# Reading Guide

Text: Isaac Newton, *The Mathematical Principles of Natural Philosophy*, translated by Andrew Motte.[1]

**Core questions:**

What is scientific understanding?

**Introduction:**

> → What we have read in Text 2
> → Newton's *Principia*
> → Newton's achievements
> → Demarcation between philosophy and mathematics
> → Questions to ask

Text 2 displays a history of humans' effort in describing motions and looking for their explanations. Aristotle categorized motions into several kinds. In particular, falling was described as a natural and uniform motion whose speed depended on the weight of the object and the resistive force acting on it. He also proposed that weight was caused by the propensity of heavy elements to their natural places. While Aristotelian physics had been widely accepted in the academia for two thousand years, various attempts were taken by medieval philosophers to refine his theory and find out the true explanation of motions.

The tradition of study of motion culminated in Newton's publication of *Philosophiæ naturalis principia mathematica* (*Mathematical Principles of Natural Philosophy*), which is often referred to as *The Principia*. Firstly published in 1687, it is doubtless one of the most important works in the history of science. The text we are going to read consists excerpts from different parts of the 3rd edition of *The Principia*., published in 1726. *The Principia* was published in three books. Book I and Book II discuss motion of bodies. In Book III, Newton constructed the system of the world. Below is a simplified table of contents of *The Principia*. Those highlighted parts are where the excerpts come from.

- □ Newton's Preface
- □ Definitions
- □ Axioms, or Laws of Motion
- □ BOOK I: OF THE MOTION OF BODIES

[1] Source: https://en.wikisource.org/wiki/The_Mathematical_Principles_of_Natural_Philosophy_(1846)

- Book I consists of 14 sections on different topics about motion.
  - BOOK II. OF THE MOTION OF BODIES (contd.)
    - Book II consists of 9 sections on different topics about motion.
  - BOOK III. THE SYSTEM OF THE WORLD
    - Rules of Reasoning in Philosophy
    - Phænomena, or Appearances
    - Propositions I-XVI
    - Of the Motion of the Moon's Nodes
    - General Scholium

The text starts with definitions such as mass (quantity of matter), momentum (quantity of motion) and inertia and axioms, which are his three laws of motion. While Newton's attempt to consider physical concepts physically is highly appreciated, he did not succeed. He declared that his focus was the mathematical properties of the concepts. After he had discussed motion of bodies in Books I and II, he was about to construct a system of the world in Book III. Newton firstly wrote down several "Rules of Reasoning in Philosophy" in Book III. With the benefit of hindsight, we can see these rules symbolized the beginning of modern science. For example, in Rule IV, it is clearly stated that theories are results of induction from phenomena and they are falsifiable. *The Principia* ends with the General Scholium, where Newton gave a final comment on universal gravitation and contemplated on the existence and attributes of the Being.

In the General Scholium, Newton said, "I have not been able to discover the cause of those properties of gravity from phænomena, and I frame no hypotheses". Had Newton already reached the limit of science? Newton only talked about the mathematical relations between physical quantities but he did not go into the meaning of them. Without understanding of the meaning, did Newton really understand the universe? What is scientific understanding?

**Suggested outline of the text:** skipped.

**Study Questions** (Answers can be found at the end of this section.)

(Definition I)

1. Which is another name for "the quantity of matter"
(a)  Mass.
(b)  Weight.
(c)  Bulk.
(d)  Density.

2. The gravity on the moon is about 1/6 of that on the Earth. Suppose there are two leaden balls of mass 1 kg and 2 kg. If they are moved from the Earth to the moon, which of the following statements is correct?
(a)  Their mass and weight remain the same.
(b)  Both their mass and weight decrease by 1/6.
(c)  Their mass has the ratio 1:2 and so does their weight.
(d)  Their mass decreases. Their weight remains the same.

(Definition II)

3. There are two identical leaden balls, one is rotating and the other at rest. Which statement is correct?
(a)  The rotating ball has a larger quantity of motion.
(b)  The rest ball has a larger quantity of motion.
(c)  They have the same quantity of motion.
(d)  The quantity of motion of the rotating ball is unknown.

(Definitions III and IV)

4. An apple is falling due to gravity. Which statement is correct?
(a)  The apple is influenced by both the gravity and its *vis insita*.
(b)  The gravitational force has become the apple's *vis insita*.
(c)  The *vis insita* of the apple has disappeared temporarily.
(d)  The *vis insita* of the apple is increasing.

(Definition V)

5. It is possible for a leaden ball to go around the Earth if
(a)  it has a fast enough speed.
(b)  it is heavy enough.
(c)  the earth is small enough.
(d)  there is no gravity.

(Axioms, or laws of motion)

|  | First statement | Second statement | |
|---|---|---|---|
| (a) | True | True | The 2nd statement is a correct explanation of the 1st statement. |
| (b) | True | True | The 2nd statement is NOT a correct explanation of the 1st statement. |
| (c) | True | False | |
| (d) | False | True | |

| 6. Your fist feels pain when you hit the wall. | The reaction force acting on your fist by the wall is larger than the force acting on the wall. |
|---|---|

7. Which statement is correct?
(a) There is no force acting on the moon because there is no gravity in the space.
(b) There is no force acting on the moon because nothing is touching the moon.
(c) There is surely a force acting on the moon because its orbit is not linear.
(d) The state of motion of the moon does not change as long as it keeps going around the Earth in same clockwise or anticlockwise direction.

(Rules of reasoning in philosophy)

8. Which statement does not represent inductive thinking?
(a) All swans in this lake are black, so all of them have their left half black.
(b) All swans in this lake are black, so I believe all swans in the world are black.
(c) All swans in this lake are black. All swans in this country should be black.
(d) All swans in this lake are black. I believe the next one I see is black, too!

(General Scholium)

9. Newton said, "Every soul that has perception is, though in different times and in different organs of sense and motion, still the same indivisible person." What did Newton argue for?
(a) God is omnipotent.
(b) God is omnipresent.
(c) God is omniscience.
(d) God is one and only one.

Answers:

| 1.a | 6.c |
|---|---|
| 2.c | 7.c |
| 3.c | 8.a |
| 4.a | 9.d |
| 5.a | |

— End —