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OF NATURAL PHILOSOPHY,

I.

ALL the subjects of human knowledge are comprehended under the general names of body and mind.

Animals consist of both; and from their motions and the motions and changes produced by them, among the bodies around them, it is manifest, that there is a connection, however inscrutable, between body and mind. They mutually affect each other.

Motions and changes are perpetually going on, in the material world, independent of the interposition of animals. These are perceived as effects, necessarily implying causes by which they are produced.—The causes are named tho' unknown.—Weight.—Heat.—Electricity.

These causes are observed to operate regularly.

Whatever are perceived of the bodies which compose the material world: their situations,
A motions,

motions, changes, are called natural appearances or phænomena ; their causes, natural causes ; the rules which these causes observe, in the exertion of their efficacy, laws of nature.

When, contemplating the works of nature, we remark the adjustment and subserviency of things: the tendency of some to support or destroy others ; we perceive manifest designs and destinations, and are irresistibly led to refer natural causes to the power, and the laws of nature to the will of intelligence, superior to human. Power.—Will.—Nature: efficient, and final causes.—Natural History.—Natural Theology.—Natural Philosophy.

The Scope of Natural Philosophy is,
1. To ascertain the laws of nature. 2. To explain the phænomena of nature. 3. And to direct the application of the knowledge of these to the improvement and invention of arts, for the accommodation of life; and to the advancement of other sciences.

II.

Man begins to acquire the knowledge of nature, when he begins to exist.—1. He enters the world possessed of instinctive arts, and capable of perception, of intuitive knowledge, and of reasoning.—2. Prompted by necessity, he

he encreases his knowledge; that his power may be enlarged. 3. Prompted by accidental motives, he advances in knowledge, and in power.—*Arts and Sciences.*

The connection between cause and effect, tho' not perceived, is ascertained by the laws of perception, and by experience and reasoning.

A rising scale of connections may be traced. 1. Artificial words, or signs, and their meaning. 2. Instinctive expressions of sentiment, and their meaning. Or natural signs, and things signified.—*Natural Language.* 3. Perceptions, and the sensible qualities of external objects. 4. Motions of bodies and the affections of matter. 5. Many phœnomena are perceived as effects, whose causes are not suggested.

Laws of nature are investigated from a few phœnomena carefully examined: from the laws, as principles of philosophy, other phœnomena are explained.—Arts are often improved, sometimes derived from science.

III.

—There is but one genuine method of teaching science, which must be formed on the

model of the natural progress of the mind in its acquisitions of knowledge.—Analysis.—Synthesis.

Of the DIVISION and ARRANGEMENT of the SUBJECT.

I.

WHEN an extensive subject of science is to be examined, the limited capacity of human apprehension requires a limitation of attention. The attention is often withdrawn from some things, and limited to others, which are inseparable. This limitation is called Abstraction; and is practised by all men. Abstract terms are frequent in common language, abundant in the language of every science.

Some Philosophers have exceeded in abstract speculation. Others, contemplating natural objects intire, as they exist, have too much neglected abstraction.

These are two extremes, which should both be avoided.—There is no middle course.—The remedy lies in alternating these two.

II. Nature

II.

Nature is an extensive subject, variously divisible. 1. Genera; species; individual. 2. Ends; means. Supreme; subordinate. 3. Cause; effect.

The rule of division is to be derived from the purpose. The three ways, specified, of dividing nature, are suited to the purposes of 1. Natural History. 2. Natural Theology. 3. Natural Philosophy.

III.

Effects only appear. Causes are suggested, with various degrees of evidence, as the knowledge of them is necessary, useful, convenient. —1. Intuitive conviction. 2. Conjecture. 3. Confirmation by experiment.—*Experimental Philosophy*.

The phænomena of nature proceed from 1. The independent properties of bodies. 2. Affections of matter. — 3. The sensible qualities of objects. 4. Higher causes.

The *independent properties* of a body are those found in it when examined by itself. Such are extension, divisibility, impenetrability.

Affections of matter are those qualities ascribed to bodies, by which they are said to move, and to produce changes on each other: those powerful agents in nature: those efficient causes, to which, tho' unknown, we give names. — Cohesion. — Magnetism. — Electricity.

Sensible qualities are those by which objects are related to us, and affect our senses. Independent properties, and affections of matter are sensible qualities, which are perceived, or suggested by our sensations. But those to which the meaning of the term is here restricted are only implied in our sensations: what they are not being suggested, but left as matter of investigation. — Heat. — Taste.

Higher, or more general causes, are those to which some of the others may be referred, as effects.

When our attention is limited to the independent properties, all is still, inactive, lifeless. — 2. When extended likewise over the affections of matter, the material world becomes a busy, animated scene; suggesting power, intelligence, design, superior beings. — 3. Man is interested in this scene. He is connected with the material world by organs of sense;

by

by means of which he perceives external objects and their qualities.

