9th April — 1776

— Of Magnetism —

All the former lectures on experimental Philosophy have been conducted by mathematical demonstration, but we are now come to a set of phenomena where this method fails. Magnetism — Electricity &c. we must enumerate all the phenomena & then set down the general laws of this method of proceeding —

Magnetism a term expressive of a class of properties or qualities of Iron ore — primitively repulsive each other & attracting iron. 2. Affecting a position respecting the axis of the earth. —

A piece of iron brought near a load stone will be attracted by it. If it is suspended on a pin passing thro

lies nearly N & S. Declin. 22° W
v 70 with the Horizon — this property
seems attributed to the loadstone; it
is a property of all Iron — A long
wire thrust thro' a cork & floated
on water, if a piece of Iron is long
rubbed it after will lie N & S
with it. This does not in the fields
where there is no wind — Effect
of Nat. Magt. suspended by a
Cotton —

Dissolve a piece of common Iron
& a magnet — A piece of common
Iron will turn itself end to the
north which is meant — but
a magnet always turns the same
the north — N ends to S. and
S. to N. — on this account called
N & S ends — Dr Gilbert calls the

the N & S poles on account of this
marking one of opposite Magnet.
General Phenomena — — —
I Dissimilar poles attract each
other
II. Similar poles repel each other
While I have been long endeavouring
to find the law of the magnetic
attraction — Same Thing as Dr Hutton
Q3 — Members of Society to
know — From what Form I must
in compute the Distance or where
is the centre of attraction — This
has given rise to Disagreement
among the Members of Soc.
Effect has Needle near each other
acted on by 4 Forces — attraction
& repulsion — how to possibly
of determining the law of attraction

There is another circumstance which seems to be left out of our Rules always & that is that the attraction is different over a considerable yd of Water —

Exp: Take bar with two steel spheres — gain the N.S. 1/2

S.P.W. says the Att cannot be 1/2 for in that case the attraction would differ but little at small distances but we shall find a very different conclusion.

10th April 1776 —

Certain distance the attraction for a magnet is considerable expansion — this distance varied by performing the experiment — Repulsion at a considerable distance decreases 1/2 —

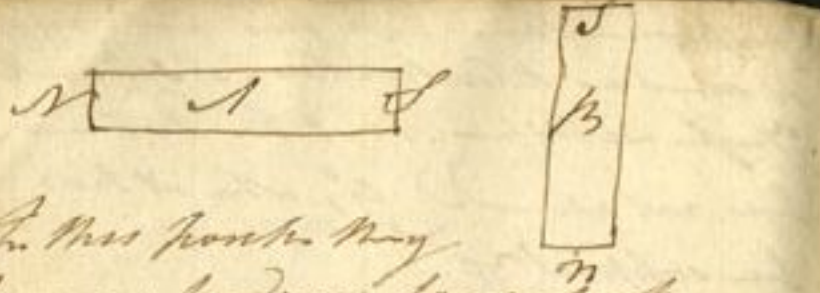
Affinity by Magnet to a particular with regard to the axis of the earth — Needle to N 3 century — Needle to N pole use full purpose — Variation — Magnetic compass — Variation called by foreigners declination — Observed by Dan Sebastian Cabot — Variety is being a remedy for purpose — 1st Logic is an aid for reason & 2d to find the Long

But the variable changes first observed by M. Gellibrand —
Mountaineers Rodsons chart —
— A Party consisting of 60 gentlemen met in the evening — Thermometer has in Sweden sometimes produced a change of 60 Degrees
Dip or inclination of the Needle
Could possibly account for 9′
of the Dip — for the Compass
the needle should balance steady
in every position this can hardly
be done by mechanical means for
some very slight variation — Now the
present amount is 74 1/4° — This Dip
Different in different parts of the
earth, but in general at the
Equator it stands horizontal
At the poles it stands a minimum

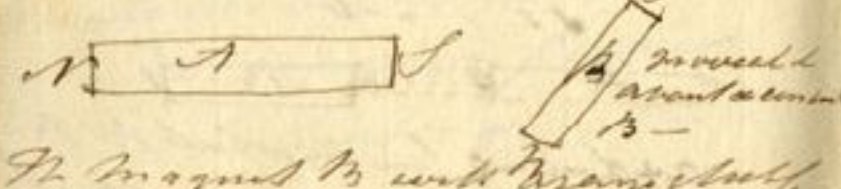
perpendicular. Dip has not varied
so much as Declination — Sufficient
Data will then first be obtained
but not exceed 9′, when it has
been supposed 30′ —

