Howards Ms.
Pro

Elementary Bodys

When we take a survey of the great Diversity of materials that seem to Compose the different Bodys in nature we might be led to conclude that it would be impracticable to reduce them to any kind of order, & did they exist so the attempt would be fruitless, but I'm inclin'd to think that they are all composed of the same materials acted on by a difference of Aggregation or that the most Compound bodys we meet with may by various processes or by Chymistry be reduced to a few Elementary principles which are similar in all bodys however different they appear - the regularity & immutability with which the Combination of the Elements have gone on since the earliest Periods is a proof of it, the most lofty trees & tender plants are nourished by the same food & their parts the same properties as ever, & animal the same is their nature, the same simplicity &

towards the

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it burnt all their Cloths; but this might have happend from the great gravity of the acid which would sink it to the bottom of the water & the Cloths dipped into it before mixture which might readily burn them & could easily have been prevented by agitation till the acid & water were perfectly united — Tho the mixture of salts & water of themselves will hardly seperate yet there are several Chymical processes for this purpose, one of which is evaporation to dry — so this operation depends upon the power of Heat to overcome the attraction of the water for the salt & to make the former fly off in vapour leaving the other dry behind it in the Vessel used for this purpose under the form of a white spungy mass composed of Particles whose figures are not easy to discern, but the method mostly followd by those who prepare salts for sale is by Chrystalization which is performd by evaporating the water till a thin pellicle or crust like dust is form.

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or

be a very complicated figure something
like described by a point in the spoke
while the wheel is going over a round hillock, whose
radius is 13 times that of the wheel. Till therefore we
know the shape & position of this figure, you must
without hesitation agree with me when I say that it is
absurd to pretend to any knowledge, or to the acquisition
of any knowledge, of the powers by which she is agetated a
blind man may with equal reason pretend to discover
the sentiments which attend the mind of a speaker
without understanding the language in which he speaks.
further let us consider the particular object of our
study. it is to investigate those powers of nature by
which the known phenomina are produced. From what
I lately delivered it appears that all our notions of
powers are taken from their effects. The effects or phenomina
are signs of the power. and therefore Lord Bacon
considerd them as the language of nature, informing us
of her laws. But this is not all, we have no notion of
the power differing from the effect. When Sir I. N
has demonstrated that the power which retains the
Moon in her orbit is a centripital power, what does
he mean? nothing more than that the Moon tends

towards the Sun a little more particularly to the subject projection in order to ascertain the form, and helps of the Eclipse and explanation which is most intimately connected with it and therefore best calculated for promoting our knowledge.

The subject of our speculation is the sensible motion and actions of bodys. By the actions we mean the production of change in the situation of other bodies. This can only be done by producing in them change of motion. motion therefore is the principle subject of our speculation.

A body in motion either wholly changes its place and describes a figure Varous according to the nature of the motion, or it only turns round its axes in which case its various points describe circles having the axes in their Centres or it does both.

In order therefore that our phenominology may be accurate, and a fit foundation for reasoning we must understand the nature of the figure described. In order to discover the forces by which the moon is agitated in her orbet round the Earth, we must know what are her motions, we most know the line she describes. To a spectator on the Earth she appears to describe an ellipse having the Earth in one focus. But in the mean time the Earth is carried round the Sun. Her real path therefore must

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towards the Earth, and were it not for her motion of projection would approach it. we consider this approach as the Effect of a tendency, but when we come to think seriously, we have no notion of the tendency differing from the approach.

When Sir I. N demonstrated that this tendency was $\div \frac{1}{D^2}$ or that at half the distance it was four times as great, what does he mean? nothing more than that at half the distance the approach which she would make is four times greater than at the whole distance.

There is one case indeed in which we seem to know the cause independent of the effect, that is impulse. and from this opinion it is that Philosophers have always endeavoured to reduce the other phenomina of nature to this. and shew them to be cases of impulse. Hence the Vortices of Descartes and the subtile fluids of other philosophers. But much labour might be spared. and much time saved which has been employed in jumbling contradections, and reconciling inconsisterkes For when we have with much labour, and at the expence of much false reasoning shewed that our phenomina is a case of impulse, we are little nearer a compleat explanation, for that power by which a body in motion produces motion and a certain determined degree of it in the body which it happens to strike, that power I say is known only by the effect, and we have no notion of the power differing from the effect itself. we must therefore not only say with Lord Bacon that the effects are the signs of their causes

and the phinomina the language of nature. but we must add that with respect to us there is no difference between the effect and the mutaphysical cause. and that we perceive the powers of nature not only by their effects but in their effects.

