Proceedings of the American Physical Society

STATE COLLEGE MEETING, JUNE 18 AND 19, 1943

THE 255th Meeting of the American Physical Society was held at State College, Pennsylvania, on Friday and Saturday, June 18 and 19, 1943. The American Association of Physics Teachers and the Pennsylvania Conference of Physics Teachers met with us, beginning their meetings on the previous Thursday evening. This was the second June meeting held in consecutive years at State College. Our hosts found themselves faced with much greater difficulties than those of the previous year, owing to causes which are too well known to require description. They acquitted themselves manfully in their double task, and the Society owes a great debt of gratitude to Dr. Wheeler P. Davey (Chairman of the Local Committee) and to many of his colleagues. One hundred and ten people registered from points other than State College; many of them did not have an easy journey.

The scientific programme included two symposia: "Physics in War Training Programmes" and "The Role of Physics in the Postwar Period." The former was designated as a symposium of the A.A.P.T., the latter as a joint symposium; actually, both were arranged by R. C. Gibbs. There were ten invited papers on our programme, most of them dealing with the use of physical methods in chemical analysis. Finally there were fifteen contributed papers, five of which (those numbered 5, 6, 7, 12, and 15) were read by title. The abstracts of the contributed papers and the titles of the invited ones are appended.

The dinner of the three Societies was held on Friday evening in the Nittany Lion Inn. Some of the officers spoke briefly, and the gathering was then addressed by W. R. Ham, of whom it should be said that he prepared his talk on twenty-four hours' notice in replacement of another speaker obliged to be absent.

At the Council meeting forty Members were elected; their names are appended. The Society had lost through death the following Fellows and Members: J. B. Engl (M), A. W. Goodspeed (F), J. Cramer Hudson (M), M. H. Kanner (M), C. M. Kilby (M), W. F. Magie (F). Mr. Magie was a former President of our Society. On June twenty-fourth occurred the death of another of our former Presidents and most distinguished Fellows, Joseph S. Ames.

The membership of the Society on June 17 numbered 4240.

Elected to Fellowship: Forrest F. Cleveland and Dean Woodridge.

Elected to Membership: Armistead, Fontaine C.; Barton, Charles A.; Bezuszka, Stanley J.; Billings, Bruce H.; Bittman, Loran R.; Burington, Richard Stevens; Butler, Howard W.; Chilton, Leonard Vincent; Cook, Emery Allen, Jr.; Day, Frank Hollingworth; Dodds, Wellesley; du Toit, S. J.; Falkoff, David L.; Frederick, Carl L.; Goldstein, Ladislas; Harris, Clyde W.; Krulikoski, Stanley, Jr.; Krumbein, A. Davis; Levine, Sol; Lewinstein, Max; Lockwood, Neil; Lund, Louis H.; Maduell, Charles Rene, Jr.; Monfore, Gervaise E.; Moon, Robert James; Moore, Carroll Lowry; Naiditch, Sam; Nierenberg, William A.; Peter, Brother Simon; Ramsey, Walter S.; Sausville, J. W.; Siegel, Edward; Simons, Charles Sands; Snyder, Frank D.; Stempin, Carl W.; Stimmel, Ronald G.; Terhune, Nelson A.; Van Poole, Thomas B., Jr.; Whitney Elliott; Zimmerman, John R., Jr.

SYMPOSIA

I. **Physics in War Training Programmes.**
II. **Role of Physics in the Postwar Period.**
R. C. GIBBS: **Some Problems Facing Physicists.**
G. P. HARNWELL: **Needs in Research.**
R. BOWLING BARNES: **Physics in Industry.**

INVITED PAPERS

W. F. G. SWANN: **Cosmic Rays.**
E. K. JAYCOX: **Modern Spectrochemical Analysis.**
NORMAN WRIGHT: **Physical Methods of Analysis and Control in the Chemical Industry.**
M. L. WILLARD: **Identification of Certain Organic Compounds.**
R. J. PFISTER: **An Addition to the Analytical Application of Raman Spectra.**