Suppose $n = a$
$d, b, c = -b$

$a+d-b-c$ seem by which the Ma-
by attraction — If Spirit
Magnets will tend to each by a seem
which with a seem last will cause
the Needle to bend being subtend
for the first & last — The same
with the repulsions — long may
the magnet the attraction of the
other is increasing this in the
N. hemisphere of the earth —



In these positions they have no tendency to each other —



If magnet B with a weight about its centre be placed in such a position as to lie in a straight line with the

$$a + b - c - d$$

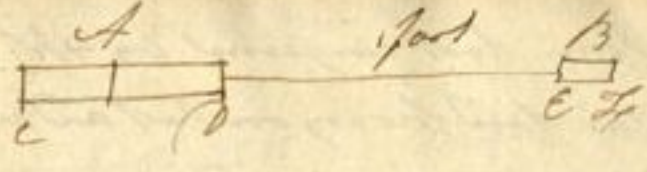
Number of Experiment

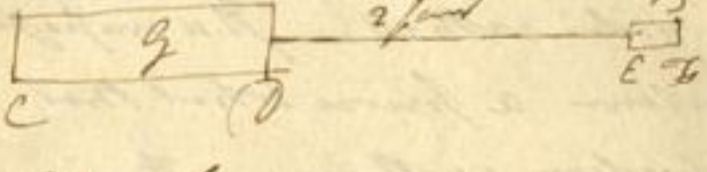
I. Strength of the Magnet

II. Distance

III. Length of Magnet —

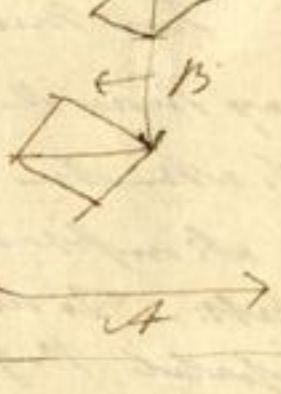
In the Construction of the Magnet the attractive power is increased as B is diminished —





$DE = A$
$EF = b$
$DC = a$

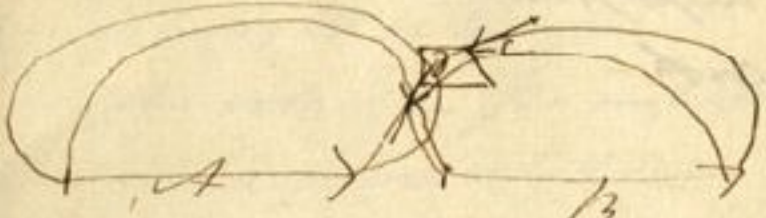
Power of A to B $= 2ab + b^2 : 2AB + b^2$



The Mean last confirmed by Mr. — I was told how to obtain a needle brought in different situations with it — It is impossible to determine a priori what the situation will be — This an effect of the Energy of the Magnet — Portions — Virtue does not exist in one point — From this experiment we may deduce the law of the magnetist attraction — in this way B B. attempt to find the law of attr. — To ascertain as much as possible the q.y of a magnet at each end they are rubbed two globes of Glass q.y round each a metallic — One the very end to attach two particles

a metal a wire flowing in the form of a cork — but this is impossible — Needle Mr. a cork —

12 April 1826



If the magnet is placed between the two A, B it will arrange itself in a straight line between them. This is a position suitable when the particles have no tendency to either, but will happen at the point where the curves touch each other but do not cut each other. All these qualities are temporary they continually decrease - the harder the Copper is from which they are taken very little

