PHILOSOPHICAL TRANSACTIONS.

Giving Some

ACCOUNT

OF THE

Present Undertakings, Studies, and Labours

OF THE

INGENIOUS,

In Many

Considerable Parts of the WORLD.

VOL. XXVIII. For the Year 1713.

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BRITISH MUSEUM
NATURAL HISTORY.

TO

Sir *Isaac Newton*, K^t.

PRESIDENT,

And to the

Council and Fellows

OF THE

Royal Society

OF

LONDON,

Instituted for the

Advancement of *Natural Knowledge*;

THIS

Twenty Eighth VOLUME

OF

Philosophical Transactions

IS

HUMBLY DEDICATED

BY

Hans Sloane, R. S. Secr.

PHILOSOPHICAL TRANSACTIONS.

For the Year MDCCXIII.

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I. *Prob-*

IV. *De motu Nervi tensi. Per* Brook Taylor *Armig. Regal. Societat. Sodal.*

Lemma I.

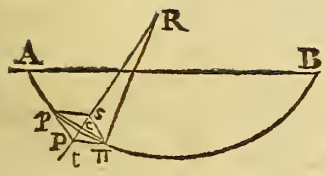


Sint A D F B, & A ΔΦ B *Curvæ duæ, quarum relatio inter se hæc est, ut, ductis ad libitum ordinatis* C Δ D, E Φ F, *sit* C Δ : C D : : E Φ : E F. *Tum ordinatis in infinitum imminutis, adeo ut coincidant Curvæ cum axe* A B ; *dico quod sit ultima ratio curvaturæ in* Δ *ad curvaturam in* D, *ut* C Δ *ad* C D.

Demonstr. Duc ordinatam c ♂ d ipsi C D proximam ; & ad D & Δ duc tangentes D t & Δ θ, ordinatæ c d occurrentes in t & θ. Tum ob c ♂ : c d : : C Δ : C D (per Hypothesin) tangentes productæ sibi invicem & axi occurrent in eodem puncto P. Unde ob triangula similia C D P & c t P, C Δ P & c θ P, erit c θ : c t : : C Δ : C D (: : c ♂ : c d, per Hyp) : : ♂ θ (= c θ - c ♂) ad d t (= c t - cd.) Atqui sunt curvaturæ in Δ & D, ut anguli contactûs θ Δ ♂ & t D d ; & ob ♂ Δ & d D coincidentes cum c C, anguli isti sunt ut eorum subtensæ ♂ θ & d t, hoc est (per analogiam supra inventam) ut C Δ & C D. Quare, *&c.* Q. E. D.

Lemma

Lemma 2.

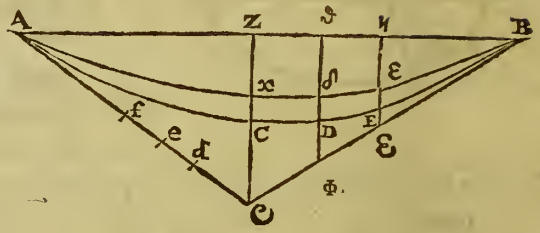


In aliquo articulo vibrationis ſuæ induat Nervus tenſus, inter puncta A & B, formam curvæ cujusvis A p π B. Tum dico quod ſit incrementum velocitatis puncti alicujus P, ſeu acceleratio oriunda a vi tenſionis Nervi, ut curvatura Nervi in eodem puncto.

Demonſtr. Finge Nervum conſtare ex particulis rigidis æqualibus infinite parvis p P & P π, *&c.* & ad punctum P erige perpendicularem P R = radio curvaturæ in P, cui occurrant tangentes p t & π t in t, iis parallelæ π s & p s in s, & chorda p π in c. Tum, per Principia Mechanicæ, vis abſoluta, quâ urgentur particulæ ambæ p P & P π verſûs R, erit ad vim tenſionis fili, ut s t ad p t; & hujus vis dimidium, quo urgetur particula una p P, erit ad Nervi tenſionem, ut c t ad t p, hoc eſt, (ob triangula ſimilia c t p, t p R) ut t p vel P p ad R t vel P R. Quare, ob tenſionis vim datam, erit vis acceleratrix abſoluta ut $\frac{P\,p}{P\,R}$. Sed eſt acceleratio genita in ratione compoſitâ ex rationibus vis abſolutæ directè & materiæ movendæ inverſè; atq; eſt materia movenda ipſa particula P p. Quare eſt acceleratio ut $\frac{1}{P\,R}$, hoc eſt ut Curvatura in P. Eſt enim Curvatura reciprocè ut radius circuli oſculatorii. Q. E. D.

