× Prussian System

— Manoeuvres of the Plain and Prin: in square lite bodies, with large intervals = front between 10 in front and 12 Deep in the two first Ranks — 6 by 10 in the Princi

+ 12 by 10, and 12 by 5 two by Sections and others

+ Principles drawn up oppose to the intervals of the Platoons — Princi

+ All the Succession and relievings in action were performed by marching their Manipuli through the intervals, also Lights intently before or behind them

— Quincunx — Skirmish

Melvillian System

1 One full line of four ranks Hastati – Principes Triarii & Velites —

2. Chequer of men not of large bodies

3. Intervals; Space in front the same times varied might be about 4½ from 3 to 6

4. ~~Depth~~ two first ranks the same —

5. On particular occasions it might be necessary to contract the front and enlarge the depth, some times two or even three times

x: Triplex acies of Cæsar

6. The relievings and [illegible] were by single men thro' the intervalls — Velites

— when rapid the Chequer might be changed to a direct order instantly

Exam^n. of the Syst:

— Mothorolus —

— Battle Romans & Latin

— Zama —

— Vegetius mentions the Triarii as resting on their arms

— No example 6 deep 9 or more — reason —

— Mauricius – says more than 16 useless less than 4 too weak —

+ Romans well calculated &c

Objections

+ Difficulty in marching
+ Great depth — Dark
— Intervals unequal to a
full line —
+ What advantage &c —
+ Camp Gates —
+ Roman Army less
than that of enemies — in
deep Phalanx easily routed
— This he supposed at Zama
+ Livy says the disparity was
changed into few ranks on
the invasion of Cannae
+ This only probable as resp
to Macedonians

Consequences

1. Time of Ascent = Descent
2. Double divides the curve equally
3. First and last velocities the same
4. Greatest random 45°
5. Greatest random double impetus
6. Equal randoms at equal dist 45
7. 15° range is 1/2 of 45° range
8. Dist 45° time squared and multp. by 16:1 gives range in feet Ex.

time 10 Sec

10
10
100
16.1
1610 feet

by this the length of the fence is required — This may be done practically — Count the number of beats in a watch 'till the shell falls — distance ascertained

Initial velocity —
Great rapidity — reduced to some small known velocity
Two bodies striking each other
Balistic pendulum
Given
1. weight of the pend
2. Ve vibrations
~~3. Length of the~~
3. Weight of the ball
4. Chord of the arch
5. Place of the chord
The velocity of the ball can be found

Examples

Ve	Ball	Feet in a second	
2	19½	1603	} in the first second
4	18¼	1163	
£	18½	1443	
£	19	1419	

A musket ball falling upon with ⅕ Velo. has a velo. of 900 feet in a second —

Resistance of the air
— Little to slow motions
hand — stone lead —
— Depends on 1 Velo.y 2 the
bulk of the body —
1.st Velocity squared —
— Mill-wheel — Ship —
2. Diameter squared, or as the
surface —
— Resistance to light bodies
greater than to heavy ones
— Guinea and feather Exp.t
— Resistance to small bodies
greater than to large bodies
Fr. G.r
1 : 2 The second meets
with 4 times the resistance
but it is eight times the
weight therefore the resistance
is but one half

To find the resistance
— Ballistic pendulum at
different distances within
point blank —
Examples
Lit Lit Velo
24 with 16: 1650 = 20+ times its
Musk.t 1 oz ~~[illegible]~~ 1670 = 120 its weight —
— When the velocity amounts
— to 1200 feet in a second it
increases in proportion more
— than three times the square
— reason — vacuum —

Range — Charge —

— Theory supposes that the ranges are in proportion to the charges — this not

1 the case —

— Greatest range with $\frac{3}{8}$ this in a 24 Lib is 30 Lib

—1 The greater the quantity of powder the greater the range but not in proportion —

+ Example a 24 Lib Gun with $\frac{1}{3}$ and $\frac{2}{3}$ ranged nearly to the same Distance —

— hence augmenting the quantity of powder in Distant cards of no use —

— Small charges do more execution than large ones

— splinters — Pistol fire

fire a board —

no cannon should be charged with more than $\frac{1}{3}$ —

Penetration —

— large balls further than less —
— Penetration nearly as the
square of the velocities —
— As 18 pr. with 1200 feet
4 lb of powd. will penetrate
34 Inches of solid oak
but with 6 lb of powd.
three times as much.
— Battering cannon will
put a ball 10 or 12 feet
into a bank of earth at
2 or 300 yards — and
4 or 6 feet into a piece
of masonry
This determines the thick-
ness of breastworks —

— Point blank —

— Altho' the projectile describes
a curve yet for some time
it differs little from a
straight line — some
imagine that gravity is
suspended for sometime —
— about 4yds 4yds
Musket from 240 to 360
with half the weight of the
much greater which pieces
varies more than in Cann.
— Battering Cannon 10 or 8
but with a small Elev. will
do execution at a much
greater distance —
Bullet is said to rise
owing to the line of vision
not being parallel to the axis
also to the position of the
powder in the piece

Recoil

— Powder acts in every direction
— upon the breech as much
as on the bullet —
— Recoil diminishes the Vel:
— of shot given to a ball —
— Energy in proportion to
the lightness of piece and
hardness of head —
— The thinner and the more
elastic the recoil Regulator
— than a Gun [illegible] there is
no recoil —
— Does the recoil take place
when the shot is in the gun?
— Court of Appl. —
— No recoil in a rifled barrel
— Position of the breech makes
little alteration — Gun [illegible]
is perhaps ¼ of the charge from
the bottom.

Windage

— Government .. 20 in 21
— thin too much — Powder
escapes between the bullet & the
— when there is no windage
the same charge ¼ further
— Gun not truly bored — foul
— first shot range shorter than
the succeeding — reason —
Short pieces less windage
than long —

Use of chambers

— 10 pounds of Powder will throw a shell 200 lb. as far as a 24lb. shot — reason

1. want of a swivel-
— with split with spr.
— fowling piece — day —

2. Chamber collects the fire which burns more violently
— shape of the chamber —
— cylindrical concave —
— Greatest advantage is the powder acting in a line passing thro' the center of the ball —
— Ex: a ball enclosed in powder
— battering pieces should have chambers —

Long and short pieces
— Nothing as yet determined on the subject
21 Diameters for our 18 lbs
14 Diameters for a field piece
24, 18 and 12 are from 9½ to 9 feet long.
— When the powder is all on fire — supposed to take time in firing — thrown out un-fired out — not good —
— Expt. a pistol throws out no more than a long piece — a longer column of air retards more than a shorter —
— Musket might be made shorter — 28 or 30 inches

Deflection of the Ball
— whirling motion
— resistance of the air dif-
ferent on different sides of
the ball —
— thrown by long shot
or bullet long rifled piece
— top — arrow — —
Rifled piece does not
shoot so far as a plane
bore — Air rifled
pistols —

Fowling piece — — —
— To shoot close should be
wider at the muzzle 1 3/4
— 28 or 30 Inches long —

Practice of grape shot —
— Musket balls one in 4
80 —
At 300 to 600 yards grape
shot Does Little execution
— At a great distance the
grape should be the large
— Charge for grape less than
for shot — —
— 1/4 charge of the shot —
— higher the charge scatters
more

Flow work – brown work

– Mining — Small mine

Forge fire – shaft 3 or 4 feet –

– Chamber $\frac{1}{6}$ shaft – nearly

– Box a cube whose side nearly fills the chamber and whose inside is $\frac{1}{9}$ the depth of the shaft –

Lift

– 100 lb. of pd.[illegible] = 10 feet mine –

– Board before the box

– Saucisson – a long tube of coarse cloth or leather

– $1\frac{1}{2}$ Diam.r. to the $\frac{1}{2}$ pound of powd.r to a foot

– tied round with a string

– Sausage –

Magget a wooden trough
— carried into the work —
through or below the
ditch — 2
— Gallery arched over —
— One Gallery several mines
— Excavation about twice
the depth — — —
—

— Boom —
— Two boats — Each anchor
Cables Lent to each —
— Span just round them
— rope — wormed — graved
— pitch — Anchors dropped
+ Cables up and Down —
— To open at one end —
— Obligue — Stockado
— Boom in the head of
a river — triangle —
— Rafts — floating batteries
+ Batteries to defend the
boom — Battery — Entrenchment
—

Camp

Tents Marquees

Standard poles & pins

Ridge poles

5 pins to each tent

Straw — one Blanket

— Mode of encamp.t the same
when Encamp.e —
— General principle
Troops may form with
the greatest expedition —
+ Encamp.d in order of Batt.
— Battalions — Reg.ts —
— Each Bat.n at the head of
its own encamp.t —
— Front of the camp equal
to the line of battle —
+ Perpendicular rows —
— Streets —
— Each Comp.y in a row
— Double rows give broad
streets —
— Entrance of the tents face the
streets

— Pegiants tent the front —
— Number of tents & Grounds
of the strength of the comp.s
60 = 12. 100 = 20 a 15 tents

– Front of a Bat: of 10 Cov
of 60 men each –
400 feet 5 Ranks
– Depth 750 feet –
+ Quarter Guard 60 Bell Tents
70 yards –
– Field Piece on the right

+ Park of Artillery
– First and Second Line
(each) 400 yards –

– Quarter Guard 30 men 6 T.
– rear Guard – 10 men 2 Tents
– Bell Tents – better to have
in the middle of the Ranks
– Kitchen 16 feet Cut.
six feet for each Tent –
– Sutlers – provisions –
+ Head quarters –
– Drums and Colours at
the Head of the main street –
– Camp colours on the flanks
and Quarter and rear Guards
a foot square colour of the
facing of the Regt. No. of the
facing Regt. –

Encampt. of Hors. —

Entrenched Camps

— Ancients always.

— seldom in Europe modern

Dimensions of Ships —
No. of Guns —
Expence —
No. of hands —
Capstans & Bars —
Time to be built —
Launching — Apparatus
Fitting as Cable —
Making Cables & Anchors
Twisting the Ropes —
Cables Length &c —
Masts —
Sailing on a wind —
close hauled — on front
Large — 2 points large
or on the beam —
3 points large on or
front aft the beam

Leeway & Fore — aft —
Bearing away —
Veering & wearing —
Luff — near the wind —
Distance to which a Ship
can be seen —
~~No. of men to carry guns~~
No. of Masts —
Magazine —
Doubling the cables —
Signals —

Hillary on Fire

Cramer on Notes

Knight on Attraction and Repl.

Batteries

Guns	ft	Fascines	10	8	6 feet
2	40	134	= 70	45	19
4	58	228	= 120	76	32
6	76	322	= 170	104	48
10	112	510	= 270	160	80

The number of men that will finish in 12 hours are

Guns men	Batt:	Fasc:		
2	50	15	= 75	in all to finish the work in 12 h.
4	70	25	= 95	
6	90	35	= 125	
10	130	55	= 185	

In Redoubts and Batteries where field pieces are used 12 feet is allowed for every Gun and two feet for every file of 2 men — Hence it is easy to compute the number of men

requisite for the defence of any work — and the reverse —
A battery is to be constructed for 200 men — and 2 feet. pieces — it must be 224 feet long
A square redoubt to contain 200 men is 40 feet in the side
Another way of constructing that shall give the side square give the number of troops — A side of a square redoubt is 124 yards — 12 × 12 = 144 men —

great care must be taken to proportion the size of a work to the number of men that are to defend it — If too large it cannot be manned properly and therefore may be taken with very little trouble or loss — If it is not of so bad consequence to make it too small, as a reserve is in many cases useful and when the work is large that it requires two or more battalions to defend it the reserve should be the 6th part of the whole — These are placed in the center ready to assist on occasion of the enemies —

A square redoubt should never be less than 160 feet in circumference or 40 feet in the side. They are usually from 80 to 90 or 90 feet in the side. If they are less than 40 feet the defendants would be incommoded one another, and would be in a disagreeable situation if the enemy should use grenades.

