OPPORTUNITIES IN SCIENCE*

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"All the important discoveries in science have been made and it is impossible for the new generation to make any material addition to the sum of human knowledge." Such a sentiment as this is frequently met, especially among those who are just beginning the study of science. As one looks back over the centuries of human history, he realizes that the civilization of today has the advantage of the accumulated knowledge of the wise men since the beginning of time. He is led to believe that in all this panorama of human progress, certainly there can remain no fundamental discovery for future generations to make. He feels that he has no opportunity to add to human comfort, safety, health or happiness because he is in competition with the accumulated wisdom of all sages of history.

Have all the worth while discoveries of science been made? It is perfectly natural for any age in the world's history to consider itself a little better than anything which has preceded it. But do we have any basis for assuming that our generation is wiser or more proficient than those which are yet to come? The comforts and conveniences which are new to us will become the commonplace essentials of the next generation while new contrivances will add materially to the efficiency and comfort of human existence. Greater discoveries remain for future workers than have yet been revealed. These discoveries of the future will doubtless be of a different type from those of the past, but I am firmly convinced that they will add to human society factors as vital and as useful as any of the basic discoveries of the previous generations.

In attempting to prove this viewpoint it is necessary to consider the opportunities which have been enjoyed by the younger generation of scientists of previous periods. We can predict the future only by a careful study of the past. Young people of other days have been confronted by problems similar to yours, and it is an inspiration for us to see how these problems have been solved. Surely, with all the advantages of our generation manifest in such

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a multitude of ways, there must be some work left for you to accomplish. Let us see how the problems of other days have been solved.

There are few things more inspiring to younger students of science than the history of the aluminum industry. Just recall that aluminum is the most abundant metal of the earth's crust. There is more aluminum within the reach of man than any other metal. Yet the amount of aluminum used today is insignificant compared with the amount of iron that is used. For many years it was not available at all, and at present it is available only at a high price. Why was it so long in arriving? Because it is never found in the uncombined form, and is generally found in compounds which are very stable. It has been very hard to get it out of these compounds. Some of the most skillful scientists of both Europe and America had worked long and faithfully at the task, but their results were not satisfactory. One day an American boy, Charles Hall, just graduating from Oberlin College, found the secret which made possible the aluminum industry. He found that the aluminum ore, bauxite, dissolved readily in molten cryolite and that upon electrolysis this solution gave the metal aluminum. All of this metal which is used today is prepared by relatively simple modifications of the Hall process.

Two tables will show how the aluminum industry has grown. Table I shows how the price of this metal has fallen as the methods of production were improved, while Table II shows the rapid increase in the use of this interesting metal. It is worthy of note that in the early days, aluminum was a precious metal, although its compounds were "as common as dirt" and "every clay bank along the road side is a potential mine of aluminum." In those early days it was a curiosity available only in very small quantities. It was produced by the use of sodium, itself an expensive metal. The drop in price in 1856-57 was due to an improved method of producing sodium. The fact that for a quarter of century the price of aluminum did not change, indicates that from 1862 to 1886 no progress had been made in the solution of this problem. Hall's discovery in 1886 brought a great increase in production and a corresponding decrease in cost. This great industry stands today as a monument to the work of an American youth, and as an inspiration to young scientific workers everywhere.

But, you may object, this work has been done and there is nothing left for us to do. Let me tell you that the aluminum industry is yet in its infancy and there remain many problems worthy of your best efforts. Aluminum is an essential component of light alloys, and this is a field which is even now attracting very wide attention. Great developments along this line are to be expected in the near future. In addition to its alloys we need to know more about the metal aluminum and its capacity for serving various uses. We know little now about welding, soldering, or patching aluminum, and these problems must be solved. It is safe to say that we have scarcely begun to know aluminum and that great studies in this line are to be expected.

TABLE I.

COST OF ALUMINUM PER POUND.

1855 in England	$275.00
1855 in U. S.	90.00
1856	27.00
1857	22.50
1862	12.00
1886	12.00
1913 (November)	0.19–0.19½
1917 (January)	0.63–0.65
1921 (January)	0.27
1929 (April)	0.24–0.26

TABLE II.

PRODUCTION OF ALUMINUM IN AMERICA.

1883	83 pounds	
1885	283 pounds*	
1895	920,000 pounds†	
1900	7,150,000 pounds	
1905	11,347,000 pounds	
1910	47,754,000 pounds	
1915	99,000,000 pounds	
1918 (War Period)	225,000,000 pounds	
1926	304,000,000 pounds	or 152,000 tons

A few years ago throughout the cotton growing states there existed a difficult problem in the disposal of the seeds which were separated from the salable cotton fibre. These seeds accumulated in such tremendous quantities that they became a nuisance and their removal involved large investments of both time and money. Now this situation has been forgotten, for cotton seeds form a valuable part of the crop. From the short cotton fibers which cling to the seeds are produced batting, stuffing of various kinds,

* New method of getting sodium perfected.
† Hall's process came into practice.

and cellulose from which rayon, writing paper, explosives, and celluloid are manufactured. From the hulls we get stock food, fertilizer, and fiber; from the meal we get cattle food, flour, and dyestuff material; from the oil we get a great variety of products including cooking oils, lard substitutes, butter substitutes, preserving oils, soap, glycerine, dye-stuffs, and paints. The cotton seed industry is now the second largest industry of the south, involving hundreds of millions of dollars annually. There are many opportunities for new developments along many lines in these industries which are very new and which contribute vitally to our modern civilization.