A. F. KIRKPATRICK: **Selective Dispersion: Physical Phenomena used in Quantitative Organic Analysis.**
C. E. WARING: **Magneto-Optic Rotation in Solutions.**
J. G. ASTON, G. J. SZASZ, H. L. FINK, and M. L. SAGENKAHN: **A Summary of the Work on Low Temperature Heat Capacities at the Pennsylvania State College during 1942–1943.**
J. E. NICHOLAS: **Some Preliminary Investigations on Dehydration of Fruits and Vegetables with Infra-Red Energy.**

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ABSTRACTS OF CONTRIBUTED PAPERS

1. The Viscosities of Pure Hydrocarbons and Lubricating Oils at Various Temperatures. M. R. CANNON AND J. M. GEIST, *Pennsylvania State College.*—Viscosity data were obtained for fifty-five hydrocarbons in the gasoline range at 0°C, 20°C, and 40°C. The measurements were made with modified Ostwald viscometers with water baths for temperature control. The viscosity-temperature behavior of the hydrocarbons followed the equation $\eta = Ae^{-B/RT}$. With this equation, the viscosities of the hydrocarbons may be calculated between 0°C and 40°C with a deviation of less than one percent. Some trends in the viscosity behavior of the measured hydrocarbons were noted. Among the octanes, the more compact molecules had the highest viscosities and viscosity-temperature coefficients. For the hydrocarbons which had approximately the same viscosities at 40°C, the alkylcyclopentanes had the lowest viscosity-temperature coefficients. They were followed by the alkylbenzenes, the alkylcyclohexanes, and the paraffins in that order. Vapor baths with automatic pressure regulation, which may be used for temperature control between 100°F and 500°F, were constructed. However liquid baths were preferred up to 210°F. The viscosities of three lubricating oils were determined at 100°F and 210°F using water baths, and at 300°F, 400°F, 450°F, and 500°F using the vapor baths. Their viscosity-temperature behavior did not follow the above equation. The measured viscosities of the lubricating oils were compared with values read from A. S. T. M. Viscosity-Temperature Charts. Above 300°F the chart values were always higher than the measured viscosities, by as much as ten percent at 500°F.

2. Solvent Extraction. K. A. VARTERESSIAN, *Pennsylvania State College.*—Solvent extraction is steadily taking its place as a unit operation in chemical engineering. Like most of them, it is primarily physical in nature. In an endeavor to understand its theory and practice, solvent extraction may be divided into the following: (a) equilibrium relationships (b) methods of operation (c) design of equipment and (d) applications in various industries. The art and science of extraction has profited a great deal by analogy with the more widely used and discussed unit operation of distillation; thus the concepts of similarity between heat and solvent and between vapor pressure and osmotic pressure have aided in organizing the subject matter, especially with regard to solvent economies, equilibrium relationships and efficiency factors. On the other hand, analogy with the unit operation of absorption has been of assistance in formulating rate and capacity equations and a view of extraction mechanism. Extraction with solvent is an effective tool in the separation of complex solutions into their component parts. It is particularly adapted to the segregation of substances having high boiling points and susceptible to decomposition. The analysis of residual petroleum oils by means of extraction with acetone at room temperature is an illustration of the numerous potentialities of this unit operation.

3. An X-Ray Study of Brasses Formed by the Interdiffusion of Copper and Zinc Deposited on Glass by Evaporization. ARTHUR A. BURR, H. S. COLEMAN, H. L. YEAGLEY, AND W. P. DAVEY, *Pennsylvania State College.*—By using the technique developed by Coleman and Yeagley, alloys were made by the interdiffusion of films of copper and zinc deposited on glass microscope slides by vaporization methods and x-ray investigations carried out. Data were obtained by means of the standard photographic powder method and by means of the Penn State Automatic X-Ray Spectrometer. Metal films used were of the order of 6×10^{-5} cm in thickness. (1) It is shown that the metal films formed on glass by vaporization and the resulting alloys formed by diffusion have the same crystal structure as the bulk metal. (2) A series of samples in the beta brass range were subjected to heat treatment at 198°C for varying lengths of time. Their diffraction patterns show that formation of any higher phase by diffusion involves temporary existence of all the other copper-zinc phases as intermediate stages. (3) Diffraction patterns recorded by the Automatic Spectrometer show orientation in the films. This gives experimental support to a proposed picture of the nature of phase changes during diffusion based on calculations from the lattice parameters. Techniques and procedure developed in this work suggest a method of determination of constitution diagrams and diffusion rates at low temperatures.