The entrance should always be made in the [illegible] least exposed to an attack. It should be 10 feet wide but if no cannon are mounted 6 or 7 feet are sufficient. It is covered by a traverse within side the work reaching 5 or 6 feet beyond the entrance on either side that the enemy may not discover any part of the garrison in the rear.

The ditch of the traverse should be at such a distance as to leave sufficient room to place the banquet or cannon. The parapet of the traverse must never be made above 5 feet thick.

To finish a redoubt with expedition, there ought to be the number of workmen employed in the construction, as there are men appointed to each face

Maxims

1. The Salient angles of all redoubts should never be less than 60°.

2. The reentering angles should never be less than 90° or greater than 120 degrees.

3. The Parapet of exposed to battering cannon should be from 12 to 18 feet thick and at least 6 feet high — the slope from the crown so as to command the country that is when the inside is 6 and the out side 4½ feet — the inner slope of the parapet is 1 foot the outer 2 or 3 feet —

4. The Ditch should be of such a breadth and depth as to afford sufficient earth for the parapet and rampart — that is for Batteries cannon from 12 to 16 feet above and 4 or 5 feet at the bottom — this will depend according to the nature of the soil — when it is of a stiff clay the slope or slope of the Ditch may not be so great —

5. The embrasures are from 1 1/2 to 2½ inside and from 7 to 9 outside wide. — Odd. make a better lining for them than Fascines — Distances between the centers of the embrasures from 12 to 16 feet. —

30 [illegible]

6. Batteries should be [illegible] 5 or 6 feet above the level ground if possible, in order that the shot may plunge better into the enemy's works

7. Magazines for the powder, shells, cartridges, are located not nearer 20 or 30 yards behind the battery towards the lines 3 or 4 feet under ground feet 4 or [illegible] square [illegible] the great magazine is in the rear, and two or more deeper ones near the guns lined on the sides with plank and covered with planks and earth. Every battery should have more than one magazine.

Gabion Batteries

A Gabion is a basket of iron
at both ends from 3 to 4 feet
high and about 3 feet Diameter
the are filled with earth and
being placed near each other
come to form embrasures for
the Guns — They are sometimes
filled with branches and small
wood, and are from 5 or 6 feet
long they are rolled along
with the branches to cover the work-
men from musket shot —
Some Gabions are made 1
foot high 1 foot Diameter above
and Ten inches below. They
are placed along the top of the
parapet to cover the men who
fire & fire of the enemy
The Gabions being brought
between them —

Some Gabions are mad 6 or 8
feet high and as much diameter
Gabions for a battery must
be 3, 6, and 7 feet diameter and
eight feet high — The are placed
in the line marked out for the
battery ~~when~~ for the merlons ~~are~~
— Each merlon requires 7 Gab.
that is 3 within of 6 feet dr,
next two of seven and on the
out side 2 of five feet —
or let the Gabions be all of
5 feet then place 4 : 3 : 2 for
the merlons leaving proper
openings for the embrasures —
— The floors or bottoms of the
embrasures are filled with
Gabions ~~of the~~ three feet high —
The Gabions are then filled

with earth brought from the
near places where it can be had —
The Gabions in case of necessity
may be filled with billets of wood
or faggots, filling also the voids
between them —

In all batteries great care
should be taken that they
are not infiladed by the enemy
works, if the situation of the Bat
— is such as to be open to this then a
parapet, or epaulement must
be raised at ~~the~~ the end of the
battery to cover the flanks. —
It must be as high as the front.

Ranges with different charges

1 Greater the quantity of powder the greater the initial velocity until the charge fills $\frac{3}{5}$ of the bore

this is a maximum —

— Penetration of bullets —

— greatest range about 3 miles

2. Ranges in certain measures

— A 24 P. ranges with $\frac{1}{3}$ nearly as far as $\frac{2}{3}$ of the ball a P.

— The diff. is greater than the

— times the same charges —

Resistance of the air the reason

— — Hence the augmenting the quantity of powder of no use in distant cannonadings

3. Small charges do more execution than large —

— Splinters either wood or stone [illegible] thrown about with a small charge

Point Blank

Although the projected Missile describes a curve, yet the first part may be a straight line — Some writers viz: Anderson insist that it is suspended for a while — This is absurd —

Musket ball from 240 : 360 yards. Varies more than in Cannon.

Cannon Ball 1000 to 1200 yards — But with a small elevation both will do execution at a much greater Distance —

Large shot move slowly than small

Deviation much less —

The resistance of the air is greater to small than large —

Chamber

The same charge of powder will throw a Shell of 24 Cwt. as far as a 24 lb Shot. — Reason — want of Recoil

— Chamber —

— Recoil diminishes the velocity of the Ball — Stone blown with Powder —

— Clay in the muzzle of the piece — Shot not near the powder — Bar. the longer it is weaker — Mines — — prepare like coals — powder —

— Quoiter wad in great charges retards the motion of the ball / quadrilateral

— Stone the ranges are not more nearly in proportion

in Mortars than in Common
+ Chamber — Fire collected
being more violently —
Point and Surface for a ball
— Force encreases in proportion
to the contraction of the Chamber
— the longer the Chamber the
greater force on the sides —
— the reaction from the sides and
bottom encreases the force at
the mouth of the Chamber
+ Greatest advantage is the
powder acting in a line
passing thro' the Centre of the
shell — for a Gun the oblique
by Dulongs Part of the force —
Suppose a ball placed in
+ the middle of a great quantity
of powder it will not be mov'd

— Foot bank. —— Merlons

— Platform 18 feet long
breadth 9 by 12 ——

5 + Sleepers each 18 feet long
and 8 or 10 Inches square
— fixed with ~~[illegible]~~ pickets
rammed with earth between
2 higher behind to prevent
the recoil, facilitate the
running the Guns into the
Embrasures. —— raising of the train
Mortar or Howitzer ——
— 1 Sleepers covered with planks
3 or 4 Inches thick ——

+ Embrasures with [illegible] ——

A Fascine battery liable
to take fire ——

To make a battery

— Two trenches ½ spade deep
— In each lay a row of fascines
— Complete the floor
Earth thrown and beat in be-
tween — Fascines of different lengths
— Gentle slope on each side
four rows will raise it 3½ ft
high —
Make the Merlons — which
— raise with fascines in like
manner
— Cover the upper part with
a bundle of 10 or 12 fascines —
blind till the Gunners have
— laid the platform and prepare
the part. is frequently made
— entire and the Embrasures
cut out afterwards.
— Unmasking

Coffer Battery
— Gabion Battery ——
— Barbet ——
Powder Magazines — Great
small —

Redout —
is commonly a temporary work
to strengthen lines or secure
a pass — Consist of 4 5 or 6 sides
— Rampart is a large bank
surrounding a work — height
— thickness.
— Sides of square redoubts are
between 12 and 32 yards —
— Number of troops to defend
Rule half the side squared =
No. of troops Exp: Side of a
square Redout is 20 yards =
— 100 Men
In France they allow a
file of men 3 feet and 12
feet for every Cann:
— a ravin in ~~one~~ redoubt re:

Twice the number of Men m.
be employed in constructing
a redoubt that are to defend it —
It should be nearly finished in
one night — Traverse —
— Star forts — Tete de ponts —
— Fleche — or arrow —

~~Lines Redans~~

— The sides of square redoubts
do not defend each other — having
only their own fire to depend upon
— the angles have no defence
— rounded — En cremaillere —
bulwork — Chevaux —

Lines —

2 kinds — Approaches

Circumval:on — first with

the castle to the town —

second kind to fortify a camp

Ditch to the enemy

— 100 men will complete 50

yards in a Day of the middle

sized lines —

— Redents or flankers — salient

angle — Curtains — use of

flankers. —

Lines are made use of for

intrenching a camp.

— Passages in the lines

— shut with Chevaux de frize

— Serving of Artillery —

Boom

2 Sheet anchors — two Cables

Slender trees or spars 8 or 10

inches diameter and as long

as possible lay them along

the cables so as to make

them 8 or 10 feet Diam:r

lay them in with 3 or 4 Inch

rope — Having finished a

sufficient length for the anchors

drop them and continue the

other side drop the two anchors

— Batteries to defend it —

Fort —

Pentagon —

— Bastions — Curtains — Gorge

— Rampart Parapet 24 yards

— foot bank — Parapet

— revetted of stone — counterforts

— Platforms of stone —

— Ramps, gentle slopes —

— Cannon are mounted at

some in Embrasures &c —

— Town built in a [illegible]

— Great square in the centre.

— Remarks —

Powder Magazines in

the Bastions, with one end

to the salient angles —

Gates are always in the
Curtain — Sally ports —
— A Ditch 30 yards broad cur[illegible]
the rampart — Berm 3 at
feet — Fraises —
— Scarp — Counter scarp
— Out works to augment its
strength —
— Ravelin — faces to the
shoulder of the Bastions
— Gorge in the counter scarp —
— Lunettes — Tenailleons &
— Counter guards before a bastion
— Inside from the counterscarp
3 Horn work — Crown
— Redoubt in the Ravelin —
— Horn work —

Covered way — 80 yards —
— parallel to the counterscarp 20 or
25 yards broad below the level
of the country —
Places of arms at the angles
greatly enhance the defence of the
covered way —
— Roads — Gates — Sally ports
— Pallisades —
Glacis —
— Works for the defence of the
Ditch —
— Tenailles — the best not
open in the flank
— Ravelins —
— Caponieres — X — Tenailles

Guns for battering 24 pr

breach begun below —

— Guns fired together —

— A small breach — Mines

on line —

— Mines —

Attack

Difference between attacking the centre and Salient of the Bastion, the latter easier — Approach now a covered way — Progress of the Miners retarded but much more from before the centre than the Salient angles of the Bastion — Necessary to defend the faces of the Bastion — Flanks Redans — Counterworks — Ravelin — Tenaillon — Lunettes — Counter Guard —

But as it is seldom found possible to stop the progress of the besiegers — the last resource must be in defence of the Ditch — Tenailles, with two faces and two flanks to each — Lastly and Tourney — Tenails have their Flanks open. They cannot be enfiladed —

Ramshorns a better defence — Less expensive —

The last defence of the Ditch is the flanks — Most important part of a fortification — They command the Ditch and breach of the opposite Bastion —

Great pains have been taken to augment the fire of the flanks

+ Double or Crenated flanks
+ Orillon and retired flanks.

Siege

Want two pockets in the
Capitals produced of the Bastions
and Revalon —

Trenches are opened under
the first night as far as the first
Park.

