of "force of gravity," then it varies with the altitude, as explained in the above query, because, in that sense, it is altogether a different thing. Generally speaking, the lever scale is a *matter-measuring* machine, and the spring balance is a force-measuring machine. The amount of matter as on a high mountain as determined by the lever scales; but the *pull* of the force of gravity on that same body is less on the mountain than it is on the surface of the earth, as determined by a spring balance (a force-measuring machine, or dynamometer). A. We are not able to agree with your use of the word "weight" in two senses. The textbooks all use the word in the sense of "measure of the force of gravity." We do not know any other scientific sense of the word. Mass is universally employed for "quantity of matter," which, as you say, is invariable. The distinction might be made as you give it, but it is not in the scientific world and in the textboks which our youth study, and it would take too long to introduce it. The game is not worth the candle. We had better continue to say mass when we mean mass, and weight when we mean weight.

(10916) H. C. E. asks: In the experiment "to measure the velocity of sound by a resonance tube," we add to one-quarter the wave length or the length of the resonant tube, a fractional part of the diameter, which correction Lord Rayleigh gives as one-half. Will you tell me why the diameter affects the experiment and necessitates this correction? A. The fact that a pipe is not an exact fraction of the wave length of its fundamental tone is determined by experiment, and the fractional part of the diameter or radius to be added as a correction can then be determined. It is true that the calculations are not exact, and the allowance for the "end correction" is not entirely satisfactory. It is to be taken as nearer 0.6 than 0.5 of the diameter. The reason is found in the reflection of the waves from the yielding air at the open end of the pipe. This has the effect to move the node farther out beyond the end of the pipe. This effect is greater in a large pipe than in a small one, since there is a broader surface of air over the open end than in a small pipe. It is simple, then, to make the end correction depend upon the diameter of the pipe. This is discussed at some length in Poynting and Thompson's "Text Book of Physics," Sound, pages 104 to 108.

(10917) R. F. K. asks: Is there any substance that can be interposed between a horseshoe magnet and a piece of steel that will prevent the attraction of one for the other? A. There is no substance which can be interposed between a magnet and a piece of steel to cut off the action of the magnet upon the steel, excepting a heavy piece of iron, heavy enough to furnish an easy path for the lines of force of the magnet. They will then take the path through the iron, and will not reach the piece of steel farther away. Magnetism cannot be insulated as electricity can.

(10918) C. S. says: Which color on a window curtain will be the most effective in keeping out heat from the direct rays of the sun? A. White is supposed to be the coolest color, that is, to keep out the most of the heat of the sun, and therefore to be coolest for clothing and curtains.

(10919) D. O. V. says: Suppose we have a 3-phase, 60-cycle, 220-volt alternating-current motor on a constant load. We apply 220 volts at the terminals, and the motor carries the load on 10 amperes of current. Now suppose we apply 440 volts at the terminals, how many amperes will the motor draw? What will be the result? Will the amperage be higher or lower than in the first case? A. If you should apply 440 volts at the terminals of a motor wound for 220 volts, the result would be that you would have to call out the fire department, and lose the machine if the fuses did not blow. It would cause a burn-out. Consider Ohm's law: Amperes equal volts divided by ohms. With an alternating current you must also introduce the induction and reactance as increasing the resistance and reducing the amperes, but if you double the volts you must of necessity greatly increase the amperes. With a direct current, doubling the volts doubles the amperes, the resistance being the same. A good book from which to learn the characteristics of electric currents and machines is Sloane's "Handy Book," which we send for $3.50. It should be in every electrician's library.

