depends, (1) on the height; (2) on the velocity of the meteorite; (3) on its size; and (4) on the configuration of the country over which it passes. He refers to the observation of Saussure that a pistol fired at a height of 5000 metres makes very little noise: he then points out that at a height of 100,000 metres the density of the air is reduced to the small value of 0·000,000,004 krg.; the temperature being supposed to be − 200° C. In such a medium as this a meteorite could produce no sound, although it might give out a very brilliant light, because its temperature and light depend not on the absolute value, but on the rapid change of density.

## SIR JOSEPH WHITWORTH

ON Saturday night last, Sir Joseph Whitworth died at the English Hotel, Monte Carlo. In the department of mechanical engineering there is, perhaps, no greater name, and his career was one upon which his countrymen may well look back with pride and pleasure. He was born on December 21, 1803, at Stockport, where his father was a schoolmaster. At the age of twelve he was sent from his father's school to Mr. Vint's academy at Idle, near Leeds, where he remained until he was fourteen, when he was placed with his uncle, a cotton-spinner in Derbyshire. Here he made himself familiar with the construction and working of all the machines then used in cotton-spinning. If he had chosen, he might perhaps have inherited his uncle's property, but he was already conscious of the true bent of his genius, and after six years' service, being unable to emancipate himself in a more regular manner, he ran away to Manchester. At Manchester he remained for four years, working in the shops of Messrs. Crighton and other employers, and obtaining a thorough mastery of the methods of manufacturing cotton-machinery. Recognising the necessity of wide experience, he went to London when he had secured all the practical knowledge that could be obtained in his special line at Manchester, and he was fortunate enough to be employed by Maudslay, who soon learned to appreciate his exceptional gifts, and took him into his own private workroom, and placed him next to Hampson, the best workman in the establishment. From Maudslay's, Mr. Whitworth went to Holtzapfel's, and afterwards to Clements's, where Babbage's calculating-machine was being constructed. During his residence in London, Mr. Whitworth began the splendid series of inventions which were to secure for him the foremost place among the mechanical engineers of his period. His first important self-imposed task was to construct the true plane, by which tool-makers might be enabled to produce, for all kinds of sliding tools, surfaces on which the resistance arising from friction would be reduced to a minimum. The work to be achieved was one of immense difficulty, and his fellow-workman, Hampson, used to laugh at him for having undertaken an impossible job. Mr. Whitworth, however, was a man of extraordinary tenacity of purpose, and did not allow himself to be discouraged. At last he succeeded, and showed his friend the perfect plane he had produced. "You've done it," said Hampson, who was astounded by a result which he had always thought to be beyond the reach of human effort.

In 1833, at the age of thirty, Mr. Whitworth, feeling that he might now safely trust to his own energies, returned to Manchester and opened a shop for the manufacture of engineers' tools. He was far from thinking that his first triumph had given the full measure of his powers. Already he had been working at another very complicated problem—how to do away with the inconveniences caused by variations in the pitch and thread of the screws used in the construction of machinery. In this enterprise he was as successful as in his first great undertaking. Obtaining specimens of the screws made by leading manufacturers, he constructed one which, without being exactly like any one of those before him, was the average of them all. It was everywhere accepted, and its introduction marked an era in the history of the manufacture of machinery. The advantage derived from the invention is that every screw of the same diameter has now a thread of the same pitch and of the same number of turns to the inch, and that all screws of the same size are interchangeable. His next achievement was the construction of an instrument capable of measuring the one-millionth part of an inch. This instrument was so delicate that when a steel bar 3 feet in length was warmed by momentary contact with a finger-nail, it at once indicated the expansion due to this slight cause.

