



THE  
GREAT  
COURSES®

Topic  
Philosophy &  
Intellectual History

Subtopic  
Modern  
Philosophy

# Redefining Reality: The Intellectual Implications of Modern Science

Course Guidebook

Professor Steven Gimbel  
Gettysburg College

**PUBLISHED BY:**

**THE GREAT COURSES**

**Corporate Headquarters**

**4840 Westfields Boulevard, Suite 500**

**Chantilly, Virginia 20151-2299**

**Phone: 1-800-832-2412**

**Fax: 703-378-3819**

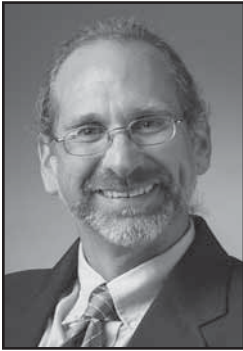
**[www.thegreatcourses.com](http://www.thegreatcourses.com)**

**Copyright © The Teaching Company, 2015**

Printed in the United States of America

This book is in copyright. All rights reserved.

Without limiting the rights under copyright reserved above,  
no part of this publication may be reproduced, stored in  
or introduced into a retrieval system, or transmitted,  
in any form, or by any means  
(electronic, mechanical, photocopying, recording, or otherwise),  
without the prior written permission of  
The Teaching Company.



**Steven Gimbel, Ph.D.**  
Professor of Philosophy  
Gettysburg College

---

**P**rofessor Steven Gimbel received his Ph.D. from Johns Hopkins University before joining the faculty at Gettysburg College, where he is a Professor of Philosophy. At Gettysburg, he has received the Luther W. and Bernice L. Thompson Distinguished Teaching

Award and was named to the Edwin T. Johnson and Cynthia Shearer Johnson Distinguished Teaching Chair in the Humanities. He also serves as Chair of the Philosophy Department.

Professor Gimbel's research focuses on the philosophy of science, exploring the nature of scientific reasoning and the ways in which science and culture interact. He has published numerous articles and four books: *Defending Einstein: Hans Reichenbach's Writings on Space, Time and Motion*; *Exploring the Scientific Method: Cases and Questions*; *Einstein's Jewish Science: Physics at the Intersection of Politics and Religion*; and *Einstein: His Space and Times*. ■

# Table of Contents

---

## INTRODUCTION

|                           |   |
|---------------------------|---|
| Professor Biography ..... | i |
| Course Scope .....        | 1 |

## LECTURE GUIDES

### LECTURE 1

|   |   |
|---|---|
| Metaphysics and the Nature of Science ..... | 5 |
|---|---|

### LECTURE 2

|                        |    |
|------------------------|----|
| Defining Reality ..... | 12 |
|------------------------|----|

### LECTURE 3

|                             |    |
|-----------------------------|----|
| Mathematics in Crisis ..... | 19 |
|-----------------------------|----|

### LECTURE 4

|                          |    |
|--------------------------|----|
| Special Relativity ..... | 26 |
|--------------------------|----|

### LECTURE 5

|                          |    |
|--------------------------|----|
| General Relativity ..... | 33 |
|--------------------------|----|

### LECTURE 6

|                          |    |
|--------------------------|----|
| Big Bang Cosmology ..... | 40 |
|--------------------------|----|

### LECTURE 7

|                            |    |
|----------------------------|----|
| The Reality of Atoms ..... | 47 |
|----------------------------|----|

### LECTURE 8

|                         |    |
|-------------------------|----|
| Quantum Mechanics ..... | 54 |
|-------------------------|----|

### LECTURE 9

|                            |    |
|----------------------------|----|
| Quantum Field Theory ..... | 61 |
|----------------------------|----|

### LECTURE 10

|                    |    |
|--------------------|----|
| Chaos Theory ..... | 68 |
|--------------------|----|

## Table of Contents

---

|   |     |
|---|-----|
| <b>LECTURE 11</b>                           |     |
| Dark Matter and Dark Energy.....            | 75  |
| <b>LECTURE 12</b>                           |     |
| Grand Unified Theories .....                | 82  |
| <b>LECTURE 13</b>                           |     |
| Quantum Consciousness .....                 | 89  |
| <b>LECTURE 14</b>                           |     |
| Defining Reality in the Life Sciences ..... | 96  |
| <b>LECTURE 15</b>                           |     |
| Genes and Identity .....                    | 103 |
| <b>LECTURE 16</b>                           |     |
| The Birth of Psychology.....                | 110 |
| <b>LECTURE 17</b>                           |     |
| Jung and the Behaviorists .....             | 117 |
| <b>LECTURE 18</b>                           |     |
| The Rediscovery of the Mind.....            | 125 |
| <b>LECTURE 19</b>                           |     |
| The Caring Brain .....                      | 132 |
| <b>LECTURE 20</b>                           |     |
| Brain and Self.....                         | 139 |
| <b>LECTURE 21</b>                           |     |
| Evolutionary Psychology .....               | 146 |
| <b>LECTURE 22</b>                           |     |
| The Birth of Sociology .....                | 153 |
| <b>LECTURE 23</b>                           |     |
| Competition and Cooperation.....            | 160 |

