its transformations, its application to existing needs, and its response to new demands. Yet the majority of our people are denied the elements of chemistry in their training, and thus grow to manhood without the slightest real understanding of their bodily processes and composition, of the wizardry by which living things contribute to their nourishment and to their æsthetic enjoyment of life.

It should not be impossible to bring into the general scheme of secondary education a sufficiency of chemical, physical, mechanical, and biological principles to render every boy and girl of sixteen possessing average intelligence at least accessible by an explanation of modern discoveries. One fallacy of the present system is to assume that relative proficiency in the inorganic branch must be attained before approaching organic chemistry. From the point of view of correlating scholastic knowledge with the common experiences and contacts of daily life this is quite illogical; from baby's milk to grandpapa's Glaxo the most important things are organic, excepting water. Food (meat, carbohydrate, fat), clothes (cotton, silk, linen, wool), and shelter (wood) are organic, and the symbols for carbon, hydrogen, oxygen, and nitrogen can be made the basis of skeleton representations of many fundamental things which happen to us in our daily lives without first explaining their position in the periodic table of all the elements. The curse of mankind is not labour, but waste; misdirection of time, of material, of opportunity, of humanity.

Realisation of such an ideal would people the ordered communities with a public alive to the verities, as distinct from irrelevancies of life, and apprehensive of the ultimate danger with which civilisation is threatened. It would inoculate that public with a germ of the Nature-motive, producing a condition which would reflect itself ultimately upon those entrusted with government. It would provide the mental and sympathetic background upon which the future truth-seeker must work, long before he is implored by a terrified and despairing people to provide them with food and energy. Finally, it would give an unsuspected meaning and an unimagined grace to a hundred commonplace experiences. The quivering glint of massed bluebells in broken sunshine, the joyous radiance of young beech-leaves against the stately cedar, the perfume of hawthorn in the twilight, the florid majesty of rhododendron, the fragrant simplicity of lilac, periodically gladden the most careless heart and the least reverent spirit; but to the chemist they breathe an added message, the assurance that a new season of refreshment has dawned upon the world, and that those delicate syntheses, into the mystery of which it is his happy privilege to penetrate, once again are working their inimitable miracles in the laboratory of the living organism.

Metaphysics and Materialism.

By PROF. H. WILDON CARR.

"IF the illusion of the scholastic method is that from mere forms we can deduce essences, then the world-view which we call materialism is only a scholastic pastime." This is the concluding sentence of Hermann Weyl's "Raum, Zeit, Materie." Whatever may be the case with the physicists, the mathematicians are under no illusion with regard to the completeness of the scientific revolution. The principle of relativity has not merely complicated the concept of physical reality; it has re-formed it. Mathematics is, and has always been recognised as being, a constructive process of the human mind exercised on physical existence. The old mathematics took its matter from physics; the new mathematics gives matter to physics. The effect is that the world-view which had become for physical science in the nineteenth century practically unchallengeable, and the acceptance of which had come to be regarded as the indispensable condition and only passport for those who would enter the ranks of scientific investigators, has become suddenly incredible. It is true, indeed, that it still has its defenders, and that it is held as firmly as ever by many who continue to be in their special departments authoritative teachers; but this does not alter the fact that for us to-day the world-view is changed, and it is not even strange that many leaders in scientific research still cling fast to the old view when we remember that the great originator of the modern inductive method in the seventeenth century, Francis Bacon, to the end rejected the Copernican theory.

Materialism does not stand for any particular theory of the nature of matter, but for the general world-view that matter, something *de facto* objective the ultimate constitution of which we may not know, and even may not be able to know, but which is entirely independent of our reason and of any thoughts we may have about it, exists and constitutes the reality of the universe, including reason and will, which as qualities or properties of some of its forms give rise to knowledge of it. This materialism reached the zenith of its expression in the Darwinian theory of natural selection, not in that theory itself, the truth of which there is no intention in this connection to call in question, but in the implications which were generally accepted as contained in it, and especially in the application which was made of it to rationalise a world-view. It seemed to point a way by which it was possible to conceive, and to some extent to follow in its history, an evolution which had produced mind from an original matter.

