CASUAL PHENOMENA.

Note observations of the following:

THUNDER STORMS—Time of occurrence and direction of motion. TORNADOES—Time of occurrence, width and direction of path, effects produced, and whether attended by electricity or hail. LIGHTNING AT A DISTANCE—Time of occurrence, direction from observer, whether zigzag, forked, or diffuse. Objects struck by lightning, as trees, buildings, &c. HAIL STORMS—Time of occurrence, direction and width of path, size and quantity of stones, and amount of injury. AURORA BOREALIS—Time of appearance and disappearance; time of the formation of arch, beams, and corona, and whether there is a dark cloud below the arch. Direction and time of occurrence of METEORS, SHOOTING STARS, SOLAR and LUNAR HALOS, PARHELIA, and PARASELENES. Time of early and late FROSTS, particularly first and last. DEPTH OF GROUND FROZEN, in feet and inches; disappearance of frost from the ground. Time of closing and opening of RIVERS, LAKES, CANALS, and STREAMS, and their extreme rise and fall. TEMPERATURE of wells and springs at least once each season. EARTHQUAKES—Time of occurrence, direction of impulse, number of shocks, and effects produced.

April 1st — Thermometer 29° before sunrise — heavy frost —

GENERAL REMARKS AND DIRECTIONS.

PRESSURE OF THE ATMOSPHERE.

One of the principal elements of meteorology is the change in the pressure of the atmosphere, which, in some extreme cases, amounts to nearly a pound on every square inch of surface. This change is indicated by the variation in the height of the column of the barometer, which stands at the level of the sea, on an average at about 30 inches.

The column of mercury is sustained by a column of air of the diameter of the tube, and extending from the ground to the top of the atmosphere. The air at the surface of the earth is about ten thousand times lighter than mercury; and, therefore, a column of 30 inches of the latter will balance nearly five miles of the former, and this would be the height of the atmosphere were it of uniform density. But the air diminishes in density, in a geometrical ratio, as we ascend, and hence the actual height is much greater. From observations on the refraction of the light which reaches the eye from the sun after it has descended below the horizon, it is proved that the height of the atmosphere is at least 57 miles. On account, however, of the rapid diminution of density, the larger portion of the air is below an elevation of four miles; and it is to the lower stratum of this thickness that the principal meteorological phenomena are confined.

If any considerable portion of the vertical column above the barometer be heated, the whole will tend to increase in length, and its extremity to project beyond the general external surface of the atmosphere, then to flow off on every side; and thus the column, which has been heated, will become lighter, while the columns around will become heavier. If a comparatively small portion of the whole column be heated, the expansion of this will perhaps not lift the entire incumbent part of the column and cause it to project beyond the general surface above, but the effect will be confined to a lateral expansion into the columns around. The latter is probably the case in many atmospheric changes; for variations have frequently been observed in the pressure of the air at the surface of the earth, when, at the same time, none were perceived on the top of an adjacent mountain.

A similar effect will be produced if, instead of an increase of temperature, a sudden intrusion of vapor takes place, as in the case of a stratum of dry air displaced by a current surcharged with moisture.

But changes of this kind cannot be perceptibly indicated by the barometer, unless they are of considerable magnitude, and extend through a mile or more of height of the lower portion of the atmospheric column. This will be evident, when we reflect that nearly 60 miles of air are balanced by 30 inches of mercury, and hence the variation of temperature which may take place on account of a change in the weight of the air, in the room in which a barometer is placed, must be inappreciable by this instrument. A change, however, in the temperature of the room, does change the weight of the mercury, and, therefore, though the pressure of the atmosphere remains the same, the barometrical column will vary, and hence the necessity of the reduction of the observations, by means of the attached thermometer, to the density of mercury at the freezing point.

From the foregoing remarks, it is evident that the barometer may be conveniently placed within doors, in a room not subjected to sudden changes of temperature, in a good light, but shaded from the direct rays of the sun. It should be secured in a vertical position by means of a plumb-line applied to the front and side. Its height above the surface of the ground, and also above the level of the sea, ought to be ascertained.

To observe the barometer, first note the degree of the attached thermometer, because the heat of the body may affect this. Next, adjust the cistern until the mercury just touches the ivory point. Then gently tap the case so as to lessen the adhesion of the mercury to the tube, and measure the height of the column. To do this, lower the vernier until the plane passing through the two lower opposite edges of it, is exactly tangent to the surface of the convexity that terminates the column. Lastly, read the vernier and enter the results in the proper column.

TEMPERATURE.

Another important meteorological element is the temperature of the air; and to obtain this, the standard thermometer should be so placed entirely in the shade as not to be materially affected by the heat of surrounding objects, and freely exposed to any currents of air that may be stirring.

