or disparage the powers and responsibilities of the President; what is really desired is that the scientists represented on the board shall have a voice in the choice of the principal executive officer of the Foundation. An amendment which would give the President the power to appoint the director after receiving nominations from the board, and which would give him the power to remove the director, would substantially meet the objection to this feature of S. 526.

Status of the board. It has been said that the board described in S. 526 would consist "essentially of private citizens" who would meet only occasionally, and it is suggested that their service would be casual and perfunctory. There is no basis for this view. All of our experience demonstrates that if strong appointments are made, the members will be conscientious to the point of sacrifice—as much so, at least, as the members of any full-time commission now serving in Washington. One of the principal reasons for specifying a part-time board was to obviate the drag which, after the formative period, affects full-time commissions; to save as much as possible of the amateur spirit in the direction of the Foundation; and to attract men and women, scientists and laymen, who might be unable to devote full time to Foundation service. It is hoped the critics of S. 526 will make a concession on this point.

It has been too little stressed, I think, that in making this provision for Federal grants to institutions and individuals we shall be better satisfied if ultimate responsibility is placed on the shoulders of a selected group of our fellow citizens rather than in the hands of a full-time official. Without reflecting unfavorably on the present administration of taxpayers' money for scientific research and education, it should be borne in mind that we are proposing a vast extension of Federal assistance which, I submit, should be subject to direction and check beyond that required for the ordinary business of Government. Related to this is the belief held by many that, to minimize if not avoid political interference and criticism, the President and the Director of the Foundation should be protected against pressure for grants; an authoritative board appointed by the President should be responsible for policies and grants.

Other details. Though the President is critical of other features of S. 526, the Congress and the scientists do not seem to be involved in any serious disagreement. The provision for the interdepartmental committee should be amended to place the direction of its activities directly under the President's authority. The provisions for special commissions (except perhaps the provision for a commission on cancer research, which might serve a useful purpose in establishing a clearing and coordinating agency) seem unnecessary and should be eliminated. (BETHUEL M. WEBSTER, *15 Broad Street, New York City.*)

Work done in compression, $pdv = dW$, say, has as its counterpart a change in potential, $vdp = dW_0$; similarly for a change in thermal energy, $dQ = TdS$, and its counterpart, $SdT = dQ_0$. It is proposed to regard this dQ_0 as potential thermal energy analogous to work potential vdp and so clarify and simplify the thermodynamics of deformation.

In a previous paper (*Science*, October 4, 1946, p. 317) it was shown that the Second Law in a very simple and useful form may be directly derived from the Gibbs thermodynamic potential, $U - TS + pv$, for any body in which that potential is uniform. When energy dU (either thermal or mechanical) is added or removed,

$$dU - TdS + pdv = 0 \tag{1}$$

by the First Law; hence

$$SdT = vdp, \tag{2}$$

the Second Law.

In other words, as the internal energy of a body is changed, whether by heat or by mechanical work, the thermal and mechanical potential energies change always by equal amounts. The "free" energies, TdS and pdv, are not equal in general, but $SdT = vdp$ ($dQ_0 = dW_0$) for every reversible process.

Free and potential energies are related through the physical properties of a body. For example, $pdv/vdp = p\beta$, where β is the compressibility defined by $dv = v\beta dp$. Similarly, $TdS/SdT = \alpha T$, where α is the thermal coefficient of expansion given by $dv = v\alpha dT$.

$$\frac{pdv}{vdp} \equiv \frac{d \log v}{d \log p} = \frac{dW}{dW_0} = \frac{dW}{dQ_0} = p\,\beta, \tag{3}$$

$$\frac{TdS}{SdT} \equiv \frac{d \log S}{d \log T} = \frac{dQ}{dQ_0} = \frac{dQ}{dW_0} = T\alpha, \tag{4}$$

$$\frac{Tdp}{pdT} = \frac{TdS}{SdT} = \frac{dQ}{dW} = \frac{T\alpha}{p\beta}. \tag{5}$$

These sets of fundamental relations permit many kinds of transformations between variables, but adiabatic coefficients must not be confused with isothermal.

In the writer's proposed general law of deformation (see *J. Franklin Inst.*, May 1921 and December 1946),

$$\frac{dy}{y} = n\frac{dt}{t} + m\frac{dp}{p} + r\frac{dT}{T}, \tag{6}$$

the parameters n, m, r are ratios of fractional increments similar to those in (3), (4), and (5) above. If y in (6) is volume, then $m = p\beta$ and $r = T\alpha$. Hence, by (6), m is simply the ratio of the increments of free and potential mechanical energy, dW/dW_0, and r is dQ/dQ_0. The creep factor involved in n of (6) is time t times a constant having the dimension reciprocal time.

The relations discussed above are, of course, exact only in the differential form given. Some of them hold in integral form over a surprisingly wide range, but in such cases the physical processes involved must remain constant. And in the differential form (6) there is no difficulty with fractional dimensions, since the parameters are simply dimensionless ratios of fractional increments, each of which is dimensionless.

Since the increments of thermal and work potential are always equal, whether due to added heat or work, it follows that the total potentials remain equal over very wide ranges.

In deriving his radiation formula, Planck found the probability of P packets of radiation, each of energy $h\nu$, being associated with N resonating particles having an average energy E_0, introducing the assumption $Ph\nu = N E_0$, or radiation density equals mechanical energy density. Fitting this assumption to the Second Law (2) involves some interesting physical relations.

For gases, $T\alpha$ and $p\beta$ are unity; hence, in a gas all four forms of energy are present in equal amounts. For most solids and liquids these products are very small, and correspondingly large potentials are to be dealt with. (P. G. NUTTING, *3216 Oliver Street, N.W., Washington, D. C.*)