4. Tables of Intensity Ratios for Scattered Molecular Beams. JOHN K. WOOD, *Pennsylvania State College.*—In the interpretation of data of experiments on the scattering

of molecular beams by molecular clouds, graphs of a non-integrable function are required. The beam intensity ratio before and after scattering is a function of the temperatures of the beam molecules and of the temperature of the scattering cloud of molecules thus giving a family of curves of intensity ratios against one temperature function, the other being a variable parameter. The integral contains a term determined by a wave mechanical consideration of the problem of collisions and does not yield a simple closed solution because of this factor. The trapezoid rule for numerical integration was used in preference to Simpson's rule since it gave a smaller error to the numerically summed integral when the molecular cloud temperature was zero. The theoretical value of the integral at this point of no scattering is 1.000. Errors were taken at this point because on integrating again with a smaller interval of the dependent variable the first point showed the largest deviation from the more accurate integration. The tables have a temperature range which will cover most experiments using Li, Na and K.

5. Further Facts Concerning the Magnetic Current. FELIX EHRENHAFT, *New York City.*—The hypothesis of the electric current was founded chiefly upon three facts: The existence of electric ions, the decomposition of water (electrolysis), the circulation of the single magnetic pole around the constant electric current. Now those three facts have been observed in magnetism as well: the existence of magnetic ions, the decomposition of water through the magnet (magnetolysis), the circulation of a single electrostatic charge around the constant magnetic current. In the microscope one observes that different gas bubbles as well as solid particles move in circles around the axis of the magnet simultaneously in opposite directions. Each of them reverses its direction of motion with the reversal of the magnetic field. The bodies carry positive or negative electrostatic charges. The existing laws of electrodynamics (Biot-Savart, H. A. Lorentz) cannot explain the new facts because the electrostatic charges in question are resting ones, etc. Just as the line integral of the magnetic force defines the intensity of the electric current (Ch. Oersted, A. M. Ampere), the line integral of the electric force defines the intensity of the magnetic current. Electricity and magnetism represent an indivisible union, reaching far above the union established by Faraday, Maxwell, and Hertz. The electrodynamic equations must be extended to include the term of the magnetic current. These theses will be illustrated by microphotographs of the experiments.*

* The experiments can be seen at C. Zeiss Inc., New York City.

6. Use of a Mass Spectroscope in Artificial Radioactive Assignments. W. M. SCHWARZ AND M. L. POOL, *Ohio State University.*—At a number of places throughout the array of stable and artificial radioactive isotopic positions unequivocal assignments of activities to definite mass numbers are very difficult or impossible even with the aid of various bombarding particles and exacting chemistry. Consequently a modified Nier type mass spectrograph was adapted for use with artificial radioactive sources. The source of ions was a high frequency spark between solid electrodes which previously had been made radioactive. Very strong and highly concentrated activities are needed for satisfactory operation. The method was checked with the 12-hour radioactive copper period. Zirconium bombarded with deuterons yielded two periods of 23 hours and 18 days which have in addition to previously reported characteristics gamma-rays energies of 1.1 and 0.97 Mev, respectively.

