on the fillet without transferrence to books. In response to inquiry, he stated that the difficulty in getting a circuit through a clock-pendulum and globule of mercury, which would be absolutely sure to close every second, might be entirely overcome by having the mercury pure and making sure of good connections; that the difference between commercial and pure mercury was a very marked one in this case. Mr. J. A. Brashear of Pittsburgh called attention to the growing importance of chronographic records in all employment of men and machinery, and described a very perfect system in use in some manufactories. Professor Newton referred to the very convenient system of the Repsolds, for printing rapidly the settings of micrometer-screws, as well illustrated upon the new Yale college heliometer in charge of Dr. Elkin. Prof. C. S. Peirce of the coast survey called attention to the great gain this would be in recording the readings of micrometer screws in the comparison of standards of length where rapidity was highly desirable, and especially the avoidance of the necessity of removing the eye continually from the eye-piece to read off the head. Professor Paul alluded to his hope of soon applying Repsold's apparatus where rapidity was of the first importance; viz., in recording the settings of the position-circle of the Nicol-prism in Professor Pickering's method of observing the eclipses of Jupiter's satellites, where as many settings as possible are wanted while the satellite is entering or leaving the shadow; and he said he hoped, with a chronograph-key in one hand, and managing the Nicol and its printer with the other, to be able to secure the record of the times and settings of the Nicol-circle every two or three seconds, working entirely in the dark, and keeping it up as long as desired.

The next paper, by Prof. J. Burkitt Webb, described a method of using polar coördinates, by transferring the origin from the centre to the end of the unit-radius, — thus substituting $(r-1)$ for r, — and then using the length of the arc and the distance out from its end upon the radius vector, as x and y are used in rectangular coördinates. He found this a very convenient transformation in the application of polar coördinates to the discussion of Amsler's planimeter; and pointing out that by substituting infinity for unit-radius in the equations thus transformed, they were reduced to those of rectangular coördinates, he thought this transformation of polar coördinates might be found generally useful.

The only paper on Monday was a presentation by Mr. C. H. Rockwell of Tarrytown, N.Y., of some results of his observations for time and latitude with the almucantar, an instrument devised by Mr. Chandler of the Harvard-college observatory a year or two ago, which promises at least to furnish an entirely new and radically different method of attacking the question of absolute positions of the stars, and very probably far to surpass all others in accuracy, on account of its freedom from systematic errors. The results thus far published by Mr. Chandler seem fully to confirm all that was expected of the instrument; and it is probably not too much to say, that it is the most important addition of the present century to the instruments and methods used in the determination of absolute star-positions. The sources of systematic error would seem to be almost wholly reduced to those of varying personal equation in the observation of transits at all speeds, and at all inclinations and directions over horizontal wires, and to possible systematic difference in atmospheric refraction in different azimuths. Mr. Rockwell exhibited some results, simply copied from his observing-books, illustrating the methods of reduction for time and latitude observations, and showing the degree of accuracy that can be attained by the instrument in both these directions. They served to show that the instrument when duplicated will give equally good results with the one first constructed; and their consideration gave rise to a very interesting discussion, participated in by many members, as to the character of work the instrument might be expected to do, in the course of which Mr. Rockwell answered, in a very entertaining way, many questions, put by various members, as to the details of observing and reducing, which were not before clearly understood on account of the novelty of the work. One of the most important problems which the instrument is specially adapted to investigate, and one which we hope Mr. Chandler will soon find time to undertake, is the determination of the declination of fundamental stars south of the equator, tying them to northern stars at corresponding zenith distances below the pole. This would seem to be by far the best, perhaps the only, method of connecting these together in a way that shall be free from systematic error.

PROCEEDINGS OF THE SECTION OF PHYSICS.

THE first paper read before the section of physics was by Prof. S. P. Langley, on the spectra of some sources of invisible radiations, and on the recognition of hitherto unmeasured wave-lengths. The measurement of infra red wave-lengths has heretofore been confined to those found within the range of the solar-heat spectrum. It is of interest to know whether there are other wave-lengths than those found in the sun's heat, so that we may perhaps explain how it is that the surface heat of one planet is maintained in spite of the ready radiations of extreme solar heat through the atmosphere. Our knowledge of wave-lengths is comparatively recent, as Fraunhofer gave the first accurate measures in 1823. His range of values was from .00036 to .00075 of a millimetre. The use of the florescent eye-piece and photography has extended the range. The extreme range of the normal eye is from about .00036 to .00081 of a millimetre, or a little over one octave. It has been known since the time of the first Herschel, that heat radiations existed below the range of vision; but it was supposed that glass absorbed this dark heat. In 1881 Professor Langley found that common glass was diathermanous to all the dark rays which come to us