## Table of Contents

---

|   |     |
|---|-----|
| <b>LECTURE 24</b>                         |     |
| Race and Reality .....                    | 167 |
| <b>LECTURE 25</b>                         |     |
| Social Progress .....                     | 174 |
| <b>LECTURE 26</b>                         |     |
| The Reality of Money.....                 | 181 |
| <b>LECTURE 27</b>                         |     |
| The Origin of Life .....                  | 188 |
| <b>LECTURE 28</b>                         |     |
| Exoplanets and Extraterrestrial Life..... | 195 |
| <b>LECTURE 29</b>                         |     |
| Technology and Death.....                 | 202 |
| <b>LECTURE 30</b>                         |     |
| Cloning and Identity.....                 | 209 |
| <b>LECTURE 31</b>                         |     |
| Genetic Engineering .....                 | 216 |
| <b>LECTURE 32</b>                         |     |
| Medically Enhanced Humans .....           | 223 |
| <b>LECTURE 33</b>                         |     |
| Transhumans: Making Living Gods .....     | 230 |
| <b>LECTURE 34</b>                         |     |
| Artificial Intelligence.....              | 237 |
| <b>LECTURE 35</b>                         |     |
| The Internet and Virtual Reality .....    | 244 |
| <b>LECTURE 36</b>                         |     |
| Data Analytics.....                       | 251 |

## Table of Contents

---

### SUPPLEMENTAL MATERIAL

|                   |     |
|-------------------|-----|
| Bibliography..... | 258 |
|-------------------|-----|





# Redefining Reality: The Intellectual Implications of Modern Science

---

## Scope:

In this series of 36 lectures, we examine the ways in which scientific and technological advances in the 20<sup>th</sup> and 21<sup>st</sup> centuries have forced us to re-envision what we believe to be real. Our views of reality derive from a number of sources—religious, cultural, political, and so on—but new theories and new tools can lead to conflicts with the picture of the universe we hold. In light of those conflicts, we are forced to develop a novel sense of what the world is truly like. This new sense of things that we derive from science and technology is not removed from the larger social context but is reflected and sometimes foreseen in the arts. In this course, we will look at both the ways in which science has reshaped our understanding of reality and the ways in which these changes have influenced the way we live, our interactions with one another, and the artifacts we create.

We will begin in the first two lectures by discussing what we mean by *reality*, where our traditional Western view of reality comes from, and the ways in which scientific and technological advances interact with our view of reality. On the one hand, science simply comes up with ways of organizing what we see. On the other hand, these organizational structures—what we call scientific theories—can be interpreted as disclosing aspects of reality itself. This interpretive project comes from science but is the work of philosophers. We examine the intersection of the scientific and philosophical projects closely.

In Lecture 3, we examine the state of mathematics at the dawn of the 20<sup>th</sup> century. With its absolute rigor, mathematics was long thought to be the bedrock of our intellectual framework. But at the beginning of the 20<sup>th</sup> century, when faced with bizarre results about the nature of infinity and non-Euclidean geometry, mathematicians found themselves in the uncomfortable position of doubting the entire basis for the mathematical program. Their struggle was the first domino, as the foundations of every science would come under scrutiny in the decades that followed.

First to be infected by this radical doubt and the need for complete reformulation were the physical sciences. In the period before the mathematical concerns began, physicists were equally complacent, assured that physics as a science was almost complete. We had Isaac Newton's theory that explained the working of gravitation and mechanics, the theory of motion. We had James Clerk Maxwell's theory that accounted for electrical, magnetic, and optical phenomena. It seemed that we could explain almost everything we see. But the two theories did not quite mesh. Scientists figured that we just needed someone clever to figure out how the pieces fit together. Someone clever appeared in the person of Albert Einstein, but instead of unifying the classical view of physics, he overturned it with his theories of special and general relativity and his proof of the existence of atoms. We will examine each of these and the theory of big bang cosmology that followed from Einstein's work in Lectures 4 through 7.

After Einstein, indeed because of another of his results—the explanation for the photoelectric effect, wherein light when focused on a piece of metal causes electrons to be emitted—the theory of quantum mechanics was developed and turned into quantum field theory. It is a strange picture of our world, in which reality is governed by probabilities that cannot be eliminated by additional knowledge. This leads to a discussion of chaos theory and systems theory, which likewise show us to be living in an intricate and sometimes unexpectedly complex world. We will explore these advances in Lectures 8 through 10 before turning to the recent discovery of dark matter and dark energy in Lecture 11. This sets the stage for a discussion in Lecture 12 of the contemporary project at the heart of physics, the grand unified theory, which seeks a single coherent explanation for all physical phenomena.

But does this encompass all observable aspects of the universe? What about human consciousness? In Lecture 13, we will look at theories that try to explain human thought and the appearance of free will in terms of quantum mechanics. Are our minds reducible to our brains, and are our brains, because they are made up of nothing but atoms, completely open to an explanation on the basis of physical theory?