Outlines

of

Natural Philosophy

containing

Electricity. — Galvanism
Magnetism. Mechanics, Pneumatics,
Hydrostatics & Optics.

Picton, N.S.
1836.

1 Electricity

1 In nature there is a substance which has been termed the Electric Fluid; and electrical Science states its various phenomena and the laws by which these are regulated.

The term electricity is derived from the Greek Elektron - Amber which was discovered by Thales to possess the power of attracting light substances, when rubbed. Theophrastus afterwards discovered the same power in the precious stone Tourmaline; but it was not till the 17th Century that Electricity was studied as a science. At that period many discoveries in electricity were made by Dr Gilbert

2, Of this Electric fluid every other body is supposed to posses a certain quantity which is denominated its natural sheare. and when bodies are in this state the fluid is said to be in equilibrio and produces no apparent effects.

The substance which is the cause of Electrical phenomena has obtained the name of a fluid from the peculiarity of maintaining its equilibrium

3. The fluid may be transferred from one body to another and both are then said to be electrified.

4. A body possessing more than its natural share is said to be electrified positively, and one possessing less negatively

5. The equilibrium of the fluid may be destroyed by friction

It is also disturbed by chemical action but in electrical experiments friction is generally employed. Temperature Ex Sulphur, Evaporation Body evaporating positively, reduced negatively Fracture - ex Sealing wax

6 When the equilibrium is disturbed by friction the fluid becomes apparent, and shows itself to be a very powerful agent

Electricity may be seen, felt, it has a smell like that of phosphorus & in the galvanic procefs it may be tasted. It is also supposed to be the cause of chemical attraction & repulsion

7. Some bodies transmit the fluid, and hence are termed Conductors or Non-Electrics; but others resist its passage and on this account are denominated Non-Conductors or Electrics.

Electric bodies are electrified by rubbing and on whatever part of their surface the fluid is deposited it remains without affecting the rest of the body, but Non-Electrics allow it a free passage to any distance

8. The Conducting and Non-Conducting powers are influenced by the state of bodies.

Ex. Water in the solid state is a non-conductor in the fluid state an imperfect conductor & in vapours a good conductor

Glass when hot is a conductor, oil when cold is a non-conductor. when hot a conductor

10. The equilibrium of the fluid is best disturbed by the friction of a conducting and non-conducting substance.

When two conducting substances are rubbed the equilibrium is restored as soon as disturbed & when two electrics are rubbed the one can only take from the other that electricity which is contained in its rubbed surface

11 When a conducting substance is separated from other objects by a Non. conductor it is said to be insulated.

12. When two bodies are electrified, the one positively and the other negatively, they are said to be in different states and attract each other.

13. When electrified bodies in different states are brought near each other. or are brought into contact by a conducting substance, the equilibrium of the fluid is restored

14. The fluid passes from one body to another with a rapidity which is almost instantaneous

Experiments have been made with conductors of great length and the fluid occupied no perceptible time in passing from one extremity to another

15. An electric presented to an electrified body indicates on the presented side a contrary state and on the opposite side the same state as the electrified body.

16. The fluid communicated to an electric remains where it is deposited.

17. In order to electrify a non-conducting substance it must be covered with one which will conduct the fluid

Upon this principle jars intended to be charged are coated with tin foil

18. When the two sides of a charged electric are connected by a conducter the equilibrium is restored.

This is the result of the theorem in Note 15

19. A number of electries connected by conductors may be charged or discharged at once.

Upon this principle the electric battery is constructed ~~the~~ both sides of the jars being mutually connected

20. The discharge of an electriped body is regulated by the size and figure of the conducting substance by which the charge is withdrawn.

The suddeness of the passage of the fluid & consequently its force are greatest in large conductors very small ones conduct it slowly & imperceptibly

21. The fluid enters the point in the form of a star and issues from it as a pencil of rays

Magnetism.