Not many years ago the only method of manufacturing coke was in the so-called beehive coke ovens. People did not like to live in the vicinity of these ovens on account of the smell and smoke which were always present. Coke is now made in the by-product coke oven, and the smoke is made into many of the most useful things we know. The coal tar tree represents the products obtained from this waste. The most brilliant dyes, beautiful in the extreme, are a product of this waste material. We have much better dyes than were known even a few years ago. In addition, out of this coal tar nuisance we get valuable medicines, antiseptics, disinfectants, perfumes, fertilizers, explosives, photographic materials, preservatives for both food and wood, road materials, roofing materials, and almost a countless number of things taken out of the material which was such a nuisance a few years ago. The chemist has a pardonable pride in the accomplishments shown in the coal tar industries. Yet, great as these savings are, much more remains to be accomplished. A total of approximately 40,000,000 tons of coal is now consumed annually in the by-product coke ovens, while several million tons are still used in the old beehive ovens, which belche forth such unpleasant smoke, and 200,000,000 tons are used annually as fuel. Notice what a small percentage of the total coal consumption in this country permits the utilization of those by-products which are so useful and valuable. Will the time come when we will heat our homes by some better method than by burning this smoky coal? I believe it will, and this is a problem which must be solved by the coming generation. Somebody will have to do the work that has not yet been done. You think the scientific problems involved in the coal and coke industries have been exhausted? They have scarcely been touched. The opportunities in that connection are limitless.

One of the greatest problems which confront the scientific workers of our generation is the elimination of wastes. Much has been accomplished along this line, but much more is waiting for careful painstaking study. One of the problems which are just now beginning to receive attention is the waste on the farm, especially such materials as cornstalks and straw. The enormous need of farm relief along such lines is very much in evidence as one rides across country in this fertile corn belt at this season of the year. Not only are cornstalks and straw quite useless, but they are a nuisance, and their removal is expensive and time-consuming. These products of plant growth contain cellulose, and if we once learn how to extract cellulose at low cost, great industrial developments may be expected; for from cellulose is prepared paper, gun-cotton, artificial silk, celluloid, photographic films, and even stock feeds, sugars, alcohol, and many other important materials. Already a start is being made in our own state in the utilization of these farm wastes, for at Danville there is now being made a high-grade paper pulp from such waste materials. The cost is now high, but as forests are removed, the cost of wood pulp must of necessity increase; so it is evident that here is an opportunity from which much may be expected.

If we turn to the realm of medicine we find that there are many, many opportunities for the young chemist. Many people are dying daily from diseases for which we have no remedy. We do have a form of treatment for pneumonia, but no remedy. The common cold involves a greater financial loss than some of the more virulent diseases, and we have absolutely no cure for it. We might also mention pleurisy, anemia, goiter, and leprosy. There are thousands of lepers living under the American flag today, mostly in our island possessions but with a surprisingly large number in various localities of the United States proper. We have ways of controlling the disease which were not known in Biblical times, but we have no cure for it. We have no cure for syphilis, diabetes, scarlet fever, tetanus, sleeping sickness, and many other diseases. They have been somewhat successfully handled, but there are no specific remedies. We need new germicides, antiseptics, etc. We need to learn much concerning the important glands and their hormones, and the effect of ultra-violet light, with its influence upon health. Surely the field and medicine is teeming with opportunities. I believe that there are more opportunities for

you who are now entering the field of science than have been offered at any previous period of the world's history.

The illustrations I have selected are those which appeal mainly to the chemist, because that is the branch of science with which I am most familiar. It is certain that other branches of science offer opportunities which are equally attractive, and many important discoveries must be expected in those lines also. Perhaps these developments of the future may not be fundamental in their nature, but they will contribute none the less to the happiness of mankind if they are concerned with the improvements and adaptation of principles already recognized.

Have respect for the history of science, revere the accomplishments of the science of today, but do not take the attitude of the pessimist and assume that we know it all. Be an optimist and believe that your opportunities are as good or better than have ever been offered to any generation in the history of the world. Study science as a living, growing, expanding unit whose usefulness depends upon the skill, devotion, and untiring effort of those who select science as their best means of adding to the world's happiness.

I cannot stop without preaching a little sermon. I wish to compliment you very definitely on your initiation ceremony. I was pleased beyond expression to see a scientific club introduce its initiation ceremonies with silent prayer. Many people believe there is a conflict between science and religion, but there is no such conflict. Let me give you my definition of science and religion. Religion is God's truth as it is revealed to man. Science, as I see it, is Nature's truth as man understands it. There may be conflict between our interpretation of God's truth and our interpretation of Nature's truth as we know it in the study of science, but truth cannot quarrel with itself.

Young people beginning the study of science are living in a wonderful age. You hear a great deal about "joy rides" and "whoopee" parties of all sorts, and you get the idea that that is the life. Don't you think it. Remember, civilization is many centuries old and is built on conventions which have come down to us from generation to generation. Do not think you can overthrow those conventions with impunity. The essential thing for a scientist is to keep his mind clear. One cannot engage in these "whoopee" parties and have a clear mind. Alcohol has great value, but I believe Providence never intended it for an internal use,

except possibly as a medicine under the skillful advice of a reputable physician. Keep your mind clear. These problems I have outlined to you will require intense thinking and hard work. Do not think you can sit on a park bench and dream your way to prominence by making a discovery. Discoveries are made by hard work. It takes a clear mind back of hard work to bring success. Do not believe that the wild stories you read in the papers are the common experience of life, for they are the unusual. If you are going to be successful as scientists, keep your wind clear and your conduct beyond reproach.