SCIENCE NEWS

Science Service, Washington, D. C.

A NEW VALUE OF THE GRAVITY CONSTANT

ASTRONOMERS calculate a little more accurately with how much force the earth and the moon pull on each other by gravity; or physicists the force with which their bodies would be pulled to the earth if they fell out of a second-story window. This can now be done by means of the new value of what scientists call the "gravitational constant" announced at the meeting of the American Physical Society by Dr. Paul R. Heyl, of the U. S. Bureau of Standards.

As a result of three years' work, much of which was done in a subterranean chamber at the Bureau of Standards, Dr. Heyl has found this constant to be expressed by the fraction 6.664 over 100,000,000. The law of gravitation, stated many years ago by Sir Isaac Newton, says that two masses of matter attract each other by a force which is greater as they are more massive, and less as the distance between them becomes greater. The exact force is found mathematically by multiplying the masses of the two bodies by each other, and dividing by the distance, and then multiplying the result by the gravitational constant. As exact knowledge of the force of gravity is important in many different branches of science, all the way from study of projectiles fired from guns to study of the motions of the stars, the gravitational constant, which the physicist calls G, must be known very precisely.

About 1740 a Frenchman, named Pierre Bouguer, made the first attempt to measure G by experiment, but the first determination of value was made a quarter of a century later by an English astronomer, Nevil Maskelyne. His method was to observe a plumb bob on two sides of a mountain. The mass of the mountain tended to pull the bob towards it, and by measuring the deflection of the plumb line from exact vertical by comparisons with the positions of the stars and knowing roughly the mass of the mountain, a value could be obtained. It was not very accurate, however, because the mass of the mountain could not be more than guessed at.

At the end of the eighteenth century, another English scientist, Henry Cavendish, used the method now employed by Dr. Heyl for the first time. By this system, two tiny masses are attached to the end of a rod, which is balanced at the end of a long wire. Two heavy spheres of lead near the ends of the rod pull on the little masses and twist the wire slightly. This twist can be measured by a little mirror attached to the wire. A spot of light may be reflected by this mirror across the room, and a slight twist will produce a much larger motion of the spot of light.

Essentially, this was the same method that Dr. Heyl has employed, but with the aid of all the improvements to be offered by a modern research laboratory. Previous to this, the most accurate results had been obtained by Professor C. V. Boys, another Englishman, and an Austrian priest, Father K. Braun, who worked independently, each in his own country, about 1895. They both obtained the same result, with G equalling 6.66 divided by a hundred million.

In 1901, Dr. G. K. Burgess, now the director of the Bureau of Standards, in working for his doctor's degree at the Sorbonne, Paris, tried the experiment, and obtained 6.64 instead of 6.66, but as this was done under pressure of time, it was not very accurate. Dr. Burgess realized this, and when be became director of the bureau he saw to it that the experiment was performed more accurately than had ever been done before. This Dr. Heyl has now completed, confirming, as far as they went, the results of Professor Boys and Father Braun, and carrying the value to another decimal place in accuracy.

INAUDIBLE SOUND WAVES

FURTHER experiments on waves of sound of such high frequency that they can not be heard, though they are capable of killing small animals and of breaking down the corpuscles of blood, have been made by Professor R. W. Wood, of the Johns Hopkins University, and A. L. Loomis, of Tuxedo Park, N. Y., at the latter's private laboratory, and were reported before the annual meeting of the National Academy of Sciences.

These rays of inaudible sound waves are produced from slices of quartz crystal, driven by oscillating electric currents of frequencies of about 500,000 a second. They travel through any liquid or soil object and heat it as they go, but do not come out into the air. Blood corpuscles in a physiological salt solution are broken down, tinging the whole body of the fluid a clear red; but if a tiny particle of gelatin—half a per cent. or less—is added the corpuscles are protected and are not broken.

If a block of artificially frozen ice is subjected to their action, the waves have no apparent effect on it until it is placed under pressure, when it at once breaks into a mass of tiny crystals. But a piece of pond ice, frozen under different conditions, resisted the waves and did not crumble. Professor Wood has no explanation to offer as yet for this difference in behavior. Finely powdered solids stirred up in water to make a suspension are driven together by the waves until they form a closely packed round mass just under the surface.

Things that can not ordinarily be mixed with water, like oil, paraffin and mercury, are forced by the vibrations to become exceedingly fine suspensions or emulsions. A paraffin candle was floated on water and the current turned on. The wax melted from the surface and came down into the liquid in the form of a cloud of microscopic white drops, forming a veritable paraffin milk that could not be distinguished in appearance from real milk. In another experiment, a little mercury was poured on the bottom of the beaker full of water. The waves broke it

up into drops so small that they could just be seen with the highest power of the microscope, scattered evenly through the water in a dense cloud. This mercury-water emulsion was as black as ink. Professor Wood believes that a possible future application of this newly discovered power of these waves may be to create emulsions out of combinations of liquids that can not be forced to mix in any other way.

