Example.—What is the weight of a cubic meter of saturated air at 10° C.? *Answer.*—At 10° the vapor pressure is 9.14 millimeters. By the formula

$$\frac{1293.05}{1+0.00367\times 10}\,\frac{760-0.378\times 9.14}{760}=1241.6 \text{ grams.}$$

A cubic meter of dry air at 10° weighs 1247.3 grams; the saturated air weighs 5.7 grams less than an equal volume of dry air.

The student should be required to construct a table giving the weight of a cubic meter of dry air for every 5° C. between — 30° and 35° C., and the weight of a cubic meter of saturated air, and the difference between them. The table may be arranged as follows:

Temperature.	Weight of a cubic meter of dry air.	Weight of a cubic meter of saturated air.	Difference.
°C.	*Grams.*	*Grams.*	*Grams.*
10	1247 3	1241.6	5.70

Example.—What is the difference between the weight of a cubic meter of dry air and of saturated air at — 20° and 30° C.? Will be answered by the above table, when completed.

Problem 16.—Give formulas expressing the weight of dry air and the weight of aqueous vapor in a kilogram of saturated air.

Solution.—If a cubic meter of dry air weighs 1.29305 kilograms, then 1 kilogram has a volume of 1/1.29305 cubic meters. Or in general, as one cubic meter of saturated air weighs by equation (1), problem 15,

$\frac{1293.05\,(b-0.378e)}{(1+at)\,760}$ grams or $\frac{1.29305\,(b-0.378e)}{(1+at)\,760}$ kilograms,

then 1 kilogram will occupy in cubic meters, the reciprocal of that, or 1 kilogram of saturated air occupies

$$\frac{(1+at)\,760}{1.29305\,(b-0.378e)} \text{ cubic meters} \ldots . (1)$$

In order to know how much dry air is present in this number of cubic meters of saturated air, we must multiply the expression by the quantity of dry air in a cubic meter, given by the first part of equation (1), problem 15, or

$$\frac{(1+at)\,760}{1.293\,(b-.378e)}\times\frac{1.293\,(b-e)}{(1+at)\,760}=\frac{(b-e)}{(b-.378e)}.$$

The number of kilograms of dry air in 1 kilogram of saturated air is

$$\frac{(b-e)}{(b-.378e)} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In a similar manner by multiplying the expression (1) by the second part of equation (1), problem 15, giving the quantity of aqueous vapor in a cubic meter, we get an expression giving the number of kilograms of vapor in 1 kilogram of saturated air, or

$$\frac{(1+at)\,760}{(b-.378e)\,1.293}\times\frac{0.622\times 1.293\times e}{(1+at)\,760}=\frac{0.622e}{(b-.378e)}.$$

The number of kilograms of vapor in a kilogram of saturated air is

$$\frac{0.622e}{(b-.378e)} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Problem 17.—How much dry air and how much aqueous vapor are contained in a kilogram of saturated air at 10° C?

Solution.—By applying the formulas of problem 16, we get, since e at 10° is 9.14 mm:—

from (2) dry air $\frac{760-9.14}{760-.378\times 9.14}=0.99247$ kilogram.

from (3) vapor $\frac{0.622\times 9.14}{760-.378\times 9.14}=0.00753$ kilogram.

Sum = 1.00000 kilogram.

The student should be required to construct a table giving (1) The volume which 1 kilogram of dry air occupies at different temperatures; (2) The volume which 1 kilogram of saturated air occupies; (3) The quantity of dry air in a kilogram of saturated air; (4) The quantity of vapor in a kilogram of saturated air. Example:

Temperature.	Volume of 1 kilogram of dry air.	Volume of 1 kilogram of saturated air.	Weight of dry air in 1 kilogram of saturated air.	Weight of vapor in 1 kilogram of saturated air.
°C.	*Cubic meter.*	*Cubic meter.*	*Kilogram.*	*Kilogram.*
10	0.8017	0.8054	0.99247	0.00753

An extended table of the weights of aqueous vapor in a kilogram of saturated air under various pressures, in the metric system, will be found in Bigelow's Cloud Report, pages 560 and 561. See also Marvin's tables for the Psychrometer and Smithsonian Meteorological Tables.

All these problems may also be solved for other pressures than 760 mm.

[*To be continued.*]

NOTES ON THE CLIMATE OF KANSAS.