What follows from the reasoning. does it not inevitably follow that without a knowledge of the real motion of bodys & their actions on each other, both as to direction and quantity, we know nothing of the powers of nature, and that our knowledge of the causes of all the sensible motions & actions of bodies is little more than a knowledge of the motions and actions themselves. all the differences will be showed to lye in this, that one change of motion may be produced by different remote causes. Thus the motion of a clock may be produced by a weight or a spring, that of a mill by the pressure or by the impulse of water, or by the impulse of wind. But in all these cases the immediate mutaphysical cause is the same. and known only in the motion which it produces. nay in the investigation of the remote cause, and the decision to which of many the effect belongs. is accomplished only by tracing thro' the immediate cause each of which are known only in its effects.

What I Have now delivered intitles me justly to say that no knowledge of the powers of Nature can be acquired but in the knowledge of the motion which they produce. and that the accuracy of our knowledge and its applicability to practice to the accuracy the purpose of life must eve

be in proportion to the accuracy of our knowledge of the motions themselves. I have farther made you sensible that these motions or changes of motions are so many figures or changes of figures. The conclusion I wanted to draw from the whole evidently follows. Viz. That it is in vain & illogical to expect any knowledge of the general laws of nature, and of the immediate causes of the phinomena; without some knowledge of the properties of figure, and the art of computation. That is without the assistance of Geometry & Arithmetic. It is impossible to show the nature of that power which retains the planets in their orbits round the sun, and to demonstrate that at twice the distance it is but ¼ as strong except to him who knows the proportions of the parts of that curve which she describes. It is impossible to teach the theory of Gunnery to him who is ignorant of the properties of a curve whose abscissae are as the squares of its ordinates. But on the other hand it is to this circumstance, to the nature of the subject, continually involving or implying the properties of figure and number that we are indebted for that accuracy which is attaind, and that progress which is made in general physic; an accuracy & progress which is to be met with in no other branch of the science of nature. It is owing to the generality & simplicity of the subject— It is always measurable may proper quantity, all the changes which are produced by the sensible motion and action of bodies are capable of being doubled, tripled halfed, added subtracted and any how proportioned. This is true of every modification of motion, it may be

swifter, slower, more to the east more to the west continued for a longer or a shorter time may be performed by a larger or a smaller body, may overcome a greater or a smaller obstacle. Each of these may be the object of our search either as the cause of some actual appearance, or as an effect to be produced. Now as this is true of all kinds of Quantities indiscriminately, any kind of quantity may be used for the general representive. The speccous of quantity which is most convenient is extended quantity the subject of Geometry. For 1st This kind of quantity is imployed in almost all the subjects of our speculation — Motion immediately involves it, for bodys move in lines straight crooked, and variously posited. It is the obvious measure of velocity, or more properly velocety is only a time expressing a certain relation between the line run over and the time imployed: that velocity being called double when the line described is double. It is the only means of measuring the quantity of matter in a body, for this depends on the Bulk & figure of the body and the distance of its particles. Lastly it is the only measure of time we can feel that one portion of duration [redacted] is greater than another, but without some extended quantity, such as the quantity of sand run out, or the quantity of space passed over by the hand of the clock or shadow of the deal we have no way of determening the proportion of different parts of time.

2dly All the properties of numbers, the foundation of the art of computation, have their analogons representation

in Geometry - a sum the sum of lines - a product the rectangle of lines - a quotient the side of a rectangle.

Thus then if we trace out the real Geometrical quantities which accur in any phiyocal phenomenah and employ the proper Geometrical representations for time and number, our investigation must acquire all that accuracy which arises from the simplicity of the subject, and which so eminently distinguishes Geometry setting it above all other sciences.