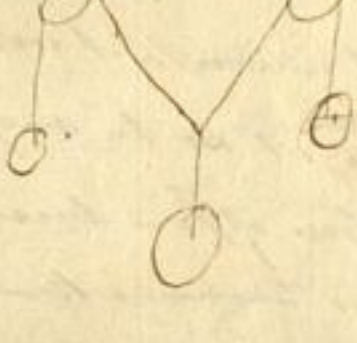
A powder emty to Mr Faraday's nature fashes Magnet, heat or heating is antagonistic to Magn: Position, they must not be held in that point - A bar of Iron that has stood long in an upright position acquires a considerable degree of Magnetism, that upper end is the South, &c. It was conjecture of Dr Gilbert that Natural Magnets might have their Virtue in this manner - A bar of Steel struck a long while with Iron a Magnet - A bar of Steel heated - dipped in the Magn: Direction to cool in the Mag: Direction - heated and cold in water -

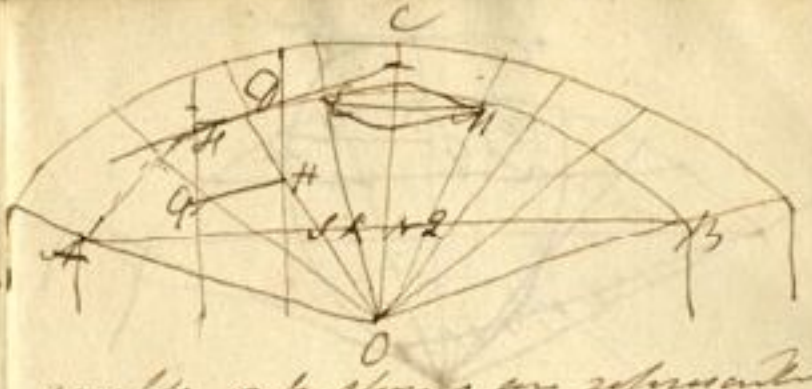
6. A bar brought in the neighborhood of the magnet will support a piece of iron in any position except when it is very near the pole of the magnet. When removed to a great distance it crosses the entire. This power may again in the neighborhood of the magnet is temporary. In case of soft iron or steel the magnetism is changed, but decays soon. If hard steel it again it more slowly and longer. Left but returns at longer. The most striking fact is that the bar assumes nearly in the same position of this great magnet

from consequence of the proposition that the iron is attracted by the magnet because it is itself known a magnet. In the polarized proportion the same effect. Both forces are not united but the poles are changed at very opposite ends. Now the attraction is mutual consequently of the becoming magnetic but we cannot say vice versa. In any position the bar will always become the north pole. A bar brought in contact with the needle turns it as the magnetic needle turns it. Now a piece of iron becomes a magnet and then becomes attracted

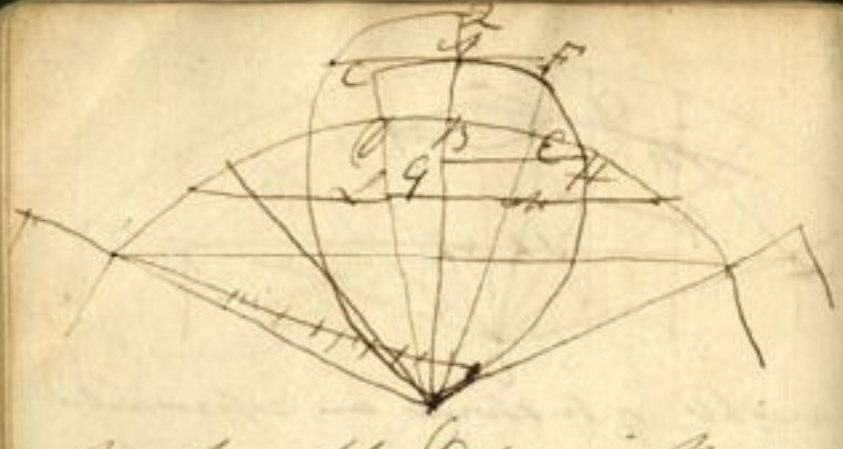
Saturday – 13 April 1776

If the Points A & B are perfectly smooth the Beam will not rest & it comes to such a situation as the two perpendiculars must cut the vertical line passing thro' the centre of Gravity the Beam

