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Meditatio in experimenta explosione tormentorum nuper instituta

Leonhard Euler

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XXXI.

Meditatio in Experimenta explosione tormentorum nuper instituta.

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1 (4)

Circa motum globorum Duo in computum veniunt, motus globi in tormento et motus extra tormentum; de quorum motuum quolibet seorsim agendum est, primum autem excutiendus est motus extra tormentum; qui determinari poterit ex tempore quo globus in aëre commoratus est, diametro globi et ratione gravitatum spécius ficarum globi et aëris. Ex hisce datis innotescit altitudo ad quam globus pervenit et velocitas initialis qua et tormento erumpit, tempus quoque ascensus et descensus seorsim. Quibus definitis progredi poterimus ad contemplandum motum globi intra tormentum et ex velocitate, qua globus egreditur, cognita, innotescet vis pulveris pyrii multaque alia maximi usus in Pyrotechnia. Suppono autem hic directionem tormenti esse verticalem ut corpus lineam rectam ascensu et descensu describat, motus enim obliquus in linea curva altioris est indaginis

Designet, e, diametrum globi in scrup. Pedis Rhenani, m:n, rationem gravitatis specificae globi ad gravitatem specificam aëris seu medii in quo globus movetur, sit t, tempus durationis globi in aëre, in minitis secundis sit porro altitudo quaesita ad quam corpus ascendit x. Scribatur pro numero cujus logarithmus est unitas, e, qui est 2,7182817... cujus logarithmus secundum Vlacq. est 0,4342944. Indicat porro N numerum graduum arcus, cujus tangens est:

$$\sqrt{e^{\frac{3nx}{4mc}}-1}$$

existente sinu toto = 1. Altitudo quesita x, ex hac aequatione erui debet:

13:11

$$t = \frac{m \sqrt{c}}{447650 \sqrt{3n(m-n)}} \left(125 N - 7162 \log_{10} \left(\sqrt{\frac{3nx}{e^{\frac{3nx}{4mc}}}} \sqrt{\frac{3nx}{e^{\frac{3nx}{4mc}}}} \right) \right).$$

Vocemus ut calculus facilior evadat: $\sqrt{\frac{3nx}{e^{\frac{3nx}{4mc}}}} = y$, erit N numerus graduum arcus cujus tangens est y, erit

$$t = \frac{m \, Vc}{447650 \, \sqrt{3 \, n \, (m-n)}} \, \left(125 \, N - 7162 \, \log \, \left(\sqrt{yy + 1} \, - \, y \right) \right)$$

Ut logarithmis Vlacqui uti liceat, multiplicari debet logarithmus per 2,7182817. Scribatur A loco:

$$\frac{447650\sqrt{3}n(m-n)}{m\sqrt{c}},$$

$$At = 125 N - 19468 \log (\sqrt{yy + 1} - y),$$

$$N = \frac{At + 19468 \log_{10} (\sqrt{yy + 1} - y)}{125} = \frac{8At + 155746 \log_{10} (\sqrt{yy + 1} - y)}{1000}.$$

qua aequatione tentando y erui debebit, tamdiu alios atque alios substituendo valores loco y donec resultet

Experimentum 1.

Factum d. 21. Aug. Anno 1727.

Globus ferreus diametri 225 scrup. explodebatur verticaliter, tempus durationis in aere erat. 45 secund. minut. n=1.

Est ergo:

$$c = 225$$
, $t = 45$, $m = 7000$ et $n = 1$.

Erit ergo:

$$A = 618$$
, ergo $At = 27816$ et $8At = 222530$.

Erit ergo:

$$N = \frac{222530 + 155746 \log (\sqrt{yy + 1} - y)}{1000}.$$

Ponatur y = 2.70, erit $\sqrt{yy+1} = 2.879$, ergo $\sqrt{yy+1} - y = 0.179$, consequenter log. $(\sqrt{yy+1} - y) = -0.7471$ et $N=69\frac{41}{60}=\frac{69683}{1000}$, sed ex aequatione invenitur $N=\frac{106173}{1000}$. Ergo y major assumi debet, sit y=3.00, erit $\sqrt{yy+1} = 3,162$. Ergo $\sqrt{yy+1} - y = 0,162$, unde log. eius est -0,790, unde prodit $N = 99^{\circ}$, sit y = 4,00, erit $\sqrt{yy+1} = 4,123$ et $\sqrt{yy+1} - y = 0,123$, cujus log. est -0,9100. Est ergo N = 80,802, sed debebat Esse $N = 75^{\circ} 58'$, sit y = 4.10, erit $\sqrt{yy - 1} - y = 0.12$, cuj. log. = -0.9208. Est ergo $N = 79^{\circ} 12'$, sed debebat esse $N = 76^{\circ} 18'$.

