of research in all fields of pure science, such a start will be made that assistance in the future will be assured.

The growing demand of industry for men to improve old processes and devise new ones through research is attracting many young men of brains to that field. Our universities are overtaxed with graduate students in science; and each one, under careful supervision, is extending the boundaries of knowledge in learning how to solve scientific problems.

The development of research of this type is assured, but there is another kind, equally important, if the industries based upon chemistry are to progress. There is an immediate need for the intensive study from a fundamental point of view of the chemistry underlying these industries. It can not be expected that a single organization will finance such work, the results of which should be available to the entire industry. In my judgment, cooperative effort will be the solution of the problem. We have seen that England, after the war, came to this conclusion; and the laboratories set up by the more important industries are doing the kind of work that will help England hold its position in the industrial world.

We are only now learning in this country the value of cooperation in industry. Where it has been tried it has succeeded. It is a different type of cooperation that has made fruit-growing so profitable in the west. The farmers of the middle west will stop their complaints when they have learned their lesson. The day of the individual and the small business organization is passing. We are learning that trusts are not entirely a menace. The individual units in great industries will find some day that they have a common ground on which they can meet and problems which they can attack in common.

Suppose a large industry—like that devoted to the utilization of rubber—should establish a research laboratory to investigate problems fundamental to the industry and for the study of which no provision can now be made in a single organization. It is easy to see that great good would come from such cooperation. Would not a cheap and reliable source of synthetic rubber be a boon to the industry as a whole? Is any single company willing to finance such an expensive research, even though the prize if won is so valuable? But if the work were to be undertaken by cooperative effort each stake in the gamble would be so small it would be a very minor item in the budget.

There is still a third type of industrial research that is growing rapidly, as it has already shown that it pays. This has to do with the detailed study of the processes used by individual companies. There is, however, a chance for improvement here. If we are to utilize the results of research in pure chemistry and in so doing make them of service to the world, we must develop new processes based on these results. The United States lags far behind in this field. Some progressive industries have seen the significance of certain phases of research in pure science and have built up industrial processes of great economic value. The application of catalytic action has added to the world's wealth.

Pure science has told us that carbon monoxide and hydrogen can be converted into formaldehyde and methyl alcohol, but others had the initiative to do the work upon which a great industry will be founded.

I am optimistic about the future of industry from this point of view. We have seen many examples and have learned the lesson. Our chemical industries are growing and producing wealth. We are getting to be a rich nation and those who have the money want to see it work and will in time learn that chemistry can produce gold in more ways than one. The financial backing will be at hand; we have but to teach the people to wait for profits.

As a result of a look ahead I am filled with confidence in the future. I see in the next half century a great development in chemistry in the world, and especially in this country, where the conditions are most favorable. I see our knowledge of matter extended so broadly that what we know to-day is but the foreground of an impressive picture. And I see an unparalleled utilization of chemical knowledge for the physical, esthetic and economic welfare of man. And when through the efforts of chemists the world has more of good health, and every one more leisure to get to know his fellows, to travel, to enjoy the best in life, the day will come when the world will be a better place in which to live and international good feeling will prevail.

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JOSEPH PRIESTLEY[1]

THE intelligent world marvels and admires the ubiquitous manifestations and astounding properties of at least one elemental body, *viz.*, oxygen. Its discoverer—from the humble walks of life—a simple-minded pedagogue—an earnest, disenthralled Calvinist in religious adherence—but happier and most active as a dissenting clergyman, as well as a dissenting subject as to forms of government prevalent in the land of his nativity—was not, on the other hand, so universally admired and appreciated, indeed, was despised, hated and persecuted by untold multi-

[1] Priestley Lecture given at the anniversary meeting of the American Chemical Society after the Priestley Medal had been conferred on Dr. Edgar F. Smith.

tudes of his countrymen, so that in 1794 and for years later, at intervals, he might have been seen walking the streets you all have trodden on your perambulations through this city, in this thanksgiving period represented in the Sesquicentennial celebration of our loved republic. Here, in due course, the discoverer of oxygen gathered with our earliest scientists. In a modest, unattractive structure on Fifth Street, midway between Chestnut and Walnut streets, bearing the name "Anatomical Museum," he witnessed on several occasions experimental demonstrations of the non-existence of that fatuous, evanescent non-entity—phlogiston, which had so beclouded and befuddled his intellect that profound observations and epoch-making discoveries absolutely escaped his discerning eye and judgment.

