

# **PHIL 3430**

## **History of Science: Newton to Einstein**

Fall 2022

Section 001 – MWF 11:15am – 12:05pm in [Club 13](#)

### **Syllabus**

The syllabus can be found at the course page: [canvas.colorado.edu](https://canvas.colorado.edu)

### **Instructor**

Joseph Wilson - [joseph.wilson-1@colorado.edu](mailto:joseph.wilson-1@colorado.edu)

*Office Hours.* Tuesdays and Thursdays 12:00pm - 1:00pm on [Zoom](#). Zoom meetings can be made by appointment.

### **Course Description**

*Anyone who is not shocked by quantum theory has not understood a single word*

– Niels Bohr

In this course we will have several goals:

One of our goals will be to understand what is so shocking about both quantum mechanics and relativity theory. We'll arrive there historically, by first looking at the rise of and debates within classical physics over questions like: what is space? What is time? What is matter? What is change?

We are also going to be wondering about the nature of the scientific enterprise itself. We'll see that science isn't just a linear march toward objective truth. Rather, scientific worldviews progress and change for interestingly truth-independent reasons.

We will observe the complicated transition from mechanistic views of physics in the 17<sup>th</sup> century to its replacement in the 20<sup>th</sup> century. Many assumptions of 17<sup>th</sup> century physics are rooted further back in time, back to the very beginnings of scientific thought in the West among the ancient Greeks. We will consider these assumptions and how 20<sup>th</sup> century physics forces us to reconsider them.

**Prerequisites:** restricted to sophomores, juniors, and seniors. Recommended: 6 hours of philosophy course work.

## Required Reading

All required readings can be found at the course canvas page, in the 'Required Readings' module.

*The Structure of Scientific Revolutions*, Thomas Kuhn

*Evolution of Physics*, Albert Einstein & Leopold Infeld

*The Philosophical Impact of Contemporary Physics*, Milič Čapek

*The Leibniz-Clarke Correspondence*

## Course Requirements

*Exam (80%).* For each of the 3 units of the course, there will be an *exam*. These exams may be composed of short essay questions.

The exam dates are set on the course schedule:

- Exams are only available ***in class*** on the day of the exam.
- If you know that you will not be able to take one of the exams on its scheduled day, ***contact me ahead of time.***
- **All 3 exams will require you purchase a Bluebook.** These are available at the student store in the UMC, and likely elsewhere. Make sure to pick them up ahead of time.

*Reading Responses (20%).* The majority of your work in this class will involve seriously engaging with the ideas and arguments presented in this course. As such, you should come to class having done the readings for the day and spent some time thinking about them. For ten different class sessions, you will submit a written response to one of the readings for the day. Your response should mostly comprise of a summary of the reading, followed by a shorter critical engagement and a set of two or three questions that you would like clarified or discussed in class. The summary should focus on the major arguments and claims of the papers. The critical engagement should comprise of questions or objections you have for the discussed views,

or extensions/applications of the view to your own life. I want to hear about how *you* are reflecting on these ideas.

I hate to have strict word limits, but as a general approximation: more than 250 words will often be required for an adequate summary, and more than 150 words will be required to adequately express your critical concerns or claims. If you are unsure how detailed your response should be, use these word-counts as guidelines (350 words total).

Reading responses are graded for completion.

## **Technology in the Classroom**

Unless otherwise stated in an accommodation, **students will not be permitted the use of laptops or other electronic devices in the classroom.** I really hate to do this, but it really is in your own interest. The use of laptops in the classroom has been linked to decreased performance in both users and classmates. As such, I will paternalistically enforce this policy. [If you really feel like you can't sit still for 50 minutes, no need to come to class. Take a day off.]

## **What Does a Philosopher Look Like?**

Like many disciplines in the academy, philosophy has historically been dominated by white men. Stereotype threat is a psychological phenomenon that causes people to underperform in a discipline in the face of a stereotype that says that “people like them” aren’t good at that discipline. However, telling students that there are no actual differences in performance in a class can defuse the anxiety that the stereotype creates and subsequently undermines those tendencies to underperform. The stereotype that says that only white men can be good philosophers is false.

For more on this, visit: <http://looksphilosophical.tumblr.com/>

## **On Seeming Smart**

Regardless of whether you’ve studied some of this material prior to this course, you might often find yourself feeling intimidated by the way academics write or talk. This might be because all disciplines employ jargon and concepts that you either might not have encountered before, or that you might have seen used differently. Jargon can be useful, but it can also be used to exclude people and make them feel like they don’t have a place in the conversation. Don’t feel that way and don’t be intimidated!

If you don’t know what a term means, ask for a definition. If you don’t know how a concept is being used, ask for clarification. For a very helpful essay that speaks to this (among other important things) see “On Being Good at Seeming Smart”:

<http://schwitsplinters.blogspot.com/2010/03/on-being-good-at-seeming-smart.html>



**Course Schedule** – Subject to change at instructor’s discretion. You will be informed when any changes occur.

<b>Week 1</b>		Readings
<b>Mon 08/22</b>	Syllabus Introduction: The beginnings of Western Science	Read the Syllabus
<b>Wed 08/24</b>	Continue The Beginnings of Western Science	Kuhn, Chapter 1
<b>Fri 08/26</b>	Aristotle	Kuhn, Chapter 2
<b>Week 2</b>		
<b>Mon 08/29</b>	Kuhn's Vocabulary	Kuhn, Chapters 3, 4
<b>Wed 08/31</b>	Rationalism, Empiricism, Kant	Kuhn, Chapters 5,6
<b>Fri 09/02</b>	Kuhnian Ideas	Kuhn, Chapters 7, 8
<b>Week 3</b>		
<b>Mon 09/05</b>	<b>No Class – Labor Day</b>	