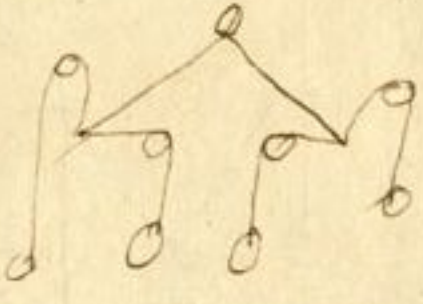


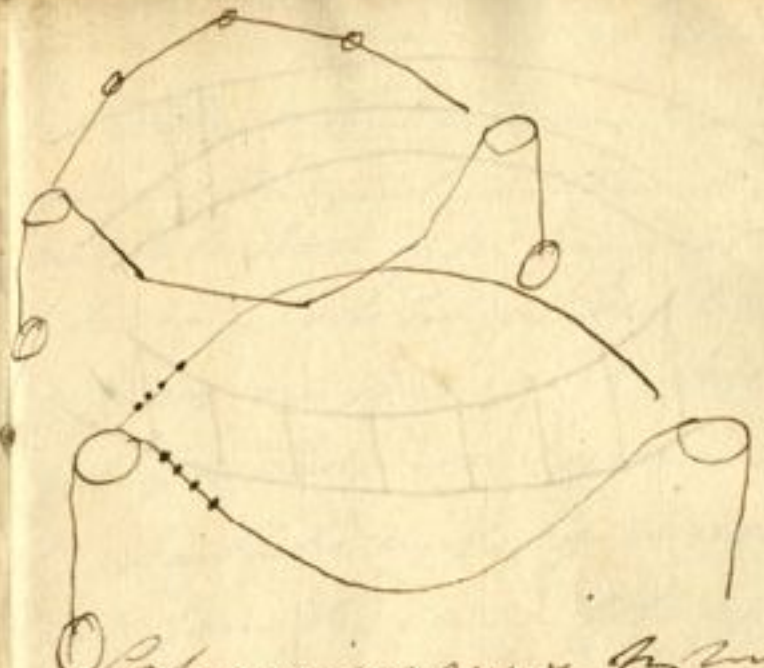


weights of the Beams are represented by the horizontal Scale of the Line A B – the Pressures by the Lines O 1, O 2, &c —

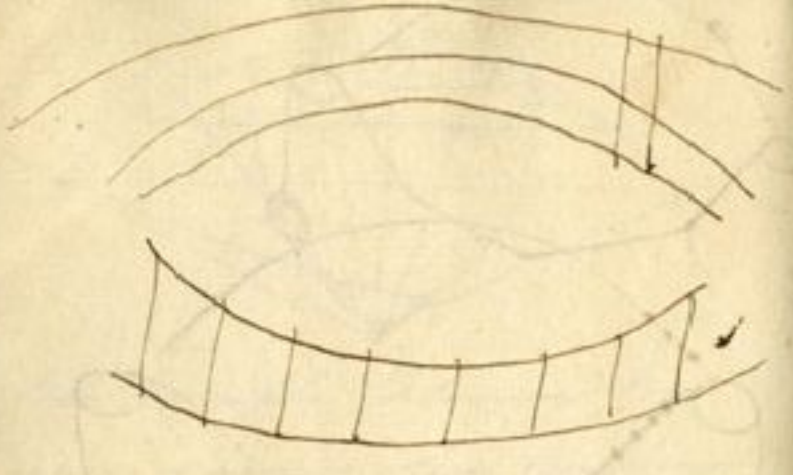


Two triangles Catenaria Triangles of arches which they have nothing to support but their own weights - but they is obliged to be in equilibrium —





Catenarian curve the least triangle that it has nothing to support but its own weight but an any Part with edges of the Arches



42

15th April 1776

Mr. Hutchins magnetic compass
on the magnet with the compass
and the needle of the magnet
when on a table made two
observations — I shall
fully on Thursday next
the Gentlemen invited to dine
with him at the usual time of
Mid Dispersion he is to bring
as a needle moved among the
Magnet for my Part I do believe
become a needle — Mr. Hutchins
of Magn: attraction may be
shown to decrease in the inverse
proportion of the square of the Dist
when two magnets are placed
near each other My pen is not

of arrows in the manner

the arrow way

If the Magnet is with his Oxford
notes to each other — or what
is better connect the same poles
with pieces of the soft Iron. —
A number of bars may be arranged
in a circle —