Magnetic attraction, in connection with the various properties of the magnets, may be next considered.

Magnets are either natural or artificial the former are ores of iron the latter are made of hard steel which retains magnetic longer than iron.

1 The magnet attracts ferruginous bodies

Not so many natural compounds of iron magnet toward them as soft iron, attracts Nickel & sometimes Hammered Cobalt

2 The magnet possesses Polarity

one end of it constantly points north, the other south

some magnets have more than two poles, others

the same at both ends these are defective.

it does not point directly north and south

but has an inclination to the East or west

this is called the variation of the compass

and differs in different parts of the earth.

there is also a diurnal variation of it.

3 Magnets mutually attract

and repel.

Similar poles ~~attract~~ repel, contrary poles ~~repel~~ attract

4 The magnet inclines to the horizon

To account for this it has been supposed that the earth is a magnet. If its power were uniform, the dip of the needle would be a guide to the longitude of any part of the earth but the inclination is not uniform

5th It imparts its properties

The magnet cannot impart more strength than it possesses. The usual way of magnetizing is by rubbing the poles of the bar to be magnetized with 2 4 or 6 magnets successively. bars may be magnetized by percussion, standing for a long time in an upright position, or by electricity.

Mechanics

1. Innumerable phenomena in the material world are the result of motion; and therefore in order to proficiency in the study of Nature, the laws of motion must be well understood

2. The motion of a body is always the effect of an active power. This may be applied either by impulse or by an accelerated force.

A force acting by impulse acts instantaneously & then ceases an accelerated force continues to act throughout the whole progress of the moving body.

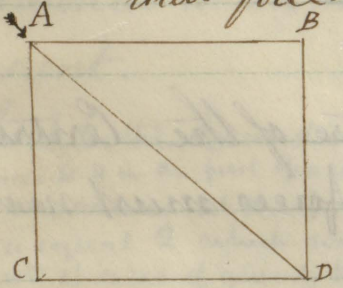
3. Motion may be the result of different forces, applied at the same time, and these may be either simple or accelerated ~~for~~ or partly both

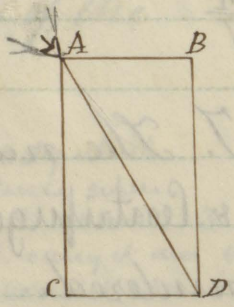
4. The medium in which motion is performed as resisting or non-resisting deserves attention.

5. In a non-resisting medium the operation of the following laws is uniform.

1. Motion which is ~~performed~~ the effect of one force is always rectilineal.

2. Every deviation from rectilinear motion is proportional to the force by which it is produced; and always in the straight line of that force.





AB = one force AC another acting upon the body A, A will move in the line of neither ~~side~~ force but in AD the diagonal of a ~~figure~~ parallelogram of which AB & AC are two sides

3. Action & re-action are equal and opposed to each other

6. With respect to simple motion it is necessary to consider the Velocity, the Space, the Time, the Momentum and the Quantity of Matter. These may be expressed in the following manner.

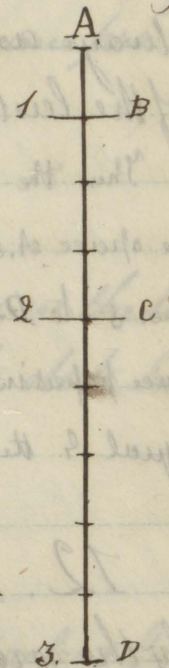
$V = \frac{S}{T}$. $S = V \times T$. $T = \frac{S}{V}$. $M = V \times Q$

$Q = \frac{M}{V}$

7. The nature of the Centripetal & Centrifugal forces must next be considered.

8. Of these an illustration may be derived from the gravitating power of matter.

9. The motion of a body descending by the force of gravity is equably accelerated.



10. The velocity is proportional to the times of the descent.

Let A be the descending body which moves to B in the first space of time when it has arrived at this point its velocity is equal 2 which would carry it over the two next spaces if gravity then ceased to act but it receives the same increase of power in the second period as the first it is therefore moved over the three spaces to C in the next period & its force is then equal 4.