Trenches are about 13 feet wide
and three feet deep. The earth
they cast is thrown on the side
next the town — Straight from
the bottom of the Ditch 7 feet
are usually begun within a
circle of the second way from
much less — run in zig zags
should point without the works
and to equal distances on each
side the Capitals produced —

The work now finish in the Day what they began at night

— Parl.ˢ are trenches 3 or 4 feet broader than the approch.ˢ Defile and breast work the same — a ~~berm or~~ foot bank of two ft left for the soldiers to fire from —

The parl.ˢ are places of arms they are intended to cover the ~~guard~~ the workmen in the trenches and join the different attacks.

— Part of the first Pal.ˢ should be finished the first night

— First Par.ˡ 600 yards from the saliant angles of the covered way.

— The second Pal.ˢ should be completed in a day or two for the Guards. —

— When the prisoners are attacked they immediately retire and the Guards recover the Sally. ~~and~~ as they are ¾ round the others quite exposed, they have greatly the advantage. — but

First batteries are placed about 100 yards before the first pl.ˢ and consequently within 500 yards of the covered way. —

— Each Battery commun.ᵗ with the Parl.ˢ by means of a trench which surrounds it —

— Two fold use to dismount their guns and drive the enemy from their defences — This points out the number and situation of the batteries —

There must be as many battery
as faces which flank the approach
— Each battery serves either to dis-
the Guns on one face or ~~mount~~ enfi-
lade the other — by ricochet firing —
— Position of the batteries —
— These batteries are of use during
the whole siege —
When the approach have ad-
— 250 yards or so beyond the
first Par. then a second Par.
is made of the same dimensions
of the first —
— Square redoubts of 20 or 24 yds
in the side are raised to protect
more effectually the approach from the
sallies —
— End of the trenches must be
held longer than the angle —

From the second Par. 3 appr.
are carried on one to the Sal.
angle of the ravelin —
As the Salliens of the besieged
become more frequent places
of arms for the troops are
made between the Par.
— When the appr. are carried
on to the ~~first~~ second Par.
the fire of the enemy becomes
so heavy ~~to carry~~ they [illegible]
proceeding any further in
this way — Covered
— Mantlet before Gabions or
— the flank — Sap — filled with
filled with sand bags —
upon the G.ns are laid
— Fascines — Sap widened to

to fill when it gets the ant.
name of branches — This work
is carried on night and day
+ Third Pl. at the angles
or on the Glacis — wider
and deeper — salters more
frequent. — Steps by which
the troops can pass in order
to the attack.
+ It is now impossible
to prevent enfilades, if the
trenches are carried on in
as before — [illegible] at the
Sal: angle — Double Sap
with traverses along the ridge
of the Glacis — When this is
advanced within 25 yards of
the covered way — Cavaliers —

The Enfilade the covered way
— Grenades — about 20 feet
long 20 feet wide — Parapets
raised very high with Gab
~~[illegible]~~ from which the covered
way can be seen and fired
into — The Batteries must
~~[illegible]~~ all play into the covered
way, while the lodgment is
on the Glacis is advancing
— Ricochet is now of most
service — Mortars — Enemy
soon driven behind the trav.
— The Sap being carried to
the Sal: angle of the covered
way — Large [illegible] traverse
is made, from which the enemy
are driven out of that part of the
covered way —

Trenches carried towards the
place of arms — From these
trenches the enemy are drawn
from behind their traverses
— The besieged have now only the
place of arms on the covered way
— But here they can make a good
defence — To drive them out
of this lodgment of Mortars for
throwing stone or Shells must
be ended at the Saliant angle
of the place of arms — If the
places of arms are fortified
with stone redoubts or traverses
as General Cochorn used at
Bergen op zoom — Then stones
will have little effect — Shells
must ruin the defence, and a detach-
ment of Grenadiers attack them
sword in hand — The Enemy
is now driven out of the covered
way — Lay mortars on the
place of arms — Batteries
in them to destroy the Cuntin
and Tenaille —
Batteries to make a breach
in the Ravelin and Bastion
— The faces of the Bastion
and the ravelin — Three
batteries one at the Saliant
angle & the other opposite
the face of the Ravelin —
The first to fire on the Bast:
the two last to make the
breach in the Ravelin
— But place about 30 yards
from the Saliant angle

Passage over the Ditch —

— Flanks the chief defence of the Ditch — importance of preserving the flanks —

— Different methods of strengthening the flanks — Double or casemated flanks —

— Orillon or retired flank —

— Batteries opposite the salient angle of the bastion for securing the flanks. —

Prot. cover 24 ft. Ditch together —

+ Passage over a Dry Ditch

— wet Ditch — curvet — very difficult — orillon —

× The more advanced works should be lower than the interior, by this means the enemy cannot so easily cover himself when he has made himself master of them. —

×

+ Long and short Guns
— Powder fires almost in t.
— three balls &c. —
21 Diameters — uncertain

+ Recoil takes place in
the Gun — Count de Lippe
— Position of the touch hole
— best near the bottom —
— in the middle —

+ wadding to mortars —
— paper — Howitzers —
+ Position of the Calibre
— Rifled barrels —
Pendulum
Co. Lon

+ Pistol — recoil
— Grape shot from sm
Calibre —
— Fowling piece —
— Shi Guns —

— Fascines — how made
— pickets — horse
6 men 12 in an
hour —
Gabions — 6 to 8
feet long 3 or 4 ft
sand bags filled with
earth —

Barr.s —

— Gate — tumulte —

— Chevaux de frise —

— Abatis — Tranchée loup —

— Crows feet — Palissades —

— Portcullice — Orgues —

Triangle a Zabrie
Bathurst may be Side
and 100 feet the with
intersection —

competitions in want ~~[illegible]~~
were inevitable, they soon became
fatal, the rude maxims of those
ages taught them to think offen-
sive war an enemy who be-
[illegible] of their tribe, war was the ne-
cessary consequence. —

The different communities from the
habits themselves of their origi-
[illegible] [illegible] held their [illegible]
on the borders of mountains were
worth of different people, from whom
they would expect [easily] an inferior
force. The difficulty of procuring [finding]
subsistence for themselves and
cattle induced them to ex-
change their station. Innumerable
for the [illegible] of [illegible]
and ravages with those who conf-

retired within [illegible]
their gates and within a [illegible]
In the progress of the art this improv[illegible]
it was soon found that simple
circular walls were not sufficient
The enemy when advanced to the wall
as he could not be seen from any
part except immediately above could
easily protect himself and undermine
the wall — To remedy this
defect it was found necessary to ~~turn~~
build the wall so as to project
towards the country at certain in-
tervals — Square towers were ac-
cordingly built at 100 or 150 yards
from each other, which commanded
each other and the intermediate
wall. The towns fortified with one
[illegible] to the country and all that they
their [illegible] beyond the wall —

tho' this ~~was~~ defended the walls and two sides of the towers the front of the tower was not defended. — Round towers substituted in their place — Even here a part of the tower was not defended. — The last and quicker improvement in the ancient fortification was the placing the square tower with an angle to the field. By this device every part of the work was seen and defended by some other part. this method continued till the invention of Gun powder. —

The attack however soon became superior to the defence, and there was used so to this day various tools and engines were contrived for undermining scaling or battering the walls — It was necessary for the besieged to keep the enemy at a distance and retard as much as possible their approach to the walls, seeing that when they once arrived it was extremely difficult to beat them off. — One of the first and best contrivances for this purpose was the surrounding the wall with a ditch. this not only obliged the enemy to fill it up before he could come up to the wall, but the earth dug out of the ditch form a mound or rampart along the inside of the wall. Otherwise sometimes two feet wide and 30 or [illegible] feet: the form is the same to this day. —

On this consisted the ancient fortification of the ancients.

Warlike Engines of the Ancients ——

The first ~~weapons~~ weapons were stones and clubs of wood — Slings next — they were in great repute among the ancients — Balearean slingers &c. — Youths trained up to this exercise — a piece of bread was laid on a beam, and the boy was obliged to sling it down before he could have it — The sling commonly was made of a piece of leather of an oval form which terminated gradually into thongs — Sheep's skin — One half sometimes of wood — Out of the sling were cast arrows, stones and lead bullets above a pound weight, whirled twice or thrice round the head.

Ancient attack

3 Different ways

1 By surprise

2. By assault or storm

3. By a regular siege

With regard to the first nothing can be said — it depends on circumstances which can seldom be foreseen, and can have no existence except on the spot —

2 The storm was conducted in this manner — They ~~surrounded~~ invested the city on all sides to terrify and weaken the inhabitants — This was called in Greek Sagēneuein in Latin coronà cingere

The corona was either single or double

1. First thank heavy armed Soldiers
2. Velites with Slings and Darts
3. Cavalry in the rear — to prevent their own foot from flying and defend them from any enemy that might attempt to relieve the place. ———

In this order they marched up to the attack — some carrying scaling ladders, others fascines and hurdles which served both to protect them and fill up the Ditch — When they advanced to the walls the heavy armed Soldiers threw themselves into the testudo — or Greek Chelone or tortoise —

— Manner of forming the testudo — use of the testudo — two rows one upon the other —

Tollenno — hoisted up several men at once. —

If this proved unsuccessful they either desisted from the attempt or had recourse to their regular siege —

— Regular siege — Lines of Circumvallation and Countervallation —

— Sometimes a double wall was built by the Greeks — Platea — towns joined the two walls at certain intervals — Lines usually Ditches as in Modern times —

— use of these Lines —

In this situation the army lay to reduce the Garrison by famine

Mounds Aggeres —

Moving towers — 200 feet high
moved on ^small^ wheels or Rollers —
consisted of several stories — in the
lower the battering ram — Catapults
balista &c. in the upper stories —

Moved on a regular ascent —
Musculus went before the tower
sloping roof of thick plank
covered with hides and raw hides

The moving tower was thus
brought up to the wall which
it equalled sometimes exceeded
in height — The battering ram
now began to play, miners
were set to work to undermine
the wall —

× Ancient mining —
Gallery —

Light armed soldiers are armed with Slings — Bows and Quivers —

The Elasticity of a piece of wood soon suggested the use of the bow which we recording Good was very ancient — Bows were made of wood or steel — they were bent in various forms. The common Negro bow when unbent is of a semicircular form — were made of yew or yew tree, but the best Bows are made of a piece of ash and yew joined together — The bow strings were sometimes made of horse hair at other times of thongs of leather &c — The arrows of light wood with an iron head which was commonly barbed with two three or four barbs on it — one of barbs —

The ancient greek method of drawing
the bow was to hold the bow be-
fore them in their left hand and
return their hand on their right
breast But the ancient Persians with
all modern nations draw their right
hand towards their right ear—
the back of the right hand down
with the arrow between the first
and second fingers— Target placed
at 150 yards distance. Arrow ~~feath~~
feathered see—

Sword Spear or pike, same as
the Roman barbs like our
Spontoon— Darts Javelins similar
but smaller— Shafts of ash and
most of them barbed points—

Defensive weapons
— Helmet — of brass — crest feathers
or horse hair —
Breast plates — of brass
+ Buckler — round or oblong &
made of light wood but more
frequently of hides and plated with
brass or even silver — Covering [illegible]
part of the body — Soldiers were
carried out of the field of battle
on dead or wounded, on their buckler
ē tan ē epi tas. was the command
of the Spartan mothers to their
sons before the battle —
Many of the Ancients would rather
lose their life than their buckler

Light armed Soldiers were armed with Slings. — Once used English —
The Elasticity of a piece of wood soon suggested the use of the bow which we accordingly find was very ancient. — Bows were made either of wood or steel — They were bent in various forms. The Grecian & Scythian bow when unbent like a semicircular form — Were made of ash or yew tree, but the best Bows were made of a piece of ash and yew joined together — The bow strings were sometimes made of horse hair, at other times of thongs of leather &c.
— The arrows of light wood with an iron head which was smooth & hooked with two three or four barbs on it — one of barbs —

Encampment

— Order the same as in
Europe — cover flanks.