(10920) J. W. B. says: I have been reading your paper for several years, and have found your answers to correspondents to be all right, except I wish to disagree with you in your answer to query 10826, in which you state that to make ground connection with the steel cresting with heavy telegraph galvanized wire would be as good a protection against lightning as could be had. Now, in the first place, you know as well as I do that copper is a better conductor for electricity than steel or iron, so I claim that the only real way to protect from lightning is to properly rod the building with a pure copper lightning rod, putting it on in one continuous piece of cable and erecting pure copper joints not less than 5 feet long nor over 24 feet apart, nor over six taps to two ground connections. I have seen buildings badly damaged by lightning that were protected just as you recommend in 10826 answer. Also I have seen telephone poles split all to pieces that had a galvanized wire grounded and run 5 inches above top of pole. So if a wire of that sort would not protect a little telephone pole, what good would it do on house or barn? A. We regret that you are unable to agree with our note upon the use of heavy galvanized wire as a lightning rod, and that we also find ourselves unable to agree with your idea of a suitable lightning rod, the tall copper rod with points raised several feet above the roof. We are minded to present a somewhat full discussion of these points from the standpoint of the most recent articles by authorities upon the matter. As to points upon the rod, we quote Dr. Neesen of Berlin, Germany, in Supplement 1503. Describing the failure of points to discharge a Leyden jar, he says: "If the small charge of a Leyden jar cannot escape during the approach of the cup, the immensely greater discharges of the air can surely not be dissipated in this way. Millions on millions of points, like the leaves and twigs of a forest, are needed. But even in a forest it happens that a single tree is struck by lightning. Conductors without points can draw the discharge to themselves from other parts of the building. In recognition of this fact, intelligent makers of lightning protectors have discarded the points of platinum, carbon, etc., once so highly esteemed." This we published in 1904. Perhaps it escaped your notice. Later in the same article the professor describes the network of wires as the most efficient means of protecting oil tanks and powder mills, and approves the use of metal ridge plates, roofs, gutters, and leaders, although the danger of air gaps in such parts of a building would render the reliance upon these rather doubtful. Turning now to some English authorities, Maxwell proposed to cover the house with a network of wires, making it in effect a Faraday's cage for protection from lightning. That so complete isolation is not a necessity in our country would prevent the use of this method here. Prof. Silvanus P. Thompson and Sir Oliver Lodge, both of the highest authority, agree that iron is to be preferred to copper. Their rules are to be found in Thompson's "Electricity and Magnetism," page 320, price $1.50. We quote for you the principal points, although we printed them in full not many years ago in the Scientific American: "1. All parts of a lightning conductor should be of the same metal, avoiding joints, and with as few sharp bends or corners as may be. 2. The use of copper for lightning rods is a needless extravagance. Iron is far better. Ribbon is slightly better than round rod; but ordinary galvanized iron telegraph wire is good enough. 3. The conductor should terminate not merely at the highest point of a building, but be carried to all high points. It is unwise to erect very tall pointed rods projecting several feet above the roof. 4. A good deep wet earth should be provided, independent of gas or water pipes. 5. Connect gas and water pipes metallically. 6. Insulate the conductor away from the walls, so as to lessen the liability to lateral discharge to metal stoves and things inside the house. 7. Connect all external metal work, zinc spouts, iron crest ornaments, to each other and to the earth, but not to the lightning conductor. 8. The cheapest way to protect an ordinary house is to run common galvanized iron telegraph wire up all the corners, along all the ridges and eaves, and over all the chimneys; taking them down to the earth in several places, to a moist stratum, and at each place burying a load of coke. 9. Over the tops of all chimneys it is well to place a loop or arch of the lightning conductor made of any stout and durable metal." We may use for an American authority Prof. Carhart of the University of Michigan, of whom you doubtless know. We quote from his textbook, "University Physics," vol. 2, page 229, of the latest revision, price $1.75. He says: "The revision of theory and the results of experiment have left much of former recommendations relating to lightning rods of doubtful value. For the condition of steady strain pointed conductors are still advisable; but it is not necessary to provide the elaborate terminals formerly deemed essential. Nor is a copper conductor of large section necessary or desirable. It is far better to provide a number of paths for the discharge down several different parts of the building, each consisting of a large galvanized-iron wire sharpened at the top, avoiding short bends and loops, and ending in a mass of iron or charcoal buried in moist earth. Such a conductor may be fastened directly to the building without insulators. It is probable that No. 4 or 6 iron wire, B.S.G., will safely carry off any discharge that is likely to traverse it. The writer has known a much smaller iron wire to conduct safely a discharge which converted smaller copper wire into vapor. Tall chimneys may be adequately protected by three or four iron wires ranged around the outside, not placed together, but connected at frequent intervals, and all well grounded." We have quoted thus at length so as to place within your reach opinions to which you may not have access, although if you have your file of the Scientific American and the Supplement you have all and much more at your hand if you search it out. The only basis of preference for copper is its durability, freedom from corrosion near gases from chimneys, as compared with iron. It has no electrical advantage over iron. Its greater cost renders it less desirable than iron. It is rarely a question of electrical resistance. Benjamin Franklin long ago noted the leaving of a good conductor by the flash to take a small wire or a streak of gilt metal on a wall paper, having an enormous resistance, relatively. Some other reason must be sought. It is found in this: There are different kinds of electrical discharges, in only one of which is resistance of any account. If the cloud rises steadily in intensity and induces a similar quiet condition of charge in the earth below, by and by the cloud and the earth will equalize, by a lightning discharge, and the strain will be relieved. Such a discharge will follow a conductor almost as well as a battery current. Such discharges are not uncommon. Lightning rods carry these off safely, and the copper rod you describe will do it well. But so will the iron wire just as well. A frequent discharge is of another sort. It is called the impulsive rush. To quote Prof. Carhart, page 228: "In this case the electric pressure is developed with such impulsive suddenness that the dielectric (the air) appears to be as liable to break down at one point as at another. Such sudden rushes are liable to occur when two clouds spark into each other and then one overflows into the earth. [You may have seen this.] The highest and best conducting points are then struck irrespective of points and terminals. The conditions determining the path of the discharge in the case of these impulsive rushes are entirely different from those of the steady strain, and points are incompetent to afford protection by preventing them." This last condition describes exactly the case of the telephone pole which you have seen struck when it had a guard wire. It is found not infrequently in the long transmission lines of the West, especially in mountainous regions, and constitutes the greatest danger from lightning. Against it no rod is effective, and the heavy copper or even iron rod, some of which we have seen put up an inch thick, is entirely worthless. Finer wires are better in this case, although not a safeguard, since if struck they may be melted and thus dissipate the electric energy by using it up as heat. Indeed, the best protection would probably be rendered by a system of wires fine enough that the current would melt them and thus save the building. One could however hardly put up a new system of wires after each stroke of lightning. There might not be time to install the new wires between the strokes, for lightning does strike twice in the same place. As we said before, we have published many articles upon lightning protection since these new facts caused a revision of practice in putting up lightning rods, and they may be found in our columns within fifteen years. Although this note is probably already the longest we have ever printed, we would add a reference to the work of the U. S. Weather Bureau upon this matter, which completely agrees with the foreign and American authorities we have so freely quoted. Any one interested may obtain these reports from the Superintendent of Documents, Government Printing Office, Washington, D. C. They are "Lightning and the Electricity of the Air," 50 cents, and "Recent Practice in the Erection of Lightning Rods," 10 cents. Inclose the money in coin or postal order, not in stamps. Valuable articles may be found in our Supplements 1212, 1452, 1581, 1524, and others to be found by reference to our Catalogue of Valuable Articles, which is sent free upon request.