11. The whole spaces percurred are always as the squeare of the times or of the last acquired velocity

Thus the body A. in the first space of time passes on one space A.B. in the second over 3 to C & in the 3d over 5 to D. and the square of 2 is equal to the whole space passed in the two first periods & the square of 3 is equal to the space passed in 3 periods

12. The velocity and Consequently the momentum are as the square root of the spaces.

The body A percurs 4 spaces in 2 and 9 in three periods and 2 is the square root of 4 & 3 of 9.

13. The velocity ~~and~~ of ascending bodies diminishes in the same proportion.

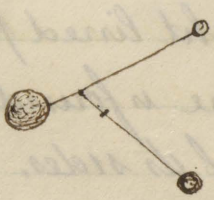
14. As all bodies move in the line of direction, it is necessary to state how there centres are found.

15. In Squares, Cubes Circles & Spheres the centres of the figure is the centre of gravity or position

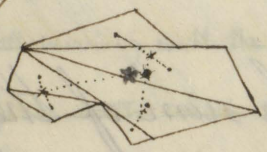
16. In right lined plane triangles. the centre is found by the bisection of two of its sides.

17. Two or more bodies may have a common centre of gravity. The common centre of gravity of two bodies is in the line of direction between them and is distant from each inversely as its quantity of matter.

18. When more than two bodies have one common centre, the common centre of two must be found as above and then viewing the matter of the two bodies as concentrated there, the common centre between that and the other must be found in the same manner.



19. In single bodies of irregular figure, bounded by straight lines the common centre is found by dividing the figure into triangles and then proceeding according to the above directions



20. In those bodies in which the centre of gravity cannot be ascertained in this way it may be ascertained by fluxions

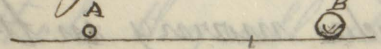
21. Respecting the centre of gravity it may be observed that whatever supports the centre supports the whole body.

22. The mutual action of two bodies upon each other does not alter the state of their common centre of gravity whether it be at rest or in motion.

23. The sum of the momentum of two bodies moving in the same direction with equal or unequal velocity is equal to the momentum of both bodies moving with the velocity of their common centre of gravity.

24. When two bodies move towards contrary parts the difference of their momentum toward these parts

is equal to the momentum of both bodies moved toward the same part with the velocity of their common centre of gravity.



Let A be = to B both moving with the same velocity, toward each other, the force with which the centre of both will move after impact is equal to the difference of their previous forces.

25. The same observations are applicable to any additional number of bodies.

26. The theory of percussion of bodies determines their ~~Momentums~~ velocities and Direction after their meet.

ing. Respecting the percussion of bodies moving with an equal velocity the following particulars may be observed.

II. When bodies moving in the same streight line strike each other the state of their common centre of gravity is not altered it either remains at rest or continues to move as formerly in the same straight line

III. If there be two non-elastic bodies and if one of them move in a straight line while the other is at rest in that line, or is moving in a slower rate in

the same direction, or is moving in a contrary direction these bodies must necessarily meet and strike each other, and after the stroke they will either remain at rest or move on together conjunctly with their common centre of gravity. If they both move in the same direction, their momentum after the stroke will be equal to the sum of their momentums before it, but it will be equal to the difference of their momentums if they move in a contrary direction. If both bodies move in the same direction, the quotient that arises from dividing the sum of their mo-

mentums. by the sum of their quantities of matter will be equal to their velocity after the stroke. If they move in opposite directions their velocity is ascertained by dividing the difference of their momentums by the same divisor

III. If one body strike against another the magnitude of the stroke is proportional to the momentum which the more powerful body loses at the concurse.