7. Radioactivities in Barium Obtained from Cesium. KATHERINE E. WEIMER, M. L. POOL, AND J. D. KURBATOV, *Ohio State University.*—Additional observations on the artificial radioactivies induced in barium indicate that a very long period of several months is obtained by the Cs+d reaction in addition to the previously reported period of 38.8 hours. The long period emits x-rays characteristic to the cesium region as well as gamma-rays. Repeated purifications identify this long period chemically as barium. After several months following a bombardment chemical separations of the barium fraction from bombarded cesium yielded no activity. Therefore this period seems best assigned to Ba^{133}. The previously reported 14.2-day period obtained from Cs+d was not observed from Hilger spectroscopically pure cesium. Proton bombardment of cesium yielded a single period of 38.8 hours also assigned to Ba^{133}.

8. Determination of Nuclear Moment of Rubidium by Resonance Radiation. RALPH ATHERTON, *Miami University. (Introduced by R. L. Edwards.)*—Radiation of λλ4201.8A and 4215.56A from a hydrogen-rubidium discharge tube was focused on a resonance chamber containing distilled rubidium. Resonance radiation from this chamber was photographed through Wollaston and Nicol prisms. The percentage of polarization was calculated from these plates and the results compared to theoretical calculations based upon nuclear moment assignments for rubidium made by Jackson. The agreement seemed to be well within experimental error.

9. Sensitized Fluorescence and Tesla Discharge Spectra of Chromium Vapor. J. G. WINANS AND W. J. PEARCE, *University of Wisconsin.*—The Tesla discharge and sensitized fluorescence spectra of chromium vapor have been obtained with the simplified procedure that was followed for lead and indium.[1] Electrolytic metallic chromium was crushed to a powder and inserted in the quartz tubes before evacuation. The completed tubes contained only mercury and powdered chromium. Spectra were obtained with different mercury pressures from about 0.1 to 15 cm. The temperature was kept as high as possible without collapsing the quartz tube. About fifty chromium lines have been

identified in the Tesla discharge spectra at medium to high mercury pressures. Six lines (the two resonance triplets at 3600 and 4300) have been obtained in sensitized fluorescence. No action of selection rules for excitation of Cr by collision of the second kind is indicated by results so far obtained.

[1] J. G. Winans, Francis Davis, and Victor Leitzke. Pb Abstract, Phys. Rev. **55**, 1126 (1939). In Abstract, Phys. Rev. **57**, 70 (1940).

10. Exterior Ballistics of Small Arms Ammunition. RALPH HOYT BACON, *Frankford Arsenal, Philadelphia, Pennsylvania.*—Previous measurements of the time of flight and of the velocity of small arms bullets have involved firing through two or more screens of some kind. These screens, of course, affect the flight of the bullet, so that it was seldom feasible to fire through more than three screens at once. Furthermore, in order to obtain velocities and times of flight as functions of the distance, it was necessary to fire a few bullets through a set of screens placed at some chosen distances, and then to fire another group of bullets through another set of screens at another set of distances, and then try to make the sets of results agree. The equations thus obtained are generally quite complicated. However, a bullet in flight carries a small electrostatic charge. The arsenal has developed apparatus for detecting the passage of these charged bullets through the plane of a loop of thin wire, without interfering with the flight of the bullet. By firing bullets through a series of such loops, and recording the transit of the bullets on a suitable chronograph, the following remarkably simple equation was obtained for velocities between 2000 and 3000 feet per second: $dv/dt = -kv^{3/2}$.

11. Isobary—A Criterion for the Stability of the Lithosphere. ROSS GUNN, *U. S. Naval Research Laboratory, Washington, D. C.*—A quantitative investigation is made of the influence of a strong elastic lithosphere on departures from isostasy. Isostasy is shown to be a special case of a more general principle that may be called the principle of isobaric equilibrium. This principle which expresses the condition for vertical equilibrium is formulated quantitatively both in terms of the resultant vertical stresses in the lithosphere and in terms of measurable gravity anomalies. Employing the principle, a stress function may be determined that permits an estimate of the fraction of the uniform superposed load actually carried by the lithosphere. By applying this method, it is found that even for the central region of a block load to be in substantial isostatic adjustment (96 percent), the linear dimension of the load must approximate 330 km, a value more than six times that often assumed. The deformed figures of the lithosphere for certain special types of load have been worked out together with the stress function that measures both the gravity anomaly and the resultant vertical stress. The resulting distributions of displaced mass that compensate for various types of earth features are found to be not at all like the distributions usually assumed in isostatic reductions.