NEW BOOKS, ETC.

Telephone Construction Methods and Cost. By Clarence Mayer, formerly Cost Statistician and Facilities Engineer, Chicago Telephone Company. Appendix A on Cost of Materials and Labor in Constructing Telephone Line, by J. C. Slippy, Consulting Telephone Engineer; and Appendix B on Miscellaneous Cost Data on Pole Line and Underground Conduit Construction, compiled by the Editors of Engineering Contracting. New York and Chicago: Myron C. Clark Publishing Company, 1908. 8vo.; pp. 284. Price, $3.

This is a highly technical book, particularly adapted for the practical man, to whom a knowledge of construction costs is essential. It contains actual cost records which have been carefully compiled, as well as practical and flexible systems for the collection of such records and methods of computing, proportioning, and prorating costs of all kinds. Its pages contain the most approved methods of doing telephone work, and give the costs of such work in all its details.

An Introduction to Electricity. By Bruno Kolbe, Professor of Physics at St. Ann's School, St. Petersburg. A translation of a second edition of "Einführung in die Elektrizitätslehre," with corrections and additions by the author. Translated by Joseph Skellon, late Assistant Master at Beaumont College, Old Windsor. Philadelphia: J. B. Lippincott Company, 1908. 8vo.; pp. 430. Price, $3.