IV. When a given body strikes directly against another given body, if the latter be at rest the quantity of the stroke

is proportional to the velocity of the body; if the second be moving in the same direction with the first but at a slower rate, the magnitude of the stroke will be the same as if the second body stood still, and the first impinged upon it with a velocity equal to the difference of their velocities; If the bodies move directly against each other the magnitude of the stroke is the same as if one of the bodies stood at rest and the other struck it with the difference of their velocities.

V. The mutual action of bodies enclosed in a certain space

is exactly the same whether that space be at rest or in motion uniformly & directly.

VII. When two bodies which are perfectly elastic strike directly against each other, their relative velocity remains unaltered

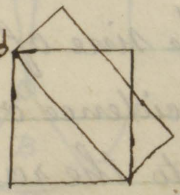
The nature of compound Motion or the Composition & resolution of Forces is next to be considered.

1. A body impelled at the same time by two forces in different directions, will move

in a direction between them.

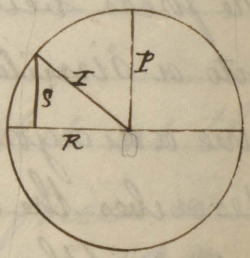
2. When a body is impelled by two forces the diagonal of a square or of a parallelogram whose sides are equal to the impelling powers will describe the direction and extent of the motion

3. When a body is impelled ~~by~~ at the same time by three forces the diagonal of a parallelogram whose sides are proportional to any two of the forces being formed with the third into a similar parallelogram will give a diagonal which describes the direction & extent of the motion.



Obs. In these cases the combined impulses are equal to an impulse which would produce a motion equal to the diagonal of a parallelogram; consequently if two sides of a triangle represent the quantity and direction of the two forces acting from a given point the third side will represent the quantity and direction of ~~the forces~~ a third force which acting from the same point will be equal to the other two ~~forces~~. This is termed the composition and resolution of forces.

Obs. 2. The effect of an oblique force is to the same in a perpendicular direction, as the sine of the angle of incidence or is to the radius.



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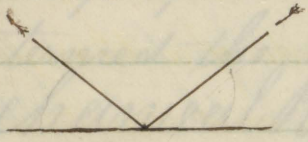
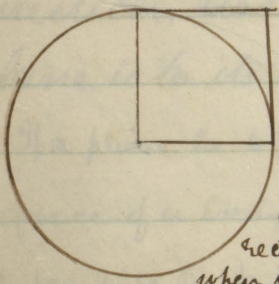
4. When the motion of a body perfectly elastic is firmly obstructed the angle of incidence is equal to the angle of reflection.



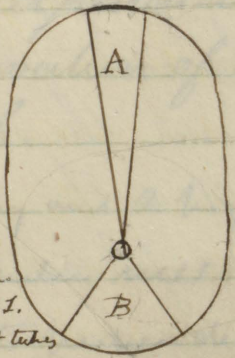
5. A simple and an Accelerated force except when they act in the same or in contrary directions produce a circular motion. The nature of the curve corresponds with the nature of the forces Applied.

1



When the forces applied are equal the body describes a circular direction as in F. 1.

2



when unequal it takes the direction of an ellipsis moving unequally in different parts of its course but is found to perform equal spaces in equal times, thus the area of ∠ A is equal to that of B.

A variety of means have been adopted to render power subservient to the purposes of life, these are termed the

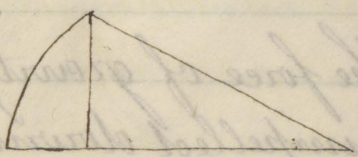
Mechanical Powers.

of which the first to be considered is the Inclined Plane.

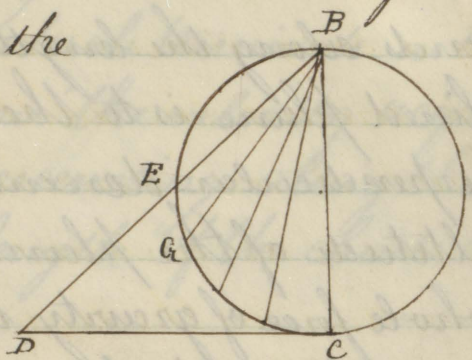
1 The force of gravity by which a body is impelled downward upon an inclined plane. is to the same force acting in a perpendicular direction, as the elevation of the plane is to its length.