Sensible qualities are not the immediate causes of perception. Several other causes are interposed, like so many links of a chain. — Perception. — Sensation. — Impression. — Condition of the organ. — Motion. — Sensible quality. — Sometimes a *Medium*.

In different instances of perception, the attention is limited to different links of the chain, while others are overlook'd. In examining the independent properties, we abstract from the intermediate links.

IV.

Natural substances are diversified by a variety of affections, and sensible qualities, and their modifications. Whereas the independent properties are common to all the parts of the material world. When, therefore, we shall have examined these, we shall be advanced in the knowledge of the whole.

Of

Of the INDEPENDENT PRO-
PERTIES of BODIES.

I.

1. **E**XTENSION: in which are implied
2. Figure. And 3. Divisibility.—
Space.

4. Impenetrability.—*Density.*—*Quantity*
of matter.—5. Inertia.—Not necessarily con-
nected with the other four.—Proportioned to
the quantity of matter.—Presumed universal,
from general induction.—6. Weight. Whe-
ther an independent property, or affection,
will appear in it's proper place.

Matter is an abstract term.

II.

Extension is the subject of *Geometry.*
Number - - - of *Arithmetick.*
Both - - - of *Algebra.*

Some skill in these abstract sciences, is ne-
cessary as preparatory to the study of other
branches of Natural Philosophy. For, being
the

the most general, they are involved in the others, and often referred to. And from them is borrowed a method of expressing measurable quantities of every kind: a scientific branch of language.

III.

Measurable quantities, of every kind, are expressed by numbers, symbols, lines.

A quantity which varies at the same rate with each of other two, is called a *compound quantity*. Such are expressed by products, rectangles.

The relation of quantities, which vary at the same rate, is expressed by ($=$) equality. Such are often justly substituted in reasoning.

A quantity which varies directly as one, and inversely as another, is expressed by a fraction.

OF THE
AFFECTIONS of **MATTER** in general;
 OR OF
PRESSING POWERS.

I.

THE strength of animals, weight, and the affections of matter, agree in these two things. That they press bodies to move; and that they proceed from the power of immaterial agents. They are, therefore, called pressing powers, or simply powers.—*Attraction.*—*Repulsion.*

II.

The effects of powers are 1. To balance each other. 2. To move bodies.

Of the BALANCE of POWERS.

I.

IN the first place, laws are to be investigated from the phænomena, by analysis.

II.

Pressure and resistance are, to us, the same; for frequently undistinguishable. Therefore equivalent, equal and opposite.—*Action.—Re-action.*

Power is transferable to different points, by ropes and rods.

III.

Rest is a proof of equality of pressure.

Pressure is a compound quantity; analysed into intensity and quantity of power.

IV.

Three powers proportioned, and parallel to the sides of any parallelogram will balance.

of the diagonal

When a power is obliquely resisted, it is resolved into two. One in direct opposition, and another perpendicular, to the resistance.

M E C H A N I C S.

P A R T I.

I.

IN the second place, phænomena are to be explained from the investigated laws.

II.

Of the *center of gravity*.—*Center of Motion*.—*Inclined plane*.

III.

Power.—Weight.—Machine.

The power and weight are not, properly, in opposition; but are two powers conspiring against a third, which is opposed to their joint effort.

Of simple machines. 1. The *Lever*.
2. Others reduced to the lever.—Wheel and pinion.—Pulley.—Barrel and handspokes.—Axis in peritrochio.—3. The *Inclined plane*.—4. Others reduced to the inclined plane.—Screw.—Wedge.

IV.

Of compound Machines.

V.

In the third place, science is to be applied to the improvement of art.

The doctrine of the balance of powers is of use, in ascertaining the strength, which ought to be given to every kind of supports. Pillars; piers; arches; beams; members of machines.

OF MOTION.

I.

MOTION.—Space.—Time.—
Velocity: uniform; accelerated; re-
tarded.—Their measures, and expressions.

Absolute and relative.—Apparent and
real.—

Quantity of motion.—Force: inherent;
imprest.—Impulse.—Resistance.—Action.—
Re-action.

II.

Of the laws of motion.

III.

Of the harmony between the laws of mo-
tion, and those of balancing powers.

PHAENOMENA explained from the
LAWS of MOTION.

I.

Of the congress of bodies.

II.

Of the descent, and ascent of heavy bodies, in vertical lines.

III.

Of the descent and ascent of heavy bodies on inclined planes.

IV.

Of pendulums.

V.

Of projectiles.

VI.

Of central forces.

Of the AFFECTIONS of MATTER
in particular.

