ART. XL.—*A New Method of Estimating the Sun's Mass and Distance, by means of the Heating Energy of Flames*; by PLINY EARLE CHASE, Professor of Physics in Haverford College.

IN a recent paper* I endeavored to demonstrate, from familiar postulates, the following proposition:

The kinetic energy of dissociated water should be to the kinetic energy of terrestrial revolution, as the mass of the earth is to the mass of the sun;

And the energy of hydrocarbons should be to the energy of dissociated water, as elastic energy, under constant volume, is to elastic energy under constant pressure.

As the proposition has obvious important bearings, I submit to the readers of this Journal the following illustrations of my method.

Various experimenters have estimated the heating equivalents of chemical combination, for hydrogen and other elementary and compound substances. The earlier estimates are very discordant, but successive improvements in apparatus led to a satisfactory approximation of results.

Molecular, as well as cosmical forces, being presumably central, the hypothesis that chemical forces vary as gravitating energies does not seem unreasonable. Stephenson and Herschel, nearly a half century ago, spoke of our various forms of fuel as containing, within themselves, solar energies which had been stored up during the processes of organization. The experiments, to which I have just referred, gave approximate measurements of those energies, but I am not aware that any one, previous to the appearance of my barometrical and magnetical discussions,† attempted to show any direct and commensurable relation, between any forms of cosmical and molecular force.

In Muspratt's Chemistry, I find, among other estimates of the

* Read before the American Philosophical Society, Feb. 16, 1872.

† Proceedings and Trans. Amer. Phil. Soc.; this Journal, 1863-4, et sub.

heating energy of Hydrogen, the reasonably accordant ones of Andrews, Dulong, Favre and Silbermann, Grassi, and Hess. According to the mean of their several results, one pound of H, burned with eight pounds of O, liberates enough heat to lift the nine pounds of gaseous H_2O *in vacuo*, $\frac{34533 \times 772}{9}$ feet.

If such a lift were accomplished, it would establish an oscillation, which would be perpetually sustained by terrestrial attraction and elastic rebound, if not counteracted by opposing forces.

Let h = mean height of oscillating vapor ($\frac{1}{2} \times \frac{34533 \times 772}{9}$ feet).*

m = mass of sun, in units of the earth's mass.

d = mean distance of sun in units of earth's equatorial radius = mean height of oscillating earth.

y_0 = $365^d 5^h 48^m 49^s$.

y_1 = time of satellite revolution at earth's equatorial sur-

$$\text{face} = 2\pi \sqrt{\frac{r}{g}}.$$

r = earth's equatorial radius (20,923,654 feet = mean of Airy and Bessel.)

g = 32.08744.

According to my hypothesis

$$h : rd :: 1 : m \therefore m = \frac{rd}{h}.$$

We have also, according to well known mechanical laws,

$m = \left(\frac{y_1}{y_0}\right)^3 \times d^3$. Solving the equations, we obtain the following values (C), which I collate with the careful astronomical estimates of Newcomb (N), and Stone (S).

	C.	N.	S.
Mass of the sun,	330,260	326,800	329,000
Distance " "	92,639,500 m.	92,380,000 m.	91,945,000 m.

If an elastic fluid is lifted above the earth's surface, subject to the (nearly) constant pressure of gravity;

The superficial pressure $\propto \left(\frac{r+h}{r}\right)^2$.

And the volume $\propto \left(\frac{r+h}{r}\right)^3$

Therefore, under equal increments of heat,

vol. under const. press. : const. vol. $\times (r+h)^3 : r^3$.

In the case of H_2O , from the values already adduced, we obtain $\left(\frac{r+h}{r}\right)^3 = 1.488$. This corresponds, approximately, to

* My theoretical mean specific heat of H_2O being $\frac{5}{8}$.

the experimental valuation adopted by Tyndall (1.421), and is virtually identical with the mean result of the experiments of Dulong, and Favre and Silbermann, upon ether and olive oil (1.494 and 1.495), as well as with the theoretical volumetric condensation of H_2O (1.5).

If my postulates are admitted, the field which they open for the verification of astronomical, thermal, electrical and chemical observations and experiments, seems unlimited. I have already in view special researches pertaining to solar temperature, æthereal density, atomicity and valency, specific and latent heats, temperature of fusion, vaporization and dissociation, mixtures of gases and vapors, periods of planetary rotation, terrestrial rigidity and tides.

Philadelphia, Feb. 20, 1872.