work, also, is attractive. M. A. B.,1912.

In a recent educational monograph * Mr. Betts, Professor of Psychology at Cornell College, Iowa, has combined the training of a psychologist with the experience of a class teacher and has given us such a clear, concise, and practical treatment of his subject that the book can not fail to be helpful to the young teacher. Even the more experienced teacher, who has her own way of carrying on a recitation, meets with little difficulties in her class room which she could eliminate by reading Professor Betts' discussion of the distractions of a class room.

Mr. Betts discusses the recitation in five chapters. In the first,

"Emerson, Selected Essays and Poems," edited by Eva March Tappan, Ph. D. Published by Allyn and Bacon, Boston and Chicago.

* The Recitation, by George H. Betts, Ph. D., Riverside Literature Series. Houghton Mifflin Company. Pp. 121.

on the purpose of the recitation, he shows the necessity of having a clear and definite aim in every recitation and then points out what are the four principal aims in good recitations. Next he considers the method of the recitation, pointing out the advantages and defects of (1) the question and answer method, (2) the topical method, (3) the lecture method, and (4) the written recitation. In the succeeding chapters he emphasizes the importance of good questioning, tells what are the conditions necessary to a good recitation, and, discussing the assignment of the lesson, shows clearly the importance of a properly assigned lesson and how to assign a lesson.

Adding to the general usefulness of the book, the complete outline of the contents at the end of the volume and the clearness of the phraseology are to be noticed.

Marie J. Galloway, 1912.

The plays of John M. Synge are the subject of an appreciative article in the January **Yale Review.** The critic, Mr. Charles A. Bennett, shows how Mr. Synge in portraying the Irish peasant life has made its joys, sorrows, brutality, beauty, humor, and tenderness intensely real to us. That susceptible Irish imagination, so akin to the changeful Irish weather, permeates the plays. Because Synge had shared all these elements in Irish peasant life, he knew how to portray them. W. S. 1912.

In the **Forum** for February 1912, Edwin Pugh's article "In Search of London," gives us an interesting though somewhat pessimistic picture of London life. He portrays the actual hurry and bustle of a busy city with its throngs of people. So real is this picture that we can almost see the people moving about in the slums and factories.

He also strikingly contrasts the London life of to-day and that of the seventeenth century with its different styles of architecture and its wretched streets. So well does he describe the streets and residences of rich and poor alike, that we who have never been there can imagine ourselves walking down the streets, past all the vice and wickedness, gazing into the sky, where here and there the spire of a beautiful cathedral points, as it seems, to higher things.

E. R., 1912.

CLIO.

The work in the Clio Society during the present term shows that Clio stands—as she always has stood—for the best things in the way of literary attainments. The magazine and book reviews, introduced during the year, are proving to be of great interest, as well as instructive, to all.

On Friday, February 23, we met with Philo in a joint meeting in the Chapel. The Philo president, Mr. Dannels, called the meeting to order and presided during the early part of the evening, after which Clio's president, Mr. Hackney, presided during the remainder of the program. An interesting program was participated in by representatives from both societies. Members of Clio took part in the following numbers:

Chorus.

Violin Solo,..Miss Galloway

Original Story,.. Miss Wilson

Debate,.................................Miss Riddle and Mr. Wade

Clio has chosen the following persons to represent her in the Annual Contest in June:

Reading—Miss Laura Butler.

Essay—Miss Agnes Redding.

Oration—Miss Rachel Camp.

Debate—Miss Elizabeth Edwards.

Among the Alumni visitors to Clio this term were Misses Izetta Landenberger, Sara Wycoff, Olga Goltz, and Messrs. Ernest Paxton and Lawrence Lytle.

Oscar J. Reckard.

PHILO.

On Friday evening, February 9, the Philomathean Literary Society met, and elected Miss Wilma Sloan as debater to represent us in the annual contest next June. After this the society adjourned to the gymnasium, where the following interesting social program was carried out:

Music ....Philo Orchestra

Bear Dance..Mutt and Jeff

Old-fashioned Literary Society.

Solo ....Dorothy Lamb

Matching Hearts.

Music .... Orchestra

Virginia Reel.

Every one present enjoyed the evening, especially the matching of hearts and the Virginia reel.

Edwin D. Snyder.

On February 23, a joint meeting of Clio and Philo was held in the chapel with the Delphic Society as guests. A feeling of friendship prevailed between the rival societies, but the excellence of the entire program showed that neither was to be outdone by the other. Members from our society participated in the following numbers:

Music .... Chorus

Oration ....Raymond McClain

Piano Duet..............................Etta and Laura Smith

Vocal Solo......................................Dorothy Lamb

Debate—Affirmative, Clyde Wyant; Negative, Helen Aiken.

