

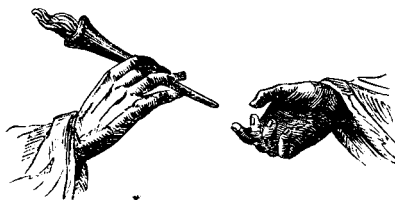
THE  
PHILOSOPHY  
OF THE  
INDUCTIVE SCIENCES,

FOUNDED UPON THEIR HISTORY.

BY WILLIAM WHEWELL, D.D.,  
MASTER OF TRINITY COLLEGE, CAMBRIDGE.

A NEW EDITION,  
WITH CORRECTIONS AND ADDITIONS, AND  
AN APPENDIX, CONTAINING  
PHILOSOPHICAL ESSAYS PREVIOUSLY PUBLISHED.

IN TWO VOLUMES.



*Λαμπάδια ἔχοντες διαδώσουσιν ἀλλήλοις.*

VOLUME THE SECOND.

---

LONDON:  
JOHN W. PARKER, WEST STRAND.

M.DCCC.XLVII.

CONTENTS  
OF  
THE SECOND VOLUME.

---

PART II.  
OF KNOWLEDGE.

---

BOOK XI.

OF THE CONSTRUCTION OF SCIENCE.

	PAGE.
CHAP. I. OF TWO PRINCIPAL PROCESSES BY WHICH SCIENCE IS CONSTRUCTED . . . . .	3
CHAP. II. OF THE EXPLICATION OF CONCEPTIONS . . . . .	5
<i>Sect. I. The Historical Progress.</i>	
<i>Art. 1. The Explication of Conceptions,</i>	
2. Has taken place historically by discussions.	
3. False Doctrines when exposed appear impossible :	
4. But were plausible before	
5. Men's Minds gradually cleared.	
<i>Sect. II. Use of Definitions.</i>	
<i>Art. 6. Controversies about Definitions.</i>	
7. Not arbitrary Definitions.	
8. Attention to Facts requisite.	
9. Definition is not essential.	
10. The omission of Definition not always blameable.	
<i>Sect. III. Use of Axioms.</i>	
<i>Art. 11. Axioms serve to express Ideas.</i>	
<i>Sect. IV. Clear and Appropriate Ideas.</i>	
<i>Art. 12. We must see the Axioms clearly.</i>	
13. Inappropriate Ideas cannot lead to Truth.	
14. The fault is in the Conceptions.	
15. Rules cannot teach Discovery ;	
16. But are not useless.	
17. Discussion as well as Facts needed.	
VOL. II. W. P.	6

	PAGE
<i>Sect. V. Accidental Discoveries.</i>	
Art. 18. No Scientific Discovery is accidental.	
19. Such accidents do not happen to common Men.	
20. Examples.	}
21. So far Explanation of Conceptions.	}
<b>CHAP. III. OF FACTS AS THE MATERIALS OF SCIENCE</b>	<b>26</b>
<i>Art. 1. Facts must be true.</i>	
2. Facts not separable from Ideas.	
3. The Ideas must be distinct.	
4. Conceptions of the Intellect only to be admitted.	
5. Facts are to be observed with reference to Space and Time:	
6. And also to other Ideas.	
7. The Decomposition of Facts.	
8. This step is not sufficient.	
9. It introduces technical Terms,	
10. And Classification.	
11. These are the materials of Science.	
<b>CHAP. IV. OF THE COLLIGATION OF FACTS</b>	<b>36</b>
<i>Art. 1. Facts are colligated by Conceptions.</i>	
2. Science begins with common Observation.	
3. Facts must be decomposed.	
4. What Ideas first give Sciences.	
5. Facts must be referred to Ideas.	
6. Sagacity needed.	
7. Discovery made by Guesses.	
8. False Hypotheses precluding to true ones.	
9. New Hypotheses not mere modifications of old ones.	
10. Hypotheses may have superfluous parts.	
11. Hypotheses to be compared with Facts.	
12. Secondary Steps.	
<b>CHAP. V. OF CERTAIN CHARACTERISTICS OF SCIENTIFIC INDUCTION</b>	<b>46</b>
<i>Sect. I. Invention a part of Induction.</i>	
<i>Art. 1. Induction the source of Knowledge.</i>	
2. Induction involves a New Element.	
3. Meaning of Induction.	
4. The New Element is soon forgotten.	
5. Induction includes a Definition and a Proposition.	

