Law of Motion.—Accelerations occur only in opposite pairs, the ratios of which are constant for given particles.

Definition of Mass.—The masses of particles are positive constants, inversely as their mutual accelerations.

Definition of Force.—Force is the product, mass into acceleration, and has the direction of the acceleration.

Choice of Axes.—Since motion is relative, force and mechanics are relative also. Hence, the foregoing and any problems based upon them should be referred to axes which, in each case, yield a mechanics most appropriate to the phenomena under discussion.

Nottingham, May 12. E. H. BARTON.

I AM much obliged to the Editor of NATURE for giving me an opportunity of commenting upon Prof. Barton's letter. In the second edition of my book on "Theoretical Mechanics" I have expressed my ideas on the subject at such length that it is unnecessary to go into details here. It may suffice to say that the first two of Prof. Barton's proposed enunciations seem to me to be too abbreviated to be of much value. To anyone who understands the theory of mechanics, as explained by the writers whom he cites, such statements could be of little use, while to anyone who does not they might be misleading. The third enunciation does not distinguish between force and the quantity which Routh called "effective force" and I call "kinetic reaction." The distinction appears to me to be important. The fourth enunciation would seem to permit an undesirable degree of freedom in respect to the choice of a reference system. I do not wish to suggest that Prof. Barton means by his brief enunciations something different from what I mean in my book, but rather to point out that such brevity as he aims at may be inconsistent with clearness in the statement of principles. One way of bringing the results of modern critical discussions concerning the laws of motion within the reach of the "ordinary student" would be to publish a short tract, on the same scale, say, as Maxwell's "Matter and Motion." In such a tract summary enunciations could be accompanied by adequate explanations. Would not this be better than providing teachers with a set of enunciations?

May 18. A. E. H. LOVE.

Further Experiments with the Gramophone.

I HAVE just seen Prof. McKendrick's letter in your issue of April 20, describing the experiments he has made with a view to improving the quality of the notes reproduced by a gramophone.

Some five or six years ago, when I was working at the auxetophone, I tried a number of similar devices, and, to a very large extent, succeeded in getting rid of the objectionable hissing and scratching sounds.

One of the horns I tried consisted of a wooden tube of rectangular section and gradually increasing area, which was doubled backwards and forwards on itself in the shape of a flat zigzag, and was practically identical with the metal horn illustrated in your paper.

In the end I found it was best to use a coiled metal trumpet of large size and gradually increasing area and about 48 feet long, in which I introduced several right-angled and "U" shaped bends; further, I fitted a "T" shaped tube close to the reproducer, which made a considerable improvement in the quality of the tone. The longer sound waves passed through this "T" shaped bend with little loss, but the very short waves, which caused most of the scratching, were absorbed at the bend, especially if the blank end of the "T" was filled with cotton wool or some other similar substance, or if an inner sliding tube, with the end closed, was introduced into the blank end of the "T," and pushed in, so as to throttle the sounds at the bend.

I also fitted a flexible joint between the needle and the actual reproducer, which further eliminated these high-period vibrations. This flexibility was obtained by giving the joint very large clearance, and filling the space in between with a highly viscous substance.

I found considerable improvement, as well, in the tone when a paper diaphragm, or when moderate quantities of paper, linen, &c., were put in the trumpet.

In conclusion, I might say that my own experiments quite bear our Prof. McKendrick's opinion on the importance of using suitably shaped trumpets in order to obtain pleasant natural reproductions of musical tones and of the human voice. CHARLES A. PARSONS.

Heaton Works, Newcastle-on-Tyne, May 17.

German East African Dinosaurs.

WITH reference to your note on the German East African Dinosaurs (NATURE, May 18, p. 390), *Die Woche* of May 6 reproduces an interesting series of photographs of the remains, taken on the site of the excavations.

Matlock, May 20. F. GILLMAN.

BREATH FIGURES.

