By drawing curves on paper which correspond to the thermal properties of various substances, the conditions have been defined beforehand under which gaseous bodies like oxygen, hydrogen, nitrogen, or common atmospheric air can be reduced to liquid and solid bodies, upsetting the notions of the last generation, which looked upon these substances as permanent gases.[1] If the mathematical formula has killed, or failed to grasp, the true life of nature, that which to the poet and the philosopher will always be the feature of supremest interest, it has on the other side given birth to that new life of ideas which in our reasoning minds serve as the images of things

example of a purely mathematical quantity which, suggested originally by a formula, acquired later a physical meaning, is that of the potential function, used first by Lagrange as a simplification in calculating the forces of a disturbing planet, and termed by Laplace "à cause de son utilité, une véritable découverte" ('Méc. cél.,' v. livre xv. chap. i.) This function, which has the property that by a simple differentiation the component of the force in any direction is found, acquired a physical meaning as the quantity, the change of which measures the work required to move a unit of matter from one point to another (see Thomson and Tait, 'Natural Philosophy,' vol. i. 2, p. 29). Other examples of purely mathematical quantities which reveal physical properties are Hamilton's "characteristic function" (see Tait, "Mechanics," 'Ency. Brit.,' 9th ed., p. 749), Rankine's "Thermodynamic function," called by Clausius "Entropy" (see Maxwell, 'Heat,' pp. 162, 189): it measures the unavailable energy of a system.

[1] Thomas Andrews (1813-85) took up the experiments begun by Cagniard-Latour in 1822, and explained how it comes about that a gas remains incondensable however great the pressure may be, provided the temperature exceeds what he termed the "critical temperature," which is different for different gases. He accompanied his statements, which were first published in the 3rd edition of Miller's Chemical Physics, by curves representing the behaviour of atmospheric air and of carbonic acid, the latter being a condensable gas, and he suggested in 1872 that the so-called permanent gases had a critical point far below the lowest known temperatures, and that this was the reason why their liquefaction had not yet been achieved. Two physicists, Cailletet and Pictet, took up these suggestions; after various trials they succeeded independently in 1877 in liquefying several of the permanent gases, notably oxygen and nitrogen. These have been followed by all the other permanent gases, including atmospheric air, of which large quantities can now be prepared in a liquefied form.