from the sun, and he has determined the wave-lengths of a newly discovered solar region by direct observation. We have in this infra red portion of the sun spectrum the greater part of the heat which sustains organic matter on this planet; and the questions arise, Does the planet radiate heat of the wave-lengths that it receives from the sun; and How is its temperature maintained, probably several hundred degrees above the temperature of space, when our observations show that the direct radiations of heat from the sun can only raise it about fifty degrees above the surrounding temperature? Experiments at Alleghany show that the dark solar heat is transmitted by our atmosphere with less difficulty than the light; and if the radiations of the soil are of this wave-length, our planet should actually be cooler on account of its atmosphere than if it had none. With this in view, Professor Langley has carried on during the last two years measurements of the radiations from bodies of the temperature of our earth. Almost the only material which can be used for the prism and lenses in this work is rock-salt. It is needless to say that the polish deteriorates after a few hours' use, necessitating a constant resetting of the surface. Leslie cubes covered with lampblack, and filled with boiling water or aniline, were used as radiating surfaces. Nearly the whole heat spectrum from these sources passed through the prism at angles which the theories of our text-books have heretofore pronounced impossible. Speaking with reserve, Professor Langley says that we have every reason to believe that heat radiated by the soil has a wave-length twenty times that of the lowest visible line of the solar spectrum. Professor Langley's results are of interest to the physicist, as showing that the wave-lengths of something more than one two-thousandth of an inch are rendered highly probable; to the astronomer, because we find that the heat radiated from the soil is of a totally different quality from that received from the sun; so that the important processes by which the high surface temperature of the planet are maintained, can now be investigated with, we may hope, fruitful results.

Much of the success of Professor Langley's work depended on the possibility of making satisfactory lenses and prisms from rock-salt. Professor Langley's paper was followed by one by Mr. J. A. Brashear, on a practical of method working rock-salt surfaces for optical purposes. Mr. George Clark succeeded in making and polishing a rock-salt prism for Professor Langley, but otherwise none had met with success; and Professor Langley was assured by the best opticians, that a rock-salt prism could not be made to show the Fraunhofer lines. Mr. Brashear proved this prediction to be false. Mr. Brashear's method consisted in the use of a pitch bed, which, while yet soft, was flattened by a plate of glass; the pitch was then cooled by water, and upon it were drilled conical holes one-quarter inch in diameter, and half an inch apart; the surface of pitch was then warmed suitably, and upon it was pressed a true plain surface. Upon the polisher thus prepared was put a very small quantity of rouge and water. The polishing was done by diametrical strokes, the operator walking about the polisher as he rubbed; this motion must be constant and continued till the last traces of moisture disappear, and the prism is to be slipped off the polisher in a perfectly horizontal direction.

Prof. H. S. Carhart presented a paper on surface transmission of electrical discharges, which was an ingenious revision of work by Professor Henry. Prof. E. L. Nichols presented some further notes on the chemical behavior of magnetic iron, a continuation of work described in a paper at the Philadelphia meeting. In the absence of Professor William Ferrel, his paper on psychometry was read by title only. Major H. E. Alvord of Mountainville, New York, presented the results of telemetric observations at Houghton Farm. This is a method by which changes in temperature are transmitted and recorded electrically; and Major Alvord's results show that, with increasing experience, the records followed more and more satisfactorily the observations made on the mercurial thermometer.

Commander Theodore F. Jewell's paper on the apparent resistance of a body of air to a change of shape, described some experiments at the U. S. torpedo station, in which a disk of gun-cotton was exploded on a metal plate. Upon each disk of the explosive had been stamped the letters 'U. S. N.', and the year in which the material had been manufactured. After explosion upon the iron, similar indentations were found upon the plate as if the air in the indented letters had been driven into the plate.

Professor T. C. Mendenhall called attention to the modifications and improvements already made or desired in electrometers, especially with reference to their use in observations on atmospheric electricity. Observations of this kind have been made regularly for the last year or two; but, as Professor Mendenhall well said, the meaning of the variations recorded is still a mystery. Prof. A. E. Dolbear read three papers: in one he described a method of studying the contact-theory of electricity by means of the telephone. He has found that a click is produced in the telephone every time the circuit is broken between two heterogeneous materials, as copper and zinc. In another paper he referred to his success in employing a Bernstein incandescent lamp for projection purposes; and in the third he described a new galvanic element of high electro-motive force and great constancy, consisting of carbon in a saturated solution of bichromate of potash and sulphuric acid, and zinc in a saturated solution of ammonic chloride; nitric acid could be used in place of sulphuric. Mr. A. J. Rogers presented a paper on electrolysis of the salts of the alkaline earth.

It is much to be regretted that Prof. J. Burkitt Webb was obliged, by want of time, to refer so unsatisfactorily to his papers on entropy and the life of the universe, in each of which he presumably discussed matters in the interest of thermodynamics.