Prob. 1.

Definire motum Nervi tensi.



In hoc Problemate & sequentibus pono Nervum moveri per spatium minimum ab axe motûs; ut incrementum tensionis ex auctâ longitudine, item obliquitas radiorum curvaturæ possint tutò negligi.

Itaq; extendatur Nervus inter puncta A & B; & plectro deducatur punctum z ad distantiam C z ab axe A B. Tum amoto plectro, ob flexuram in puncto solo C, illud primum incipiet moveri (*per Lemma* 2.) At statim inflexo Nervo in punctis proximis Φ & d, incipient hæc puncta etiam moveri; & deinde E & e, & sic deinceps. Item ob magnam flexuram in C, illud punctum primò velocissime movebitur; & exinde auctâ curvaturâ in punctis proximis D, E, *&c.* ea continuo velocius accelerabuntur; & eâdem operâ, imminutâ curvaturâ in C, id punctum vicissim tardius accelerabitur. Et universaliter, punctis justò tardioribus magis & velocioribus minùs acceleratis, tandem fiet ut viribus inter se ritè temperatis, motus omnes conspirent, punctis omnibus ad axem simul euntibus & simul redeuntibus, vicibus alternis ad infinitum.

Sed ut hoc fiat debet Nervus semper induere formam curvæ A C D E B, cujus curvatura in quovis puncto E est ut ejusdem distantia ab axe E ɣ; velocitatibus etiam punctorum C, D, E, *&c.* constitutis inter se in ratione distantiarum ab axe C z, D ϑ, E ɣ, *&c.* Etenim in hoc casu,

casu, spatia C x, D ♌, E ε, &c. eodem tempore minimo percursa, erunt inter se ut velocitates, hoc est ut spatia percurrenda C z, D ♑, &c. Unde erunt spatia residua x z, ♌ ♑, ε n, &c. inter se in eâdem ratione. Item (*per Lemma* 2.) erunt accelerationes inter se in eâdem ratione. Quo pacto, semper servatâ ratione velocitatum inter se eâdem ac spatiorum percurrendorum, puncta omnia simul pervenient ad axem & simul redibunt : adeoq; rectè definitur curva A C D E B. Q. E. D.

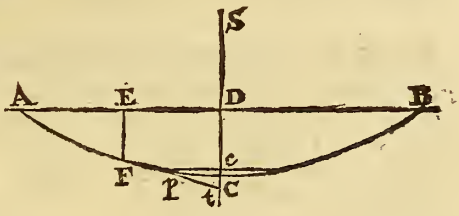
Præterea, comparatis inter se duabus curvis A C D E B, & A x ♌ ε B, *per Lemma* 1. erunt curvaturæ in D & ♌, ut distantiæ ab axe D ♑ & ♌ ♑ : adeoq; *per Lemma* 2. acceleratio dati cujusvis puncti in Nervo erit ut ejusdem distantia ab axe. Unde (*per Phil. Nat. Princip. Math. Sect.* X. *Prop.* 51.) vibrationes omnes, tam maximæ quam minimæ, peragentur in eodem tempore periodico, & puncti cujusvis motus similis erit oscillationi corporis Funipenduli in Cycloide. Q. E. I,

Cor. Sunt Curvaturæ reciprocè ut radii circulorum osculantium. Sit ergo *a* linea data, atq; erit radius curvaturæ in $E = \frac{a\,a}{E\,n}$.

Prob. 2.

Datis longitudine & pondere Nervi, unà cum pondere tendente ; invenire tempus unius vibrationis.

Extendatur nervus inter puncta A & B per vim ponderis P, & sit nervi ipsius pondus N, & longitudo L. Item constituatur nervus in positione A F p C B, & ad



punctum

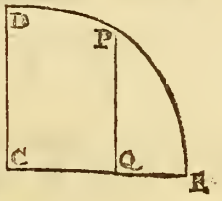
punctum medium C erige normalem C S = radio curvaturæ in C, & occurrentem axi A B in D; & sumpto puncto p ipsi C proximo, duc normalem p c & tangentem p t.

