maintained until no further changes take place in the sample under study. Even small fluctuations in temperature may be responsible for erroneous data, especially in multicomponent systems. A thyratron thermostat based upon that of H. S. Roberts (*Temperature: Its Measurement and Control in Science and Industry*, by H. S. Roberts, American Institute of Physics and Reinhold Publishing Corporation, New York, 1941, pp. 604–610), in which the furnace winding forms one arm of a Wheatstone bridge, was constructed to supply proper temperature control for such studies.

In the method of control developed, an AC bridge and amplifier control firing of a thyratron. Both the phase angle and amplitude of the unbalanced bridge voltage influence the response of the thyratron. The plate impedance of the thyratron, reflected through a transformer whose primary is in series with the furnace, regulates the current to the furnace winding. The control response requires only one sixtieth of a second. This thyratron control is highly sensitive and essentially independent of normal fluctuations in line voltage. It allows furnace temperatures to be maintained constant within ± 0.1°C. for several hours, and within ± 1.0°C. for several days. This precision thermostat has been employed for the control of relatively high temperatures, i.e., in the range 1000°–1550°C. W.R.E.

Precision Thermostat for High Temperatures. By W. R. Eubank. *Rev. Sci. Inst. 21: 845, October, 1950.*

■ Ionic Mathematics

Ionic solutions differ from nonelectrolytic solutions of the same molecular weight in showing much greater deviations from the laws of perfect solutions. This is due to the comparatively long range of the forces between the solute particles. The Debye-Hückel theory has, for twenty-five years, given correctly the first approximation to these deviations. Unfortunately, even this approximation fails at fairly low concentrations.

In this paper a method not hitherto employed is used to obtain the theoretical equation for the deviations from perfect solution law to an approximation beyond that given by the Debye-Hückel theory. The method employed follows closely the pattern used to compute deviations of gases from the perfect gas law. It makes use of a simple mathematical trick to avoid a difficulty introduced by the long range of the forces between ions, which has previously hindered the use of this method.

In the Debye-Hückel theory the deviations are proportional to the square root of the concentration. In this paper those deviations which are proportional to powers up to the three-halves power of the concentration are computed. J.E.M.

The Theory of Ionic Solutions. By Joseph E. Mayer. *J. Chem. Phys. 18: 1426, November, 1950.*

■ Photometrics

Photometric devices, especially those intended for the measurement of color, must be highly sensitive to small differences if they are to give useful information. Some of the most successful instruments in current use employ a null principle in which a phototube is alternately shown the sample and a standard. The information obtained is generally integrated or fed into a ratio device and the results are frequently recorded as percent reflectance (or transmittance). Perhaps the best known illustration of this type of photometric instrument is the GE spectrophotometer.

The present device has some points of similarity with the GE spectrophotometer but new features make it less expensive and at the same time give it some unique and interesting operating characteristics.

Two tungsten filament lamps are operated from a combination of alternating and direct currents in such a way that the lamps themselves are modulated in opposite phases. Thus they can be used directly in a null type instrument to illuminate respectively a sample and a standard for photometric comparison in an integrating sphere.

By using the resulting phototube signal as the source of alternating current for the lamps, this device becomes a servomechanism with photoelectric coupling. In this form it can be adapted for the measurement of density. By introducing the proper filters, spectrophotometric or colorimetric data can be obtained. J.E.T.

A New Photometric Device. By John E. Tyler. *J. Opt. Soc. 40: 693, October, 1950.*

■ Airglow

The airglow is that part of the light from the night sky which originates in the upper atmosphere. It is bright line or band spectrum and consequently an analysis of the wavelengths and intensities is one method of understanding the physics and chemistry of the upper atmosphere. Since the light from the night sky is very faint, the instrumentation must be of high light gathering power and very sensitive. The spectrograph used in the investigation has a high speed camera with an aperture ratio of 0.7. The photometer uses the highly sensitive photomultiplier tube and a specially designed amplifier which will give both the sensitivity and the time resolution required. The photometer automatically sweeps the sky recording the intensity from horizon to horizon.

The airglow spectrum shows the presence of atomic sodium and oxygen high in the atmosphere. The oxygen lines are "forbidden" ones and are the same as the green and red auroral lines; however, they are not excited by the bombardment of the atmosphere with ionized particles as in the case or auroral displays. The blue, violet, and ultraviolet parts of the spectrum are dominated by numerous faint bands which have been identified with forbidden bands from the nitrogen and oxygen molecules. Spectrophotometric observations of the sodium D-lines during twilight give the distribution of sodium atoms in the atmosphere. The distribution in the region from 60 to 120 km is that which would be expected if the sodium atoms were a component of the atmosphere, but for the region from 200 to 600 km the concentration is much greater.

Any reasonable theory indicates that the emissions must come from relatively thin layers, hence, an analysis of the variation of intensity with zenith distance will give a measure of the height to the layer. Observations show that the emission layer for the green auroral line is about 100 km and for the sodium D-lines is between 250 and 300 km. The heights of the emissive layers are important data required for the understanding of the physico-chemical processes in the upper atmosphere. In general the processes are the dissociations of molecules by ultraviolet sunlight during the day and recombinations at night. Owing to the low densities the recombinations continue throughout the night and the energies of dissociations released by this process furnish the energy for the excitation of the airglow spectrum. C.T.E.

Progress in Studies of the Airglow in Upper Air Research. By C. T. Elvey. *Am. J. Phys. 18: 431, October, 1950.*