I know that of late an opinion has been allowed to gain ground that a compleat knowledge of natural phulosophy may be acquired without mathematicks. But this is the language of those who having no mathematical knowledge themselves, cannot be admitted as competent judges. I appeal to fact - it is only in those parts of the science which have been mathematically considered that nat. phulosophy can boast of having carried on her investigations with certainty, success, and utility. Many think themselves natural phulosophers because they are in the habit of making experiments in Electricity, Magnitism, & hymistry &c. This is very laudable, and by such labours the science will in proper hands, advance. But I would desire you to remember that these gentlemen are either Natural historians, employed in collecting facts, and perhaps arranging them in such a manner as may enable the man of true science to investigate their causes, or they are imployed in Chymistry, Phisiology, or such other branches of the general study of nature where, as yet, we contend ourselves with discovery of causes, and where the immediate cause of the phenomina is out of the question. When the Chymists made their collection of Chymical

laws of solution precipitation and so on, they were either natural historians, or contented with joining together events whose relation was remote, but when Sir Isaac N. attempted to investigate the immediate cause, and consider that power which caused the effervescence in a mixture of chalk and aqua fortis he found himself obliged to proceed on the properties of quantity. when Dr Black pointed out a variety of double exchanges, and arranged them in a convenient order he was either a Natural historian or contented with a discovery of remote causes. But when he came to investigate the immidiate cause of the double exchange, & assert the nature of the power which produces it, he is obliged to employ the property of number and figure In short. Gentlemen; without a moderate share of Mathimatical knowledge, you can expect nothing than a school-boys acquaintance with natural philosophy resembling those religionists who take up their opinion on the authority of their priests, and neither can give a reason for what they think they believe, nor apply it to any good purpose in life. Without a moderate share of Mathematical knowledge you may read the flimsy and indeterminate writings of a Nollet or a Priestly, but you cannot profit by the truths delivered by a D'Lambert or a Newton.

To such of you therefore as wish to advance beyond the imperfect rudements of general physics I would earnestly recommend the cultivation of mathimatical

learning. I do not mean that you cant
philos to great advantage without being posesed of
Mathimatical knowledge which is necsary for understa
ding all the writings of Newton, Euler, Bernouillie and
such eminent philosophers. Newton was the inventor
of a new mathematicks, and, fond of his invention, he ha
shown its applicability to physicks at great length.
Euler, Bernouillie and others seem rather to have
taken natural philosophy as a subject on which
they would employ their Mathematical knowledge
than to have considerd mathemadicks as an instru
ment for acquiring an acquaintance with the operation
and powers of Nature. These and several others ha
therefore amused themselves and displayed their math
matical knowledge and address in determining
what would be ~~necessary~~ the events were the pow
of nature of such and such a kind or what powers wo
be necesary for producing such and such phenome
But if we content ourselves with knowing what
powers nature really exerts and what are these circu
cumstances which regulate the phunomuna conseque
on the powers which really obtain a very moderate shar
of Mathimatical knowledge is suffecent.
If it is not presuming, I would venture to say that,
among the infinite variety of powers which the aut
of nature might have implanted in the works of his
hands he seems to have chosen those which were most
simple and best fitted for succesfully employing the

rans laws of vers of his intillectual creatures. If you have Larned therefore the elements of plane Geometry and the most obvious propositions of the Conic-sections, you are in a condition to Study Natural Philosophy with profit and acquire such a knowledge of it you will be able to apply to the purposes of life, which must be considered as the great end of all our Study.

Thus I have at considerable length given you an account of the general subject aim of Natural Philosophy, as the science employed in investigating the causes and explaining the phenomena of nature exhibited in the matereal System. I have shown you what is the proper method of conducting ourselves in both of these tasks namely by a comprehensive and distinct history of the subject. and by a copious induction confirmed by experiment. I than took notice of an important distinction to be made amoung the phinomena of nature. In one clafs the changes were produced by means of sensible motions and actions in the other by such as are insensible, and only infered from the change, by analogy with the first. I then gave you my reasons for proposing to confine my attention to the first clafs, as most likley to make us acquainted with the immediate causes of the observed changes, and as affording us a probability of ever explaining the phenomena of the other kind by tracing out the intermediate causes and

effects which concur. Who imperceivd. & spun the effect. I showed that this restriction of the study under the name of general physics pointed out to us the form of our investigation, and the helps which we must take Viz, the sciences of arithmetic and Geometry.