Large bodies are slowly heated and slowly cooled, and are, therefore, almost always above or below the temperature of the air. Hence, a thermometer should not be placed in contact with the side of a house. The best position for the thermometer is in the middle of a projection from a window on the north side of the house, so as to be entirely in the shade. It should be covered with a slanting roof to shed the rain, and enclosed on three sides and the bottom with horizontal slats, like window blinds, so as to permit the free circulation of the air, while the radiation from surrounding bodies, and the direct rays of the sky are excluded. The enclosure or box should be painted white on the outside to reflect off the rays of heat. The same enclosure may contain the wet and dry-bulb thermometers.

It may be important to observe, in conducting meteorological observations, that there are two kinds of heat—namely, heat of high and that of low intensity. The first is received directly from the sun; the second is given off from all bodies of low temperature, or from a stove heated below redness. The first, like light, passes through all transparent bodies; the second is stopped in a considerable degree by glass, and all transparent substances, except rock salt. The first, in some cases, may be considered as converted into the second; for instance, intense heat, which is absorbed by a dark body, is again radiated as heat of low intensity. It is on this principle that we explain the effect of the melting of snow around a wooden post; the intense heat from the sun is reflected from the white snow, as light is, and absorbed by the dark-colored wood, and from this is again radiated as heat of low intensity, which is absorbed by the snow, and produces the liquefaction of the latter. The accumulation of heat in closed spaces covered with glass, is also readily explained on the same principle. The intense heat directly from the sun enters through the glass, is absorbed by the materials within, and raises the temperature, or is radiated back as heat of low intensity, which cannot penetrate the glass, and hence the accumulation of heat. Saussure found the temperature indicated by a thermometer exposed to the sun, in a small box, blackened inside and out, and covered with glass, to be 191° F.

Heat of all kinds readily passes through the air; and, as all bodies are continually radiating it, a thermometer exposed to a clear sky, which reflects back no rays, will fall several degrees below the temperature of the air; hence, when the object of the meteorologist is to obtain the temperature of the air, the thermometer ought not to be exposed to any portion of the sky. Also, from the fact that heat of low intensity does not radiate through glass, the thermometer may be placed on the outside of a double window without being materially affected by the heat within.

MOISTURE.

Another important meteorological element, is the amount of moisture in the air. This, with the amount and distribution of heat, are elements most essential to the agriculturist, since they principally determine the capability of different districts for the production of vegetable life.

Different views have been entertained as to the manner in which moisture is contained in the air. According to Saussure and the older meteorologists, it was considered as dissolved in the atmosphere, and that the solvent power of the latter for the former, increased with the temperature. According, however, to later meteorologists, the vapor in the atmosphere exists in an independent state. Dalton, who first advanced this hypothesis, proved conclusively, that water in a vacuum gives off a new portion of vapor, which is forced into the same space, at every increase of heat, and that, consequently, the density and elastic force of vapor, in free space, depends entirely on the temperature to which the water is submitted. If the temperature is lowered, a portion of the vapor will fall in the form of cloud or water. He also proved, from conclusive experiments, that just as much vapor, at a given temperature, will exist in a given space filled with air, as in a vacuum. This result he explained on the hypothesis that the atoms of air and moisture exert no repulsion on each other; that the atoms of air only repel atoms of air, and atoms of vapor only repel atoms of vapor; that the atoms of one fluid exist in the interstices of the other, and that each is, as it were, a vacuum to the other. On this principle he founded the method of determining the elastic force of vapor, and the quantity of moisture in the air at a given time.

This theory is, doubtless, a true expression of the statical condition of a mixture of air and vapor; and if sufficient time be allowed, the two fluids will arrange themselves as if the one were a vacuum to the other. It requires, however, some time for this arrangement to take place. The atoms of each fluid appear to offer a mechanical impediment to the free motion of the atoms of the other, and the diffusion takes place slowly, instead of almost instantaneously, as it would in the case of a vacuum; and since the air is almost constantly changing its temperature, and continually in motion, the statical condition which the theory supposes, seldom if ever takes place, except approximately. Still, the law of Dalton is the fundamental principle on which many of the most important meteorological phenomena depend.

The measurement of the quantity of vapor in the atmosphere is by no means so simple a process as that of obtaining the pressure of the temperature. An approximation to the relative moisture of the air, from day to day, may be obtained by the simple hygrometer, or, rather hygroscope, employed by Mr. Dalton. This consists of a fishing-line 30 or 40 feet long, permanently fastened at one end, and stretched over pulleys backward and forward by a weight at the other. To adjust this instrument, the cord is first heated in an oven until it is perfectly dry; the position of the pointer on the weight is then marked. The cord is next thoroughly wetted by means of a sponge, the position of the pointer again noted, and the distance between the two points divided into one hundred equal parts, each of which is called a degree. An observer, for want of a better, may construct an instrument of this kind, the indications of which, carefully noted, would, in many particulars, afford interesting results.