If a plane be 6 feet long and 2 high the force of a body descending will be as as 2 is to 6 or $\frac{1}{3}$ of its perpendicular force

2. The space which is described by a body descending freely from rest towards the earth is to the space which it will describe upon the surface of an inclined plane, in the same time, as the length of the plane is to its elevation or as the radius is to the sine of the plane's inclination



3. If upon the elevation B C, of the inclined plane B D as a diameter the semicircle B E G C, be described the part B E of the inclined plane which is cut off by the semicircle is that part of

the plane over which a body will descend in the same time that another body will descend free. 

by and perpendicularly along the diameter of the circle, hence it follows that a body will descend over every chord of the semicircle and to C in equal times.

4 the time in which a body descends along the length of an inclined plane is to the time of its perpendicular descent along the altitude of the plane or as the whole force of gravity is to that part of it which acts upon the plane

5 A descending body whether it proceed along a plane or in a perpendicular direction acquires

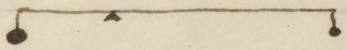
equal velocity: hence in all chords of a circle which terminate in the ~~circle~~ horizon the velocity acquired by bodies descending along them is as the length of the chords respectively

6. The times of descent along two planes of unequal lengths but equally inclined are as the square roots of their respective lengths.

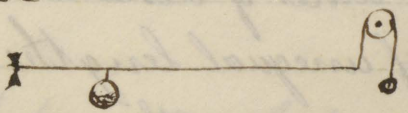
Lever

1 Of levers there are different kinds, and these, according to their nature, have different properties

2 In a lever of the First kind the fulcrum lies between the weight and the power



3. In the Second kind, the weight is between the fulcrum and the power



4. In the Third the power is between the fulcrum and the

weight

5. In all levers if the quantities of the power and weight, whatever be their directions, be inversely as the perpendiculars let fall from the centre of motion on their respective directions they will be in equilibrio.

6

6. Along with the lever may be comprehended the Balance, respecting which there are certain particulars that deserve attention.

7. The arms of the balance should describe equal arches. they should also be of homogeneous and inflexible materials, and as long as possible

8. The axes should be at right angles to the beam, well polished and hard, and the bearing edges not too obtuse. the rings which support the axis should also be well polished parallel, and of an oval figure.

9. The points of suspension ought to be in the line of the centre of motion and the effect of the index by an opposite weight.

10. The centre of motion should be a little above the centre of gravity

11. Helsham's property of the balance deserves to be considered

If a person be weighed in a scale and exactly balanced, and if he then step up and outwards against the beam his weight will appear to be greater because by pushing outwards the scale in which he stands the lenght of the lever is increased

Wheel and Axle.

1 In the Axis in Peritrochio or wheel and axle, the velocity of the weight is to the velocity of the power as the diameter or circumference of of the axis is to the diameter or circumference of the wheel.

2. A fixed pulley is useful to change the direction of a power, but affords no mechanical advantage. This is acquired by means of the moveable pulley.

3. In every system of pulleys the power is to the weight as one is to the whole number of cords.

4. The principal defects of the pulley, and the means of avoiding them, ought to be considered.

The cords of pulleys sometimes become twisted and in complex systems friction and the rigidity of cordage greatly diminish the power. The friction of axles is sometimes diminished by the use of friction  wheels but there is a tendency to render machinery complex.

Wedge

1. The use of the wedge is generally understood but the true theory of its operation is not well ascertained

The wedge acts not so much by the force applied as by percussion which by causing the particles of bodies to vibrate makes them seperate more easily

2. It produces its effect not so much by the application of power as by means of percussion.

3 According to its figure it consists of one or more inclined planes, and then the power is to the resistance at the elevation of the plane is to its length

Screw.