RADIO MEASUREMENTS

RADIO measurements are now made a thousand times as accurately as four years ago. Where in 1923 radio engineers made their measurements to an accuracy of 1 per cent., they now go to a thousandth of a per cent., according to a paper given by Dr. J. H. Dellinger, in charge of the radio laboratory of the U. S. Bureau of Standards, at the meeting of the American section of the International Union of Scientific Radio Telegraphy.

Part of this increased accuracy has been due to the use of the piezo-electric oscillator. With this device, a small crystal of quartz, between two metallic electrodes, can control the wave length of a broadcasting station to a considerable degree of accuracy. However, Dr. Dellinger stated that the use of the crystal by no means dispenses with careful adjustments. By the use of the crystal oscillator it is easily possible to obtain an accuracy of a tenth of a per cent., but for a higher degree of accuracy all the conditions, such as the temperature of the crystal, must be carefully controlled.

If American and Canadian broadcasting stations do not keep to their proper wavelengths, it will not be for the lack of accurate standards, for Dr. Dellinger told of comparisons made by the Bureau of Standards with the Canadian radio authorities. One of the bureau's standard crystal oscillators has been sent to Canada for comparison with their standards, and it has been found that the two agree to within a hundredth of one per cent.

M. S. Strock, also of the bureau, told of its work in disseminating standard frequencies of radio waves. One way of doing this is by calibrating meters sent in by outside agencies with the bureau's standards, but the most effective way is by the use of the transmitting stations themselves. "The basis of this scheme," he said, "depends upon the fact that a standard of radio frequency may, neglecting the effects of interference, be transmitted over great distances and reproduced at the receiving station with an accuracy equal to that of the transmitter."

This method is used by sending out regularly standard frequency signals from the Bureau's station WWV. Careful check is kept also of the frequency of a selected list of stations near enough to Washington to be received directly at the bureau. There are thirteen of these standard frequency stations, and in addition, a list of "constant frequency" stations, which includes about 5 per cent. of the stations of the country, are checked a little less carefully. Standard frequency signals have been broadcast from 6XBM, at Stanford University, California; 1XM, at the Massachusetts Institute of Technology, and 9XL, of the Gold Medal Flour Company, near Minneapolis.

FOSSIL-BEARING ROCKS OF THE GRAND CANYON

THE fossil-bearing rocks of the Grand Canyon, which have recently aroused much interest because of the discovery in them of footprints of long-extinct animals, are now yielding remains of the leaves and stems of plants among which these animals roamed and fed, many millions of years ago. At the meeting of the National Academy of Sciences, Dr. David White, of the U. S. Geological Survey, told of his examination and identification of many specimens from this region.

The plants that grew on the ancient floodplain of red sand through which the great gash of the Grand Canyon has since been cut were very little like the ones that grow in the forests of to-day. Their nearest relatives still living are the ferns and tropical cycads and similar plants.

The plant remains were all preserved by being deposited at the bottoms of streams or ponds, but there is evidence that these bodies of water were not permanent, but appeared during rainy seasons and dried up when the rains ceased, just as most of the streams and ponds in the arid Southwest do to this day. Pressed between thin layers of water-deposited sand that gradually hardened into strata of sandstone, the leaf and stem fragments were preserved like botanical specimens in a huge book, and even after their own substance had gradually decayed and almost wholly vanished, their imprints were left on the stone just as the print of a pressed flower is sometimes left between the pages of an old volume, shelved many years ago and never opened.

The knowledge gained of the ancient animals of the Grand Canyon region was summarized and brought down to date by Dr. Charles W. Gilmore, of the U. S. National Museum. Footprints of extinct reptiles and amphibians have been found in three distinct formations. These are known respectively as the Coconino, Hermit and Supai formations. Thirty-three species were represented by tracks in these three levels, 22 species in the Coconino, 8 in the Hermit formation, which also yielded all the plant fossils studied by Dr. White, and 3 species of animals in the Supai. Remains of insects were found for the first time in the Hermit formation. More than two tons of stone slabs bearing fossil footprints are now in the U. S. National Museum.

STEAM WELLS

BORING for live steam as men bore for oil, with the possibilities of running engines and turning dynamos without the burning of a pound of fuel, was described before the meeting of the National Academy of Sciences by Dr. Arthur L. Day, of the Carnegie Institution of Washington. The steam wells described by Dr. Day are in Sonoma County, Calif., where operations have been going on for some time to exploit a field of hot springs and steam vents similar to those of Yellowstone National Park, but on a smaller scale.

So far five borings have been sunk. They reach depths of from 300 to 600 feet, yielding a total of nearly 5,000 horsepower of live steam. The temperatures at the bottoms of the wells vary from 160 to 185 degrees, and the

pressures attain a maximum of 276 pounds per square inch. Besides steam, various gases come out of the wells, making up less than two per cent. by volume of the product.