Another method of obtaining the amount of vapor, is by means of what is called the "dew point." To explain this, it may be remarked, that if the air, or rather the space it occupies, were constantly saturated with moisture, the quantity at any time could readily be ascertained by inspecting a table containing the amount of water which can exist, at different temperatures, in a vacuum. Such tables have been formed by Dalton and others from direct experiment; and if the air is a vacuum to moisture, then the same table will give the amount of vapor which exists in the atmosphere at any temperature, provided the space is saturated with moisture, or has as much as it can hold at the temperature. This, however, is seldom the case, and in order to find the amount of vapor, we resort to the expedient of producing, artificially, a state of saturation. For this purpose, we cool down a portion of the air until the temperature corresponds with the quantity of vapor which the air at the time contains—a condition that is readily perceived by the beginning of the formation of a cloud, or the deposition of dew. With this temperature, which is technically called the "dew point," we enter the tables before mentioned, and ascertain the corresponding quantity and tension of vapor.

The dew point is found in practice, by placing a thermometer in a thin metallic tumbler, partially filled with water, and gradually cooling the liquid until dew begins to settle on the outside of the vessel. In this way the stratum of air, which surrounds the tumbler, is gradually reduced in temperature until it arrives at the point of saturation, and begins to deposit its moisture. During the cooling, the water should be constantly stirred with the thermometer, and the temperature indicated at the moment the dew begins to appear, will be the dew point. In summer, a sufficiently low temperature can generally be obtained by pouring into the tumbler cold spring water; but, should this not produce a deposit, recourse must be had to ice-water, and in winter, to a mixture of snow and salt.

Another and a more ready method of determining the hygrometrical condition of the atmosphere, is by means of the *wet* and *dry*-bulb thermometer. The dryer the air, or the further it is from saturation, the more rapid will be the evaporation from a wet surface; and, consequently, the greater will be the cooling of the body from which the evaporation proceeds. By a series of experiments, the relation of the amount of fall of temperature, produced by evaporation and the temperature of the dew point, has been determined so that the quantity and tension of the vapor may be ascertained, when the temperature of the air and its reduction by evaporation are known.

The most rapid method of ascertaining the reduction of temperature, due to evaporisation, is to observe the indication of a thermometer, the bulb of which is covered with linen cloth and wet with pure water. A small vessel of rain water should be left exposed, in order that the liquid may be of the temperature of the air. Immerse the bulb of the instrument several times in this by elevating the cup. After this, the thermometer should be allowed to stand a few moments until it indicates the temperature of evaporation. In cold weather, the bulb may be constantly surrounded with a thin stratum of ice. The wet bulb is sometimes supplied with water by the capillary attraction of a cotton wick from a cup of water, which may be placed on a level or a little below the bulb.

RAIN AND SNOW.

Another element of meteorology is the amount of rain which falls on different parts of the earth. The simplest method of determining this, would be to expose a cylindrical or square vessel freely to the rain, and to measure the depth of the water which is caught in it after each storm or shower. Greater precision, however, is obtained by employing a rain-gauge, which consists of a circular or square funnel, with a jug below to receive the water, and a measuring vessel to estimate the quantity. If the area of the orifice of the funnel be one hundred times that of the measuring vessel, each inch of the latter will indicate a hundredth of an inch of rain falling on the earth adjacent. The gauge should be placed so that it may not be sheltered in any direction by buildings or trees, from the oblique descent of the rain. The whole apparatus should be sunk in the earth in a cask provided with a wooden cover, with the mouth of the funnel a few inches above the surface of the ground. Care should be taken that the rain does not rebound from the surface into the funnel; to prevent this, the surrounding space may be covered with old carpet or cloth.

To ascertain the amount of water produced from snow, a column of the depth of the fall of snow, and of the same diameter as the mouth of the gauge, should be melted and measured as so much rain. As a general average, it will be found that about 10 inches of snow will make one of water.

CONCLUSION.

The above directions are applicable to full sets of standard instruments; but few of the observers are furnished with these, and, therefore, results of a very precise character are not, in most instances, to be expected. The observer ought, however, in all cases, to render his results as accurate as possible, and not to consider them of little value even though they should fall far below his ideal standard of perfection. Though the barometer may not give the absolute pressure of the atmosphere, yet it may serve to indicate the time of maximum and minimum pressure, and its oscillations may be comparable with each other, and thus be of value in ascertaining the law of transmission of atmospheric waves. So, also, the thermometer, though its scale may not be entirely correct in every part, yet the probability is, that, in the course of the year, the errors will compensate each other, and the mean temperature of the place be made known. This may also be the case, although the instrument has sometimes indicated too high and sometimes too low a temperature, on account of its proximity to buildings or other large objects less liable to be suddenly affected by heat or cold.