*Sect. II. • Use of Hypotheses.*

- Art. 6. Discoveries made by Guesses.
  - 7. Which must be compared with Facts.
  - 8. Hypotheses are suspected.
  - 9. Hypotheses may be useful though inaccurate.

*Sect. III. Tests of Hypotheses.*

- 10. True Hypotheses foretel Phenomena,
- 11. Even of different kinds.—Consilience of Inductions.
- 12. True Theories tend to Simplicity.
- 13. Connexion of the last Tests.

CHAP. VI. OF THE LOGIC OF INDUCTION . . . . . 74

- Art. 1. Steps of Generalization.
  - 2. May be expressed by *Tables*,
  - 3. Which exhibit Inductive Steps ;
  - 4. And the Consilience of Inductions ;
  - 5. And the tendency to Simplicity ;
  - 6. And the names of Discoverers ;
  - 7. And the Verifications of Theory,
  - 8. By means of several easy Steps.
  - 9. This resembles Book-keeping.
  - 10. The Logic of Induction.
  - 11. Attention at each step required.
  - 12. General Truths are not mere additions of particulars :
  - 13. But a new view is introduced.
  - 14. Formula of Inductive Logic :
  - 15. May refer to Definition.
  - 16. Formula inadequate.
  - 17. Deductive Connexion of Steps.
  - 18. Relation of Deductive and Inductive Reasoning.
  - 19. The Criterion of Truth.
  - 20. Theory and Fact.
  - 21. Higher and Lower Generalizations.

CHAP. VII. OF LAWS OF PHENOMENA AND OF CAUSES . . . . . 95

- Art. 1. Knowledge of Laws of Phenomena.
  - 2. *Formal* and *Physical* Sciences.
  - 3. Causes in Astronomy.
  - 4. Different Mechanical Causes in other Sciences.
  - 5. Chemical and Vital Forces as Causes.
  - 6. Differences of these kinds of Force.
  - 7. Difficulty of conceiving new Causes.

	PAGE
<i>Art.</i> 8. Men willingly take old Causes.	
9. Is the Magnetic Fluid real?	
10. Are Causes to be sought? (Comte's Doctrine.)	
11. Both Laws and Causes to be studied.	
<b>CHAP. VIII. OF ART AND SCIENCE . . . . .</b>	<b>106</b>
<i>Art.</i> 1. Art precedes Science.	
2. Contrast of Art and Science.	
3. Instinct and Insight.	
4. Difference of Art and Instinct.	
5. Does Art involve Science?	
6. Science unfolds Principles.	
7. Science may improve Art.	
8. Arts not classified with Sciences.	
<b>CHAP. IX. OF THE CLASSIFICATION OF SCIENCES . . . . .</b>	<b>113</b>
<i>Art.</i> 1. Use and Limits of such Classification.	
2. Classification depends on the Ideas.	
3. This points out Transitions.	
4. The Classification.	
<b>INDUCTIVE TABLE OF ASTRONOMY . . . . .</b>	<b>118</b>
<b>INDUCTIVE TABLE OF OPTICS . . . . .</b>	<b>119</b>