To make artificial Magnets

1. It is not otherwise material of
in what part of the Magnet it is to touch
a Magnet. —

2 A circular piece of steel or Iron
touched in the centre, that
centre becomes one ~~becomes~~
pole & the circumference the
other. — the corners a bar — both
ends become one pole & the middle
point touched the opposite.
best way of touching a long
needle is to lay it between two

magnets. - By Sinclair - rub
the bar one way - if backwards
it will reverse it - any number
of strokes will make it no
stronger than one -

Better way is to join two
bars with piece of soft Iron
which have magnets with
their dissimilar poles a little
asunder then rubbed perpen-
dicularly along the bars -
must be rubbed for the second bar
in the rubbing both ways al-
ways accumulates the magnetism

Antoine's method is to rub
the two magnets on each side
towards the bar. - This method
is to be done at 10. to 12 or 14 -
i.e. 10 strokes of Antoine counting
pounds as 12 or 15 of Canton

In Canton's method Knife Edge
the bar will carry a greater
weight. - Bar is then a magnet
weight - The bars attract each
other with strength from each other.

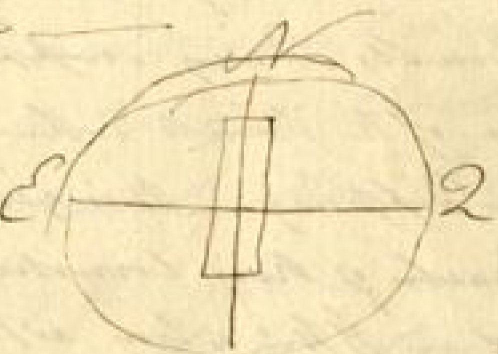
Suspend a magnet so that in the
Magnetic direction it takes its
Magnetism longest it follows that
in the opposite direction it loses
it soonest. To know the poles
of a Magnet present them to
a Magnetic needle for the
like poles will repel the
unlike attract each other. —
Mr Canton rubbed Magnets
with a Poker and long steel
bar long stood in a perpen-
dicular direction — Antoine
placed the bars between two
large bars of Iron in the magnetic
meridian

and rubbed them with ~~other~~ two bars held oblique beginning at the middle

after a few are made they may be taken for each other & thus the strength of all increases.

16 April 1790

Earth a great M[agnet] having its pole near the center of the Equator one of the ... pole near Baffin Bay. & the other in the opposite point ——



At the Eq. the Needle is parall to the horizon — at the north side of Baffins Bay it will be nearly perpendicular — not exactly at the Equator the line of no dip perhaps near the middle of South America

If you take yr knife & touch the
N. Point it a small magnet
— Phenomena as such as would
result for an irregular magnet
with two weak & two strong
poles. The center of which on
the needle must be a problem of
great difficulty & very complex.
— Latitude of the points when
the is no dipping — This gives
us the Equator of this constructed
magnet — If this is true a needle
of steel or cork would tend to the
north side of the Lason. The Equat
would be known. This would be
quite unnecessary for a detail
of yours — I think the mode
pointed to the north the other
laid down with about one pole

if it is meant it will attract
to the poles — The position of
magnetic is agreeable to this Rot.
Magn: — heating — hammering a
Iron in the Magn. Meridian or in
the neighborhood — South pole
of the great magnet is near to
the N. Pole of the world —
Then it must follow that the
N. Pt of the needle in northern
Lat: should Dip — Position of
the Rot. magnet in N. point
is in the magn. Meridian —
Dividing the needle carefully
mounted for the supposed
but the change of this direction
— Some think the great magnet

revolves —

Finish the remainder with Magnet found near one pole of the Magnet. This must be at least 1500 miles below the surface of the earth. — All needles change — Earthquakes & eruptions change the Direction of the needle — Accurate change with position of the Poles & Equator should have with Parallels each other. — Equator & meridians

17th April 1776 —

All Iron Steel & Iron ores do contain two general poles. Not Perpendicular poles as hard, as Iron Steel poles respect each other — If not a bar of Iron long to be magnetized & a Magnet become a Magnet — but how can they be made — Rules to find the centre of Magnetism — Iron Steel or Loadstone can not well be cut in two pieces — like a pipe — Steel — Magnet iron only parts by Magnetism & the Iron in Proportion