1. A screw is merely a revolving inclined plane. It is usually combined with the lever.

2. When the lever and screw are combined, the resistance and power are in equilibrio when the first is to the last as one circumference of the power is to the distance between two contiguous threads of the screw.

All the mechanical powers are reducible to the lever.

It is a principle generally admitted into mechanical treatises, that by means of any of the preceding powers or of any of their combinations in complex machinery no increase of power is acquired. This must be admitted with limitations.

In complicated machinery much of the power is lost by friction and other unavoidable imperfections.

In complicated machinery, the powers and effects are computed by the principles already stated in illustrating the nature of the mechanical powers.

Pneumatics

Pneumatics treat of the mechanical properties of permanently elastic bodies.

The two principal qualities of aeriform bodies are their Gravity and Elasticity

1 Gravity.

A quart of air weighs nearly 16 grains and its pressure upon bodies

on the surface of the earth is 16 lbs upon the square inch. This causes the operation of the common pump, Barometer and Siphon.

Ex. A florence flask exhausted is lighter than when full of air.

An open topped receiver with bladder tied over it when exhausted will be pressed with such force that the bladder will burst with explosion — Magdeburg hemispheres — Water & mercury may be forced through wood by pressure of air. &c &c

2 Elasticity

The particles of vapours and gases exercise a repelling power and consequently have a tendency to expand on this account they can be condensed & rarefied.

Ex. - flaccid bladder in an exhausted receiver becomes tense by elasticity of the contained air — a ~~received~~ shrivelled apple will be expanded by the elasticity of the contained air - An egg with a hole made in the small end will have its whole contents expelled by the expansion of the air-bubble in the large end — forcing pumps and fire engine.

Hydrostatics

Hydrostatics is that branch of Natural Philosophy which treats of the mechanical properties of Non-elastic fluids.

Fluids are regulated by the general principles of Gravitation but in small quantities they are affected by different kinds of attraction

Aggregation — as drops of rain

Affinity — as water adhering to glass

The tendency of the parts of a fluid to separate when in large quantities occasions several peculiarities.

1. The parts of a fluid gravitate separately.

2. When unconfined they spread in every direction.

3. They preserve a level surface

4. They press equally in every direction.

5. They press with a force proportional to their perpendicular height.

Optics.

Optics treat of the nature of Light, Colours & Vision. Des Cartes supposed Light to be a subtle fluid dispersed through the universe; and that it acquires a vibratory motion from those bodies termed Luminous.

The

According to the Newtonian theory light is an emanation from luminous bodies

Light has been supposed by some to contain three primitive colours: but by others to contain seven.

Rays of light proceed from luminous bodies in shaught lines

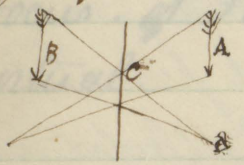
The shaught course of the rays of light is affected by various causes.

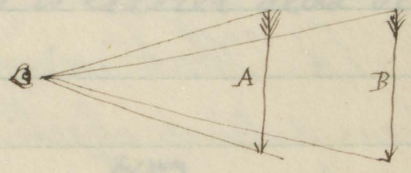
When rays of light fall upon a body they are partly absorbed, and partly sent back or reflected.

Incoming — Catoptrics
coming — &
Parallel — Dioptrics

impression of light remains on the retina
$\frac{1}{10}$ th of a second

When rays of light are reflected, the angle of reflection is equal to the angle of incidence



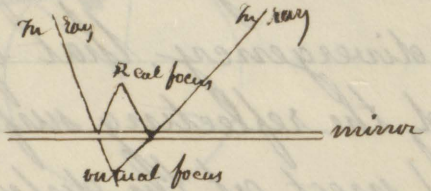


from this principle arises the visual angle or that angle in which the rays of light from the extreme points of an object to the eye in proportion as this is great or small so will we see the object large or small. Thus the objects at A & B being of the same size but at different distances will appear to be of different sizes. One of the effects of the visual angle is that an object A seen in the mirror c will appear as if at B.

