weight of gas varies directly as the absolute temperature at constant pressure, and the pressure varies directly as the absolute temperature at constant volume. Hence, when heat is added at constant volume, V_c, the resulting equation is $\frac{P_2}{P_1} = \frac{T_2}{T_1}$, or, for the same temperature range at constant pressure, P_c, the relation is $\frac{V_2}{V_1} = \frac{T_2}{T_1}$.

In general, for any weight of gas, W, since volume is proportional to weight, the relation among P, V, and T is

$$PV = WRT \tag{3}$$

where

P = the absolute pressure of the gas, pounds per square foot.
V = the volume of the weight W, cubic feet.
W = the weight of the gas, pounds.
R = a constant depending on the nature of the gas. The average value of R for air is 53.34.
T = the absolute temperature, degrees Fahrenheit.

This is the characteristic equation for a perfect gas, and while no gases are perfect in this sense, they conform so nearly that Equation 3 will apply to most engineering computations.

HUMIDITY

Humidity is the water vapor mixed with dry air in the atmosphere. *Absolute humidity* has a multiplicity of meanings, but usually the term refers to the weight of water vapor per unit volume of space occupied, expressed in grains or pounds per cubic foot. With this meaning, absolute humidity is nothing but the actual density of the water vapor in the mixture and might better be so called. A study of the Properties of Saturated Steam in Table 8 indicates that water vapor, either saturated or superheated, at partial pressures lower than 4 in. of mercury may be treated as a gas with a gas constant R of 1.21 (with partial pressure of vapor expressed in inches of Hg.) in the characteristic equation of the gas $pV = wR\,(t + 460)$. Within such limits, the density (d) of water vapor is

$$d = \frac{w}{V} = \frac{e}{1.21\,(t + 460)} \text{ (pounds per cubic foot)} \tag{4a}$$

$$= \frac{5785\,e}{t + 460} \text{ (grains per cubic foot)} \tag{4b}$$

where

e = actual partial pressure of vapor, inches of mercury.
t = dry-bulb temperature, degrees Fahrenheit.

Specific Humidity

It simplifies many problems which deal with mixtures of dry air and water vapor to express the weight or the mass of the vapor in terms of the weight or the mass of dry air. If the weight of the water vapor in a mixture be divided by the weight of the dry air, and the weight of dry air

be made unity, we have an expression of the weight of water vapor carried by a unit weight of dry air. This relation has no generally accepted name. It has been variously called: mixing ratio, proportionate humidity, mass or density ratio, absolute humidity, and specific humidity. Of all these terms *specific humidity* is the most suggestive of the meaning which it is desired to express and it has found considerable use in this sense even though it is defined in *International Critical Tables* as the ratio of the mass of vapor to the total mass. It will be understood here that *specific humidity* refers to the weight of water vapor carried by one pound of dry air.

The gas constant for dry air, when the partial pressure of the air is expressed in inches of Hg., is 0.753; so that the specific humidity, if represented by W, is

$$W = \frac{e}{1.21\,(t + 460)} \div \frac{B-e}{0.753\,(t + 460)}$$

$$= 0.622\left(\frac{e}{B-e}\right) \text{ (pounds)} \tag{5a}$$

$$= 4354\left(\frac{e}{B-e}\right) \text{ (grains)} \tag{5b}$$

where

e = actual partial pressure of vapor, inches of mercury.
B = total pressure of mixture (barometric pressure), inches of mercury.

Relative Humidity

Relative humidity (Φ) is either the ratio of the actual partial pressure, e, of the water vapor in the air to the saturation pressure, e_t, at the dry-bulb temperature, or the ratio of the actual density, d, of the vapor to the density of saturated vapor, d_t, at the dry-bulb temperature. That is:

$$\Phi = \frac{e}{e_t} = \frac{d}{d_t} \tag{6}$$

The relative humidity of a given mixture at a given temperature is not the same as the specific humidity, W, of the mixture divided by the specific humidity, W_t, of saturated vapor at the same temperature, for from Equations 5a and 6

$$\frac{W}{W_t} = 0.622\left(\frac{\Phi\,e_t}{B - \Phi\,e_t}\right) \div 0.622\left(\frac{e_t}{B-e_t}\right) = \frac{\Phi\,(B-e_t)}{B - \Phi\,e_t} \tag{7}$$

The specific humidity of an unsaturated air-vapor mixture cannot, therefore, be accurately found by multiplying the specific humidity of saturated air by its relative humidity; although the error is usually small especially when the relative humidity is high.

With a relative humidity of 100 per cent, the dry-bulb, wet-bulb, and dew-point temperatures are equal. With a relative humidity less than 100 per cent, the dry-bulb exceeds the wet-bulb, and the wet-bulb exceeds the dew-point temperature.

RELATION OF DEW-POINT TO RELATIVE HUMIDITY

A peculiar relationship exists between the dew-point and the relative humidity and this is found most useful in air conditioning work. This