As a maker of engineers' tools Mr. Whitworth of course soon became famous, and in 1853 he was sent to America as one of the Royal Commissioners to the New York Exhibition. Afterwards he drew up a remarkable report on American manufacturing industry. On his return to England it was suggested by the late Lord Hardinge that the great mechanician, whose fame was now firmly established, should be asked by the Government to design and produce machinery for the manufacture of rifles for the army. The rifles at that time issued to the army were carefully examined by him, and he decided that if his services were to be of any avail it would be necessary for him to determine the form and dimensions which would produce the best results. With an alacrity very unusual in such matters, the Government consented to erect in his private grounds at Rusholme, near Manchester, a shooting-gallery 500 yards long. Here Mr. Whitworth laboured assiduously, trying many kinds of experiment, and at every stage of his progress making absolutely sure of his ground before advancing a step towards fresh conclusions. The result of his investigations was to revolutionise the manufacture of rifles. As the *Times* has said, "he determined, by absolute and precise experiment, the effects of every conceivable pitch and kind of rifling, and of every length of projectile, from the sphere to one of twenty diameters in length; and he settled once for all the conditions of trajectory and of accuracy of flight." The significance of his efforts began to be understood by every one when, at the first Wimbledon meeting, Her Majesty fired the first shot from a Whitworth rifle, placed on a mechanical rest sliding upon true planes. At 400 yards' range the bullet struck the target on its vertical diameter, one inch and a quarter above the intersection of the horizontal. What he established with regard to rifles he found to be in the main true with regard to weapons of a larger calibre, and he proved the importance of this fact by constructing a series of magnificent cannon.

In the course of his inquiries as to the principles which ought to be observed in the manufacture of rifled small arms and ordnance, Mr. Whitworth became penetrated by the conviction that a new material must be provided, since mild steel was apt to be rendered unsound by the imprisonment of escaping gases during the process of cooling from the molten state. He solved the problem by using great hydraulic presses for the squeezing of the molten metal in the act of cooling, so that the particles might be brought into closer contact and the gases liberated. The steel produced by this method is remarkable for its lightness, strength, and tenacity, and is largely used in the construction of boilers, screw-propeller shafts, and for other purposes.

In 1869 Mr. Whitworth was created a baronet, and he had already been for some years a Fellow of the Royal Society and a D.C.L. of Oxford. He had amassed wealth, and thoroughly appreciated all the advantages it secured for him. He was, however, a man of enlightened ideas and generous impulses, and early in 1869 he did splendid service to mechanical and engineering industry by founding the Whitworth Scholarships, which

he endowed to the extent of 100,000*l*. He was twice married—first, in 1825, to Fanny, youngest daughter of Mr. Richard Ankers; then, in 1871, to Mary Louisa, widow of Mr. Alfred Orrell. Notwithstanding his unwearied attention to business, he contrived to have some leisure time, and he spent it very agreeably at his estate of Stancliffe, in Derbyshire, where he devoted himself to landscape gardening. He also derived a great deal of pleasure from his horses and his herd of short-horns. For some time his health had been failing, and until lately he went every winter to the Riviera. Two years ago he made for himself at Stancliffe a winter garden, hoping that he might thus be able to spend the winter at home. Last year he went abroad again, and now, at the age of eighty-three, his long and great career has come to an end. The whole civilised world may be said to be familiar with his name, and he will always be remembered as the most illustrious English mechanician of the present age. Few men of his time have done more for the nation than Whitworth. His "Scholarships" have had the most important influence upon the knowledge and training of the rising generation of engineers. There are now nearly 200 Whitworth Scholars throughout the land, and they will doubtless be largely represented at his funeral.