In the now ancient abode of the American Philosophical Society—diagonally across the way from the Anatomical Museum—he mingled with the membership of that august body and gave expression at times to his views on topics under discussion; pleasing by his urbanity, by the display of broad scholarship, by his genius, by his scientific interests, to such a degree that some years subsequently he was obliged to peremptorily decline the use of his name for the presidency of the society.

And, down on North Second Street in the old Baptist church, on a Sunday night during his brief sojourn in the city, he and his loyal companion (Mother Priestley, affectionately so-called) were to learn that the intolerant, unchristian spirit which had pursued him and his had found its way even to these shores, for upon their entrance in the church, as they passed down its main aisle to a seat, the pastor, a learned doctor of divinity, espying them, arose and raising his eyes and hands toward heaven, exclaimed in loud tones:

> See, O Lamb of God, how they would pluck
> Thee from Thy throne!

What could have been the thoughts of that aged, godfearing couple from beyond the sea!

The divine who thus sought to humiliate them chanced to be a member of the American Philosophical Society. In the course of a few days there came to him from the secretary of the society a brief communication demanding an immediate apology for his unjustifiable conduct or expulsion from membership would ensue. The apology was made.

At the southwest corner of 4th and Locust streets is a handsome colonial home. There resided the eminent Caspar Wistar. There, quite often, congregated the first men of the city—first in national affairs, in commerce, in the learned professions, in science and in literature. Frequently, he of whom I speak could have been observed there. He was happy in the company of dignified and brilliant men. He loved to be with them. He was deeply appreciated and eagerly sought after because of his winning ways, his tolerance and liberality. He was also moderately convivial, though he said that one glass of wine at dinner was enough for an old man, but he did not prescribe his own practice as a universal rule.

Would that you all might read the fascinating little novel by Harriet Martineau, entitled "Briery Creek." In it the subject of this sketch appears as the hero.

If you will pass out to 22nd and Chestnut streets, you may there view the splendid home of the First Unitarian Church—there because of the self-sacrificing labors of the isolator of oxygen. He was the founder of his faith—the Unitarian—in this community. His pulpit appearances here were at first in the churches of evangelical communions, but later almost exclusively in the "Greal Hall" of the University of Pennsylvania. This was because gradually there had arisen suspicion of him, engendered mainly by anonymous vitriolic attacks from one bearing the nom de plume "Peter Porcupine," otherwise William Cobbett, an Englishman whose pen, dipped in gall, spared the venerable scientist in no wise. Despite it all, the exponent of experimental endeavor enjoyed the near association of his Reverence, Bishop White, leader of the Anglican faith, John Ewing, dominant in Presbyterian councils, and crafty John Adams, of New England birth and training, who honored the preachings of oxygen's discoverer on all occasions, openly congratulating him upon his broad catholicity and his devotion to the instilling of the highest principles of Christianity.

Such was the one whom, as chemists, we justly revere, and who as frequently described was one

> whose genius, like a star of dazzling resplendance, shines with conspicuous lustre in the galaxy of his brilliant contemporaries—the philosophick Priestley.

But he was more:

(1) A writer, the philanthropy of whose heart never slept.

(2) A metaphysician—truly the first of his age.

(3) A politician who assiduously labored to extend and illustrate those general principles of civil liberty which are happily the foundation of the constitution of his adopted country.

(4) A man who inspired the readers of his generation to *think* and investigate beyond any writer of his day.

Chemists everywhere should read not alone his communications setting forth the discovery of oxygen, but all his scientific publications. The science world of

his day viewed them as epoch-making, for they appeared in splendid translations in all the languages of contemporary Europe.