Reflected rays are affected by the concavity or the convexity of the surface from which they are sent.

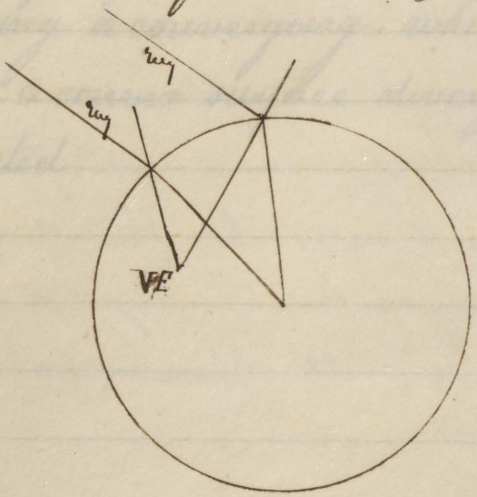
Rays of light whether parallel, diverging or converging, which fall upon a convex surface diverge when reflected.

The point upon which rays of light are concentrated, or may be supposed to be concentrated is termed a Focus. A Focus is either real or virtual.

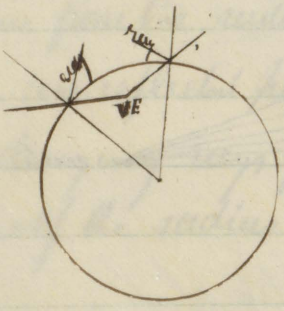


Respecting the virtual focus of rays, reflected from a convex surface it may be remarked

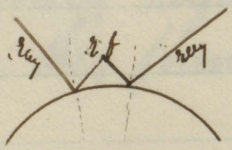
1st. That incident parallel rays from distant objects are reflected with such divergency, that if protracted beyond the reflecting surface, they would meet at the distance of half the radius of convexity.



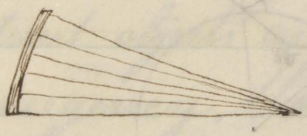
2dly. That diverging incident rays from near and minute objects, form their virtual focus nearer the reflecting surface than half the radius of convexity



3dly. That when converging incident rays proceed from an object at a distance less than half the radius of convexity, they have a real focus without the surface, but at a greater distance a virtual focus behind it.



In a reflecting concave surface, rays proceeding from the centre of concavity, are reflected in the same direction



For optical purposes small sections of large spherical surfaces are generally used.

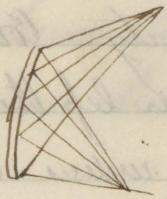
Sections of large spheres produce least distortion

Parallel rays falling upon a convex surface, form a focus at half the distance of the centre of concavity. Convergent, rays proceeding from less than the length of the radius from the radius or from beyond it diverge, are reflected parallel or form a focus, diverging rays form a focus at less than half the radius.

Foci of reflection are Incident or Principal

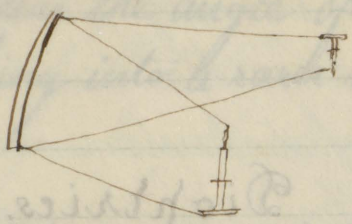
When rays of light are reflected from a concave surface and intersect each other they form caustic curves

As the one focus approaches the other recedes.

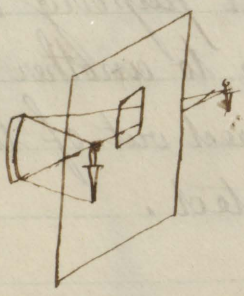


The intensity of light or heat collected in the focus of a concave mirror is nearly as the square of its diameter directly, or as the principal focal distance, inversely.