PRESSING powers agree in that they all alike obey the general laws of balance, and of motion. But they are distinguished by being separately subjected, each to it's own particular laws.

Of

OF GRAVITATION.

PART I.

I.

THE lines in which bodies press downward, by their weight, (vertical, or plumb-lines,) are inclined to each other.—Hence may be inferred,

That the earth is a globe. And

That gravitation is an affection of matter.

II.

The figure of the earth is confirmed by the explanation of phænomena. 1. A ship, sailing in any one direction surrounds it. 2. To the people on board, the higher parts of tall objects, to which they approach, come first in sight; and the lower parts of those, from which they recede, are first intercepted from their view. 3. If the course be east, the rising, and setting of the heavenly bodies, are accelerated; if west, retarded.

PHYSICAL ASTRONOMY.

PART I.

I.

Of the diurnal motions.

II.

Of the annual motions.

III.

Of the solar system.

IV.

Of the universal system.

Of

OF GRAVITATION.

PART II.

THE moon gravitates to the earth. —
Hence it is inferred, That

The intensity of gravitation is greater, in proportion as the square of the distance is less. And hence the Copernican system is established.

PHYSI-

PHYSICAL ASTRONOMY.

P A R T II.

GRAVITATION is the power, that retains the primary planets, circulating in orbits round the sun ; and the secondary round their primary.

Of comets,

Of the fixt stars. — And universal system.

Of

OF GRAVITATION.

P A R T III.

GRAVITATION to the center of a sphere arises from gravitation towards each particle of it.

All the particles of matter gravitate mutually, with forces varying with the distances,

The law of this variation is deduced from the law of gravitation to the center of a sphere.
— And is the same.

Of

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OF COHESION.

PART I.

COHESION may be considered, in the first place, only as a power resisting any force applied to separate the parts of bodies; or to move them separately.

The difference of bodies, arising from the difference of strength, or intensity with which their parts cohere, is a difference in degree only. Bodies are otherwise greatly diversified by different modifications of cohesion.

This variety arises from the degrees and combinations of 1. Hardness. 2. Elasticity. 3. Fluidity. 4. Softness.

OF HARDNESS.

OF ELASTICITY.

OF FLUIDITY.

Of the PRESSURE of FLUIDS,

OR

HYDROSTATICS.

Of the MOTION of FLUIDS,

OR

HYDRAULICS.

Of

OF ELASTIC FLUIDS,

OR

PNEUMATICS,

OF SOFTNESS,

Of the CHANGES of MOTION

from resisting MEDIA.

OF FRICTION.

MECHA

M E C H A N I C S,

P A R T II.

OF the resistances arising from the motion of machines. — *Perpetual motion.*

Of the proportion betwixt the power and weight, requisite to produce the greatest effect by machines. — *Maximum.*

C

MECHA-

L 20 J
M E C H A N I C S.

P A R T III.

I.

O F practical skill in machinery.

II.

Of examination of machines,

III.

Of contrivance of machines.

IV.

Of the cultivation of mechanic genius.

C O H E.

C O H E S I O N .

P A R T II .

C O H E S I O N reaches to a distance.

O F E L E C T I V E A T T R A C T I O N S .

O F M A G N E T I S M .

C 2

O f

OF ELECTRICITY.

I.

HYPOTHESIS. 1. The phænomena of electricity are produced by the affections of a particular fluid. 2. The particles of which attract each other at very small distances, and repel at greater distances. And 3. This fluid has various affinities to other substances.

II.

Of the elective attractions, or affinities of the electric fluid.

III.

Of the motions of electricity.

IV.

Electricity is perceived by every sense.

V.

Of the phænomena explicable from the doctrine of electricity.

VI.

Of the uses of the knowledge of electricity.

OF SENSIBLE QUALITIES.

MANY links are overlook'd in, almost, every instance of perception. And the attention is limited to one or another, as interesting.

The attention is limited sometimes to one, sometimes to another, in the same instance.
—Hence the ambiguity of many words.

From those circumstances of objects, which are perceived, we learn to infer others, which are not perceived.—Hence perceptions are distinguished into original and acquired.—Habits.—Habits of inattention.

Organs of sense.—Nerves.—Sensorium.

Different qualities are explored by the same sense. And the same quality by different senses.

O F T O U C H .

THE properties, affections, and conditions of objects, which qualify them to make impressions on the organ of touch, are magnitude, figure, impenetrability, vis insita, motion. — *Minimum sensibile.*

O F T A S T E , S M E L L , and some other
S E N S E S .

BODIES are qualified to excite the sensations by their elective attractions. Which are not explored, but inferred.

Pleasure. — Pain. — Appetite. — Involuntary motion.

Of HEAT and COLD.

I.

THE word, Heat, sometimes signifies a sensation, sometimes a quality. The quality is not perceived, but it is a subject of investigation.