## BOOK XII.

### REVIEW OF OPINIONS ON THE NATURE OF KNOWLEDGE, AND THE METHOD OF SEEKING IT.

<b>CHAP. I. INTRODUCTION . . . . .</b>	<b>119</b>
<b>CHAP. II. PLATO . . . . .</b>	<b>122</b>
<b>CHAP. III. ARISTOTLE . . . . .</b>	<b>128</b>
<b>CHAP. IV. THE LATER GREEKS . . . . .</b>	<b>134</b>
<b>CHAP. V. THE ROMANS . . . . .</b>	<b>137</b>
<b>CHAP. VI. THE SCHOOLMEN OF THE MIDDLE AGES . . . . .</b>	<b>141</b>
<b>CHAP. VII. THE INNOVATORS OF THE MIDDLE AGES . . . . .</b>	<b>155</b>
<i>Art.</i> 1. General Remarks.	
2. Raymond Lully.	
3. Roger Bacon.	
<b>CHAP. VIII. THE REVIVAL OF PLATONISM . . . . .</b>	<b>174</b>
<i>Art.</i> 1. Causes of Delay in Knowledge.	
2. Causes of Progress.	

<i>Art.</i> 3.	Hermolaus Barbarus, &c.	
4.	Nicolaus Cusanus.	
5.	Marsilius Ficinus.	
6.	Franciscus Patricius.	
7.	Picus, Aggrippa, &c.	
8.	Paracelsus, Fludd, &c.	
CHAP. IX.	THE THEORETICAL REFORMERS OF SCIENCE . . . . .	189
<i>Art.</i> 1.	Bernardinus Telesius.	
2.	Thomas Campanella.	
3.	Andreas Cæsalpinus.	
4.	Giordano Bruno.	
5.	Peter Ramus.	
6.	Melancthon.	
CHAP. X.	THE PRACTICAL REFORMERS OF SCIENCE . . . . .	203
<i>Art.</i> 1.	Character of Practical Reformers.	
2.	Leonardo da Vinci.	
3.	Copernicus.	
4.	Fabricius.	
5.	Maurolycus.	
6.	Benedetti.	
7.	Gilbert.	
8.	Galileo.	
9.	Kepler.	
10.	Tycho.	
CHAP. XI.	FRANCIS BACON . . . . .	226.
<i>Art.</i> 1.	Common estimate of him.	
2.	We consider only Physical Science.	
3.	He is placed at the head of the change:	
4.	And justly.	
5.	(I.) <i>He proclaims a New Era</i>	
6.	(II.) <i>By a change of Method;</i>	
7.	Including successive Steps;	
8.	Gradually ascending.	
9.	(III.) <i>He contrasts the Old and the New Method.</i>	
10.	(IV.) <i>Has he neglected Ideas?</i>	
11.	No.	
12.	Examples of Ideas treated by him.	
13.	He has failed in applying his Method	
14.	(V.) <i>To the Cause of Heat, or Therapeutics</i>	

	PAGE
<i>Art.</i> 15. He seeks Causes before Laws.	
16. (VI.) <i>His Technical Form worthless.</i>	
17. He is confused by words.	
18. His "Instances."	
19. Contain some good Suggestions.	
20. (VII.) <i>His "Idols."</i>	
21. (VIII.) <i>His view of Utility.</i>	
22. (IX.) <i>His Hopefulness.</i>	
23. (X.) <i>His Piety.</i>	
 CHAP. XII. FROM BACON TO NEWTON . . . . .	252
<i>Art.</i> 1. Harvey.	
2. Descartes.	
3. Gassendi.	
4. Actual Progress.	
5. Otto Guericke, &c.	
6. Hooke.	
7. Royal Society.	
8. Bacon's <i>New Atalantis.</i>	
9. Cowley.	
 CHAP. XIII. NEWTON . . . . .	274
<i>Art.</i> 1. Animating effect of his Discoveries.	
2. They confirm Bacon's views.	
3. Newton shuns Hypotheses.	
4. His views of Inductive Philosophy.	
5. His "Rules of Philosophizing."	
6. <i>The First Rule.</i>	
7. What is a "True Cause?"	
8. <i>Such</i> as are real?	
9. Or <i>those</i> which are proved?	
10. Use of the Rule.	
11. Rule otherwise expressed.	
12. <i>The Second Rule :</i>	
13. What are Events "of the same kind?"	
14. <i>The Third Rule :</i>	
15. Not safe.	
16. <i>The Fourth Rule.</i>	
17. Occult Qualities	
18. Ridiculed.	
19. Distinction of Laws and Causes.	