— Number — companies

— Streets — 5 men in a tent —

— face the streets —

— Double rows Ten rows

Encampment the same as the order
of Battle —

1 Quarter Guard 2. Line of Parade
3 Tents — Bell Tents 4. Subalterns 5
Capt: 6. Lt Col: and Major 7 Col: &
Staff — 9. Sutler 10 Butcher
11 Rear Guard —

Description of works —

— of them —

— of mortars

— Practice —

— hot bullets — when first fired — how fired —

— Sods

— Trenches — batteries —

× query what is a mill-battery

— Fascines — Gabions —

Sand bags — Carts —

Arrangment —

1. Origin of war — encroachments of the Ancient tribes —

— Ancient fortifications — circumvallations — square and round towers — angle to the field —

— Ancient attack and defence

+ Revolution in the art of war by the invention of Gunpowder

2. Modern fortifications —

Encampment

— Order the same as over Europe — vide Genl.

— Number — companies

— Streets — 5 men in a Tent —

— face the streets —

— Double wave Gen. vide Encampment the same as the order of Battle —

1 Quarter Guard 2. Line of Parl.
3 Tents — Bell Tents 4. Subaltern 5
Capt: 6. Lt Col: and Major 7 Col &
Staff — 9. Artillery 10 Rebels
11 Rear Guard.

composed with our bomb
A bomb of 8 or 6 Cw
can be thrown to the distance
of above two miles —
and this by the simple
force of the match —
Figure to yourselves a
great number of Mortars
playing continually
from the batteries round
a besieged town, and bombs
like one uninterrupted
tempest of fire falling
alone on all the quarter

forcing their passage
irresistibly
thro' every thing that
opposes them demolishing
buildings, and burying
multitudes under the
ruins, tearing up moun-
tains, sweeping away
whole ranks of men,
and tossing their mangled
limbs thro' the firmament
with the violence of light-
ning even subterraneous
vaults, overthrowing under
or setting on fire whatever
is within their reach

These more destructive
than all the engines of
the ancients put together
So with their battering
engines bearing compari-
son with our cannon
— These engines used
to be destroyed by fire
their return to Caesar
at Marseilles —
What are their
means, those compared
to ours, bursting open
in a moment the bowels
of the earth, blowing up

whole troops of men and
twenty in files the
strongest walls, the
firmest towers and even
the solid rocks — not
to mention the effects
of our brave Grenadiers.
fire locks —

Animals have no method
of forming their
machines — they employ
the same force to a light
as a heavy body — [illegible]
mountain —

Tr

great adv

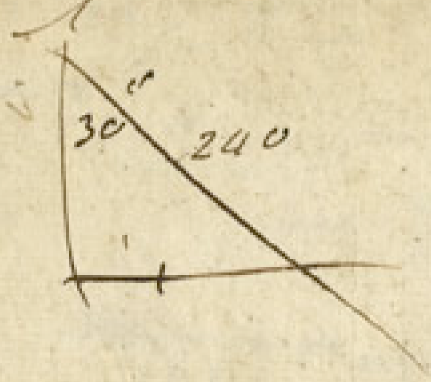
their vessels were
top heavy —

Have ~~[illegible]~~ few
arms been of service
to maintain the —

whole troops of men

running in fire

Shringes



9 .16

1600.
177.7

1600
711.1
729 9.

711.1 (1.9
512
192 | 199
1721
2630
1944
4560
729
61510

51
9
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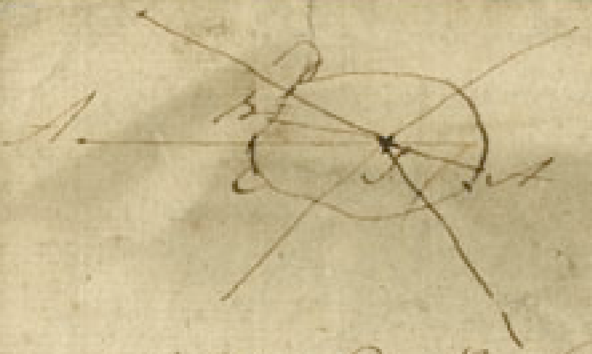
24
21
24
192
1944

19
29
501
712
7921
9
2156



1 Dr. 1 Opt. Ori 1 Jn. Ori

Otri. m. A S j Jn. Dist. Distand

then observations from the earths

first to be an elipse All the Phen.

agreed to this El. whose Ecc. 1/64 —

V. inversely . Distance A the Ez.

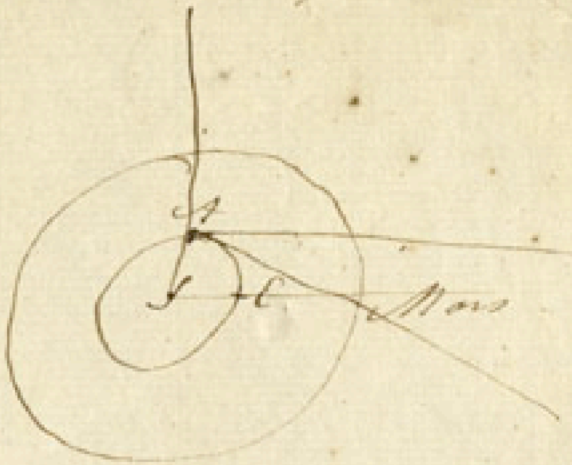
Daily Mo. inversely :: D²

angular V

PG : AH :: Sd :: SP

PG x SP = AH x SA

To determine the Rad. of the Planet.



Observe some time when Mars comes in oppos. to the sun — length of time [illegible] again observe — [illegible] of the [illegible] of the Earth

Another way —

Mars in conjunct. with a star $1\frac{3}{4}$ [illegible]

6th Effect of the Planets — 22 Oct

periodic — tropical shorter than the real or Sydereal revol.

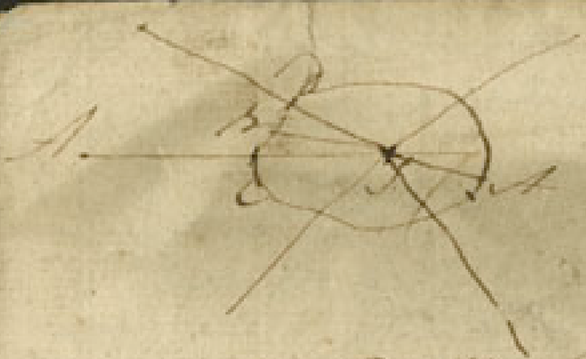
Syder. revolutions

	d	h	'	"	y	d
E	365	6	9	11		
M	27	7	43	5		
Mercury	87	23	15	37		
Venus	224	16	49	13		
Mars	1.321	23	30	43		
Jup.	11.317	8	51	26	11	315
Sat.	29.176	48	36	42	29	164

If the planets inequality of [illegible] corresponding to the inequality of the earth. Equation of [illegible] planets orbit found as the [illegible]

	°	'	"
M	23	40	49
V	–	45	30
Earth	1	55	37
M	10	41	47
J	5	37	1
S	6	27	19
Mer	6	18	3

Diff. between the mean and apparent motions — equation of the orbit



1 Ol. 1 Opt. Dist. Jn. Di

D. Min. A S ysr. Dist. 1st D Moon

then observations prove the earths

orbit to be an ellipse All the Phen.a

agreed to the El. whose Ecc. 164 —

V. inversely : Distances At Aph.

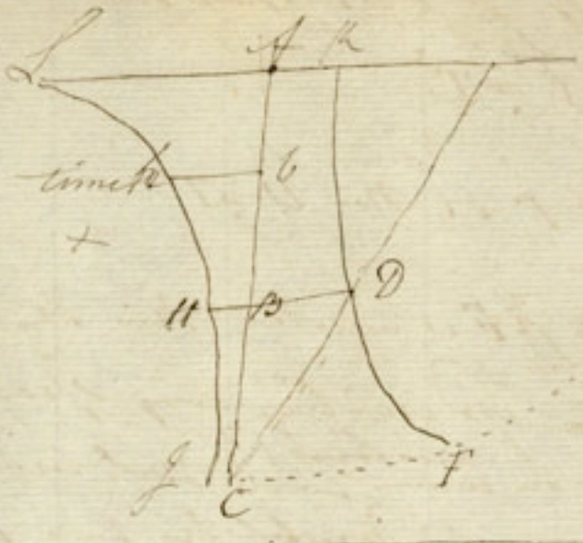
Angly Vel. inversely :: D²

angular V

PG : AH :: SA : SP

PG × SP = AH × SA

5



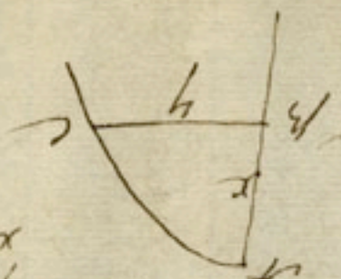
5 Dec.

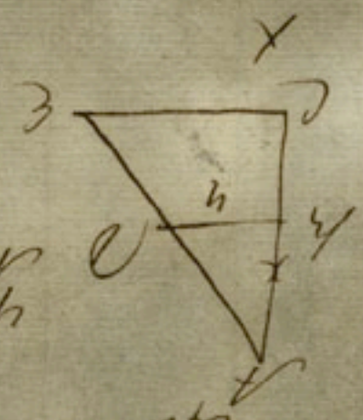
$y = \frac{1}{v}$

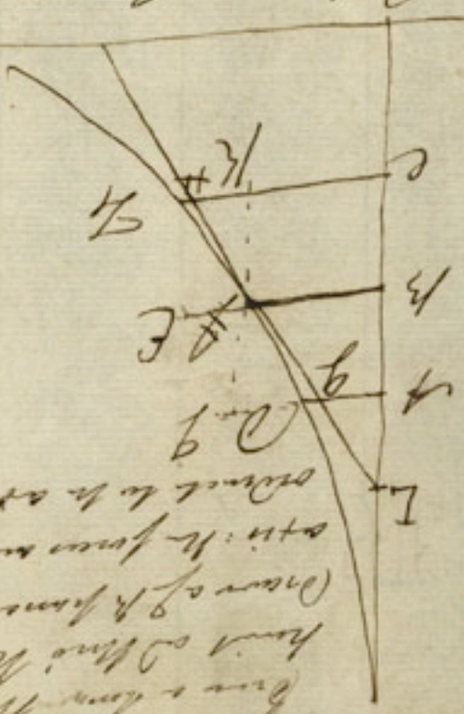
$\frac{1}{v} \times s = \frac{s}{v} = t \times \frac{vt}{v} = t$

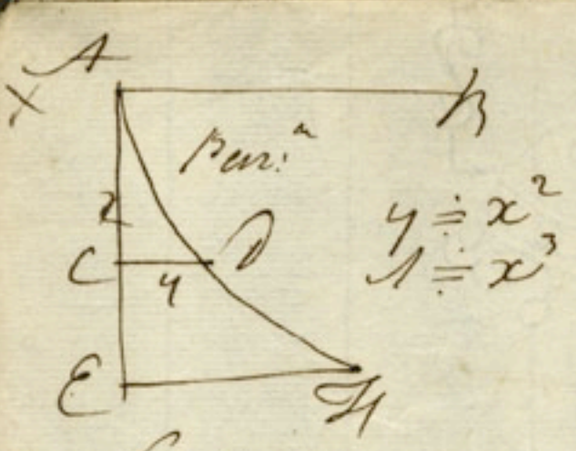
$v = \frac{s}{t}$ rate of the motion.