It may not be obvious at once that the mere rejection of the Newtonian concept of absolute space and time and the substitution of Einstein's

space-time is the death-knell of materialism, but reflection will show that it must be so. If space is not endless, but finite (and this is the essential principle of the Riemannian geometry), and if time is not in its existence independent of space, but co-ordinate with the spatial dimensions in the space-time system (and this is the essential principle of the concept of the four-dimensional continuum), then the very foundation of the materialistic concept is undermined. For the concept of relative space-time systems the existence of mind is essential. To use the language of philosophy, mind is an *a priori* condition of the possibility of space-time systems; without it they not only lose meaning, but also lack any basis of existence. The co-ordinations presuppose the activity of an observer and enter into the constitution of his mind. If you distinguish, as, of course, you must and do, the observer from his space-time system, it is not a distinction of two separate existences externally related; they exist only in their relation, as when, for example, we distinguish an activity from its expression.

This is not a metaphysical gloss on a scientific principle, nor is it an attempt, as some may think, to obstruct the clear path of scientific progress with speculative cobwebs; it is the plainest matter of fact. Everyone who ignores it will simply find himself left stranded, unable to play any part in the conquest of the new realm opening before science.

In fact, it is not from philosophy, but from science, that this rejection of materialism comes. No one has expressed it with greater force and with fuller conviction of its fundamental importance than Prof. Weyl. In the introduction to the book which I have quoted, the whole of which is devoted to an exposition of the principle of relativity, he says:—

Whatever *matter* might ultimately prove to be, one thing we have always felt we knew for certain: that it is a substance underlying all change, and that every bit of matter could be measured as a quantity. Its substantial character found expression in a law of conservation. We believed the quantity of matter remained constant throughout all change. Till now philosophy has usually regarded this as *a priori* knowledge, unrestricted alike in its generality and in its necessity. To-day the certainty is changed to doubt. After physics in the hands of Faraday and Maxwell had set up another character, the *field*, above that of matter, and after mathematics on the other side, burrowing during the last century in a logical exploration beneath the basis of Euclidean geometry, had destroyed our confidence in its evidence, there has burst in our days a revolutionary storm which has swept away the ideas of space and time and matter, which till now had been the firmest supports of natural knowledge,—only, however, to make room for a freer and deeper insight into things.

Materialism is essentially a monistic and atomistic conception of reality. For it matter is primordial, and mind is derived. Philosophers from the beginning of philosophy have been conscious of the intellectual difficulty of such a concept, but it has always seemed, even to philosophers, a necessary presupposition of physical science. Science, it was conceded, must at least proceed *as if* it were so. The principle of relativity is the rejection of it, a rejection based on the discovery, not of theoretical difficulties, but of practical matters of fact. The supposed fundamental reality on which materialism as a world-view was supported has proved a vain illusion, and materialism is left in the air. The new scientific conception of the universe is monadic. The concrete unit of scientific reality is not an indivisible particle adversely occupying space and unchanging throughout time, but a system of reference the active centre of which is an observer co-ordinating his universe. The methodological difference between the old and the new is that mathematics is a material, and no longer a purely formal, science.

Damascene Steel and Modern Tool Steel.

THREE years ago Col. N. T. Belaiew presented to the Iron and Steel Institute the results of a very careful study of the general properties and structure of Damascene steel, and pointed out the great claims it had to the attention of all those interested in tool steel. He has now contributed a second paper, entitled "Damascene Steel," to the proceedings of the institute, September, 1921, in which an endeavour is made to substantiate this statement, especially as regards high-speed steels. In his view a marked analogy exists in the structure and also in some of the properties of both types of steel, and a comparative study, therefore, will probably prove beneficial in explaining the properties of these materials and improving the qualities of existing rapid-cutting tools.

Damascene steel belongs to the hypereutectoid series of carbon steels with an average content of about 1·5 per cent. of carbon. This carbon exists as iron carbide, Fe_3C, the well-known cementite; 1·5 per cent. of carbon represents 22·5 per cent. of cementite; about one-half of this is present with ferrite as the eutectoid pearlite; the remainder forms excess or free cementite. Of this the latter is distinctly the coarser, and in order to globularise or spheroidise the plates in which it exists in the casting, repeated careful hammering and heating are necessary. In this operation the plates are first broken down into small, irregularly shaped crystals, and are afterwards spheroidised, being of such a size that surface tension is able to exercise a marked influence on their ultimate form. The completeness of this spheroidisation is shown in the photomicrograph of an Indian Damascene blade contained in the author's paper, in which the large spheroids have resulted from free cementite, while