	PAGE
CHAP. XIV. LOCKE AND HIS FRENCH FOLLOWERS . . . . .	295
<i>Art.</i> 1. Cause of Locke's popularity.	
2. Sensational School.	
3. His inconsistencies.	
4. Condillae, &c.	
5. Importance of Language.	
6. Ground of this.	
7. The Encyclopedists.	
8. Helvetius.	
9. Value of Arts.	
10. Tendency to Reaction.	
CHAP. XV. THE REACTION AGAINST THE SENSATIONAL SCHOOL	308
<i>Art.</i> 1. "Nisi intellectus ipse."	
2. Price's "Review."	
3. Stewart defends Price.	
4. Archbishop Whately.	
5. Laromiguière.	
6. M. Cousin.	
7. M. Ampère.	
8. His Classification of Sciences.	
9. Kant's Reform of Philosophy.	
10. Its Effect in Germany.	
CHAP. XVI. FURTHER ADVANCE OF THE SENSATIONAL SCHOOL	320
M. Auguste Comte.	

BOOK XIII.

OF METHODS EMPLOYED IN THE FORMATION OF  
SCIENCE.

CHAP. I. INTRODUCTION . . . . .	334
<i>Art.</i> 1. Object of this Book.	
2. An Art of Discovery not possible.	
3. Use of Methods.	
4. Series of Six Processes.	
5. Methods of Observation and Induction.	
CHAP. II. OF METHODS OF OBSERVATION . (2) . . . . .	337
<i>Art.</i> 1. Referring to Number, Space, and Time.	
2. Observations are never perfect.	



- Art. 3.* (I.) *Number is naturally exact.*  
 4. (II.) *Measurement of Space.*  
 5. Instruments Invented in Astronomy,  
 6. And improved.  
 7. Goniometer.  
 8. Standard of Length.  
 10. (III.) *Measurement of Time.*  
 11. Unit of Time.  
 12. Transit Instrument.  
 13. Chronometers.  
 14. (IV.) *Conversion of Space and Time.*  
 15. Space may Measure Time.  
 16. Time may Measure Space.  
 17. (V.) *The Method of Repetition.*  
 18. The Method of Coincidences.  
 19. Applied to Pendulums.  
 20. (VI.) *Measurement of Weight.*  
 21. Standard of Weight.  
 22. (VII.) *Measurement of Secondary Qualities.*  
 23. "The Howl" in Harmonics.  
 24. (VIII.) *Manipulation.*  
 25. Examples in Optics.  
 26. (IX.) *The Education of the Senses,*  
 27. By the Study of Natural History.  
 28. Preparation for Ideas.

CHAP. III. OF METHODS OF ACQUIRING CLEAR SCIENTIFIC  
 IDEAS; and first OF INTELLECTUAL EDUCATION (358)

- Art. 1.* (I.) *Idea of Space.*  
 2. Education by Geometry.  
 3. (II.) *Idea of Number.*  
 4. Effect of the usual Education.  
 5. (III.) *Idea of Force.*  
 6. Study of Mechanics needed,  
 7. To make Newton intelligible.  
 8. No *Popular* Road.  
 9. (IV.) *Chemical Ideas.*  
 10. (V.) *Natural History Ideas.*  
 11. Natural Classes to be taught.  
 12. Mathematical Prejudices,  
 13. To be corrected by Natural History.  
 14. Method of Natural History,