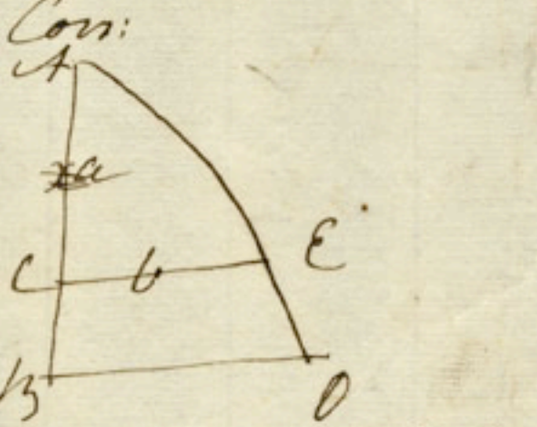
$vt = s$ of motion.

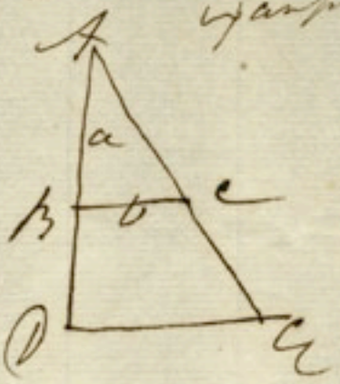


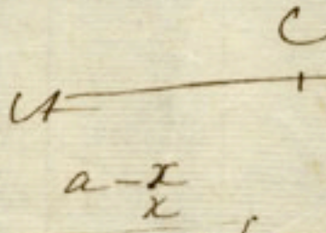












Prop 2d

Let the parallelog. ABG

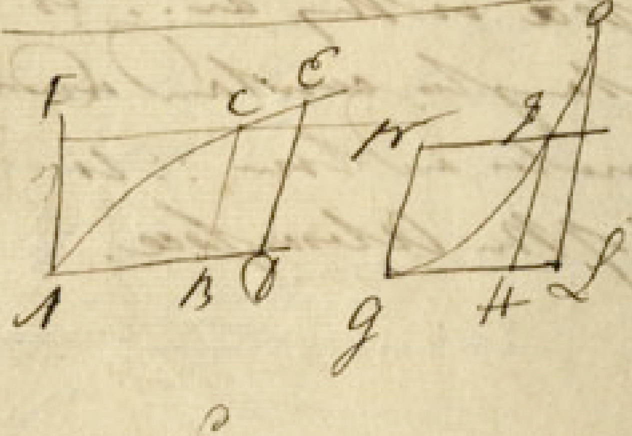
and the space ACB flow

together, by the motion of C

parallel to itself along

AB then fluxion ...

to the fluxion CB are equ...



Prop 3d

Prop. In any curves ACE,

GgO having the ordinates

similar by relation to axis

the fl. of the areas ~~at the~~

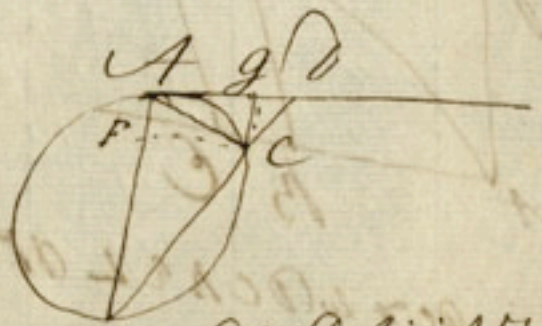
where the ordinates are

are :: to the fl. of the abscis

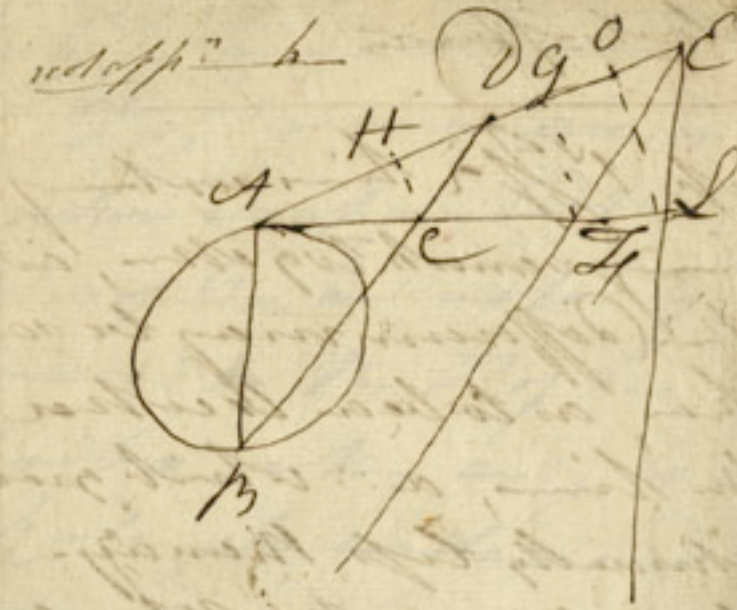
Prop 5th In any such curves
the Ps of the areas are in
the ratios compounded of
the ratios of the abscissæ
& the Ps of the
abscissæ or any ratio
bearing the same ratio
as those abscissæ :: to
Ps of the Abscissæ.

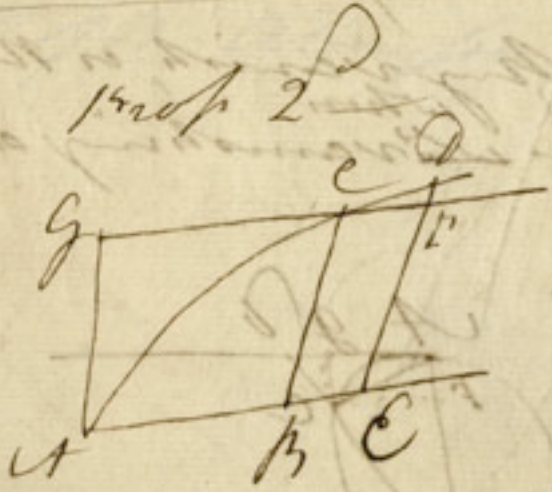
Velocity = Fluxion

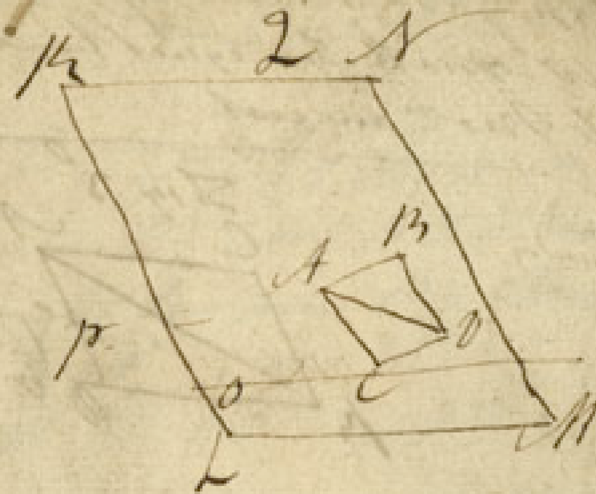
Prop 1st If time vanish
in any given ratio, and
the difference may be so
taken as to bear the ratio
of the time, & which grows
continually less than any
assignable :, the V. with
which any vanish, or the
Fluxion when vanishing are
equal



B Dg : DA :: AE : AB


H
A
C
B


A
B
C

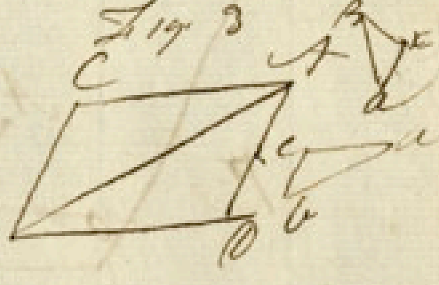


77. Whether Dispute what
mechanics are necessary ~~[illegible]~~ truth
or only contingent truths
They are necessary in so far as
they result from the nature of
Math and Mec.; but contingent
in so far as it implies no absurdity
to say that the Author of
Nat. might have imposed
the reverse on our works

Exp: falls 1st Law of Mot:
— W. Smith: has reached to
to Mot: and rest

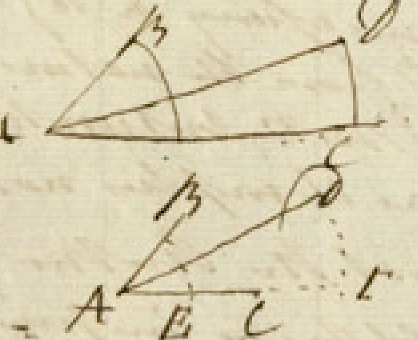
Fig 3d

Thursday



Force CB :: Sin ∠ CAB i.e. any
one by the other two

Fig 4



O which the forces are :: to the
velocities — Effe :: as tools
Lab: Eff: :: velo:^{2}

of the comp and the resl of
Mot

50 It is indifferent whether we
consider the body to Fig 2 or
urged by two forces 1 and 2 or
by a 3rd &

51. The forces acting AB & AC are
called simple or constituent
That acting along AD is called
compound or resultant

52. Fig. 4 the forces urging
the body along AB are called
the simple or constituent forces
while the force which would urge
the body along AD is called
the comp: or equivalent
resultant.

In the converse of Motion
forces so combined is called

be comp.d of motion or force and

the comp.g a motion or force as

the result of their combination

is called the resolution of motion

or forces.

86 — 1st The const.t or resultant

of 2 forces lying in one

plane

85. 2d The = :: to the sides

of a triangle which are

transversal — or any two similar

inclined to the direction Fig. 3

86 — 3d Each is :: to the sine of

the angle contained by the

other 2.

87 — 4th The joint action of 2 F.

which ... is in one direction

is = to the sum of their separate

actions Fig. 4

88. Forces are :: to the V.s which

they communicate

89 — 5 The joint action of 2 F.

which act in opposite D.s =

to diff. separate actions Fig. 6

90. Cor: Equal & oppo. F.

produce no motion they are to

stall: each other to be in Equilib.