Y. Friendly — Experiments on Iron already Cavendish has regard to Electricity —

Iron — found with them properties

I. Its particles each obey $\frac{1}{D^2}$

II. Attract Iron $\frac{1}{D^2}$

III. Powers of Repulsion Iron Iron.

and with still greater Repulsion on the pores of hard steel

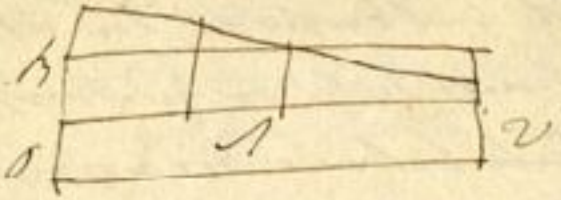
All the phenomena of Magnetism may be explained on the supposition that a globe or cylinder of magnet with two properties

I. Its particles repel each other in the inverse square of the distance

II. Its particles attract the particles of Iron —

III. It moves with great Friendly to the pores of Iron and more powerfully to the pores of hard steel.

III. That the particles of Iron repel each other with a force $\frac{1}{D^2}$.



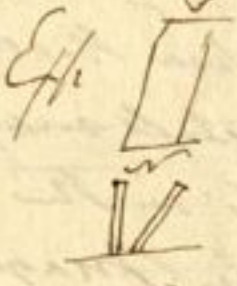
Action of F on $l = a$
F on $f = -b$.
f_g or $f = c$
f_g on $i = -d$
$a + c - b = + c$

$+a - b - c + d$
$a + d - b - c$

Effects being suspended of an
iron pith ball Brass &c the other
two pieces supported perpendicularly below a magnet
which each other — two bars
suspended a pith on the
approach of the Magnet
separate. Other effects of same kind
same kind — Magnet repulsion
and in any case be stronger
than attraction at the same
distance — Repulsion
arrange steely in all the
different positions — Effects
of the Magnetic fluid on
iron would be more
powerful

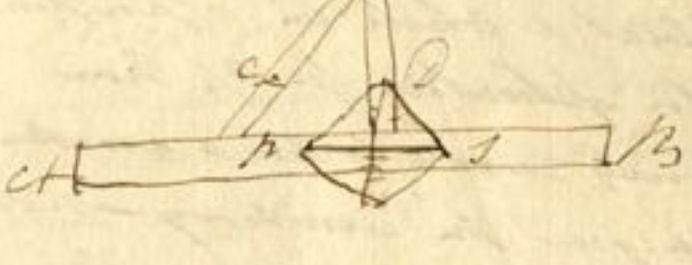
— strength with a small Magnet
in these cases — Effects of heat
that must act upon Magnetism
strength &c. Upon Faster in short
all the phenomena are satisfactorily
accounted for from the hypothesis

Philosophers have in vain attempted to find the cause of gravitation



Attraction as much the
Attraction and Repulsion
common fluid Attraction of
in no respect as opposed to
Magnetism but to be regarded
to the Assembly of Magnetic

the Poles — experiments alter
one Pole should be made
to a Northern at the
same Distance — Speculation of
the magnetic fluid in it's Detention
state would be reduced to
a cone — A particle of Iron
would do the same, but this
is impossible to be effected
— Short passage about Needle
— A bar of hard steel may
have several poles in the
same manner as the Magnet
— Process of magnetic motion
Ohm? — A weak Magnet
may communicate more Mag:
than a stronger one —
A strong Magnet may communi:
no more Mag: than a weak
one — A weak bar Magnet
will destroy a Magnet with
which it is magnetical-
ly in contact with a strong one — it
renders it stronger — If
Coulomb's method of determining



weak comm: Pole

$\frac{C f P}{C f - P}$

All the Phenomena of Natl Magnetism — Each need more — A Magnet had red hot & allowed to cool Destroys the magnetism — If a magnet is ground, or rubbed on file its magnetism is increased — If a steel bar was magnetized & while in a perpendicular position struck very hard it would not only lose its magnetism but acquire the contrary — not so when coupled even with a weak magnet — like a a weak magnet shot or card — Bar was rubbed & consequently a quarter degree of Variation from my observatory

As in the description of a letter is presumed that the words when combined together make sense —

