persons cannot be too cautious in accepting statements relative to the richness of lead ore or silver, until a proper analysis has been made from specimens which represent the general characters of the vein or metalliferous deposit.

HEAT & MOTION.—A NEW PHILOSOPHY.*

How frequently does it happen that two men thinking and acting, independently of one another, arrive at similar results by very different means. Who does not remember the history of the planet Neptune, and the almost simultaneous prediction of its existence by the English mathematician, Adams, and the French astronomer Leverrier? In 1845 Adams computed the place of this planet within two degrees, and placed the manuscript containing his calculations in the hands of the Astronomer royal, in whose possession they remained, almost unnoticed, until 1846, when Leverrier announced that a planet ought to be found in a particular part of the heavens, where, to the astonishment of the world, it was actually discovered by M. Galle on the 23rd Sept. of the same year. So also with the planet Vulcan; a village doctor humbly pursuing celestial observations, with the grand idea constantly in his mind that he should sooner or later discover a planet between Mercury and the sun, saw a dark spot across the disc of the great luminary, and at once knew that he had seen what his previous calculations told him ought to exist. Meanwhile Leverrier, observing the perturbations in the motion of the planet Mercury, arrived at the conclusion that there must be another unobserved body between Mercury and the Sun. He declared his conviction to the Academy of Science, and in due course the village doctor, Lescarbault, at Orgéres, tremblingly wrote to the Imperial Astronomer that he had seen the planet whose existence the great mathematician had predicted.

As in the sublime science of Astronomy, so also in the not less beautiful field of experimental research, two men, living far apart and totally unknown to one another, conceived and worked out the same idea by totally different methods. Dr. Mayer, of Heilbron, in Germany, enunciated the exact relation which exists between heat and work or mechanical force, in the spring of 1842. He arrived at his results by reasoning on certain observed effects. In 1843 Mr. Joule communicated a paper to the British Association, in which he described a series of experiments on magneto-electricity, executed with a view to determine the mechanical equivalent of heat. He found that to raise one pound of water one degree of Fahrenheit's thermometer, as much heat was required as would raise seven hundred and seventy-two pounds weight, acting mechanically, one foot high. Dr. Mayer, in 1842, determined, by calculation, the mechanical equivalent of heat to be 771·4 foot pounds, differing only from Mr. Joule's determination by $\frac{1}{16}$ of a pound in 772 pounds. We shall explain further on what is meant by foot pounds, and the expression "mechanical equivalent of heat."

In the series of lectures delivered by Professor Tyndall before the Royal Institution last year,* the rudiments of a "New Philosophy" have been brought within the reach of any person possessing ordinary intelligence and culture, who takes the trouble to think about what he is reading and observing.

Heat has always been a great mystery. Men have puzzled their brains for generations about its origin, its entity, its relations, its effects and its finality. The achievements of heat through the steam engine are known wherever steam has been made the agent of motive power. But motive power implies mechanical force, and every child finds that by rubbing his hands sharply together he produces heat; hence some common quality must unite this agent, heat, with the ordinary forms of mechanical power. Heat and mechanical force then, are very intimately connected, in fact, one cannot exist without developing in some form or other its inevitable companion.

Let us examine this relationship, and endeavour to state in popular phraseology what is now known of heat, and its invariable associate mechanical force.

As an illustration of the practical results of the conversion of heat into mechanical force, the following may be instanced:—a pound of coal placed under the boiler of the best steam engine now constructed produces an effect equal to raising a weight of one million pounds a foot high. But the mechanical energy resident in one pound of coal and liberated during its combustion, is capable of raising to the same height ten times that weight; nine-tenths at least of its mechanical power being lost in overcoming friction and other imperfections of even the best steam engines.

Accurate experiment implies the use of accurate and sensitive instruments. The common thermometer, however delicately constructed, is far too sluggish and inert a piece of mechanism to subserve the purpose of the modern inquirer into the secrets of the "New Philosophy."

* This article by the Editor was published in the December number of the *British American Magazine.*

* Heat considered as a mode of Motion. By John Tyndall, F.R.S.