91 — 6 The forces which have

the D.s and :: of the sides are

Pro: of a Parall.m all balance

each other Fig. 4

92 — 7 A particle of matter may

be urged along by many forces

and their resultant be had by the

foregoing rules.

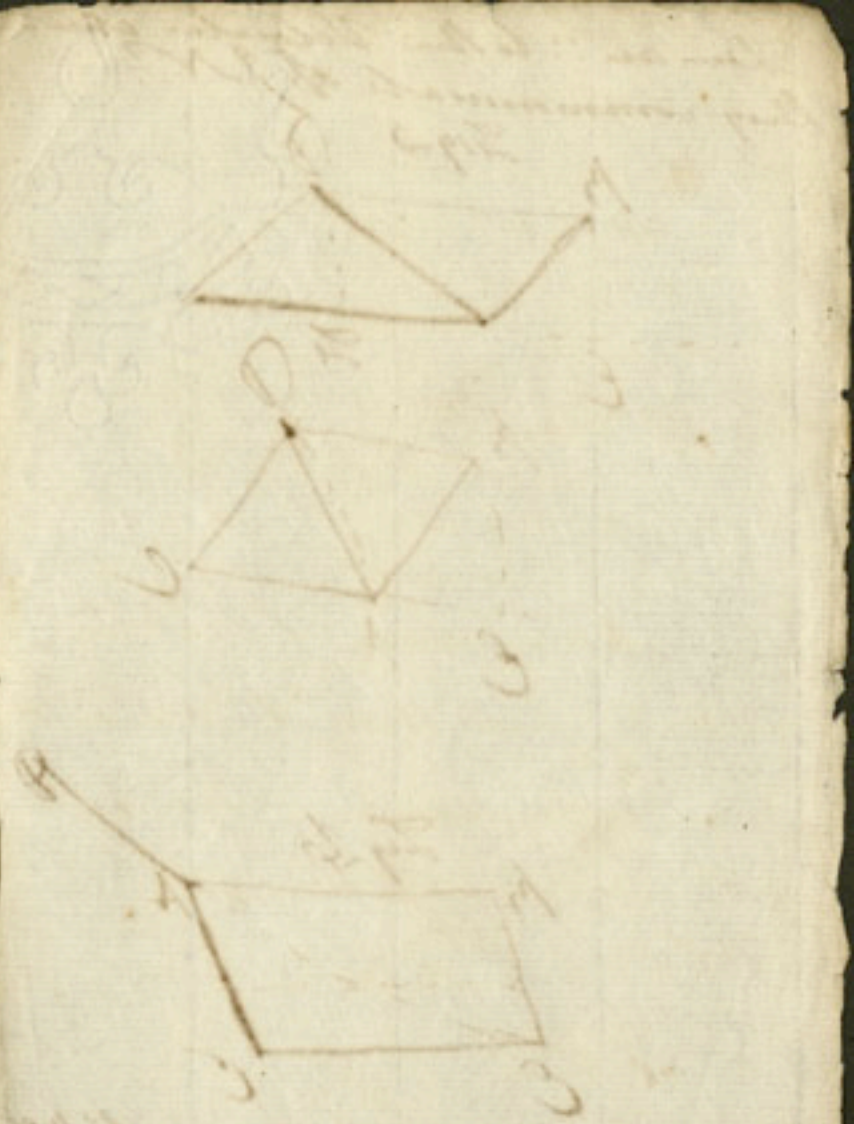


Fig 5

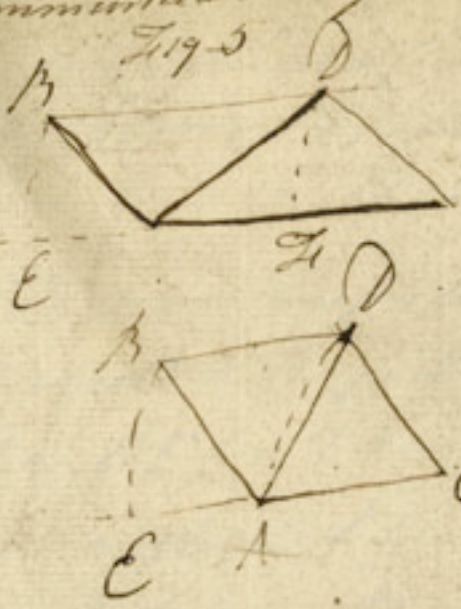
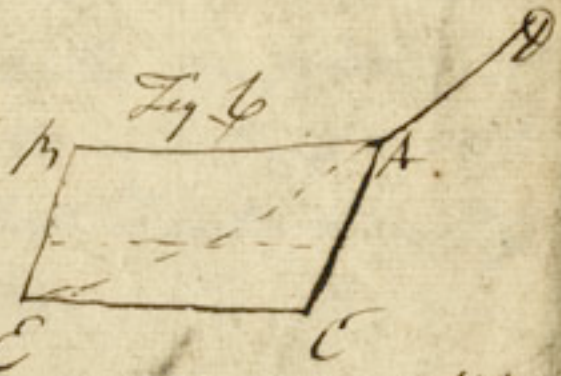


Fig 6



Nov 1833

137 Coroll: 1 $V^2 : v^2 = FS : fs$

When spaces are $FS = fs$

if under uniform

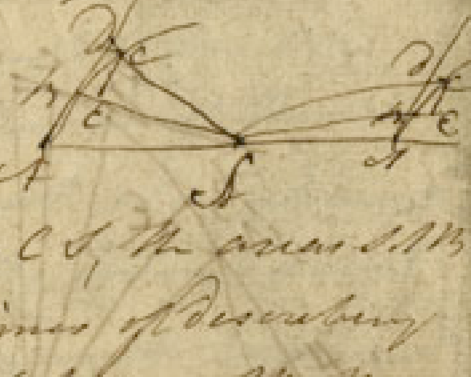
or under tangen-

$F : f = s : S$

= velocities are inversely as the forces

Fig 46

144 If a body A revolves freely in any curve ABC and if we draw the tangent line a point D such BD = AB

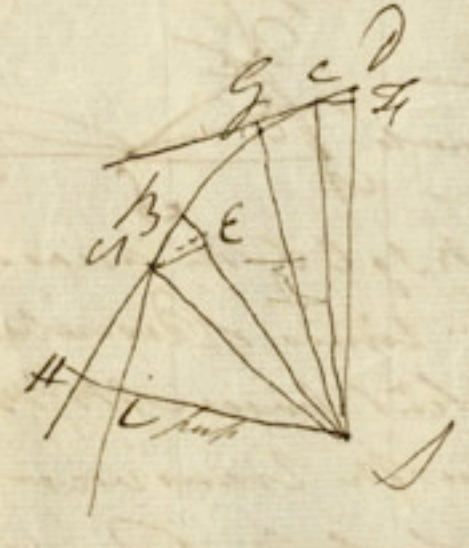


then drawing from any three points A, B, C the lines AS, BS, CS, the areas SAB, SBC are :: times of describing the contiguous bases AB, BC.

In this case the transverse force by which the body is made to deflect from the tangent BD is a force continually directed to the point S

147. The velo: of a body revolving by a centripetal force is inversely :: two perpendiculars drawn from the center of forces to the tangent drawn thro' the place of the body

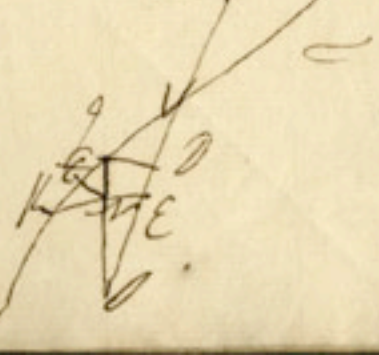
Fig 15

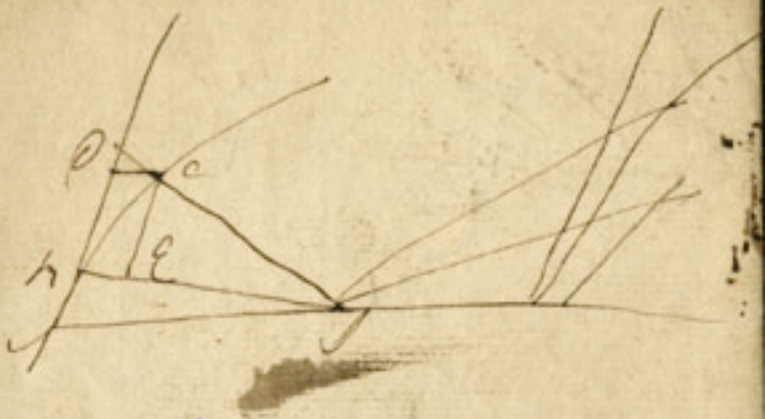


148. The angular velocities are inversely proport: to the squares of the perpend: from the center of forces

149. Fig 16—

If a body revolves in any curve A B K & another body moves by means of the same force in the line A S proport: to the center of forces, they will revolve in equal times along lines A D equally distant from S. Their velocities will be equal at all the equal distances



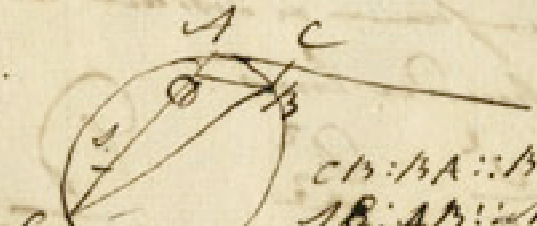

c

4th Oct. 1773

Curves may be considered either as evolutions or productions. Latter more

C

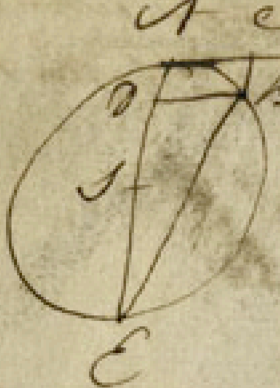
155. Central forces are directly [the]
:: V^2 and inversely :: chord
of curvature circle w.ch passes thro
the center of force



CB : BA :: BA : AE
AB : AB :: AB : AE

$$BC = \frac{AB}{AE}$$

$$F = \frac{V^2}{ch}$$



$F = \frac{V^2}{D}$

---

131 In different circles the [illegible] forces tend to centre are directly :: distance and inversely :: to the square of the periodic time ——

+ In diff. circles the Vel. are as the circumference or distance described & the periodic time

$F = \frac{V^2}{D} \quad \frac{\frac{D^2}{P^2}}{D} = \frac{D}{P^2}$

2? 9 Oct. 17[illegible]

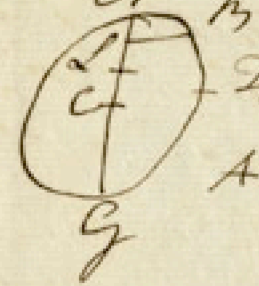
Have how [illegible] of altitudes when on the Meridian — Poles recalled Metaphorically — Can on the earth may be measured but not so in the heavens, done by comparing the angles by a [illegible] divided. But for any point 180

In applying the [illegible] of any [illegible] on the heavens we cannot refer to the earth — but to stars — by [illegible] on it. A point the [illegible] of the stars. To find the places of stars. Transit Instrument [illegible] ES SA — ES. as the time of the [illegible] or to the diff. of the [illegible] to 360: Difference of Meridians constellations [illegible] —