Hoc continuando reperitur y=4.31, hoc in casu exacte admodum obtinetur aequatio, ut ne in centesimis erretur. Et erit $N=76^{\circ}56'$ ut inveniatur altitudo ad quam corpus pertigit, erit:

$$\sqrt{\frac{3nx}{e^{4mc}}} = 1 = y$$
, adeoque $e^{\frac{3nx}{4mc}} = 19,5761$, ergo $\frac{3nx}{4mc} = 0,4342944 = 1,2915908$,

seu:

dia.

$$x = \frac{2100000.1,2915908}{0,4342944} = 6245$$
 ped. Rhen.

Hinc innotescit velocitas initialis, seu altitudo ad quam eodem impetu in vacuo pervenisset, est enim:

$$e^{\frac{3nx}{4mc}} = \frac{4c(m-n) + 3nK}{4c(m-n)},$$

denotante, K, altitudine in vacuo describenda, erit ergo:

$$K = 20997.1857,61$$
 scrup. = 39004 ped. Rhenan.

Tempus quod globus in ascensu consumit est aequale, $=\frac{mNV\sigma}{3581\sqrt{3}n(m-n)}$ min. secund. id est (ob N=76.93 et $V_c=15)=15\frac{1}{2}$ minut, secund. Tempus ergo descensus est $29\frac{1}{2}$ minut, secund, ut adeo differentia inter tempus ascensus et descensus sit 14 minut, secund. 101

$$At = 125N - 19168 \log Vyy + 1 - y$$

Experimentum II.

not all view Eodem die winstitutum

Ex eodem tormento idem globus explodebatur, dimidia pulveris quantitate, mansit ille in aere 34 min And attorion toplands y even debt bit. taudm aibs atque alios substituendo valeres bero y doner resulte

Est ergo:

t == 34.

m = 7000,

et A = 618,

erit:

M receptation of a light and the contract of t

Est ergo:

$$N = \frac{168096 + 155746 \log \sqrt{yy + 1} - y}{1000}$$

ponatur y=2.00, erit $\sqrt{yy+1}$ 100 y=0.236; cujus $\log 7$ est =0.6270; hinc inventur N=70.91 det departure. esse 63° 26', hoc modo tentando invenitur tandem sumi dehere loco y, 2,185, erit $N = 65^{\circ}$ 25', erit erges

 $\frac{3nx}{4mc} = \frac{\log \cdot 5.77422}{0.43429} = \frac{0.76147}{0.43429}, \quad \text{under } x = \frac{21000000.076147}{0.43429} \text{ scrup.} = 3682 \text{ ped. Rhen. together the property of the proper$

Dein altitudo adquam in vacuo pervenisset est 10025,862 ped. Rhenanis Tempus ascensus est 13,19 minut secund. Ergo tempus descensus est 20,81 minut? secund. attantal acousaire a to the acous

toroute her the come let Factum do 230 Aug. Anno 1727. The med to the first of the

Idem globus diametri 225 scrup, explodebatur verticaliter, et tempus erat 2 minut, secund, quantitas pul veris 1 Loth seu ½ pars praecedentis. different esse W = 707 1m

Est argo ut appra , eilempor resimilar 7000, man in 1 car , sed t = 2. : in 1 = 618; 9 : 11 est 1 1 = 1286, charleigon 8 4t = 9888. 37 6 37 4 4 1 in 11 11 11 11 11 11 11 11 11 11 11 Ergo ob:

Consequenter erit: $N = \frac{9888 + 155746 \log \cdot (\sqrt{yy + 1} - y)}{1000}$.

Respectively. Tentando quid loco y substituendum sit reperietur esse y = 0.075, unde est $N = 4^{\circ}$ 19'. Est ergo:

undicacil valuelina carraits are altitude ad quam codem impetu in vacuu percentiscot, est commi

Ergo:

$$\frac{3\,nx}{4\,mc} = \frac{0,002300}{0,4343}$$

 $x = \frac{2100000.0,0023}{0.4342} = 11122$ scrup.

TO C. modicing 19th Establish

pervenit ergo globus ad altitudinem 11 pedum.

Dein est $0.005625 = \frac{3 \, n \, K}{4 \, c \, (m - n)}$. Ergo $K = 2099700 \cdot 0.005625 = 11800 \cdot \text{scrup}$. Differential ergo altitudingue in vacuo et aëre est 678 scrup. Tempus autem ascensus, est 3581.444 = 0,88 minut. secund., ergo tempus descensus est 1,12 minut. secund.