Although we have many works on elementary electricity, the present volume will be welcome for the fact that it deals with the subject in a manner that is decidedly out of the ordinary. The material was originally delivered by Prof. Kolbe in the form of lectures to his class in St. Petersburg; and in order to present the subjects in a practical way, and one that would impress the students, he made a collection of electrical experiments which were new and directly to the point. Many of the experiments were original, and others were unearthed from the back numbers of scientific periodicals where they lay buried from the gaze of the general public. As a result the book entirely lacks the stereotyped illustrations which one invariably finds in works of this character. Part I covers first the subject of static electricity, and dynamic electricity is taken up in the second part. The volume closes with an appendix containing historical remarks, repairs, and supplementary and practical hints.

The Principles of Mechanics. For Students of Physics and Engineering. By Henry Crew, Ph.D. New York: Longmans, Green & Co.; London, Bombay, and Calcutta, 1908. 12mo.; cloth; 295 pages; 110 figures. Price, $1.50.

The author of this book is the Fayerweather Professor of Physics in the Northwestern University, and his work comprises lectures which during several years have been given to second-year students in physics in the institution. The previous training needed for pursuing the education laid down to the students is a course in general physics and one, either concurrent or antecedent, in the calculus. This course in the science of mechanics consists of kinematics, kinetics, some applications of general principles to special problems, friction, dynamics of elastic bodies, and fluid motion.

The Wonder Book of the Atmosphere. By Edwin J. Houston, Ph.D., Author of "The Wonder Book of Volcanoes and Earthquakes." New York: Frederick A. Stokes Company. 12mo.; cloth; 326 pages; 69 illustrations. Price, $1.50.

The attempt has not been made in the book to explain all atmospheric wonders, the author assuming that they can be better treated in other Wonder Books in the series. The field of discussion has been wide enough to include, among other matters, the composition of the atmosphere, its temperature, climate, wind, moisture, dust, navigation, ozone, weather myths, and prodigies. The work is sufficiently painstaking and reliable, and a valuable contribution to scientific research of the phenomena of our thin shell of air. It is also a large addition to atmospheric folk-lore, to such an extent that much of the volume might be considered as material fitted for a wonder book of the imagination.

Deutscher Schiffbau 1908. Herausgegeben aus Anlass der ersten deutschen Schiffbau - Ausstellung in Berlin. Chefredakteur: Geh. Reg. Rat Professor Oswald Flamm, Charlottenburg. Lex. = 8°, 230 Seiten mit 239 Abbildungen. Verlag Carl Marfels, A.-G., Abteilung: Zeitschrift "Schiffbau," Berlin S. W. 68, Zimmerstrasse 9. Price, $1.

This volume may be regarded as an expression of German engineers on German shipbuilding. The principal articles are "The Development of the German Navy," by J. Rudloff; "The Marine Engine, its Modern Design, and its Future Prospects," by Prof. Krainer; "The Marine Steam Turbine," by H. Schmidt; "Development and Present Status of Marine Boilers and Marine Auxiliary Machinery in Germany," by Prof. Walter Mentz; "Marine Gas Engines," by Prof. F. Romberg; "High School Training in Naval Architecture," by C. Flamm; "German Iron and Steel Industry and German Shipbuilding," by Fritz Luermann; "Shipyards," by Prof. W. Laas; "Cranes at the German Shipbuilding Exposition of 1908," by C. Michenfelder; "The German Shipbuilding Industry," by F. Meyer; "General Review of the Institutions and Authorities Identified with the Mercantile Marine," by Matthaei; "Electrical Plants for Ships," by C. Arldt; "Fitting Out Ships," by Fr. Jappe.

Autogenous Welding of Metals. By L. L. Bernier, M.E. New York: The Boiler Maker, 1908. Paper; 45 pages; illustrated. Price, $1.

The chapters in this small work are translated from Reports of the National School of Arts and Trades of France, and illustrated by numerous figures and engravings. They describe the application of autogenous welding to the manufacture of tanks; gasometers; receptacles for liquids or gases, with or without pressure; steam and hot water boilers; kettles; small boats; automobiles; piping, either steel, copper or brass, and coils of all kinds; and also its application to repairing old or new castings injured through such defects as blowholes, cracks, etc. To these are added its application to the manufacture of steel, brass, bars and plates, and to the destruction of metals, structures, etc.

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