Art. 15.	Resembles common Language.	
16.	Its Lessons.	
17.	(VI.) <i>Well-established Ideas alone to be used.</i>	
18.	How are Ideas cleared?	
CHAP. IV.	OF METHODS OF ACQUIRING CLEAR SCIENTIFIC IDEAS, <i>continued.—OF THE DISCUSSION OF IDEAS</i> (3)	374
Art. 1.	Successive Clearness,	
2.	Produced by Discussion.	
3.	Examples.	
4.	Disputes not useless,	
5.	Although “metaphysical.”	
6.	Connected with Facts.	
CHAP. V.	ANALYSIS OF THE PROCESS OF INDUCTION (4)	380
Sect. I.	<i>The Three Steps of Induction.</i>	
Art. 1.	Methods may be useful.	
2.	The three Steps.	
3.	Examples.	
4.	Mathematical names of the Steps.	
Sect. II.	<i>Of the Selection of the Fundamental Idea.</i>	
Art. 5.	Examples.	
6.	The Idea to be found by trying,	
7.	Till the Discovery is made;	
8.	Preluded by Guesses.	
9.	Idea and Facts homogeneous.	
10.	Idea tested by the Facts.	
CHAP. VI.	GENERAL RULES FOR THE CONSTRUCTION OF THE CONCEPTION (6)	389
Art. 1.	First: for Quantity.	
2.	Formula and Coefficients found together.	
3.	Example. Law of Cooling.	
4.	Determined by Experiment.	
5.	Progressive Series of Numbers.	
6.	Recurrent Series.	
7.	Use of Hypotheses.	
8.	Even with this there are Difficulties.	
CHAP. VII.	SPECIAL METHODS OF INDUCTION APPLICABLE TO QUANTITY (4)	395
Sect. I.	<i>The Method of Curves.</i> (5)	
Art. 1.	Its Process.	

Art. 2.	Its Use.	
3.	With imperfect Observations.	
4.	It corrects Observations.	
5.	<i>Obstacles.</i> (I.) Ignorance of the Argument.	
6.	(II.) Combination of Laws.	
Sect. II.	<i>The Method of Means.</i>	
Art. 7.	Its Relation to the Method of Curves.	
8.	Its process.	
9.	<i>Argument</i> required to be known.	
10.	Use of the Method.	
11.	Large masses of Observations used.	
12.	Proof of the Use of the Method.	
Sect. III.	<i>The Method of Least Squares</i>	
Art. 13.	Is a Method of Means.	
14.	Example.	
Sect. IV.	<i>The Method of Residues.</i>	
Art. 15.	Occasion for its Use.	
16.	Its Process.	
17.	Examples.	
18.	Its Relation to the Method of Means.	
19.	Example.	
20.	"Residual Phenomena."	
CHAP. VIII.	METHODS OF INDUCTION DEPENDING ON RESEMBLANCE	412
Sect. I.	<i>The Law of Continuity.</i>	
Art. 1.	Its Nature and Application,	
2.	To Falling Bodies,	
3.	To Hard Bodies,	
4.	To Gravitation.	
5.	The Evidence.	
Sect. II.	<i>The Method of Gradation.</i>	
Art. 6.	Occasions of its Use.	
7.	Examples.	
8.	Not enjoined by Bacon.	
9.	Other Examples.	
10.	Its Value in Geology.	
11.	Limited Results.	
Sect. III.	<i>The Method of Natural Classification.</i>	
Art. 12.	Examples of its Use.	

*Art.* 13. Its Process.

14. Negative Results.

15. Is opposed to Arbitrary Definitions.

16. Propositions and Definitions correlative.

17. Definitions only provisional.

CHAP. IX. OF THE APPLICATION OF INDUCTIVE TRUTHS (6) 425

*Art.* 1. This forms the Sequel of Discovery.

2. Systematic Verification of Discoveries.

3. Correction of Coefficients.

4. Astronomy a Model.

5. Verification by new cases.

6. Often requires fresh calculation.

7. Cause of Dew.

8. Useful Applications.

CHAP. X. OF THE INDUCTION OF CAUSES (5) . . . 431

*Art.* 1. Is to be pursued.