9 Dec
With the — the — sphere — a plane at
large plain — Celestial influence
— Horizon — North window on which
have the circles of the circumpolar
stars — To find the pole star —
by the pointers — having the pole
we get another Division — Cardinal
points — two vertical planes on the
and north at right angles — Zenith
and Nadir. other planes for azimuth
A Telescope fixed in these circles
of Altitude. Altitude of a celestial
object measured by a quadrant —
— South pole — axis — circles
greater the further from the pole
Eq.^l.r circles so called from the
position — Meridian passes through
the Zenith & poles — Stars have

— Globes — Cel. Sines G — Any
Great circles cuts every other
great circle into two equal parts —
To correct the relation of stars is
the daily business in an observatory
— Size of Comet 2 methods
which I understood by a thread
[illegible] center — To find the pole —
by Alt. of a circumpolar star —
Equator known from the position of the
Bulk of the Earth Poles — Bouguer —
found length of the pole at Rome
[illegible] which length [illegible]
[illegible] circle [illegible] the [illegible] —
Lat: Long: mode of [illegible] by the
Eclipses of the Moon or Jupiter
[illegible] by a watch —

159 If a body fall along half of Base by the uniform action of that force by which it describes the circumference it will acquire the velocity with which it revolves



$$AD : AL :: \frac{AB^2}{AG} : \frac{AD^2}{AG}$$

$$AL = \frac{AD^2}{AG}$$

$$AL = \frac{4AL^2}{AG}$$

$$AL = \frac{4AL \times AL}{AG}$$

$AG = 4AL$

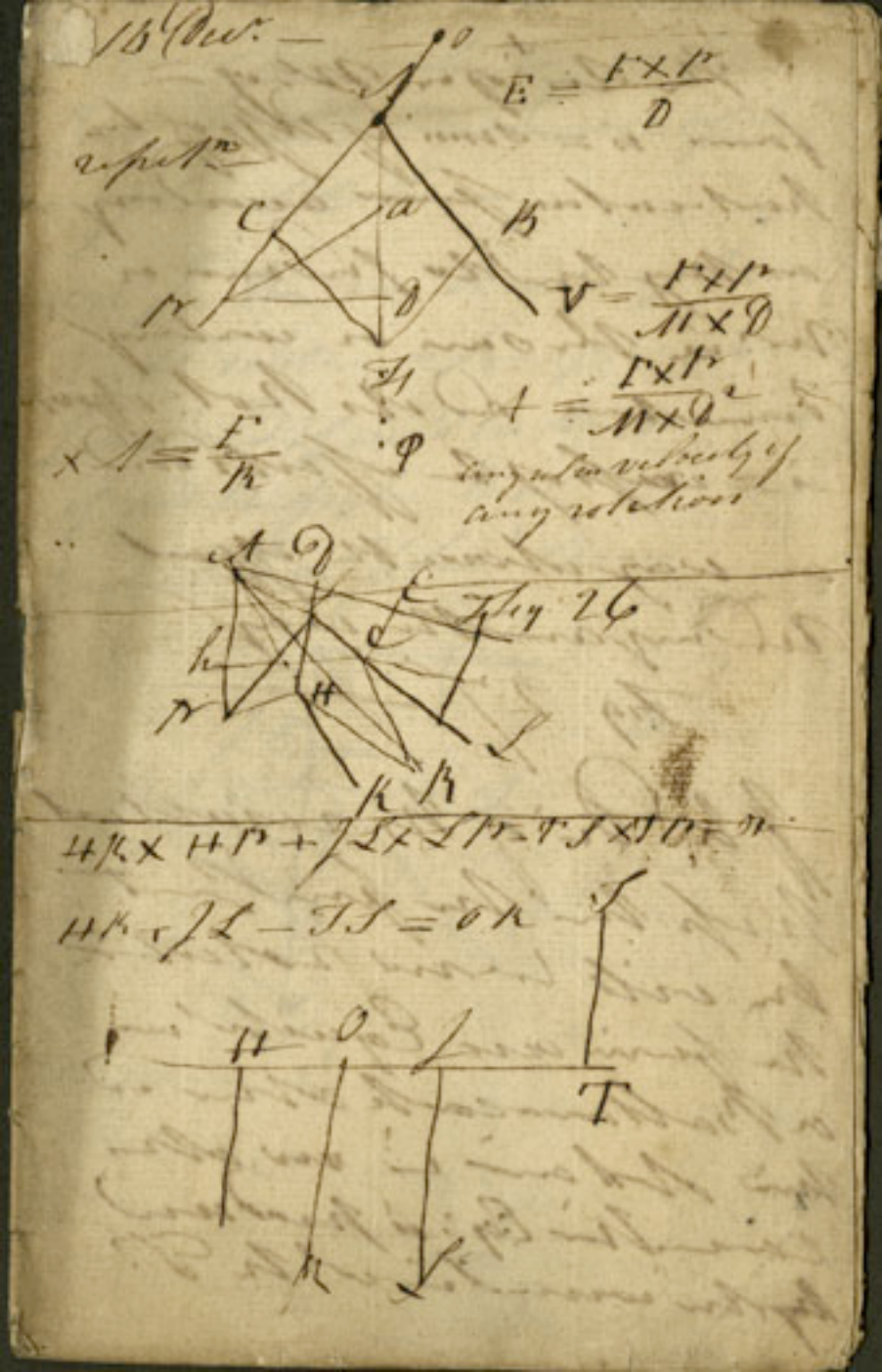
$AC = 2AL$

$AL = \frac{1}{2}$ Rad: 1

$$= \frac{4AL}{AG}$$

160. The periodic time is to the time of fall through ½ radius as the circumference of a circle is to the radius

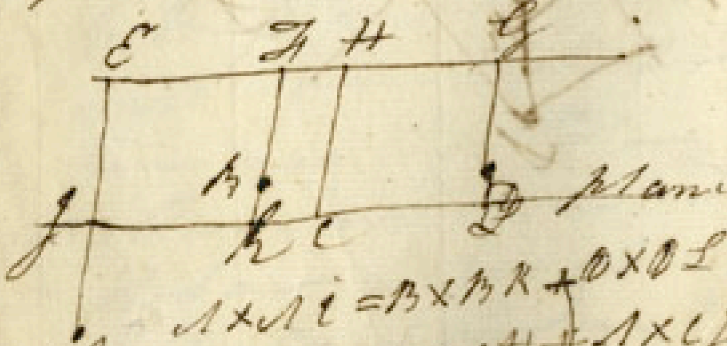
— Same figure as above —



1st being mean [illegible]
11 Constrained [illegible] 2 [illegible]

Of the M[t] of a System

19th For any system of bodies a point may be found such that if a plane be made to pass through it, and a further body [illegible] the products of the bodies to the plane the sum of all the products on one side shall be = sum of all the products on the other



$A \times Ai = B \times Bk + D \times Dl$

$A \times Ae = A \times iH + A \times ef$

$B \times Bd = B \times ch + B \times bk$

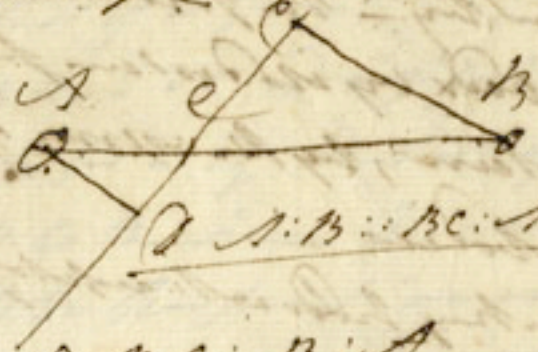
$D \times Dg = D \times cH - D \times Dl$

$= \{ A + B + C \times Ch$

147 The distance of the centre of a system from any plane may be found by ÷ the products of each body by its distance from the plane, by the sum of the bodies

with bodies which [illegible] oblique

The centre of gravity of
2 bodies A and B lies in the
straight line which joins
the centres of the bodies & so that
their distances from it are
reciprocally as the bodies



D A : B :: BC : AC

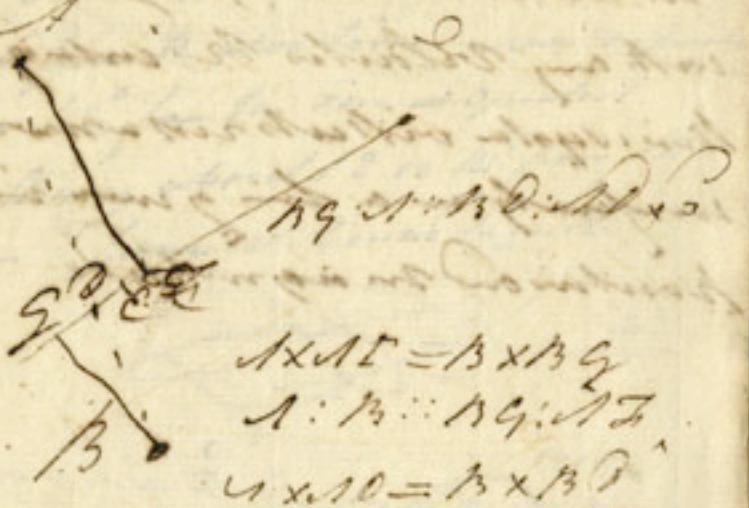
A : B :: BC : AC

AD : BE : B : A

AD × A = BE × B

The centre of gravity of 3 bodies
lies in the straight line joining
one of the bodies with the
centre of the other two, and
divided it in such a manner
that the 3d body is to the
distance of the 2 centres as

the distance of the 3d body from the
common centre

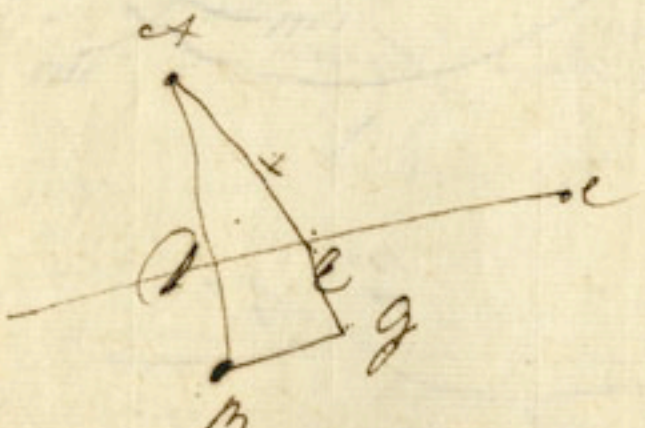


AG : AB :: AD : AC

AC × AE = AB × AG

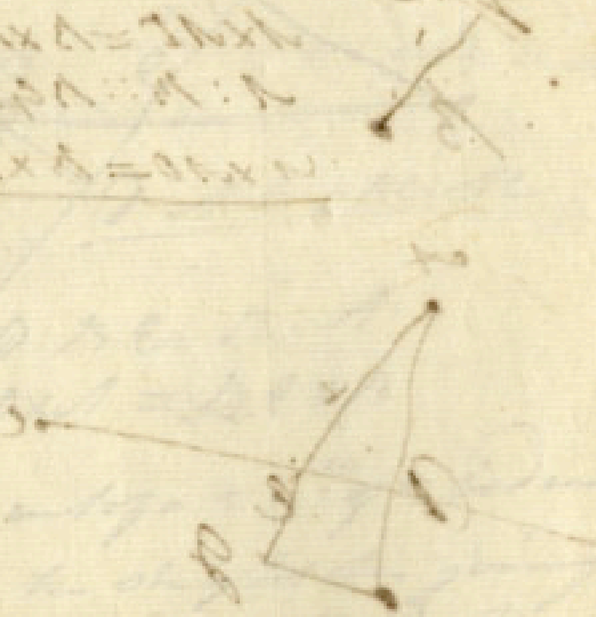
A : B :: BG : AE

A × AD = B × BG



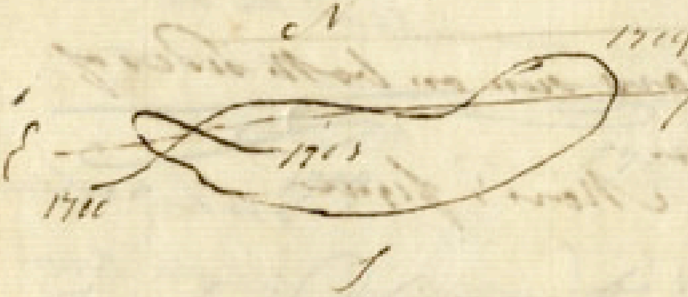
A + B : C :: CE : ED

20°. If three bodies move uniformly in any direction A, B, C and with any velocities the centre of this system either rests or moves uniformly in a line given in position and magnitude



