LETTERS TO THE EDITORS

PHYSICS

Standard Unit of Pressure in Vacuum Physics

A UNIT of pressure in terms of the height of the column of a liquid manometer is essential, since such an instrument, including the compression manometer (McLeod gauge), is indispensable in the measurement of low pressures. Even in the recent methods[1] developed for measuring pump speeds and calibrating vacuum gauges, in which the only magnitude needed to be determined accurately is a rate of gas flow, manometers are required.

The use of the existing practical unit (mm. mercury) has already been challenged by the tremendous development of the physics and technology of vacuum. This unit is characterized by the following features: (1) It does not express a pressure in the basic terms of force per unit area. (2) It is not related decimally to the absolute units of pressure. (3) Its value is affected by temperature and geographical position. While the third characteristic appears to be a disadvantage which can be eliminated by the application of some corrections, the second characteristic would require fundamental alteration in the definition of the unit.

The pressure h in mm. mercury is evaluated by applying the hydrostatic equation $p = g\,\Delta\, uh$, where p is the absolute pressure in C.G.S. units and $u = 1$ mm. $= 0{\cdot}1$ cm. is the unit of the column height. Since gravity $g = 980{\cdot}665$ cm. s.$^{-2}$ and mercury density $\Delta = 13{\cdot}5951$ gm. cm.$^{-3}$ at 0° C. are considered as standard values, we obtain for $h = 1$ mm. mercury:

$$1 \text{ mm. mercury} = g\,\Delta\, u = 1{\cdot}333,22 \times 10^3 \text{ dyn. cm.}^{-2}$$

All previous suggestions[2] aimed at standardization of the pressure unit have not sought to alter this relationship in such a way that p and h would become simply related. In the following I will discuss this possibility as a practical proposition.

The main point is to transform the above relation into:

$$g\,\Delta\, u = 10^n$$

where n is an arbitrary integer. Here only u and g can vary, the latter factor being limited between 978 and 983, the gravity at the equator and pole, respectively. It results that u has two limits $u_1 = 0{\cdot}07482 \times 10^{n-3}$ cm. and $u_2 = 0{\cdot}07526 \times 10^{n-3}$ cm. An acceptable magnitude for practice would be $u' = 0{\cdot}075$ cm. $= 3/4$ mm. From this assumption it follows $n = 3$ and for gravity the value $g' = 10^6/75\,\Delta$ cm. s.$^{-2}$ or $g' = 980{\cdot}7455$ cm. s.$^{-2}$ within one part in 10^8.

Thus we have:

$$p = g'\,\Delta\, u'h' = 10^3 h' \quad \text{dyne cm.}^{-2}$$

The pressure corresponding to $h' = 1$, that is, $p = 10^3$ dyne cm.$^{-2}$, may be taken as standard unit and conveniently termed 'vac'. This pressure unit, 1 vac $= 10^3$ dyne cm.$^{-2}$, corresponds to a mercury column of exactly $0{\cdot}75$ mm. height under the conventional conditions: g' as above and $\Delta = 13{\cdot}5951$ gm. cm.$^{-3}$ at 0° C. Therefore, pressures expressed in vac are measured by taking $0{\cdot}75$ mm. instead of 1 mm. as unit of the mercury column. Since $0{\cdot}7500615$ mm. mercury $= 10^3$ dyne cm.$^{-2}$, 1 vac may for all practical purposes be equated to 3/4 mm. mercury within less than one part in 10^4.

Recommendation of vac as standard unit of pressure would require the adoption of the conventional value g', which is different from the standard gravity. Such a decision will not cause any confusion because the latter value has little use in vacuum physics. However, vacuum physicists will greatly benefit by simplification of conversion to the absolute unit. No complications regarding the recalibration of vacuum gauges are involved.

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[1] Florescu, N. A., Sixth Nat. Symp. on Vac. Technol., Trans., 1959, Philadelphia (to be published).

[2] Dayton, B. B., Vacuum Symposium, Trans., 132 (1954).

Radiative Recombination in Gallium Phosphide Point-Contact Diodes

CAREFUL observation of the radiation emitted from point-contact gallium phosphide diodes under conditions of reverse bias has shown that the luminescence is associated with the recombination of carriers in the breakdown region of the current-voltage characteristic. Electroluminescent radiation has been observed in gallium phosphide by several workers[1–5]. The electroluminescence appears to be associated with p–n junctions formed between the p-type bulk and an n-type skin on the surface of the material and at grain boundaries. From measurements of optical absorption in gallium phosphide, a value for the energy gap at room temperature of $2{\cdot}19$ eV. was deduced. This value is in good agreement with the value of $2{\cdot}20$ eV. for the room temperature band gap measured at Bell Telephone Laboratory[6].

We obtained a measurement of the energy spectrum of the recombination radiation by a simple and convenient arrangement of a diffraction grating and a 35-mm. camera. A diffraction grating with 15,000 lines per inch was attached to the 50-mm. extension bellows of an Exakta camera, and a 100-μ slit was affixed in the focal plane of the lens. With this arrangement, both zero-order and first-order spectra are visible on a single frame. The gallium phosphide luminescence was exposed through the slit to Ansco Super Hypan film for times up to 30 min. Fig. 1 is a print of one such exposure ($\times 10$). (The zero-order spectrum is not shown.) The two discrete lines at the left of the figure are the two prominent lines from the spectrum of gallium (4033 Å. and 4172 Å.), and are used for calibrating the spectrograph. They may be obtained by producing an arc between the point contact and the gallium phosphide crystal after the exposure of the recombination radiation has been made. Fig. 2 is a densitometer trace of the negative showing the wave-lengths and energies of the observed radiation. Correcting for the spreading effect due to the width of the slit, the energy of the recombination radiation is here observed to be between $1{\cdot}96$ and $2{\cdot}19$ eV., with a peak density at $2{\cdot}12$ eV. The peak