Prof. E. L. Nichols has, by means of a spectro-photometer described at a previous meeting, compared the spectrum of the unclouded sky with that of the light

reflected by magnesium carbonate, illuminated by direct sunlight. Repeated measurements of the relative intensities of corresponding portions of these spectra throughout their whole length, and similar comparisons of the spectrum of the magnesium carbonate with the direct spectrum of the source of illumination, have furnished data from which the character of the light sent us from the open sky can be determined, and, in one sense, its color also. The measurements show that the spectrum of the sky is of the same character as that of white light, varying less from the reflection spectrum of a perfectly colorless object than do the spectra of such substances as white paper, sulphate of calcium, carbonate of magnesium, lamp-black, etc. Similar measurements were made of the reflection spectra of Lord Rayleigh's 'blue cloud,' formed by the precipitation of sulphur by hydrochloric acid in a solution of hyposulphite of sodium, and of thin films of antimony oxide. It was found that the same is true of the light reflected by these substances. The blue color of the sky and of other opalescent media is, according to these results, not due to an excess of the more refrangible rays in the light reflected by them, but is of subjective character. This view the author has maintained in a previous paper, in which it was pointed out that a well-known peculiarity of the eye, its rapidly increasing sensitiveness to violet, with decrease of intensity of illumination, is sufficient to account for the appearance of the sky, and of many other objects, without having recourse to the hypothesis of selective reflection. The object of the present paper is the presentation of experimental evidence bearing upon this question. It is to be regretted that Prof. S. P. Langley had left town before this paper was read. A number of those present called attention to the disagreement of the results of Professor Nichols with those obtained by Professor Langley.

Professor Nichols's paper was appropriately followed by that of Prof. C. K. Wead, who exhibited a combined spectro-photometer and ophthalmospectroscope. This instrument, made by the Geneva society, is intended to combine with the least possible duplication of parts, several of the best instruments for the study of spectra. It gives the measure of the relative brightness of the spectra: 1°, by the width of slits or by smoked glasses; 2°, by Nicol prisms outside the collimator; 3°, by combination of the two. Further, it allows: 1°, the mixture of any two spectral colors in any relative intensity, and their comparison with an intermediate spectral color by 'Donder's coupled slits;' 2°, the addition of either the simple or the mixed color of a measured quantity of white light (Glan); 3°, the comparison of the simple or mixed colors of the spectrum with the light from a colored body.

In a paper on weather changes of long period, Mr. H. Helm Clayton of Ann Arbor cited evidence that there are at times slow progressive movements of barometric change, and of temperature from west to east. Mr. Clayton also made an attempt to show a certain periodicity in the character of the weather of the United States during the last year, and claimed to be able to make predictions based on this periodicity for a month in advance. The paper excited considerable adverse criticism.

Two papers by Dr. J. W. Moore of Easton, Penn., were devoted to an explanation of apparatus for classroom demonstration of electrodynamic phenomena. A paper read by Prof. H. W. Eaton of Louisville, on the relation of vanishing and permanent magnetism, contained results of an investigation which he had undertaken at the suggestion of Wiedemann.

Prof. C. J. Reed of Burlington, Io., exhibited a piece of apparatus for classroom demonstration of the laws of falling bodies.

CHEMISTRY IN THE SERVICE OF PUBLIC HEALTH.[1]

IN the study of hygiene from the chemical side, we are obliged to consider not only the normal conditions of the earth and atmosphere, but the changes which are brought about by the crowding together of individuals on account of the pursuit of manufacturing industries.

In the service of sanitary science, chemistry has an educational office to fill. The public has very little conception of what the capabilities and limitations of chemistry are. It is hard to make a person believe that water to be analyzed must be brought in a clean vessel, and that the chemist cannot distinguish between the impurities of the water and those of the jug. It is almost impossible for the chemically uneducated public to understand that when chemical action takes place, the properties of the substances concerned are not carried into the product; that because vitriol is used in glucose factories the product does not contain the acid; and the use of aquafortis in making oleomargarine, is equally startling.

There must needs be reformers and philanthropists, but many of these are extremists; and nowhere, more than in sanitary matters, is a little knowledge a dangerous thing. At one time all the evils were attributable to microbes, and at another to sewer-gas. Microbes may be left to the biologists, and possibly sewer-gas as well, since chemists have failed to discover any substances in the gas which could produce the well-known ill effects. In the matter of food adulteration, the origin of the terror is often obvious; thus, that tea is said to be adulterated with prussic acid, arose from the use of Prussian blue in the facing. Chemists are periodically obliged to distinguish between adulterations which are merely falsifications and those which are harmful, and it must be remembered that even the purest commercial products contain small amounts of foreign substances.

It is, perhaps, not altogether to our credit that we so often need the spur of extravagance to lead us to

[1] Abstract of an address delivered before the section of chemistry of the American association for the advancement of science, at Ann Arbor, Aug. 26, by Prof. W. R. NICHOLS, of the Massachusetts institute of technology, Boston, vice-president of the section.