By T. B. JENNINGS, Section Director. Dated Topeka, Kans.

[Read before the Kansas Academy of Science November 30, 1906.]

In reviewing the history of a country it is customary to divide it into prehistoric and historic periods. In writing of the climatology of this State we shall divide it into two periods, the first period extending from the earliest reliable written accounts of its weather down to the time (1887) that systematic observations and records were practically begun over the entire State. Tho the State is young, it has a few records that began in the dim past. The Fort Leavenworth record began in 1836, the Fort Riley record in 1853, the State Agricultural College record in 1858, the Kansas University record in 1868, the Independence record in 1872, and the Dodge record in 1875.

FLOODS.

The old river boatmen give an account of a flood in the eastern part of the territory and in the Missouri River in 1785 which past down that river and into the Mississippi, flooding the American bottoms across from St. Louis, and which for many years was referred to as "The Great Flood." Twenty-six years later the Missouri River bottoms were again flooded.

About the last of February or first of March, 1826, heavy rains began in what is now the southeast quarter of the State, raising the Neosho and its tributaries "out of their banks" and flooding their bottoms; heavy rains continued in the territory during the season. In June the lowlands near the mouth of the Kaw were flooded, owing to high water in the Kaw and Missouri rivers meeting; in the fall a destructive flood swept down the Neosho, carrying away wigwams, houses, and gathered and ungathered crops.

In 1844 occurred probably the worst floods eastern Kansas has ever experienced. Rev. Mr. Meeker, who was missionary to the Ottawa Indians and was living on what is now the site of the city of Ottawa, in his letters gave a graphic account of the condition of the Marais des Cygnes and the destruction wrought by it at that point. From the 7th to the 20th of May there were nine days of rain, and daily from the 23d to the 29th, inclusive, rain fell; it began again on June 7, and on the 12th the Marais des Cygnes overflowed its banks, carrying away outhouses, fences, cattle, pigs, and chickens; the river began falling on the 14th and began rising again on the 20th.

At Fort Leavenworth the rainfall for June, 1844, was 8.53 inches; for July, 12 inches; for August, 8.08 inches, aggregating 28.61 inches for the three months. (The normal annual precipitation for that place is 30.89 inches.) Mr. Richard W.

Cummins, of the Fort Leavenworth Agency, reported to the Government: "All those farming on the bottom lands of the Kansas River and other bottom lands lost their crops entirely, and not only their crops, but nearly all their stock, hogs, cattle, and even horses. * * * The Konzas farm is mostly on the bottom lands of the Kansas River, which was overflowed from bluff to bluff." S. M. Irvin, Indian Agent in charge of the Great Nemaha Subagency, reported: "The past season, you must be aware, has been a most unpropitious one for farming operations. The unprecedented fall of rain which took place in June and July, by which much of the best farming land of the Indians was several times inundated, has been a serious drawback upon the aggregate value of the farming products."

W. W. Cone in his "Shawnee County History", speaking of the flood of 1844, says: "During the flood Major Cummings, Paymaster of the U. S. Army, wishing to cross from the south to the north side of the Kaw River at Topeka stepped into a canoe at about the present site of the corner of Topeka avenue and Second street and was rowed by an Indian from there to the bluffs, near the present residence of J. M. Harding, in Soldier township, the water then being 20 feet deep over the ground where North Topeka now stands".

Mr. P. E. Chappell, of Kansas City, Mo., an old river steamboatman, states that the flood of 1844, in the Missouri River, was confined to the lower river and adds: "The entire bottom from the Kaw to the mouth of the Missouri was completely submerged, and from bluff to bluff presented the appearance of an inland sea". He further states that in 1845 and in 1851 there was unusually high water in the river and all the second bottoms and low slough were submerged. We find that at Fort Leavenworth 15.80 inches of rain fell during June, 1845, while in 1851 the Fort Leavenworth record shows for May 6.40 inches, for June 8.16, July 6.78, and August 5.02, a total of 26.36 inches.

THE DROUGHT.

Mr. E. C., in his paper "In at the birth, and–" says in part: "During the winter of 1859-60, the sun shone forty-five consecutive days thro a cloudless sky upon a snowless plain. Thru the summer of 1860 the hot wind parched the soil and no harvest followed the seed time; hence the approaching winter brought an alarming outlook". (He was living in Marshall County then.)