THE manner in which aqueous vapour condenses upon ordinarily clean surfaces of glass or metal is familiar to all. Examination with a magnifier shows that the condensed water is in the form of small lenses, often in pretty close juxtaposition. The number and thickness of these lenses depends upon the cleanness of the glass and the amount of water deposited. In the days of wet collodion every photographer judged of the success of the cleaning process by the uniformity of the dew deposited from the breath.

Information as to the character of the deposit is obtained by looking through it at a candle or small gas flame. The diameter of the halo measures the angle at which the drops meet the glass, an angle which diminishes as the dew evaporates. That the flame is seen at all in good definition is a proof that some of the glass is uncovered. Even when both sides of a plate are dewed the flame is still seen distinctly though with much diminished intensity.

The process of formation may be followed to some extent under the microscope, the breath being led through a tube. The first deposit occurs very suddenly. As the condensation progresses, the drops grow, and many of the smaller ones coalesce. During evaporation there are two sorts of behaviour. Sometimes the boundaries of the drops contract, leaving the glass bare. In other cases the boundary of a drop remains fixed, while the thickness of the lens diminishes until all that remains is a thin lamina. Several successive formations of dew will often take place in what seems to be precisely the same pattern, showing that the local conditions which determine the situation of the drops have a certain degree of permanence.

An interesting and easy experiment has been described by Aitken (Proc. Ed. Soc., p. 94, 1893). Clean a glass plate in the usual way until the breath deposits equally.

"If we now pass over this clean surface the point of a blow-pipe flame, using a very small jet, and passing it over the glass with sufficient quickness to prevent the sudden heating breaking it; and if we now breathe on the glass after it is cold, we shall find the track of the flame clearly marked. While most of the surface looks white by the light reflected from the deposited moisture, the track of the flame is quite black; not a ray of light is scattered by it. It looks as if there were no moisture condensed on that part of the plate, as it seems unchanged; but if it be closely examined by a lens, it will be seen to be quite wet. But the water is so evenly distributed, that it forms a thin film, in which, with proper lighting and the aid of a lens, a display of interference colours may be seen as the film dries and thins away."

"Another way of studying the change produced on the surface of the glass by the action of the flame is to take the [plate], as above described, after a line has been drawn over it with the blow-pipe jet, and when cold let a drop

of water fall on any part of it where it showed white when breathed on. Now tilt the plate to make the drop flow, and note the resistance to its flow, and how it draws itself up in the rear, leaving the plate dry. When, however, the moving drop comes to the part acted on by the flame, all resistance to flow ceases, and the drop rapidly spreads itself over the whole track, and shows a decided disinclination to leave it."

The impression thus produced lasts for some days or weeks, with diminishing distinctness. A permanent record may be obtained by the deposit of a very thin coat of silver by the usual chemical method. The silver attaches itself by preference to the track of the flame, and especially to the *edges* of the track, where presumably the combustion is most intense. It may be protected with celluloid, or other, varnish.

The view, expressed by Mr. Aitken, which would attribute the effect to very fine dust deposited on the glass from the flame, does not commend itself to me. And yet mere heat is not very effective. I was unable to obtain a good result by strongly heating the *back* of a thin glass in a Bunsen flame. For this purpose a long flame on Ramsay's plan is suitable, especially if it be long enough to include the entire width of the plate.

It seems to me that we must appeal to varying degrees of cleanliness for the explanation, cleanliness meaning mainly freedom from grease. And one of the first things is to disabuse our minds of the idea that anything wiped with an ordinary cloth can possibly be clean. This subject was ably treated many years ago by Quincke (Wied. Ann. II., p. 145, 1877), who, however, seems to have remained in doubt whether a film of air might not give rise to the same effects as a film of grease. Quincke investigated the maximum edge-angle possible when a drop of liquid stands upon the surface of a solid. In general, the cleaner the surface, the smaller the maximum edge-angle. With alcohol and petroleum there was no difficulty in reducing the maximum angle to zero. With water on glass the angle could be made small, but increased as time elapsed after cleaning.

As a detergent Quincke employed hot sulphuric acid. A few drops may be poured upon a thin glass plate, which is then strongly heated over a Bunsen burner. When somewhat cooled, the plate may be washed under the tap, rinsed with distilled water, and dried over the Bunsen without any kind of wiping. The parts wetted by the acid then behave much as the track of the blow-pipe flame in Aitken's experiment.

