increases with altitude, especially near the lower cloud stratum. (Paper read, July 10th.)

Some of the results obtained during more than 100 ascents of *ballons-sondes*, 7 of which ascents were higher than 14,000 meters, 24 higher than 13,000 meters, and 53 of which reached 9,000 meters, were discussed by de Bort in a paper read before the Academy on August 21st, last. The most important conclusions reached are as follows: I. The temperature at different altitudes shows notable variations during the course of the year, which are much greater than was supposed as the result of the older observations made in balloons. II. It appears that there is a fairly well-marked tendency to an annual variation of temperature as high up as 10,000 meters, the maximum being reached towards the end of summer, and the minimum at the end of the winter. This phenomenon is much complicated by the marked variations from day to day, which are related to the conditions of atmospheric pressure.

CENTIGRADE *versus* FAHRENHEIT SCALE.

THE discussion as to the relative merits of Centigrade and Fahrenheit scales has lately come up again in connection with the use of these scales in meteorological work. In *Nature* for August 17th, Buchanan points out that the zero on the Centigrade scale occurs at such a place as to make nearly half of the readings come below zero. Hence the scale must be read upward half the time and downward half the time, which is awkward. Furthermore, the averaging of the results is extremely troublesome, and mistakes are easily made. Clayton (*Nature*, Sept. 17th), agrees with the opinion expressed by Buchanan, and makes the novel and ingenious suggestion that if the Centigrade thermometer is ever adopted for meteorological purposes by the English-speaking nations, the freezing point of water should be marked 273° on the scale and the boiling point 373°. By this method meteorologists would have at once the temperatures concerned in the change of volume of gases, and embodied in many formulæ, and the difficulty of the inverted scale, above referred to, would be eliminated.

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NOTES ON INORGANIC CHEMISTRY.

A PAPER on Solid Hydrogen was read by Professor Dewar at the Dover meeting of the British Association and is reprinted in the *Chemical News*. It is only since the fall of 1898 when it has been possible to obtain liquid hydrogen in quantities of one or two hundred cubic centimeters, that attempts could be made to solidify it. The principle used was that of a vacuum tube containing liquid hydrogen immersed in a bath of liquid hydrogen contained in an outer vacuum tube connected with an air pump. When the pressure in the outer tube is reduced below 60 mm., the hydrogen suddenly solidifies into a white froth-like mass like frozen foam. In the inner tube the upper part of the solid hydrogen is frothy, but below it is a clear solid resembling ice. The solid melts at a pressure of 55 mm., or under a pressure of 35 mm. at 16° absolute (—257° C.). The boiling point of liquid hydrogen at 760 mm. pressure is 21° absolute (—252° C.). The foamy structure of the solid hydrogen is doubtless due to the fact that rapid ebullition is substantially taking place throughout the entire liquid, owing to its extreme lightness, for the specific gravity of liquid hydrogen is only 0.07 at its boiling point, and its maximum density not over 0.086. The lowest temperature now obtainable is from 14° to 15° absolute (—259° to —258° C.), reached by the evaporation of solid hydrogen in a vacuum.

A NEW method of separating the active constituents of racemic compounds is described by Marckwald and McKenzie in the last *Berichte* of the German Chemical Society. It is based upon the fact that while isomeric acids of the fatty series have nearly the same affinity, and the same limit of ester formation, the speed of the latter depends very markedly upon the structure of the acid molecule. In the described experiment racemic mandelic acid and menthol were heated together for an hour—menthyl mandelic ester was formed and that portion of the mandelic acid which was unacted upon was recovered and found to be lævorotary; the dextro-rotary acid was thus changed to the ester first. While perhaps of no practical application, this method is of theoretical interest, as it adds a purely chemical method of splitting racemic compounds, to the three already known, the mechanical, the bio-chemical and the physical.

J. L. H.

LIMITATIONS OF THERMODYNAMICS.

An important paper has recently been issued from the press of Dunod as a reprint from the *Revue de Mécanique*, current volume, in which M. Georges Duchesne presents the results of a very extensive experimental study of the thermal and thermodynamic processes in operation in the steam engine and especially during the period of emission, which has been the most difficult of investigation and the most obscure of all the elements of the vapor-engine cycle.*

With a vapor engine in steady operation the observation of the amount of liquid passing through the system in the unit of time gives the measure of the quantity taken into the working cylinder at each stroke of its piston, and this, with the determination of 'quality' by the 'calorimeter,' and automatic registration of volumes and pressures, by the 'indicator' of Watt, permits the exact apportionment of energies and the physical condition of the fluid to be determined from the instant of closure of the induction-valve to its opening at the commencement of exhaust. The delineation of the 'saturation-curve' on the indicator-diagram, for the quantity of fluid known to have entered the cylinder, gives the measure of contemporaneous volumes of the corresponding quantity of 'dry and saturated' vapor which serves as the unit of the scale measurements of the relative volumes, and weights of liquid and vapor in the mixture constituting the working fluid, or the extent of superheating, if at any point superheated. From the instant of commencement of emission, however, no measure is obtainable of these quantities, and the problem becomes incapable of solution by ordinary observation.

Donkin has sought the solution of this particular question of the state of the vapor in the period of emission and that of compression by the use of his 'revealer,' by means of which the fluid is sampled and tested as to quality, and Professor Carpenter, in the laboratories of Sibley College, has sought the same end by the use of the now familiar 'steam-calorimeter,' taking off samples of the steam automatically at certain points in the portion of the cycle to be investigated. Donkin concluded that the vapor in the exhaust period was wet; Hirn, Carpenter and others, including Dwelshauvers-Dery, have found it dry. M. Duchesne revises the work of Donkin, particularly, and concludes that, contrary to the deduction of the investigator himself, the research indicates that the vapor is dry and saturated during the period of emission. He decides that the results of those experiments furnish 'proof of the complete dryness of the surface at the end of emission.' If dry at this point, they will presumably continue dry up to the beginning of the period of compression, and, then, mechanical compressions alone affecting the fluid, superheating should occur. This was the conclusion of the writer long before the apparatus and method of recent research was ready to give its testimony in the case,* as respects economically operated engines; but the contrary as regards uneconomical engines, in which the working fluid, after entering the cylinder, is very wet, and Willans based upon the same conviction the details of design in his engine insuring that the moisture deposited upon the cylinder-walls should be swept off as thoroughly as possible by the current of the working fluid. M. Duchesne finds confirmation of these anticipations in the work of Hirn, of Delafond and of Dwelshauvers-Dery; the latter affording him very conclusive evidence, which he reviews at length.

The conclusions reached are the following, in substance:

(1) When, in the engine-cylinder, the vapor is saturated and the walls humid, the vapor and the water on the surface of the metal in immediate contact with the liquid assume almost instantaneously the same temperature.

(2) If the surface is dry, it may take a temperature superior to that of the fluid.

* L'état de la Vapeur a la Fin de l'Émission; par Georges Duchesne, Ingénieur, ancien Assistant du Professeur V. Dwelshauvers-Déry; Paris, Vve. Ch. Dunod, 1899. Royal 8vo., pp. 15.

* Manual of the Steam-Engine, Vol. I., § 53, pp. 355–627, especially p. 631. Trans. A. S. M. E., 1890, No. CCCLXII.; 1894, No. DLXVI.; 1894, 1896, pp. 843, etc.