## NOTES

SINCE our last week's number was issued, Prof. Huxley has sent an important letter to the *Times* on the subject of the true functions of the Imperial Institute. From this letter we make the following extract:—"That with which I did intend to express my strong sympathy was the intention which I thought I discerned, to establish something which should play the same part in regard to the advancement of industrial knowledge which has been played in regard to science and learning in general, in these realms, by the Royal Society and the Universities. I pictured the Imperial Institute to myself as a house of call for all those who are concerned in the advancement of industry; as a place in which the home-keeping industrial could find out all he wants to know about colonial industry and the colonist about home industry; as a sort of neutral ground on which the capitalist and the artisan would be equally welcome; as a centre of intercommunication in which they might enter into friendly discussion of the problems at issue between them, and, perchance, arrive at a friendly solution of them. I imagined it a place in which the fullest stores of industrial knowledge would be made accessible to the public; in which the higher questions of commerce and industry would be systematically studied and elucidated; and where, as in an industrial University, the whole technical education of the country might find its centre and crown. If I earnestly desire to see such an institution created, it is not because I think that or anything else will put an end to pauperism and want—as somebody has absurdly suggested—but because I believe it will supply a foundation for that scientific organisation of our industries which the changed conditions of the times render indispensable to their prosperity. I do not think I am far wrong in assuming that we are entering, indeed have already entered, upon the most serious struggle for existence to which this country has ever been committed. The latter years of the century promise to see us embarked in an industrial war of far more serious import than the military wars of its opening years. On the east, the most systematically instructed and best informed people in Europe are our competitors; on the west, an energetic offshoot of our own stock, grown bigger than its parent, enters upon the struggle possessed of natural resources to which we can make no pretension, and with every prospect of soon possessing that cheap labour by which they may be effectually utilised. Many circumstances tend to justify the hope that we may hold our own if we are careful to 'organise victory.' But, to those who reflect seriously on the prospects of the population of Lancashire and Yorkshire—should the time ever arrive when the goods which are produced by their labour and their skill are to be had cheaper elsewhere—to those who remember the cotton famine and reflect how much worse a customer famine would be, the situation appears very grave. I thought—I still think—that it was the intention of the Prince of Wales and his advisers, recognising the existence of these dangers ahead, to make a serious effort to meet them, and it was in that belief that I supported the proposed Institute." We are glad to see that in the pamphlet which is now being circulated by the organisers of the Imperial Institute it is acknowledged that in this communication Prof. Huxley "has clearly defined the functions of the Imperial Institute as recognised by the propounders of the scheme."

THE Royal Society of New South Wales offers its medal and a prize of 25*l*. for the best communication (provided it be of sufficient merit) containing the results of original research or observation upon any one of a list of subjects which it has published. Communications on the following subjects must be sent in not later than May 1 next:—On the silver ore deposits of New South Wales; origin and mode of occurrence of gold-bearing veins and of the associated minerals; influence of the Australian climate in producing modifications of diseases; and on the Infusoria peculiar to Australia. A year later the Society will receive papers on the anatomy and life-history of the Echidna and Platypus; the anatomy and life-history of Mollusca peculiar to Australia; and the chemical composition of the products from the so-called kerosene shale of New South Wales. The subjects on which communications must be sent in not later than May 1, 1889, are:—On the chemistry of the Australian gums and resins; on the aborigines of Australia; on the iron ore deposits of New South Wales; list of the marine fauna of Port Jackson, with descriptive notes as to habits, distribution, &c. The competition is open to all without any restriction whatever, excepting that a prize will not be awarded to a Member of the Council for the time being; neither will an award be made for a mere compilation, however meritorious in its way. The communication to be successful must be either wholly or in part the result of original observation or research on the part of the contributor.

THE Compagnie du Congo pour le Commerce et l'Industrie is organising an expedition, composed of geologists and others, for the exploration of the Upper Congo and its tributaries.

WE regret to announce the death of Mr. Edward Livingstone Youmans, a well-known American writer on science. Mr. Youmans was born in New York in 1821, and though suffering much from defective vision, prosecuted from his early youth the study of science. He became well known as a public lecturer. He planned the "International Scientific Series" in 1871, in connection with which he made several visits to Europe. In 1872 he established the *Popular Science Monthly* in New York. Mr. Youmans died on Thursday last, January 20.

IT is sometimes said that intellectually Scotland does not stand on so high a level as in former times. This may be true so far as literature is concerned, but it is certainly not true with regard to science. At a recent meeting of the Royal Society of Edinburgh Mr. John Murray, of the *Challenger*, one of the Vice-Presidents, declared that he questioned whether any country in the world, taking its size into consideration, could show a better record of scientific work or a greater mass of scientific literature than Scotland during the past ten or twenty years. In making this statement Mr. Murray's object was not to glorify his own country but to show that its scientific establishments have a solid claim to better treatment than they have hitherto received at the hands of the Government. Money grants, he stated, of considerable annual value are devoted to the maintenance of learned Societies in London and Dublin. In Scotland, according to Mr.