

VI. *A Remark upon the New Opinion relating to the Forces of moving Bodies, in the case of the Collision of Non-Elastic Bodies.* By Mr. John Eames, F. R. S.

1. **T**HE antient Opinion, and most generally entertained, is, that the Forces of Bodies in Motion are as their Quantities of Motion, *i. e.* as their Quantities of Matter multiplied by their respective Celerities.

2. The new Opinion is, that the Forces of Bodies in Motion are as their Quantities of Matter multiplied by the Squares of the Velocities; so that in equal Masses the moving Forces will not be as the Velocities themselves, but as their Squares.

3. Hence it follows, that a Body moving with five Degrees of Velocity, moves with five and twenty Times more Force, than when it moves but with one Degree; whereas according to the common Opinion, it has but five times as much, *i. e.* proportional to its Velocity.

4. The latest Experiments brought to prove the truth of the new Opinion are made upon soft, or yielding Substances. Now these have been already observed to be a little complicated, and improper for this Purpose. The proper Use of Experiments of this kind being rather to discover, and settle the Laws, which such kind of Substances observe in the Resistance they make to Bodies moving in them, than the Forces themselves, with which the Bodies move, which ought to be determined before hand by some simple Experiment, fit to determine that Matter.

5. A

5. A variety of Experiments have been made, and reasoning used in *England* and *France*, to prove the Truth of the common Opinion; but they do not entirely satisfie all the Gentlemen on the other side of the Question. The present ingenious Professor of Mathematicks and Philosophy at *Utrecht* tells us in the Preface to his *Epitome Elementorum Physico-Mathematicorum*, publish'd this Year, Anno 1726, *In corporum motorum viribus supputandis amplexus sum sententiam Cl. Leibnitzii, Hugonii, Poleni, S. Gravesandii, & antiquæ valedixi, quam hætenus foveram, & docueram: Neque me retinuerunt argumenta doctissimorum virorum in Galliis & Britannia eandem defendentium.*

*Et quando experimenta à Poleno & S Gravesandio descripta examinantur & inspiciuntur, tam manifesto evincunt vires corporum percutientium esse in ratione composita ex quadrata velocitatum, & simplici massarum, ut illis subscribere teneamur, nisi apertissimis contradicere studeamus.*

6. I beg leave to examine the truth of the new Opinion in the Case here propos'd, *viz. Vires corporum percutientium*; and I shall endeavour to shew from their own Principles, that it cannot be true in all the Cases of Non Elastic Bodies.

7. 'Tis allow'd, that the common Rules of finding the Velocities of Non-Elastic Bodies after the Stroke are true: For thus the ingenious Mr. *S. Gravesand* tells us in Paragraph 251, of his *Supplementum Physicum*; *Ex hoc principio (i.e. multiplicando massam per velocitatem) deduxêre Philosophi ipsas illas regulas n. 234. s. 237. s. quas nos variis modis ex principiis nostris deduximus; mirum hîc quid contigit, error erroris fuit destructio, & duplex error ad veritatem conduxit; falsum de mensura virium secuti sunt principium, & quod veritati etiã minimè congruum est, nullam vim intro premendo partes*

*partes, & harum superando cohæſionem corpora amittere poſſuere.*

8. Now the Rule for finding the common Velocity of Non-Elaſtic Bodies moving the ſame way after the Collifion, is, to divide the Sum of the Quantities of Motion in the two Bodies, by the Sum of the Quantity of Matter.

9. 'Tis alſo granted, *Motu duobus corporibus communi corpora hæc in ſe mutuo agere non poſſe.* In Sect. 215. *Supplement. Phyſ.*

10. *Pendet ergo iſtus à velocitate reſpectiva, qua manente intenſitas impactionis eadem erit, quomodocunque celeritates abſolutæ variant.*

11. *Ab intenſitate hac pendet partium introceſſio, quæ ergo ſemper eadem erit, ſi duo corpora eadem velocitate reſpectiva in ſe mutuo incurrunt, quibuſcunque velocitatibus moveantur.*

12. Theſe Principles furniſh us with an Argument againſt the new Opinion. For if it be true, then equal Cauſes may have unequal Effects, and that in their own ſenſe of an Effect: The Proof ſhall be taken from Inſtances of the Effects of the Collifion of Non-Elaſtic Bodies, whoſe reſpective Velocities ſhall be always equal.

13. Let (A) and (B) ſtand for two Non-Elaſtic Bodies of equal Quantities of Matter; and let (B) be at reſt, while (A) moves towards it with 8 degrees of Velocity.

1. Here the common Velocity after the Stroke will be half the Velocity of (A) before the Stroke, *i. e.* 4 degrees. Conſequently the force in (B) thus communicated by the Stroke will be as its Square, or 16.

2. Let (B) move forward with two degrees of Velocity, and (A) follow it with 10 degrees; the respective Velocity will be 8 as before; consequently by Paragraph 10th of this Paper, the Strokes in both cases are equal. The Velocity in (B) after the Stroke will be half the Sum of the Velocities before the Stroke, or 6 degrees, by Paragraph 8th.

According to the new Opinion, the Forces being as the Squares of the Velocities, the Force of (B) before the Stroke will be to its Force after the Stroke, as the Square of 2 is to the Square of 6; *i. e.* as 4 is to 36. Subtract the Force in (B) before the Stroke, from the Force it has after the Stroke, and you have the Degrees of Force communicated by the Stroke: Which, if this Opinion were true, would be 32, *i. e.* just double the Number of Degrees communicated by the same Force in the former Instance, which was but as 16. Thus equal Strokes produce unequal Effects in our sense of Effects.

14. The following Table gives several other Instances. In the three first Columns you have the Velocities of the two Bodies both before, and after the Stroke; in the two next, you have the Forces in (B) both before, and after the Stroke; and in the sixth, the Difference of those Forces, or the different Degrees of Force effected by the same Stroke; and in the last Column, the Proportion of those Forces, or Effects of the Cause or Stroke.

The Velocity in			The Forces in B.		Force communicated by the Stroke.	Proportion.
$\underbrace{\quad}$ A	B	B				
8	0	4	0	16	16	1
10	2	6	4	36	32	2
14	6	10	36	100	64	4
18	10	14	100	196	96	6
22	14	18	196	324	128	8
26	18	22	324	484	160	10
$\underbrace{\quad}$ Before	$\underbrace{\quad}$ After		$\underbrace{\quad}$ Before	$\underbrace{\quad}$ After		
the Stroke.			the Stroke.			

15. If it be said, that I have not consider'd the other part of the entire Effect of the Stroke, the Intropression of the Parts; I reply, this will make but a small Alteration in the matter; since the Intropressions in all these Cases are equal, ( Paragr 11.) the relative Velocities being by supposition the same: So that notwithstanding upon the whole, one and the same, or equal Causes, will produce unequal Effects.