It remains for me to give you an account of the manner in which I propose to communicate to you such information as I am able. and the method w^ch I intend to follow.

The method of teaching an experimental science must be considerably different from that in which a person might learn it propria Marte. Here I must take the advantage of all that is already known. The successive application of men to this study has discovered many properties of body which have a very great generality and upon which many other properties depend as consequences. I must begin therefore with the considerations of these most general properties and by the rules of the Aristotelian Logic deduce their immideate consequences.

These being nearest to the general principle, must themselves have a considerable extent each of them having a set of consequences flowing from them distant from those which flow from any other. All these I shall consider in order deducing in each the particular consequences from the general principle till at last we shall have exhausted all the clases primary

laws of subordinate of natural phenomena leaving nothing unexamined but individual facts which cannot be the subject of a general Course.

Were we sufficiently acquainted with the general powers of nature there would be no occasion for deviating from this plan. But this is not alway the case and therefore in order to produce the more forcibl convictions or your understanding, and at the same time make you acquainted with the inductive Logic, I shall begin each considerable article of the following Course by a history or account of some characteristic phenomena which, obtaining thró the whole Class of phenomena compared in that article may be supposed to be a consequence of the general law which distinguishes that Class. In Order to discover this general law the phenomena will either be related as the subject of common and daily observation, or it will be exhibited to you in the way of an experement. Where I can I shall show how this phenomena may be deduced from the properties of body which are yet mor general. This will be a specimen of the ~~Analysis~~ which makes one great object of philosophy descussion.

Having this established a law which extends over a certain class of bodies I shall then by its means explain all the chief subordinate phinomina thus given you a specimen of the theory.

In this last branch of our employment if the general principle is well authenticated, and the consequences justly drown, the demonstration or theory must be compleat and the conviction inevitable. But as this process must be carried on by means of the abstract sciences, and the object presented by them to the mind is of a very refined nature, and is ~~so~~ with difficulty apprehended by the imagination with that degree of veracity which is necessary for enabling us to reason from it with clearness and steadiness, it is extreamly proper to remedy this inconveniency, and to render the attention more easy, as well as the Idea more lively. This may be done by exhibiting to the Eye an experiment, which tho only a single fact, yet gives the mind a sensible object of prection which it can contemplate and remember much more steadily than if it was mearly a creature of the imagination. I could by a proper description convey such a notion of this room that a person with some attention, could perfectly understand any narration which I should give of any occurrence in it But a moments glance at the room would be infinitely better than the most accurate description.

I shall therefore accompany my lectures with a regular course of experements chiefly with this view of giveng you a sensible object of attention and thus illustrate my philosophical doctrines. But I must

not dignify this with the title of experemental philosophy. Experemental Philos.y is the investigation of the general powers of nature by a copious induction of experements or facts. This is the illustration of known principles by means of one experiment. Indeed in those parts of our subject &c are note yet fully understood, I shall be obliged to exhibit experiments with the ij other view. as representatives of a thousand others of the same kind made use of in order to assert some general principles &c we have not been able to deduce from any yet more general.

I have just one thing more to say on this head. The value of any character does not depend on what a man knows, but on what he can do. Knowledge &c terminates in itself alone is but an amusement - at the same time it is the amusement most becoming a man. Gentleman. and one who has the advantage of a liberal education. It must however be classed amoung ij Luxuries of life I should think the employment of an idle hour. But the science has a close connection with life, it mingles with all ij arts, in the foundation of many, & contributes to the improvement of all I shall ever look on this therefore as our principle object, to point out to you the practical uses of doctrines &c may be established from time to time. What we have scientifically investigated a a course. and established as a property of matter. we now employ as a mean in order to produce its proper effects as the end proposed by ij artist. means consist in the exertions of power. and in ij view are called efficient causes and their effects. considered as ends intentionally to be accomplished. are called final causes —