Mr. Wm. H. Coffin, who settled in Leavenworth County in the 50's, speaking of the drought, says in part: "In the great drought in Kansas, from June 19, 1859, to November, 1860, not a shower of rain fell at any one time to wet more than two inches deep, and but two light snows in the winter ('59-60). Roads never got muddy, and the ground broke open in great cracks. There were no vegetables whatever, and a burning hot wind in July and August withered everything before it. Fall wheat came up in the spring but withered and died; most counties did not harvest a bushel. Low bottom lands, where well tilled, gave some corn, but most other lands dry fodder. Prairie grass grew until July, then all withered and died—enough was secured mostly from low bottom lands. Wells, springs, and streams dried up".

The Hon. Geo. W. Martin, in an address before the Old Settlers' Association of Geary County, September 21, 1901, said in part: "The changed condition in Kansas is indicated by the tone of the people during the recent dry spell. It is no easy matter to reclaim a new country, but the people of Kansas have accomplished marvels. The drought of 1860 began September 1, 1859, from which date there was no rain until September or October, 1860. * * * On the 13th of July the mercury went up to 112° and 114° in the shade (the highest temperature at Manhattan was 115°), and, with a hot scorching wind, it kept at these figures for weeks. The leaves withered and fell off the trees, and eggs roasted in the sand at midday. The dates of the beginning and ending of the drought vary in locations, but it may be said that there were from twelve to fourteen months between rains".

Horace Greeley, writing in the New York Independent of February 7, 1861, referring to the drought of the preceding year, said: "* * * Drought is not unknown to us; but a drought so persistent and so severe as that which devastated Kansas in 1860 is a stranger this side of the Mississippi. No rain, or none of any consequence, over an area of 40,000 square miles, from seed time till harvest—wheat, Indian corn, buckwheat, successively deposited in the earth, to die without germination, or to start only to be blighted and wither for want of moisture".

Mrs. Susie M. Weymouth, in the Daily Capital, July 19, 1901, says: "The drought of 1860 gave to Kansas the ignominous name, 'droughty Kansas'. * * * It seemed for a time that the powers of heaven and earth were against us. * * * Previous to 1860 a good many trees were planted. The hot winds of that summer told on them, and in after years the south side of the trees told of the fearful heat which they had past thru, for there was always a dead part. That year will go down in history as having the hottest day on record. * * * It was in July * * * a frightful day. People fled to their cellars and every door and window was closed. It was as if the wind was coming from a red-hot furnace for nine or ten hours. Next day we looked to see what damage it had done—birds, chickens, and stock had succumbed and the trees were badly injured; the tender things for two feet on the south side were as dead as if a fire had swept thru them".

The year 1874 has been called a drought year, but it was not; it was a grasshopper year.

CLAYDEN'S CLOUD STUDIES.

As we often have occasion to refer to the volume entitled "Cloud Studies", by Arthur W. Clayden,[1] it seems proper to call the attention of American observers and students to this excellent work, which in some respects supplements the important papers published by our American colleague, Mr. H. H. Clayton, of Blue Hill Observatory. Mr. Clayden has been a long time known to meteorologists as the secretary of the special committee on meteorological photography, of the British Association for the Advancement of Science, and he has published annual reports on that subject since 1890. He was a wrangler in the Tripos, Christ College, Cambridge, 1876, and science master at Bath College, 1878, and is now principal of the Royal Albert Memorial College, Exeter; he is therefore thoroly familiar with the physical problems that enter into cloud study, and with the laboratory methods necessary to secure good photographs and accurate measurements. His present volume shows that perfect familiarity with the subject that enables one to write "down to the level of the nontechnical reader" without making any technical mistakes; so that this book will be for a long time treasured as one worth reading and studying. The work is not merely a collection of halftones, with descriptions of the clouds, but it is full of suggestions as to their methods of formation, and will stimulate the reader to further studies. It is the work of an independent thinker, who does not often go far astray from the facts and principles that belong to exact science.

Some items that have caught our attention may be worth mentioning, but really every one of the 180 pages contains something good.

On page 16 the author urges the advantage of observing delicate details by studying the reflection of a cloud in a black glass mirror; we are sorry to find that his book is so wholly taken up with photographic work that he has, we believe, not even mentioned the nephoscope and the ordinary use of the

[1] Published by John Murray, London, 1905.