
By ARNOLD COURT

California State University, Northridge CA, USA

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The latent heat of vaporization of water, $L_v$, varies with temperature because the specific heat of water vapour is less than half that of liquid water—or maybe the variation is the cause of the difference. The total energy required to warm water from $T_1$ to $T_2$, then convert it to vapour at $T_2$, must be the same as that needed to evaporate it at $T_1$ and then warm the vapour to $T_2$. This is shown clearly in the attached diagram, used in my teaching for two decades.

But these relations are ignored in Dr Henderson-Sellers' interesting development from thermodynamic principles of a 'new formula' in which $L_v$ decreases according to $(1 - 33.91/T)^{-2}$. It depends on the variation with temperature of the saturation vapour pressure, but not on that of the specific heats. How close is this formula to the difference between the currently-accepted formulas for the specific heats of liquid and gaseous water?
Reply by B. HENDERSON-SELLERS

Arnold Court depicts graphically the relationship between latent and specific heats for water. He asks how closely my algebraic formula is related to his graphical information. Indeed, based upon thermodynamical considerations, it is easily shown that

\[ \frac{dL_v}{dT} = c_p (\text{vapour}) - c_p (\text{liquid}) \]

such that if formulae were available to a high degree of precision and accuracy for these specific heats, this would provide an alternative derivation for a highly accurate representation for the latent heat, \( L_v \). However I am not aware of such formulae for the specific heats (tabular data for \( c_p \) (liquid) as a function of temperature being given in e.g. Smithsonian Tables). Of course one could always take my Eq. (8) for \( L_v \) together with the Smithsonian values for \( c_p \) (liquid) to derive \( c_p \) (vapour). However, such values of specific heat for both liquid and vapour are found to be (slight) functions of temperature. For example, the value for water changes between 4217.7 J kg\(^{-1}\)K\(^{-1}\) at 273 K to 4178.2 J kg\(^{-1}\)K\(^{-1}\) at 373 K with a minimum of 4178.2 J kg\(^{-1}\)K\(^{-1}\) at 308 K. Hence the values on Professor Court's diagram must be constant approximations to such values.

Although this diagrammatic presentation might be a useful adjunct for teaching, it must be stressed that SI units should be used, especially since there is an ambiguity in the definition of the calorie (as a function itself of temperature). I would therefore suggest that if Professor Court were to produce such a diagram in SI, then my own approach would enable him to increase the accuracy of his values for specific heats to that for the latent heat (approx. 2 parts in 10,000).