12. Heat Conduction in Blocks and Cylinders. C. B. POST, *The Carpenter Steel Company, Reading, Pennsylvania.*—Solutions of the heat-conduction equation are discussed for computing the rates of cooling at 1300°F during quenching in various finite sections such as cylinders, bars and blocks. The proposed method utilizes simple combinations of the temperature functions for the quenching of cylinders of infinite length and slabs for which tables are available. These calculated rates of cooling in finite sections are used to determine hardness contours in hardened steel blocks and cylinders. Data are presented showing the comparison of calculated and experimental hardness contours in various steel shapes.

13. Supersonic Measurements in Gases. W. H. PIELEMEIER, *Pennsylvania State College.*—A number of previous investigations of the velocity and the absorption of sound waves in gases were reviewed. Curves are shown for V_0, the velocity of low frequency and of V_∞, the velocity of high frequency sound waves in dry CO_2 as a function of temperature from 0 to 100°C. Another set of curves shows how f_m, the frequency producing maximum absorption per wavelength depends on the water vapor concentration in the CO_2 at approximately one atmosphere pressure. Evidence is presented for *two* distinct relaxation times for each given concentration. Most of this evidence is found in the published work of Knudsen and his students and in our data. A number of investigators have doubted the existence of two distinct relaxation times in CO_2. Acetaldehyde[1] has recently been investigated and was found to have three distinct relaxation times. Our measurements with helium of high purity show that the specific heat agrees well with the theoretical value and that the absorption agrees better than earlier results. Byers' work in this laboratory with carbon tetrafluoride furnishes a reliable value for the specific heat and for the relaxation time of CF_4.

[1] Alexander and Lambert, Proc. Roy. Soc. **179**, 499 (1942).

14. Measuring Small Increments of Length by Hydraulic Michelson Interferometer. C. G. STERGIOPOULOS, F. H. NADIG, AND J. L. BOHN, *Temple University.*—By applying hydraulic magnification to move one of the mirrors of the Michelson interferometer, increments of length of the order of 10^{-7} cm are detected. The apparatus consists essentially of two vertical cylinders of different diameters, partially filled with mercury and connected at the lower ends. Each is fitted with a freely moving plunger. Displacement of the large plunger is detected by the interferometer, one of whose mirrors is fixed to the smaller plunger. To verify the magnification as given by the dimensions of the apparatus, readings on this apparatus were compared with readings on a conventional Michelson interferometer. The instrument was used in the measurement of magnetostriction but can be applied to other small changes in length or may be used as a surface roughness indicator.

15. The Application of Multiplier Photo-Tubes to Quantitative Spectrochemical Analysis. E. A. BOETTNER, *Wyandotte Chemicals Corporation, Wyandotte, Michigan,* AND G. P. BREWINGTON, *Lawrence Institute of Technology, Detroit, Michigan.*—A bridge circuit consisting of two multiplier photo-tubes (RCA 931) has been adapted to indicate the ratio of intensities of spectral lines when the tubes are mounted on a spectrograph in place of the photographic film. It has been found that holding the voltage constant on one tube (set on an internal standard line) and varying the voltage applied to the other tube (set on an impurity line), the plot of the logarithm of the concentration of the impurity in the source *vs* the difference of voltage applied to the two tubes is a straight line. Quantitative analyses made using this circuit and calibration method have approached and in some cases equaled the accuracy and sensitivity possible with a photographic plate. Some indication has been obtained that if proper light sources were available the galvanometer reading representing unbalance of the bridge might be of significance for quantitative analyses.

AUTHOR INDEX TO ABSTRACTS OF THE STATE COLLEGE MEETING