In his experimentis erat longitudo tormenti 7260 scrupula. In sequentibus autem idemi tormentimo autifulication tum est sed abbreviatum ut ejus longitudo erat saltem 5808 scrupula: In primo experimento erat quantitas pulveris 16 Loth, in secundo 8 Loth, in tertio 1 Loth. Seemsus et degrensus al 1 minut serrui

511 Y

Experimentum IV.

Factum d 2. Sept. Anno 1727.

Idem globus diam. 225 scrup, explodebatur verticaliter, pulvere I Loth et cecidit demum post 8 minut, secund.

iterum

$$c = 225$$
, $m = 7000$, $n = 1$, $n = 1$.

inde erit.

$$N = \frac{N}{100} = \frac{39552 + 155746 \log_2(1/yy + 1 + y)}{97999 + 1000 \log_2(1/yy + 1 + y)}$$

inde reperitur:

$$y = 0.33$$
. Erit ergo $N = 18^{0}25'$. With the least approximates

Est ergo:

Insterno altitudo ad quam globus ascendit, 1215 pedry 14 digry, 7 dincy altitudo cautement ad quam cinexacuo pervenisset, R = 2099700.0, 1089 = 228 ped., 5 dig., 8 lin. Tempus autem ascensus est $= \frac{7000.18,41.45}{3581.144} = 3,7$ secund. Ergo tempus descensus erat = 4,3 secund. $= \frac{1000.18,41.45}{1000.1000} = \frac{1000.18,4$

Experimentum V.

The same and Eodem die factument

Idem globus ex codem tormento, pulvere 4 Loth operato, explodebatur, ceritempus quo in aëre mansit fuit

Est ergo:

$$c = 225, \quad m = 7000, \quad n = 1, \quad i = 20.$$

Est erec

$$\frac{19880 \times 10^{-1000}}{N} = \frac{19880 \times 155746 \log 1(\sqrt{yy+1} + y)}{1000}$$

- But may have within any her?

Fet arma

$$y = 0.93$$
, ergo $N = 42^{\circ} 56'$, $e^{\frac{3 nx}{4mc}} = 1.8649$.

Tran.

$$x = \frac{2100000.0,27044}{0,43429} = 1307,707 \text{ ped.}$$

Dein R = 2099700.0,8649 = 1816,025 ped. Tempus autem ascensus est:

$$=\frac{7000.42,93.15}{3581.144}=\frac{210.4293}{103849}=8,6$$
 secund.

Argo tempus descensus erat = 11,4 minut secund.

Experimentum VI.

Eodem die factum.

Idem globus ex eodem tormento, pulvere 8 Loth onerato, explodebatur, et tempus quo in aëre mansit fuit 28 secund, minut.

Est ergo:

$$c = 225, \quad m = 7000, \quad n = 1, \quad t = 28$$

Ergo:

$$N = \frac{138432 + 155746 \log_{\bullet} (\sqrt{yy + 1} - y)}{\text{Colling for the state flats } 21000 + \text{Colling for the state }}.$$

WELL COURT April 2 h Gunt

Hinc reperitur: per manufactive $\pm 1,52$ and et ma $N=56^{\circ},39'$, and $a^{4mc}=3,3104$, and $a^{4mc}=3,3104$

unde:

$$x = \frac{2100000.0,519828}{0,43429} = 2513,621$$
 ped. Rhen.

14: - 1 - 1 - 1 Way to went of First - - 15. California Tempus ergo descensus est = 16,55 secund.

Bill 0 00 Experimentum VII.

Ex codem tormento, sed 12 Loth onerato, cjaculabatur globus idem et tempus donec cecidit erat 32 minus canal

Erit:

$$N = \frac{158202 + 155746 \log_2(\sqrt{yy + 1 - y})}{1000}$$

Unde consequitur esse:

$$y = 1.93$$
.

. Commission from T. 3nx

Ergo: 3255776 scrup. 2100000.0,6733099 ale 3255,776 ped. Rhen. seu 3255776 scrup.

Sed erit:

$$00 = K = 20997.372,49 = 7821,172 \text{ ped.}$$

 $\frac{240.6261}{100000}$ = $\frac{42.67}{100000}$ minut, secund set tempus descensus erit = $\frac{19.33}{100000}$ Tempus autem ascensus est ==

$$\frac{3mc}{4mc} = \frac{3mc}{2} = 1.9649.$$

begreen weing fill to large submersed adquite

Expression 33. Linker the hirelines.

tion singues in course to more to be some of the course of the state o