Then should be read his lectures on oratory and criticism and on general history, as well as his volume on "Perspective," that his profound attention to literature in general, as well as to art, may be noted.

However, your thoughtful consideration must be called to another truly remarkable work of Joseph Priestley—further proof of his versatile intellect—a work the fitness of which and the belief in which are to-day evidenced on all sides of us.

Indeed, if the Priestley medallists for the next quarter of a century were each, in turn, to discuss some domain in which our hero has left his imprint, the complete story of his versatility could not be conclusively told.

Ten years before discovering oxygen—that was in 1764—Joseph Priestley wrote an "Essay on a Course of Liberal Education for Civil and Active Life," saying that when he became a tutor in the old Warrington Academy he found

> the far greater part of the students were young gentlemen designed for civil and active life, whereas the course of study, as in all other places of liberal education, was almost entirely adapted to *the learned professions;* and it occurred to me that, besides the lectures which they had been used to attend, other courses might be introduced, which would bring them acquainted with such branches of knowledge as would be of more immediate use to them when they should come into life.

Accordingly, he proceeded to prepare a new curriculum. He was far in advance of his fellow educators, as the "Essay" shows. Brief abstracts from it are these:

> I would recommend as new subjects (1) Civil History and (2) Civil Policy; such as the theory of laws, government, manufactures, commerce . . . and (3) the study of the country's *present constitution and laws* that the student may acquire a more thorough acquaintance with his own country. . . . Time was when scholars might, with a good grace, disclaim all pretensions to any branch of knowledge but what was taught in the universities . . . but those times of revived antiquity have had their use, and are now no more. We are obliged to the learned labours of our forefathers for searching into all the remains of antiquity, and illustrating ancient valuable authors; but their maxims of life will not suit the world as it is at present. . . . The politeness of the times has brought the learned and the unlearned into more familiar intercourse than they had before. They find themselves obliged to converse upon the same topics. The subjects of history, politics, arts, manufacture, commerce, etc., are the general topics of all sensible conversation.

Are not these suggestions modern in their tone and are not our technical schools, our schools of finance and commerce, of administration—products of these visions of Joseph Priestley upon a "Liberal Education"? That printed document to which reference has been made is rich to overflowing in similar thoughts. A pioneer truly was he in education—a profound student—the speeches of his detractors to the contrary notwithstanding.

A few years subsequently he wrote "Remarks on a Proposed Code of Education," and a third and rather lengthy document, possibly influenced thereto by Benjamin Franklin, on "Miscellaneous Observations Relating to Education, more especially as it respects the Conduct of the Mind."

And now—quite recently (*Journal of Educational Research* for May, 1926) has appeared a very interesting and learned article in which the writings of Herbert Spencer and Joseph Priestley are compared—extracts from their publications being printed side by side and closely contrasted. The concluding paragraph of this startling communication reads:

> In their non-Conformist position, their opposition to state control of education, their individualism, their radical attitude on science, their utilitarianism, the two men agree closely. It is not strange that Herbert Spencer should have gone to this intellectual ancestor of his for ideas; but it is singular that the debt should not have been discovered before; and it is note-worthy that the debtor on every occasion fought vigorously in defense of his various claims for priority. Spencer's chief additions to Priestley's eighteenth-century thought were a slashing style and a brilliant faculty for special pleading. Few, if any, other writers on education have attained a great reputation so cheaply; but perhaps fame rarely conforms to the facts.

But I must stop. Another side of this versatile brother chemist has been called up; and when he is properly understood and known, future generations will encircle his name with

> those never-fading wreaths, compared with which the laurels that a Caesar reaps are weeds.

We chemists of America, holding high that name, glory in the privilege of

> doing honour . . . to Priestley, the peerless defender of national freedom in thought and in action; to Priestley the philosophical thinker; to that Priestley who held a foremost place among "the swift runners who hand over the lamp of life," and transmit from one generation to another the fire kindled, in the childhood of the world, at the Promethean altar of science.

EDGAR F. SMITH

JAMES ALEXANDER LYMAN

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