Periodical ....Lela Shupe

Edith E. Ulery.

EXCHANGES.

The Midwinter number of **The Pennsylvania Association News** is just the kind of Y. M. C. A. paper needed to keep up the courage of an association worker. By reading of the success of other associations he is given strength to meet the difficulties of his own field. The article entitled, "Association Work, Its Effect," we find of special interest. Do you not think your paper would be improved by more articles of this type?

The **Athenaeum** of West Virginia University is truly a newspaper. Many school papers word their news so vaguely or so blindly that only some one intimately connected with the daily routine of the school can obtain from them definite information. The **Athenaeum**, we are glad to say, is free from this defect.

Wayland Zwayer.

Quite a number of the periodicals received at the exchange table this month have had several displeasing features. In a few papers the more serious material has been almost entirely crowded out by the joke and personal departments; since the latter are of local interest only, it would be well for the editors of such magazines to balance their publications by taking up articles of more general value.

The reasons for vocational education are well set forth in an article appearing under that title in the last issue of **The Amulet.**

The Grove City Collegian contains a great deal of original work by students; this is especially commendable in a school periodical.

The reports from the literary societies that are found in the **B. S. N. S. Quarterly** are indicative of a high standard in that kind of work. Their particular study of the leading operas, great writers, and the customs, art, literature and songs of the various countries, will certainly prove most profitable.

We are grateful for the following exchanges:—**The Amulet, The Grove City Collegian, The Waynesburg Collegian, The Lutheran N. S. Mirror, The Normal Herald, The Northern Illinois, The Red and the Black, The Pharos, The B. S. N. S. Quarterly, The Beaver,** and **The Normal College News.**

Edith E. Ulery.

ALUMNI NOTES.

In Memoriam.

Annie Dias, of Buena Vista, Allegheny County, died at her home, January twenty-ninth. Miss Dias belonged to the class of 1900, and had taught in and near McKeesport each year since her graduation. She is held in esteem as a person of excellent Christian character and high ideals.

1886.

Mr. Reed, (non-graduate) was at the school March 1, arranging for the entrance of his daughter.

1897.

Mr. A. B. Cober of Berlin, Pa., who is at home on a year's vacation from the Philippine Islands, where he had been Supervising Teacher for three years, visited the Normal March 2, 1912. He sails for Manila, April 10, 1912, and returns to take up the same lines of work.

1900.

Prof. T. L. Pollock, superintendent of schools of East Pike Run township, delivered an interesting address at Deem's School House, February 17, 1912.

1901.

Mrs. Florence Miller Oliver visited her sister, Mrs. C. M. Fraser, of the school.

1903.

Mr. W. Reed Morris is doing government work in Panama.

1906.

Miss Aura Schlafly is now teaching in Mt. Eaton, Ohio.

J. Olan Yarnall, Esq., of California, Pa., is announced as a Roosevelt delegate to the Republican State Convention.

Mr. Edward McCleary is now in San Antonio, Texas, with the Athletics of the American League.

1908.

Miss Sara Wycoff of Elizabeth, Pa., visited the school February 25, 1912.

Mr. Clyde Bitner is a prosperous business man of Anaconda, Montana.

"The Campus," published by Allegheny College, Meadville, Pa., announces that Mr. Robert Piersol. '12, and C. E. Vogel, '12, have been chosen among the foremost six of the one hundred and fifty contestants in the annual oratorical contest of the Pennsylvania Arbitration and Peace Society. The plan of the contest is to choose six of all the competitors on the basis of thought and composition. These six meet and deliver their oration, the time and place are not yet decided. Andrew Carnegie gives the prizes of seventy-five and fifty dollars.

Misses Maude Morris and Bernice Graham are teaching in Elizabeth, Pa., and Miss Mabel Matter teaches in West Elizabeth.

1910.

Miss Bessie Downing is doing good work in the primary grade at Jeanette, Pa.

Mr. J. Earl Bell, principal of the Dawson Schools, visited the Normal recently.

1911.

Among the alumni visitors to the school were: Miss Catherine Pirl, Mr. G. B. Lineburg, Miss Olgo Goltz, Miss Goldie Minehart, Miss Goldie Cary, Mr. Frank Hamilton, Miss Izetta Landenberger.

Miss Lillian Jobes, who teaches in Chamouni, Pa., was married February 17, 1912, to Mr. Frank Thomas. Mrs. Thomas intends teaching the remainder of the year.

The Cercle Francais was the guest of Miss Bertha Charles February 10, 1912. Misses Reinhard, Harrigan, Hanlon, of the class of 1911, Miss Groleau (1908), Miss Noss (1904), and the Misses Herron of Monongahela, attended the meeting.