Fahrenheit’s Scale. Dalton’s Scale.

—40° (Freezing point of Mercury), —175°

32 (Freezing point of water), + 32

110 (Middle of scale), 122

212 (Boiling point of water), 212

296 272

342.7 302

409∙8 342

520.3 402

600.7 422

By this new scale of temperature it was found that many of the apparent anomalies in the effects of heat were resolved, and the complex relations of its phenomena rendered very simple. Amongst others, the most important were the phenomena of vapours, as it was found that, on the new scale of temperature, the elastic force of different vapours increased almost exactly in a uniform ratio to equal increments of heat.

But the further progress of experimental science soon raised up serious grounds of objection to this view. It was found that Dr Dalton had rated the inaccuracies of the present scale somewhat too high. His results were thus rendered inapplicable to the advanced state of some branches of thermal science ; and his theory, instead of being modified and improved, was first hastily discredited and then summarily dismissed. Unable to follow the theory to its whole extent, it was abandoned even when it had furnished a safe guide thoroughly to explicate the intricacies of obscure truth.

It is now, therefore, necessary to examine the views of those who have endeavoured to form adequate representations of the mathematical law which connects the clastic force of vapour with its temperature. We shall first of all examine the methods and views which they have adopted, and then consider whether there may not be deduced from the clear theoretical views of Dr Dalton, tested and modified by the results of modern experiment, mathematical expressions of a character, at once less empirical, and more closely in accordance with observed phenomena.

37. M. de Prony was the first to represent, by a purely empirical formula, the law which governs the relation between the temperature and the elasticity of aqueous vapour. It was derived by him, in 1796, from the experiments of M. de Betancourt, and constructed according to a method of interpolation, which he afterwards presented to the Academy of Sciences, and which they have placed among the *Mémoires des Savans Etrangers.*

The Formula which he has thus obtained is y=efi + λ∙r *—e* u'+λ'∙r\_e *<r∙r~f + e °,\*(' ;*

*y* being the height of the mercurial column of pressure, *x* the temperature.

*e* the base of the common log. . . =10.

*p* an empirical coefficient, . . . = 0.068831

λ = 0.019438

λ' 0.013490

0.058576

*<r,*  0.049157

*t* = 4.686080

*f .......* = 3.932560

The same formula holds in the case of alcoholic vapour, the numerical coefficients being changed, and a constant quantity A=1.126447 subtracted from the result.

*fc=* —0.04853, λ=0.02393, r=0.0467, p=2.60249 *p =* —0.63414, λ'=0.09653, ***<r*** =0.0294, p,= 1.64909 This formula was afterwards improved by its author,

and presented in the following more elegant and convenient shape.

*z~ft V+ft* f'+i“ fτ B.

*II PH III III*

Where *z* is the mercurial column of pressure, *x* the tem­perature centigrade, and *g, (tll pω pl* p,, fu equidistant constants derived from experiment.—For water, these values are :—

ft= —0.0000000196 p = 1.136006

I ∕

ju= +0.023403 ,= 1.038037

***It H***

*p=z* —0.023403 f= 1.022490

*m m*

and hence he has formed the numbers which we have united in a subsequent table.

M. de Prony’s formula for the vapour of alcohol is— \*=f\* r'+f4 fj+∕\*!

***∕ H H PI Pl ∙lll***

the constants being

,\*=—0.000058 p=L090391

i ∕

*fc=* +0.024669 p= 1.045453

ff »

*μ=* +0.005677 p=0.836030

***Pl III***

*P= iP+P+Μ∖ r"* If ∏ *!r I*

= —0.030288

These numbers refer to the centigrade thermometer, and to an atmosphere of 0.7577 metres in height.

These formulæ indicate some singular phenomena at high temperatures, which have not been observed in re cent experiments, and may therefore be deemed anomalies of the formulæ themselves rather than the legitimate results of the experiments they were intended to represent. The formulæ are, besides, much too operose to be useful.

38. The experiments of Dr Dalton are adopted by La place in the fourth volume of the *Méchanique Céleste,* where we find him applying them to the calculation of the influence of the aqueous vapour of the atmosphere upon astronomical refractions. As an empirical formula agreeing sufficiently with Dr Dalton’s experiments, he adopted the following approximation :—

*fn ~ p.* (10)n **0∙0144S4T««.0.0000625526** Q

*f* being the force at any temperature *n* of the centesimal scale, reckoned from the point of ebullition, and *p* the pressure of the atmosphere =0.76 metres ; or that we have only to add to the log. of 0.76 the quantity n.0.0154547 —*n2*.0.0000625826 and we have the log. of the common tabular logarithm of the corresponding elasticity at *n* centisimal degrees of temperature.—*Meeh. Cel.* iv. 273.

These numbers agree very well with the observations they were intended to represent, from 0° to 100° centigrade, but are found inaccurate above and below these points.

39. M. Biot, adopting still the methods and experiments of Dr Dalton, found it necessary to modify the formula in order to obtain a closer approximation to truth. Using the notation in which we hare expressed Dr Dalton’s method of calculation, Biot considers

***fn=Pan***

as a first approximation ; of which the Iogarithmic form is Log.y = log. 30. + *n* log. α ; which would always give the logarithm of the elastic force, provided the ratio were accurately constant ; but, as it is variable in Dr Dalton’s observed numbers, it would be convenient to represent the variation of the logarithm

of the elastic force thus :—

Log·./« = log. 30. J *» n + β n\* + y n3,* &c.

*«, ß, V,* being constants derived from experiments thus— and setting out from 100° cent. as the zero—

If *n =* 0° the number given by exp. is Fo = 30. in.

*n* = 25 Fii = 11.250

n = 50 FJ0= 3.500

« = 75 p7f= 0.910

By substituting successively these values in the formula we get