~~Effect of Imagination~~

Upon the whole all the Phenomena both of Attraction & repulsion of electricity & Magnetism are satisfactorily accounted for on the principle of the Atmosphere which is compressed into more or less density as it is heated or cooled — Also the Phenomena of Evaporation & Precipitation of Rain &c &c appear to be satisfactorily accounted for on the same principle. & it is also presumed that as a principle which accounts for the Phenomena of Nature & Art is however still a conjecture but it can be applied

Queries

I. What is the best way of giving Magnetism by a Horse shoe Magnet?

II. The above Magnet, should it be placed in the Magnetic direction? if so must the poles be upwards? —

III.

22 April 1776

Electricity

Electricity denotes the first matter when it was above body or said to be acted upon by friction — a subtle rarified aetherial Duplex Light bodies — this may be called a property of all bodies — but this term only is confin'd modification — Electric bodies denominate Electrics — Non-Electrics denominate Conductors or bodies capable of receiving Electric fluids in them —

General Law — Any body so brought into the neighbourhood of an Electrified body becomes Electrified — A conductor on a Glass stand — Cork Ball — in this position Most Electrics

are bodies easily excited by friction and the Electric matter enters & issues by. The most perfect Electrics are the most perfect conductors — Dr Watson — goes into a Metallic circuit two longer than a short which is a worse conductor — Effluvia & Imbibed by conductors are not emanated by electrics — Any body communicating with the ground should not be insulated — Glass the best conductor of electricity for machine — Light bodies brought near to, fly to and by it near to fly from it is not the best way to conduct — Points dispose

on an Insulator — plate must be perfectly dry — Support of Conductor must be perfectly dry — it is said to be insulated — It cannot be perfectly insulated — In an ordinary manner no Electricity can be collected, it will part into the vacuum in the next conductor — Air a conductor — sometimes becomes a good conductor —

1. An Elec. body attracts other El. Bodies elec. in the same way as conductors.

Two small balls suspended as the appearing by Electrified tubes — A ball a particle can be first charged with a quantity of Elec. it will attract a particle of the same quantity of Elec. it will repel — a pricking sensation — noise — smell — Sparks — if a succession of sparks on the delicate glass tube will be heated — Electricity cannot be collected into a small ring, black spot — Line will perpetuate it velocity upon a wire put into it is upon a wire put into it is collected — Elec. by Electrical Machine is material — Mechanical properties — Heavy in its nature of an E. become elastic &c. Air will be followed — may be reduced — It will not be conducted — It is of a different nature

the same as the end of the consideration
Every body may be in 3 Poss:
States with regard to each other
It may possess its natural
share, more or less than its
Nat: Share — Post: Neg: Elect:
Analogy between Electricity
& Magnetism — Pos: Poles
Pos: Elect — Magn: and
the Poles by to attract
each by to repel — The
earth consid: as one
Electr: attracts at long a
distance — consideration of others
Magnetism by Revolving cage
Electricity by

similar Poles repel &c — the
sun is electric. Elect must be
in some Assembly or element
&c — a small bit of steel made
into the Telegraph — time elect:
at — Lapse &c

23 April

Sir, in a new con: it is also an
Instrie — In a Day or two we can
may be sensibly electrified.
Should a repetition of Electricity
continues it is necessary to
be warned of the approach of
Electricity — Bells — &c: &c:
in the same way. repeal each other
— A body brought near one a con:
has both the ends electrified,
but of different Power. Bodies
not of different Power.
made with little balls on
them. The above made with
iron wire the electricity
is not lost by passing over
a little of sealing wax rather
in a considerable time. and of no

of opposite kind — Upon touching
the Con: the end of the wire made
which formerly attracted, will
now repell — The electric fluid
becomes a conductor. & Bodies
charged

Electric fluid — Matter
Part of the con: bodies repel
Dissimilar } Do

Three sheets more with Jarrets
in the form of conducting bodies
with great Dexterity in
removing bodies
over charged — inductance
1st Cloth the Electric fluid
cannot leave it charged

Cor 1. Let two bodies A & B be brought near each other will attract —

II. Let be or be connected with the ground. A will be more strongly —

III. If two bodies, as ours, be otherwise changed with all each other shall more strongly

IV. The bodies equally endued as ours charged with opposite each other —

5. Bodies unequally charged may attract & repel each (Sentence

II Cor. The phenomena which take place when the two masses of the electric matter —