<b>Wed 09/07</b>	Kuhn vs. Popper	Kuhn, Chapters 9, 10
<b>Fri 09/09</b>	First portion of <i>The Structure of Scientific Revolutions</i>	Kuhn, Chapters 11, 12
<b>Week 4</b>		
<b>Mon 09/12</b>	Second portion of <i>The Structure of Scientific Revolutions</i>	Kuhn, Chapters 13, Postscript
<b>Wed 09/14</b>	Matter	Capek, pgs. 3-31
<b>Fri 09/16</b>	Space	Capek, pgs. 35-51
<b>Week 5</b>		
<b>Mon 09/19</b>	Time	Capek, pgs. 121-140
<b>Wed 09/21</b>	Action at a Distance	Capek, pgs. 35-51
<b>Fri 09/23</b>	Galilean Relativity	Capek, pgs. 54-65, 67-77
<b>Week 6</b>		
<b>Mon 09/26</b>	Motion	Einstein & Infeld, pgs. 3-65
<b>Wed 09/28</b>	Scientific Revolution Timeline	
<b>Fri 09/30</b>	Scientific Revolution Timeline	

<b>Week 7</b>		
<b>Mon 10/03</b>	Mechanistic Paradigm	Capek, pgs. 79-117, 135-140
<b>Wed 10/05</b>		
<b>Fri 10/07</b>	<b>Exam 1</b>	
<b>Week 8</b>		
<b>Mon 10/10</b>	Intro to Leibniz	Leibniz-Clarke letters 1,2
<b>Wed 10/12</b>	Absolute vs Relative Space and Time	Leibniz-Clarke letters 3,4
<b>Fri 10/14</b>		
<b>Week 9</b>		
<b>Mon 10/17</b>	Correspondence; Newton's God Arguments	Leibniz-Clarke letter 5
<b>Wed 10/19</b>	Vacuum	Einstein & Infeld, pgs. 69-153 (over the next week or so)
<b>Fri 10/21</b>	Electricity and Magnetism	
<b>Week 10</b>		
<b>Mon 10/24</b>	Electricity and Magnetism Part 2	
<b>Wed 10/26</b>	Thermodynamics	

<b>Fri 10/28</b>	Light	You should definitely have finished Einstein & Infeld, pgs. 69-153 by now.
<b>Week 11</b>		
<b>Mon 10/31</b>	Special Relativity 1	Einstein & Infeld, pgs 153-208
<b>Wed 11/02</b>	Special Relativity 1.5	Capek, pgs. 143-156; 216-217
<b>Fri 11/04</b>	Special Relativity 2: $E=mc^2$ and Paradoxes	Capek, pgs. 175-185,199-212
<b>Week 12</b>		
<b>Mon 11/07</b>	General Theory of Relativity	Capek, pgs. 143-156; 216-217
<b>Wed 11/09</b>		
<b>Fri 11/11</b>	<b>Exam 2</b>	
<b>Week 13</b>		
<b>Mon 11/14</b>	General Theory of Relativity	Capek, pgs. 244-260
<b>Wed 11/16</b>	Two Slit Experiment; Quantum Mechanics	Einstein & Infeld, pgs. 245-280
<b>Fri 11/18</b>	Quantum Mechanics: Indeterminacy, interpretations	Capek, pgs. 262-287
<b>Week 14</b>		



<b>Mon 11/21</b>	<b>Fall Break - No Class</b>	
<b>Wed 11/23</b>	<b>Fall Break - No Class</b>	
<b>Fri 11/25</b>	<b>Fall Break - No Class</b>	
<b>Week 15</b>		
<b>Mon 11/28</b>	Quantum Mechanics - Interpretations	Einstein & Infeld, pgs. 280-297 Capek, pgs 289-329, 333-357
<b>Wed 11/30</b>	Quantum Mechanics – Philosophical Stuff	Capek, pgs. 361-400
<b>Fri 12/02</b>	Mechanistic Thinking within the Social Sciences	2 Letters: Engels to Bloch 1890, Engels to Borgius 1894
<b>Week 16</b>		
<b>Mon 12/05</b>	Mechanistic Thinking within the Social Sciences Part 2	
<b>Wed 12/07</b>		
<b>Fri 12/09</b>	<b>Reading Day – No Class</b>	
<b><i>FINAL EXAM</i></b>		<b>In our usual class room</b>



## University Policies

### Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Conduct & Conflict Resolution policies](#).

### Requirements for COVID-19

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policy on [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

CU Boulder currently requires masks in classrooms and laboratories regardless of vaccination status. This requirement is a precaution to supplement CU Boulder’s COVID-19 vaccine requirement. Exemptions include individuals who cannot medically tolerate a face covering, as well as those who are hearing-impaired or otherwise disabled or who are communicating with someone who is hearing-impaired or otherwise disabled and where the ability to see the mouth is essential to communication. If you qualify for a mask-related accommodation, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus. In addition, vaccinated instructional faculty who are engaged in an indoor instructional activity and are separated by at least 6 feet from the nearest person are exempt from wearing masks if they so choose.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the [Public Health Office](#) ([contacttracing@colorado.edu](mailto:contacttracing@colorado.edu)). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the [Public Health Office](#) ([contacttracing@colorado.edu](mailto:contacttracing@colorado.edu)).

### Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or [dsinfo@colorado.edu](mailto:dsinfo@colorado.edu) for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

## **Preferred Student Names and Pronouns**

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

## **Honor Code**

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code ([honor@colorado.edu](mailto:honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the [Honor Code website](#).

## **Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation**

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about university policies, [reporting options](#), and the support resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive

information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit [Don't Ignore It](#).

## **Religious Holidays**

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Let the instructor know if you require accommodations for religious observances and they will be provided.

See the [campus policy regarding religious observances](#) for full details.