2. Induction of Substance.

3. Induction of Force.

4. Induction of Polarity.

5. Is Gravity Polar?

6. Induction of Ulterior Causes.

7. Of the Supreme Cause.

APHORISMS:—

APHORISMS CONCERNING IDEAS. (*Aph.* I—CXIII.) . . . 443

APHORISMS CONCERNING SCIENCE. (*Aph.* I—LVI.) . . . 466

APHORISMS CONCERNING THE LANGUAGE OF SCIENCE . . . 479

*Aphorism* I. Relative to the Ancient Period . . . 480

*Art.* 1. Common Words.

2. Descriptive Terms.

3. Theoretical Terms.

*Aphorism* II. Relative to the Modern Period . . . 492

*Art.* 1. Systematic Nomenclature.

2. Systematic Terminology.

3. Systematic Modification.

*Aphorisms* (III, IV, V, VI, VII,) relative to the Application  
of Common Words . . . 502

*Aphorisms* (VIII, IX, X, XI, XII, XIII, XIV,) relative to  
the Construction of New Terms . . . 509

	PAGE
<i>Aphorism XV.</i> Relative to the Form of Terms . . . . .	538
<i>Art. 1.</i> Terms derived from Latin and Greek.	
2. German Terms.	
3. Descriptive Terms.	
4. Nomenclature. Zoology.	
5. ————— Mineralogy.	
6. ————— Botany.	
7. ————— Chemistry.	
8. ————— Crystallography.	
 <i>Aphorism XVI.</i> Relative to the Composition and Inflexion of Terms . . . . .	 549
<i>Art. 1.</i> Hybrids.	
2. Terminations of Substantives.	
3. Formations of Substantives (names of things.)	
4. Abstract Substantives.	
5. Rules of derivation from Greek and Latin.	
6. Modification of Terminations.	
 <i>Aphorism XVII.</i> Relative to the Mode of Introducing Changes	 564

## APPENDIX.

### PHILOSOPHICAL ESSAYS PREVIOUSLY PUBLISHED.

ESSAY I. ON THE NATURE OF THE TRUTH OF THE LAWS OF MOTION . . . . .	573
ESSAY II. REMARKS ON MATHEMATICAL REASONING AND ON THE LOGIC OF INDUCTION . . . . .	595
<i>Sect. I.</i> <i>On the Grounds of Mathematical Reasoning.</i>	
<i>Sect. II.</i> <i>On the Logic of Induction.</i>	
ESSAY III. DEMONSTRATION THAT ALL MATTER IS HEAVY . . . . .	624
ESSAY IV. DISCUSSION OF THE QUESTION :—ARE CAUSE AND EFFECT SUCCESSIVE OR SIMULTANEOUS? . . . . .	635
ESSAY V. ON THE FUNDAMENTAL ANTITHESIS OF PHILOSOPHY . . . . .	647
ESSAY VI. REMARKS ON A REVIEW OF THE PHILOSOPHY OF THE INDUCTIVE SCIENCES . . . . .	669

---

THE  
PHILOSOPHY  
OF THE  
INDUCTIVE SCIENCES,

---

PART II.  
OF KNOWLEDGE.

VOL. II. W. P.

B

De Scientiis tum demum bene sperandum est, quando per SCALAM veram et per gradus continuos, et non intermissos aut hiulcos, a particularibus ascendetur ad Axiomata minora, et deinde ad media, alia aliis superiora, et postremò demum ad generalissima.

In constituendo autem Axiomate, Forma INDUCTIONIS alia quam adhuc in usu fuit, excogitanda est; et quæ non ad Principia tantum (quæ vocant) probanda et invenienda, sed etiam ad Axiomata minora, et media, denique omnia.

BACON, *Nov. Org.*, Aph. civ. cv.