Heat is lost, and acquired by communication.

Quantity,—Intensity,—Degrees, of heat.

Degrees are measured by the expansion of metals, and of fluids.—*Thermometers.*

II.

The sensations, heat, and cold are excited, when the quality heat is communicated to, or from the organ. Heat when to, cold when from.

III.

Heat is generated by friction, and by intestine motions.—*Animal heat.*

IV. Of

IV.

Of the effects of heat.

V.

Of the phænomena produced by heat.

VI.

Of the arts depending on the management
of heat.

OF HEARING.

I.

WHAT qualifies objects to excite the
sensation of sound, is a subject of in-
vestigation.—Suggested to be action.—And a
medium is inferred.

II.

Of the medium of sound.

III.

Of the affections and modifications of
sound.

IV.

Of language.—And music.

OF SEEING.

I.

THE qualities perceived by sight are magnitude, figure, colour.

Of the places of sensible objects.

A medium is inferred; and many of the laws of light are investigated, by all men.

II.

Of the propagation of light in right lines.

Ray.—Pencil.—Beam.—Luminous.—
Shining.—Illuminated.

Radiation.—Reflection.

III.

Of the reflection of light.

IV.

Of the refraction of light.

V.

Of vision.

VI.

Of colours.

VII.

Of the inflection of light.

VIII.

Phænomena explained.

IX.

Of optical arts, and instruments.

X.

Of light.—Heat.—Fire.

Of

OF HIGHER CAUSES.

WHEN particular efficient causes, and laws of nature, deduced from the phænomena, are traced further; they are found to flow from others, more general and fewer, as in tracing the branches of a tree, from the twigs towards the trunk. But unity is not reached in tracing efficient causes alone.

A like branching of final causes is traced in the connection of things into systems, and their subordinations.

Final and efficient causes, considered together, are found to be united in the power and will of intelligent beings: the perception of design executed, furnishing evidence of the existence, power, and other attributes of a designer.

Partial contemplation of nature introduces
the belief of many Gods.

The unity of nature proves the unity of
God.

introduces

the unity of

the

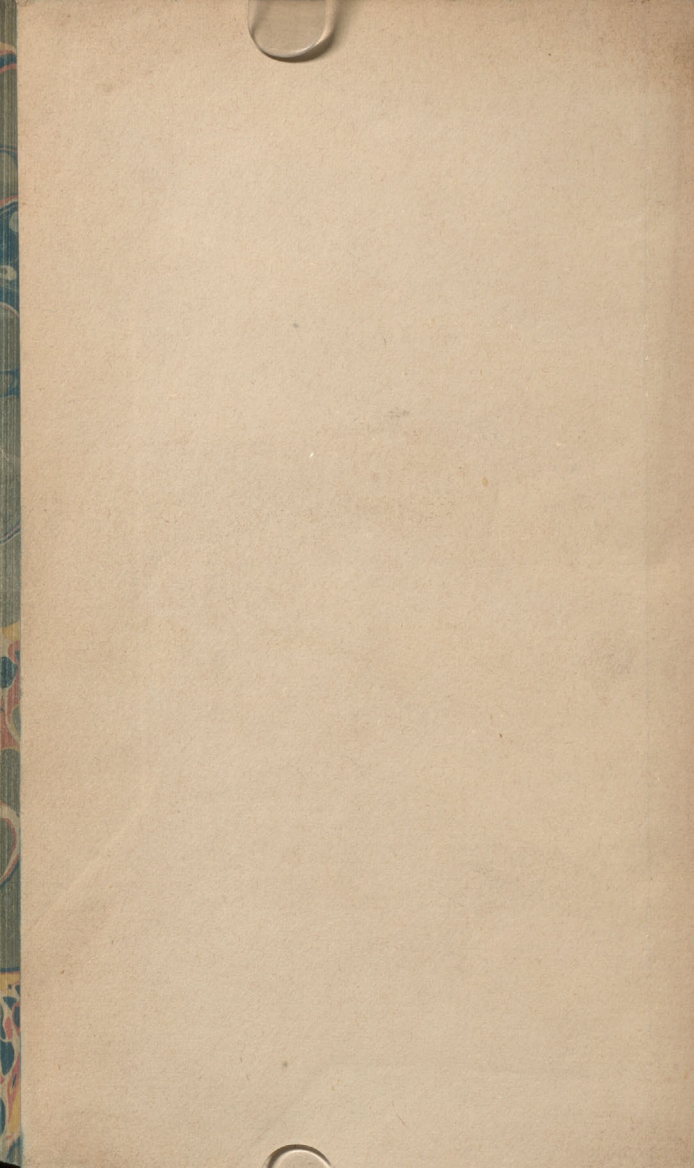
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