The sphere is overcharged in consequence of which retained on the outside surface — on the outside surface of brass an undercharge being on the outside capable containing all in the inside being with remain at rest —

The two spheres A & B in opposite Powers discharge by a fluid which be subsequently undergoing change — the reduction: in A will be to be accomplished

but: i B as the Circ^{e} of AB
to CD.

$$\frac{cd}{Ac} = \frac{cD}{cD} = \frac{1}{cD} \quad \&$$

h, AB : CD :: 1 : 1

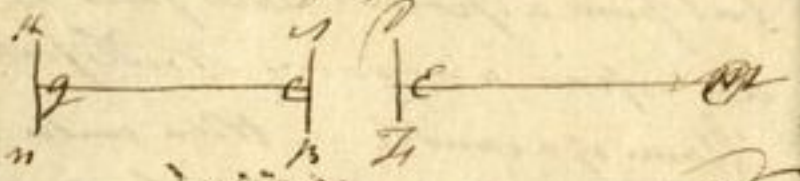
7th April 1776

Attraction ensues partly but
by not repulsion. Hence
Repulsion when the Conductors
made in two spheres exist on
a parabolic plane on their
surface will be as their
Diameters — when reduced to a
point the system will be
instantly quiet — whether
rem, or undischarged. —
Experiment — Pith balls will
not rise so high if a needle

is fixed to the conductor
Explosion the air is repelled
but cannot remove or account of
the pressure of the atmosphere
but from a point with force the
air rushes in a stream. Needle flame
flame of a candle — When conductor
charged the stream will take its
from the point — Wind put
from round — when once conductor
charged — the in from the point
when it is entirely is going
out — The point held on the
opposite side of the candle from
the conductor — A person was
thrown into electricity with great
care — sparks — spun from
the body into which it

prove the fact that it is always
pos a point whether connected
with the conductor or not.

Charging of plates



suppose the plate A to be charged
whatever be the distribution
of the fluid at the points A H

n : 1 :: cc : com

$\frac{1}{n} = \frac{q}{r}$ $\quad 1 - n : 1$

$1 h = R$

$O H = n$

$R - h \times \frac{1-n}{n} = R \times 2n \times n^2$

$R = \frac{}{2n - n^2}$

AB 6 in 4 CB $\frac{1}{6}$ 60 times

the fluid in AB more in H

Effi — A coated plate on both sides
with communicating with the
ground — Then one side with the table
— two balls vibrating between the
plate slowly — The appearance as
the same with a jar — quantity
redundant
of matter on the coated something less
25 Aug
than the
plate with charged to Distance
for the machine —

Two pieces of the pith ring each hang
on each side rise and fall alternately
as either side is touched —
A plate with a square piece of
coating not communicating with
each other, & two com: with earth
the 4th — Method of Quadrangle —

The whole redundant matter is
found along the metallic communication
— Jar charged both in and the
outside — with charge another —
— Redundant fluid is mostly
supposed all lodged in the surface
of the glass, and not in conducting
surfaces. — Jar filled with pewter filings
with water — then filled with the filings
first is coating — sometimes the
inside is a vacuum which is
a perfect conductor — Quantity
of accumulated fluid is: surface
dimensions of the glass — Battery
— Electrometer is best placed
near the machine — Thereby
please it on the battery this
because gives it a tendency to throw
out the electricity into the air —
— Insulated rubber — best conductors.
— Jar charged at the same time, from neg.
& the other positively — best way
is to connect the outside with the
rubber — This give rise to Pos. &
theory of Neg. and positively El.
Cavendish. 61 Ord. Phil. Trans.

26 April 1776

Phenomena

1 Excitation 11. conducting —

The most common method of excitation is by friction — the cause unknown — It some bodies with but different substances with different conditions — caste often or glass produce negative — the hard powder —

All bodies in the above catalogue may be excited by melting them two together — the former in the catalogue become + the latter — some bodies become excited by heating — Tourmalin — when heated become electric — the one end positive — the other negative — Some Animals have a power to excite electricity by some unknown