Ergo, ut in Lemmate 2, constat vim absolutam quâ acceleratur particula p C, esse ad vim ponderis P, ut c t ad p t, i. e. ut p C ad C S. Sed est pondus P ad pondus ipsius particulæ p C, in ratione compositâ ex rationibus P ad N, & N ad pondus particulæ p C, vel L ad p C; hoc est, ut P × L ad N × p C. Quare compositis his rationibus, est vis acceleratrix ad vim gravitatis ut P × L ad N × C S. Constituatur itaque pendulum longitudine G D: tum (*per Princip. Math. Sect. X. Prob.* 52.) erit tempus periodicum Nervi ad tempus periodicum istius penduli, ut $\sqrt{N} \times C S$ ad $\sqrt{P} \times L$: At (per eandem Propositionem.) datâ vi gravitatis longitudines pendulorum sunt in duplicatâ ratione temporum periodicorum; unde erit $\frac{N \times C S \times C D}{P \times L}$, vel (pro C S scripto $\frac{a\,a}{C D}$, *per Cor. Prob.* 1.) $\frac{N \times a\,a}{P \times L}$ longitudo penduli cujus vibrationes sunt isochronæ vibrationibus Nervi.

Ad inveniendam lineam a, sit Curvæ abscissa A E = z, & ordinata E F = x, & ipsa Curva A F = v, & C D = b. Tum (*per Cor. Prob.* 1.) erit radius curvaturæ in F = $\frac{a\,a}{x}$. At dato $\dot{v}$ est radius curvaturæ $\frac{\dot{v}\,\dot{x}}{\ddot{z}}$. Unde $\frac{a\,a}{x} = \frac{\dot{v}\,\dot{x}}{\ddot{z}}$; adeoq; $a\,a\,\ddot{z} = \dot{v}\,x\,\dot{x}$: & sumptis fluentibus $a\,a\,\dot{z} = \frac{\dot{v}\,x\,x}{2} - \frac{\dot{v}\,b\,b}{2} + \dot{v}\,a\,a$ (ubi additur data quantitas $-\dot{v}\,b\,b$

$\frac{-\dot{v}\,b\,b}{2} + \dot{v}\,a\,a$, ut fiat $\dot{z} = \dot{v}$ in puncto medio C.) Et hinc peracto calculo erit $\dot{z} = \frac{a^2\dot{x} - \frac{1}{2}b^2\dot{x} + \frac{1}{2}x_2\dot{x}}{\sqrt{a^2b^2 - a^2x^2 - \frac{1}{4}x^4 - \frac{1}{4}b^4 + \frac{1}{2}b^2x^2}}$

Evanescant jam b & x respectu a, ut coincidat curva cum axe, & fiet $\dot{z} = \frac{a\dot{x}}{\sqrt{bb - xx}}$. At centro C & radio C D = b descripto quadrante circulari D P E, & facto C Q = x, & erectâ normali Q P, atque arcu D P existente y, erit $\dot{y} = \sqrt{\frac{b\dot{x}}{bb - xx}} = \frac{b}{a}\dot{z}$.



Unde $y = \frac{b}{a}z$, & $z = \frac{a}{b}y$. Et facto $x = b = CD$, (quo casu etiam fit y = arcui quadrantali D P E, & $z = AD = \frac{1}{2}L$) erit $\frac{1}{2}L = a \times \frac{DE}{CD}$, atq; $a = L \times \frac{CD}{2DE}$. Sit ergo C D ad 2 D E (ut diameter circuli ad circumferentiam) ut d ad c; atq; erit $aa = LL \times \frac{dd}{cc}$. Substituto itaq, hoc valore pro a a, erit $\frac{N}{P} \times L \times \frac{dd}{cc}$ longitudo penduli isochroni ipsi Nervo. Sit ergo D longitudo cujus tempus periodicum est 1, atq; erit $\frac{d}{c}\sqrt{\frac{N}{P} \times \frac{L}{D}}$ tempus periodicum Nervi. Q. E. I. Sunt enim pendulorum tempora periodica in dimidiatâ ratione longitudinum.

Cor. 1.

Cor. 1. Numerus vibrationum Nervi in tempore unius vibrationis penduli D eſt $\frac{c}{d} \times \sqrt{\frac{P}{N}} \times \frac{D}{L}$.

Cor. 2. Ob datum $\frac{d}{c} \times \sqrt{\frac{1}{D}}$, tempus periodicum Nervi eſt ut $\sqrt{\frac{N}{P}} \times L$. Et dato pondere P eſt tempus ut $\sqrt{N \times L}$. Item conſtitutis Nervis ex eodem filo, quo caſu fit N ut L, eſt tempus ut L.

V.