Similar wells have been operated on a large scale for several years in Italy. Concerning these, Dr. Day remarked, "Compared with the development of natural steam in Tuscany, where more than 30,000 H.P. is now commercially developed, the conditions in California appear to be somewhat more favorable from the point of view of the uncondensable gases carried and their corrosive effect upon metals. The total power available is probably smaller. The oldest of the California wells has now been flowing intermittently for five years with undiminished pressure."

VANADIUM

THE addition of a new metal, vanadium, to the world's resources, is announced by J. W. Marden and M. N. Rich, research scientists of the Westinghouse Lamp Company.

Vanadium has been known in its compounds for a long time, according to Dr. Marden and Dr. Rich, but in spite of a century of efforts on the part of chemists no one has previously been able to produce it in its pure form. The method employed by the authors is to heat a mixture of vanadic oxide, metallic calcium and calcium chloride in an electric furnace for an hour at a temperature of nearly 1,400 degrees Fahrenheit. After cooling and stirring the resulting mass in cold water, metallic vanadium is obtained in the form of beads.

"The beads of vanadium are very bright, have a steel-white color and are quite malleable, soft and ductile," say the authors. "They can be melted in a vacuum in a high-frequency induction furnace, rolled into wire and worked up into other shapes. As far as analysis can determine, they are 99.9 per cent. pure metal.

"There is no known use for this new metal at present, but undoubtedly it will have special properties that will make it useful. Tungsten, for example, was once a useless metal, but is now of inestimable value for filaments in incandescent lamps, for high-speed tool steel alloys and many other purposes. Vanadium may, in time, prove equally serviceable."

ITEMS

USING an electrical heat-measuring device so incredibly delicate that it is sensitive to two trillionths of an ampere of current and will measure temperature changes of as little as one ten millionth of a degree Centigrade, Dr. A. V. Hill, of Cornell University, has measured the temperature changes in nerve fibers during their activity. In describing his experiments before the National Academy of Sciences, he stated that his object had been to learn more about the nature of nervous action. Older theories have held that nervous impulses were not like other physiological processes, but were physical waves like light or radio waves. These ideas were based on the absence of any detectable heat given off by nerves as a result of stimulation. But with the extremely sensitive instrument devised by Dr. Hill it is possible to measure the almost vanishingly minute temperature rise that occurs in a single nerve fiber when it is caused to react. The moment of activity of a nerve is followed by a prolonged period of recovery, during which nine times the initial amount of heat is given off.

THE loss in weight that we all undergo every day has been the object of research by Dr. Francis G. Benedict and Cornelia Gollay Benedict, of the Carnegie Institution of Washington, who reported their results at the recent meeting of the National Academy of Sciences. Two sensitive balances were used in the work. Both were strong enough to sustain the weight of a man, but sensitive enough to register small changes in weight. One of the balances would indicate a change of one third of an ounce, and was so constructed that the volunteer for the experiment could sleep all night on its platform. The other was a hundred times as sensitive, but could be occupied for only an hour or so at a stretch. The total moisture losses of this class from a woman of average weight were found to average around 30 grams, or one ounce, per hour; for a man the figure was about one third higher. An auxiliary device permitted the separate measurement of losses from the lungs and skin, and these averaged 50 per cent. from each source of water loss. Other mechanisms measured the carbon dioxid given off, the percentage of water in the outgoing breath and also its temperature.

A NEW process for making sugar out of sawdust was described by Professor Erik Haegglund, of Abo, at the coal and wood chemistry conference recently held in Stockholm, where he reported that at Geneva, where the process is being tried on a commercial scale, from 65 to 70 per cent. of the sawdust by weight can be converted into sugar. For Sweden, where forestry is one of the dominating industries and where most of the sugar has to be imported, the method is likely to become of the greatest importance. Several hundred thousand tons of "wood sugar" can be produced annually from easily accessible raw materials.

BECAUSE it resembles a star twinkling at night more than any other precious stone, the blue zircon of Siam has been rechristened "Starlite" by Dr. George F. Kunz. These flashing blue stones from Siam are unusual in that they are never blue at all when found in their natural state, but are brown or reddish in hue. The stones are placed in a crucible and burned in a fire from six to eight hours exposed to a solution of cobalt nitrate and potassium ferrocyanide, said Dr. Kunz, in announcing the new name to the New York Mineralogical Society. The chemicals do not touch the stones which are being changed in color, but the fumes do the coloring. After cutting it is necessary to expose them again to the fire from five to twenty minutes. This is the most brilliant blue and green precious stone. The flash is more near that of the diamond of the same color and resembles the occasional sparks from copper contacts, especially when a trolley pole hits a wire. It also has the brilliancy and color of some stars.