An even better treatment is with hydrofluoric acid, which actually renews the surface of the glass. A few drops of the commercial acid, diluted, say, ten times, may be employed, much as the sulphuric acid, only without heat. The parts so treated condense the breath in large laminæ, contrasting strongly with the ordinary deposit.

It must be admitted that some difficulties remain in attributing the behaviour of an ordinary plate to a superficial film of grease. One of these is the comparative permanence of breath figures, which often survive wiping with a cloth. The thought has sometimes occurred to me that the film of grease is not entirely superficial, but penetrates in some degree into the substance of the glass. In that case its removal and renewal would not be so easy. We know but little of the properties of matter in thin films, which may differ entirely from those of the same substance in mass. It may be recalled that a film of oil, one or two millionths of a millimetre thick, suffices to stop the movements of camphor on the surface of water, and that much smaller quantities may be rendered evident by optical and other methods. RAYLEIGH.

NORTH SEA FISHERY INVESTIGATIONS.[1]

THE third Report on the Fishery and Hydrographic Investigations conducted by the Marine Biological Association under the international organisation is the most interesting yet published. It contains statistical papers dealing with the abundance and migrations of edible fishes in the North Sea; the age and growth-rate of plaice from the same region; and the fishing action of trawl nets with respect to the size of mesh. There are also accounts of the distribution of fish-eggs in the North Sea during the summer, and of the physical conditions of the water of the English Channel, and its contained plankton throughout the year 1906.

The first, and most lengthy, paper in the Report is one of unusual interest and value. In it Miss R. M. Lee has summarised and discussed a series of records kept by the masters of nine Grimsby steam trawling vessels, which fish over the whole of the central part of the North Sea. These records cover the period 1904–8, and represent the results of 14,543 hauls of the otter trawl net, which means about 53,995 hours' fishing. The statistics have been treated most clearly and concisely, and show for each of twenty-three areas into which the whole North Sea has been divided, the monthly average quantities of each of the more important species of marketable fishes caught by the vessels per ten hours' trawling. In order to render these results comparable with those obtained by other statistical workers (Fulton, D'Arcy Thompson, Redeke), the author has calculated factors which enable one fishing unit to be converted into any of the others used.

From these data (which are based on the practical knowledge acquired by a number of very experienced fishermen) Miss Lee has deduced the general distribution of each of the species of fish considered over the whole area of North Sea represented, the migrations from one subarea to others, the spawning movements of the fishes, the variations in density from month to month, and the general change in the productivity of the fishing grounds from year to year. Her paper, and a former one which dealt in a similar way with records kept by a number of Lowestoft sailing-trawler skippers, form a picture of the present condition of the North Sea fishing area which must prove to be of inestimable value for the fishery administrators of the future. If, in the early 'seventies, before steam trawling had become the predominant method of fishing, such a summary by a trained statistician had been made, how much controversy and trouble might have been avoided! Even as it is, a comparison of Miss Lee's results with those imperfect records which we possess of fishery operations in the North Sea in the 'seventies and 'eighties shows most strikingly the change which has taken place, and enables us to realise, to a degree hitherto unattainable, how very great must have been the diminution of the stock of fish inhabiting the North Sea. It is not a question of the decadence of a fishing ground, but rather the fishing-out of an accumulated stock, and the establishment of a new equilibrium, on a lower level, between the natural powers of recuperation of a fish population and the catching power of the British and Continental fishing fleets. And there can be little doubt that, in the absence of concerted measures for cultivation, this equilibrium must settle down to still lower levels. It is sincerely to be hoped that this work may be continued by Miss Lee.

Dr. Wallace has continued his former work on the natural history of the plaice and subjects to detailed analysis, a mass of data representing individual deter-

[1] Third Report (Southern Area) on Fishery and Hydrographical Investigations in the North Sea and Adjacent Waters, 1906–8. [Cd. 5546]. 1911.