XIX. On the value of " γ " for a perfect gas

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To cite this article: Charles V. Burton B.Sc. (1887) XIX. On the value of " γ " for a perfect gas , Philosophical Magazine Series 5, 24:147, 166-167, DOI: [10.1080/14786448708628076](https://doi.org/10.1080/14786448708628076)

To link to this article: <http://dx.doi.org/10.1080/14786448708628076>

Published online: 29 Apr 2009.

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Supplementary Observations.

Date.	Time.	Temp.	Elongation.
April 25.....	9.30 P.M.	49.0	24.5
„ 25.....	10.0	48.5	23.0
„ 26.....	10.45	50.8	22.5
„ 27.....	9.20	63.7	23.0
„ 28.....	10.20	54.5	25.0
„ 29.....	9.20	50.0	24.5
„ 29.....	11.0	48.6	25.5
„ 30.....	11.20	45.8	23.5
May 4.....	10.0	48.6	40.0
„ 4.....	11.0	56.8	86.0
„ 5.....	11.0	51.8	118.0
„ 6.....	7.45	51.0	124.0
„ 6.....	9.20	52.5	124.5
„ 8.....	9.15	59.0	124.0
„ 10.....	8.50 A.M.	54.7	143.5

XIX. On the Value of “ γ ” for a Perfect Gas.

By CHARLES V. BURTON, *B.Sc. (Lond.).**

THE ratio, γ , between the two elasticities or the two specific heats has been measured, in the case of gases, by various experimental methods. Some of these methods are based on the assumption that the gas in question may be considered approximately perfect.

The object of the following investigation is to show that γ has the same value ($\frac{5}{3}$) for all perfect gases, and can be calculated for this hypothetical class of bodies from purely theoretical considerations.

Let us take a certain portion of perfect gas whose volume is v , pressure p , and molecular kinetic energy W . The isothermal elasticity of the gas under these conditions,

$$E_t = p.$$

Now, in order to find the isentropic elasticity, let the gas be compressed adiabatically until its volume is diminished by dv , the volume after compression being $v_1 = v - dv$; and the pressure being at the same time increased to $p_1 = p + dp$.

* Communicated by the Author.

Let the work done in compressing the gas be dW ; and W_1 the kinetic energy after compression. Then, since the gas is a perfect one,

$$W_1 = W + dW$$

$$= W + p \, dv \text{ in the limit.}$$

Now, by a well-known relation, we have

$$\left. \begin{aligned} pv &= \frac{2}{3} W, \\ p_1 v_1 &= \frac{2}{3} W_1 = \frac{2}{3} (W + p \, dv); \end{aligned} \right\}$$

$$\therefore p_1 = \frac{\frac{2}{3} (W + p \, dv)}{v_1}$$

$$= \frac{pv + \frac{2}{3} p \, dv}{v - dv}$$

$$= p \left(1 + \frac{2}{3} \cdot \frac{dv}{v} \right) \left(1 + \frac{dv}{v} \right)$$

$$= p \left(1 + \frac{5}{3} \cdot \frac{dv}{v} \right);$$

$$\therefore dp = p_1 - p = \frac{5}{3} p \cdot \frac{dv}{v}.$$

Therefore the isentropic elasticity

$$\begin{aligned} E_\phi &= v \cdot \frac{dp}{dv} = \frac{5}{3} p \\ &= \frac{5}{3} E_t. \end{aligned}$$

So that $\gamma = \frac{5}{3}$ for all perfect gases.