16 Oct.

— Venus observed 3 times of the [illegible]
measured from the other time — when [illegible]
abt 45°, from the sun — greatest
brilliancy about 12 or 14° from the
sun   figure of Venus as seen



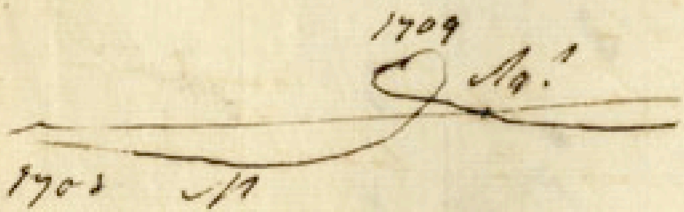
Mercury's greatest Elongation

25–26°

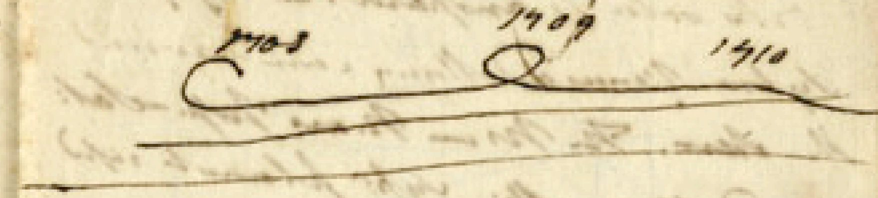
Motion of Mercury for 1 y.

Mars seen on both sides of the Sun

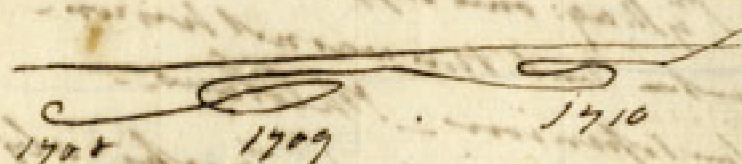
Mars's figure



Jupiter's figure



Saturn's figure



This figure determined by the Ecliptic —

Solar System. [illegible] of

these irregularities [illegible] of

sight. [illegible] the planets

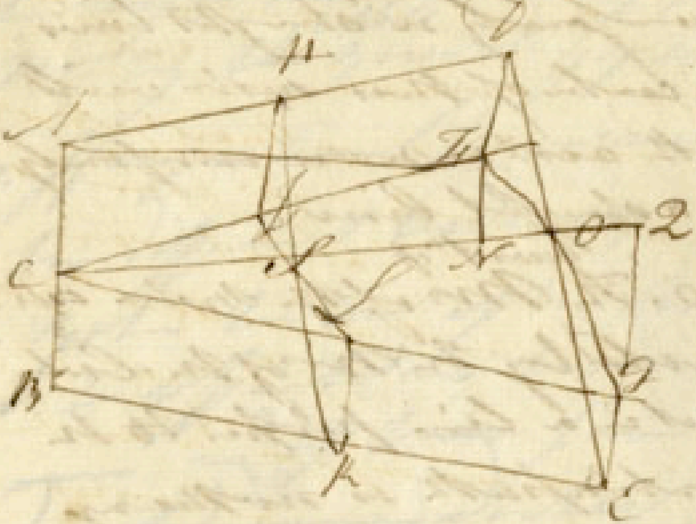
Epicycles [illegible]

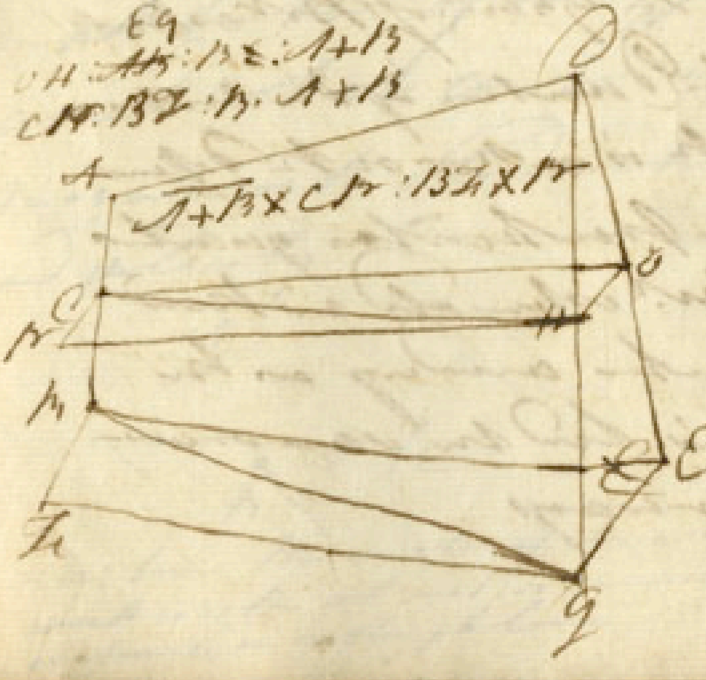
[illegible] Epicycles will not account

[illegible] for all the Phenomena [illegible]

— Ptolemy's Almagest — system
the solar transparent — Egyptian
system Venus and Mercury move round
the sun. the Moon Mars Jup. Sat.
round the earth. Supp. planets [illegible]
when the approach to the sun —
All the ancients were obliged to have
recourse to these epicycles —
Pythag: one supposed the sun the
centre but this was not his own
[illegible] opinion — Philolaus —
Copernicus — Tycho's Brahe objections
a slow drift for the [illegible]
of G.d [illegible] by a instantaneous
impulse — [illegible] of [illegible]
Stack [illegible] — Tycho's
system —
G.l [illegible] the Eg.n objections
[illegible] of G.d not so great

18th Dec.r 1775





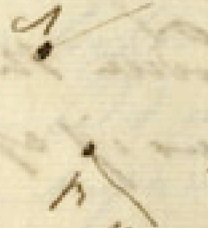
209 If any set of bodies move
uniformly in straight lines
the center of their system will
either rest or move uniformly
in a straight line.

quantity of
210. The Mo. of the system esti-
mated by the Mo. of the Center
but in a line perpend. to the
Center's path is nothing.

211. The Quan. of Mo. estimated
in the direction of the Center's
path is = sum or the differ-
ence of the products of quantities
of Mo. estimated in those
directions according as the
bodies tend the same or con-
trary ways

212 The Vel. of the C. of the System
is found by ÷ the quantity
whole
of Mo. by the quantity of matter

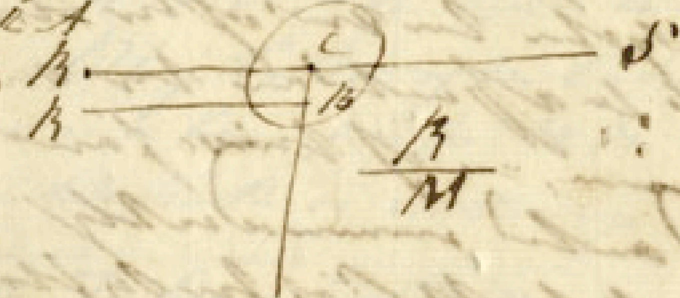
213. If any external permanent
or the different tendency
the system the Mo. of the Cent-
will be affected in the same
manner, as if being force
had acted immediately
on all the M. of the System
collected at its center and
moving with the Center's
velocity



Cor: then the center of the whole
would be either at rest or move
uniformly in a straight line

force not equal for the part, but
from the different bodies which com-
pose the system

19 Oct. —



Of constrained system

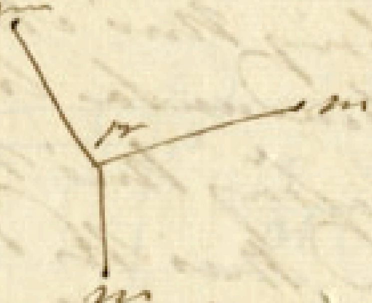
226. Any external force ap-
plied to any part of a rigid
system will produce the com.
progressive mo.n as if appl.d at
the center

226 If the result.t of the
external forces does not pass
thro' the center, the syst. will
acquire a progressive mo.n and
a mo. of rotation round an
axis passing thro' its center
perpendicular to the
plane passing thro' this
center and thro' the direct.n
of the resultant

Sect 2 of the constrained
mo. of a syst.

228 Let M be the [illegible] of
particle of M in a rigid
syst. and d its distance from
the axis of rotation then [illegible]
[illegible] is resistance to rotat[illegible]
[illegible] by this force

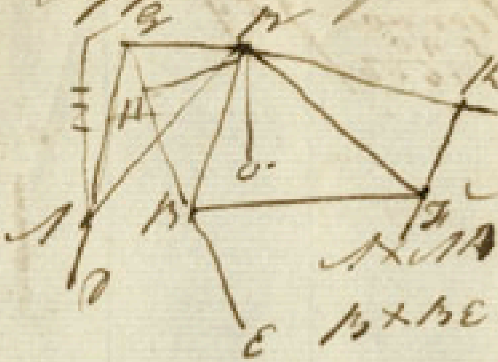
The d^t if further be the results
applied by be which equate
will be expressed by the
formula $\int md^2$



$+\dfrac{B \times P}{\int md^2}$

eq. The angular veloc.y of rotat
ion will be expressed by the
formula * where B represents
the resultant of all the forces
acting on the syst.m and P
the perpend.r dist.e of its direction from
the centre of rotation

Application of above formula



A × AD × PG

B × BE × PH

$$\frac{A \times AD \times PG \pm B \times BE \times PH - \&c\; P \times Pk}{A \times AP^2 + B \times BP^2 + C \times CP^2}$$

$+\dfrac{B \times P}{\int md^2}$

23. The Vel: of any point
for instance of the centre O
will be expressed by the
formula ×