Images in a concave mirror are seen inverted



Concave reflectors as they form an image of an object before their surface are employed for the purposes of amusement & deception



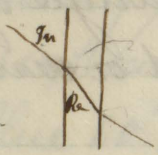
It is generally supposed that light is reflected before it touches the reflecting surface

Dioptrics.

Rays of light falling upon particular objects partly pass through them.

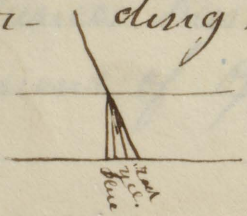
Rays of light passing obliquely from one medium to another of a different density are turned out of their straight course or refracted.

Light passing into a denser medium has the angle of incidence longer than larger than the angle of refraction but passing into a rarer medium it is less



Ref. power of At. is to Water as 3 to 4
" " Glass " 2 " 3
" " Diamond " 2 " 5

When light is refracted it is also enlarged in a sectoral manner and according to its refrangibility displays different colours.



In different mediums the refracting and dispersing powers do not always bear the same proportion, but in the same medium the angle of dispersion becomes larger or smaller as the angle of refraction is encreased or diminished.

Respecting the number of primitive colours philosophers are not agreed, but it is proved by synthesis that the 7 mentioned by Sr I. Newton produce colourless rays when blended in ~~different~~ the following proportions.

Red, 45; Orange 27; yellow 48; Green 60; Blue 60, Purple 40; Violet 80.

A knowledge of the different refractive and dispersive powers of different substances has tended to the improvement of Optical instruments.

A transparent medium having at least one side convex or concave is termed a Lens. Of these there are various kinds and each has an appropriate name. Every lens has a centre, axis & vertices.

Plano- Convex

Double Convex

Plano- Concave

Double Concave

Concave- Convex

Minis-cous.

Rays of light falling upon a lens, except on its centre proceed from it according to the laws of refraction.

The different refrangibility of the colored rays occasions an imperfection of lenses, which was long supposed to be insurmountable. But it has been remedied by achromatic improvements.

The principal focus of a lens may be determined either by calculation or experiment.

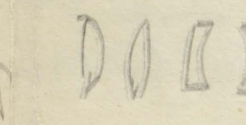
In some lenses the principal focus is real but in others virtual. The principal focal distance of a plano-convex is nearly equal to the diameter of its sphere, and in a double convex it is nearly equal to the radius. The virtual foci of plano-concave and double concave are in the same proportions.

respecting the number of Primitive colours Theophrastus as it agreed but it is known by experiments that the 7 made by Sir I. Newton produce colours less when blended the following two pictures

Red 45, Orange 27,
Yellow 48, Green 60,
Blue 60, Purple 40
Violet 80.

of knowledge of the different representations of different forms of minus transparent mediums has tended to the improvement of optical instruments & transparent mediums many at least one side convex concave is termed a lens.

of there there are numerous kinds and each has an appropriate name Every lens has a centre axis and vertices



Concave convex

Mirrors

rays of light falling on a lens except on its centre proceed from it according to the law of refraction.

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In some lenses the imaginary
focus is real but in others not
true. The imaginary focal dis-
tance of a plano concave lens
is nearly equal to the diam

List of Conductors & Non-Conductors of Electricity.

Conductors.— Metals, Charcoal, Plumbago, strong Mineral and weak vegetable Acids, Mettallic ores, Ice above 13°F., Snow, Living Animals & vegetables, Flame, Steam, Powdered glass & sulphur, Resins melted, Glass Red hot.

Non-Conductors.— Amber, Resins, Sulphur Glass. Vitrified Bodies, Gems, Silk. Wool, Hair, feathers, Paper, Leather, Dry Gases, Dry vegetable Bodies, Marble &c, Ice below 13° Oils, Dry Mettallic Oxides.

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convex lens it is nearly equal
to the radius. The virtual
foci. of plano convex & double
concave are in the same
proportions.

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