

1962), with reduced fading amplitude and then gradually rose to original level by $H + 60$ min. San Francisco dropped 10 db., recovering in 15 min. A Los Angeles signal on 6,185 kc/s dropped 7 db. and recovered in 30 min. *NPM* phase advanced about 90 μ sec, recovering to 35 μ sec in 1 h and to normal in 4 h. Its signal-level increased by 10 db. within the response time of the system, decaying to normal in 45 min. *NBA*, Balboa, on 18 kc/s also showed slightly increased amplitude, with similar recovery.

(6) November 4, 1962. *H h* at 0730 G.M.T. No effect was observed on the San Francisco or Ecuador signals. *NPM* appeared to show a small phase advance of about 10 μ sec, recovering within 20 min.

We thank the Engineer-in-Chief, Postmaster-General's Department, for permission to publish this communication.

R. L. TRAINOR
L. J. DERRICK

Engineering Division,
Postmaster-General's Department,
Melbourne.

PHYSICS

The Temperature Scale

Now that physicists and electrical engineers have almost universally adopted the m.k.s. system of units, which system eliminates the usual conversion factors of g_c and J for the force and heat units, respectively, I find that there is still one conversion factor that has not been eliminated. This is the so-called gas constant R or universal gas constant \bar{R} . This constant arises from an incorrect selection of the temperature scale.

The centigrade scale, as is well known, is determined by marking on a thermometer 100 intervals between the freezing and boiling points of water. The thermodynamic or Kelvin scale has the foregoing temperature intervals but bases the zero point on the ideal gas law.

The usual treatment is to start with the ideal gas law as:

$$pV = R\theta \tag{1}$$

where θ is the absolute temperature, and R is the gas constant and is different for each gas. The universal gas constant is obtained from Avogadro's law, that is:

$$pVM = p\bar{V} = MR\theta = \bar{R}\theta \tag{2}$$

Where \bar{R} is the so-called universal gas constant, \bar{V} the volume of the gas per kilogram mole and M is the molecular mass number of the gas (usually called molecular weight, a misnomer).

There is no good reason for using the gas constant \bar{R} as there is to use g_c or J . Therefore, to have a completely unified m.k.s. system of units, I propose the temperature scale be selected such that $\bar{R} = 1.0$. Hence, equation (2) becomes:

$$p\bar{V} = \theta \tag{3}$$

and equation (1) will be:

$$pV = \frac{\theta}{M} \tag{4}$$

In the m.k.s. system of units the temperature unit will now be joule/kilomole, and its dimension L^2/T^2 . The conversion factors R and \bar{R} no longer need be memorized or tabulated in hand-books, for R is the reciprocal of molecular mass number and $\bar{R} = 1.0$.

The scale of the temperature can be found from the fundamental constant given by Rossini¹ as:

$$p_0\bar{V}_0 = T_0 = 2,271,160. \pm 40 \text{ joule/kilomole for ideal gas at } 0^\circ \text{ C and } P_0 \rightarrow 0$$

For convenience the following two conversion factors are given for the Fahrenheit and centigrade scales which can be used until the absolute m.k.s. temperature scale has been universally adopted for all thermometers.

Given temperature	Multiply by	To obtain
Degree Fahrenheit (Rankine)	4,619.0	joule/kilomole
Degree centigrade (Kelvin)	8,314.4	joule/kilomole

It can be seen that this unit of temperature is a small quantity compared with the Rankine or Kelvin unit temperature. So, we may use kilojoule/kilomole as the scale or, better, mark the thermometer in units of 10^4 joules/kilomole. Therefore, freezing of water will be at 227.116×10^4 joules/kilomole instead of 273.16° K . The intervals on the usual mercury thermometer will be only $1/83144$ larger than the present centigrade scale.

There are other advantages of this scale. By dispensing with the gas constants we see clearly that temperature has the units of specific energy, that is, L^2/T^2 . In using temperature in dimensional analysis we will not fall in the error of considering temperature endowed with a separate dimension.

By understanding the proper dimension of temperature we note the specific heat defined as:

$$c = \frac{dq}{d\theta} \tag{5}$$

and entropy defined as:

$$ds = \frac{dq}{\theta} \tag{6}$$

are dimensionless quantities. One can look in vain for a text-book on thermodynamics or physics that will point out this fact. Instead, these quantities will be given a dimension depending on the outmoded units used; for example, $B.T.U./lb.-^\circ \text{ F.}$, $C.H.U./lb.-^\circ \text{ C.}$, $\text{kg cal/kg.-}^\circ \text{ C}$, $\text{ft.-lb./slug.-}^\circ \text{ F}$, etc.

Other simplifications come to mind, for example, Boltzmann constant $k = 1/N$ is now seen as only the reciprocal of the Avogadro number.

To sum up, a temperature scale is proposed that eliminates the gas constants as conversion factors and fits temperature into the m.k.s. system of units. This means all hitherto existing temperature scales should be abolished and only one absolute m.k.s. temperature scale used in the future.

J. C. GEORGIAN

Washington University,
Saint Louis, Missouri.

¹ Rossini, F. D., *Chemical Thermodynamics*, 477 (John Wiley and Sons, Inc., New York, 1950).

Rotational-vibrational Eigen Values and Eigen Functions for Diatomic Molecules

As is well known, the Schrödinger equation for diatomic molecules can be solved exactly only for rotationless states in very limited cases as, for example, by Morse¹ and myself². The purpose of this communication is to give a potential curve, which is more accurate than the Morse curve and has the advantage that the Schrödinger equation can be solved exactly for vibrational-rotational states. The potential curve considered here has the form:

$$U(r) = D_e + \frac{a}{(r/r_e)^2} - \frac{b}{(r/r_e)} + \frac{n(n+1)c^2}{\gamma(1+cr/r_e)^2} \tag{1}$$

where D_e is the dissociation energy, r_e is the equilibrium distance and $\gamma = (2\mu r_e^2/\hbar^2)$, where \hbar is the Planck constant and μ is the reduced mass of the nuclei. In equation (1) a , b , c and n are constants, which can be determined from the three following conditions³: $U(0) = +\infty$, $U(r_e) = U'(r_e) = 0$, $U''(r_e) = k_e$, as also from the formula for the vibrational-rotational coupling constant α_e (ref. 4). Here k_e denotes the force constant. After simple calculation we obtain:

$$(a/D_e) = \frac{\Delta(1-c^2) + c(c-2)}{1-2c}, \quad (b/D_e) = \frac{2\Delta(1+c) - 6c}{1-2c},$$

$$\frac{\Delta-1}{1-2c} = \frac{n(n+1)c^2}{\gamma D_e(1+c)^4} \tag{2}$$