year of school life be not lost, that the student may begin in college where he leaves off in the high school, with preliminary work reasonably complete and satisfactory.

Rufus P. Williams.

SCIENTIFIC BOOKS.

Municipal Public Works, their Inception, Construction and Management. By S. Whinery, Civil Engineer. New York, The Macmillan Company. 1903. 8vo. Pp. 241. 8½ in. by 5¾ in.

This is an excellent book on a subject which is more and more attracting the attention of the general public. It is written by an experienced engineer 'for the inexperienced city official and for the urban citizen.' Although it treats of engineering subjects it is not a book of engineering. It is rather a book of public policy in municipal engineering affairs, and as such it differs from many books which have recently appeared with similar titles.

The early chapters in the book are elementary, describing the scope of municipal works, the relation to them of the engineering departments and the manner of financially providing for their support. The author then takes up the question of contract work, and discusses various details of it, such as advertising, preparing specifications, opening bids, awarding contracts, supervising the work, etc. He favors contract work as opposed to work done directly by the city, but points out many weak points in the ordinary contract. Contractors he divides into three classes—the honest and responsible contractor, the irresponsible and unreliable contractor and the boodler; and his descriptions of the conditions which operate to develop these different individuals are most instructive. He is strongly opposed to the compulsory award of contracts to the lowest bidder, and believes that in this, as in many other matters, the engineer or the commissioner should have more latitude and be held personally responsible for the result. In some of these matters the author is at variance with present custom, his theory being, apparently, that there is less chance of bad results due to the use of autocratic power by an occasional dishonest or unfit official than by the operation of laws which continually hamper honest officials and which are ignored or broken by the dishonest ones.

Perhaps the most valuable portion of the book is that which relates to the financial side of municipal works. The subjects of guarantees, special assessments, uniform accounts, municipal ownership, quasi-public corporations are treated in special chapters. His criticisms of the ordinary methods of municipal accounting are severe, but none too severe, as any one will admit who has attempted to compare the cost of any class of municipal work for different cities. And he is quite right when he says that many questions of public policy are being to-day obscured because of false statements issued with no intention to deceive, but simply as a result of bad bookkeeping. Among these questions he places that of 'municipal ownership' of public utilities, and while not wholly deprecating the modern trend toward public purchase of private water works, electric light works, etc., he believes that such changes should be made only after a more complete study of all the financial elements which enter into the question than is usually given to it. His comments upon the proper treatment of such matters as maintenance, operating expenses, interest, depreciation, sinking funds, in connection with the valuation of private property are worthy of serious consideration.

Instead of the wholesale municipal assumption of public utilities he favors private ownership under suitable control, and in the last chapter he outlines a plan and offers it as a solution of this vexed question. He would organize all quasi-public corporations under a general state law, similar in its general features to the present interstate-commerce law, and would make the law 'so radical and far-reaching as to assume, within limitations, the absolute control of quasi-public corporations and of their relations between them and the municipal corporations.'

Whether or not the reader agrees with all the author's conclusions upon the questions

discussed, he will admit that his points are well argued and that the book has given him a clear outlook upon the broad subject of municipal works.

GEORGE C. WHIPPLE.

DISCUSSION AND CORRESPONDENCE.

ELECTRICITY AT HIGH PRESSURES.

TO THE EDITOR OF SCIENCE: Some three or four years ago* I put forward the idea that just as with increase of vacuum and potential the Roentgen rays become more and more penetrating, there may possibly be produced, when cathode ray ions (electrons) move with the very highest velocities, rays that penetrate considerable thicknesses of nearly all bodies without undergoing absorption. Interstellar space may be traversed not only by light and heat waves, but also by rays of the more recently discovered penetrating kinds including those of extreme penetrating powers above assumed as possible.

From what source would such highly penetrating rays as are referred to come? Might they not come from matter (electrons or assemblages of electrons called atoms, or even small masses of matter) moving with such very high velocities as are somewhat comparable with the velocity of light? These assemblages of electrons on impact would probably give Roentgen rays of all orders up to the very highest or most penetrating. Such rays would be absorbed only in larger or denser masses of matter and the absorption would ordinarily be undiscoverable. The celestial bodies, as the stars, planets, etc., would probably absorb the rays, and the rays in being so absorbed would add energy to the masses, tending to some extent to keep up their temperature.

The natural question arises as to whether there are any existing conditions under which the smallest particles could attain high velocities. When an extremely minute particle of matter near the sun or in the outer envelope of gas around the sun is of a nature to absorb the radiation, a radiation pressure will be exerted upon it which may, if the particle is small enough, be in excess of gravitational force. Such particles continuously expelled, in virtue of the excess of radiation pressure over gravitation, may give rise to the coronal streamers around the sun. If the condition just pointed out be possible, the particle will, under the difference of force, be accelerated outwardly from the sun, and continue to move away with an acceleration which, though diminishing, is still an acceleration. Such particles would naturally be expected to leave or be driven away from any hot star.

That a particle once started away will continue moving outwardly with an acceleration, follows from the fact that both the radiation pressure and gravitation vary as the inverse squares of the distances. This means that if a particle is moving towards the sun under the influence of gravitation, it will not at any time be stopped by the radiation pressure unless it be subdivided into smaller particles. It also means that any set of particles moving from the sun under radiation pressure in excess of gravitation must continue forever moving away, unless such particles are brought together into large masses or collide with other masses. It is possible that the limiting velocity which could be attained would be the speed of light waves in the ether. Such rapidly moving particles, whether consisting of many molecules or atoms (groups of electrons) or consisting of separate electrons or ions would probably, on striking other particles or masses, give out intense radiation of the Roentgen ray order, and accompany the same by heat radiation, or visible radiation, or both. Such particles might even serve to illuminate some of the apparently cold nebulæ, either by the impact generating heat and light, or by fluorescence.

Here, then, is the outline of a new corpuscular theory of energy conservation, which is not the Newtonian corpuscular theory, but which supplements the undulatory theory in providing a mode of recovery for at least a portion of the energy of radiation. Any particle which is set in motion by the radiation pressure is within limits converting the energy of radiation into mechanical move-

* 'Electricity at High Pressures,' lecture before the New York Electrical Society, March 29, 1899.