Philosophy of Science Survey

Week 2

PHIL 2160. Ohio University. Spring 2021.

Annotations

- Familiarize yourself with Perusall (you are given an overview when you first use it).
- Reading assignments are described within Perusall and on weekly pages of the course website.
- Each annotation is graded 1, 2, or 3 (3 being substantive).
- Each assignment is graded 1, 2, or 3. For full credit, make at least 2 substantive annotations. Partial credit is given based on the number, quality, and timeliness of your annotations.

frontiers in Education

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Use of a Social Annotation Platform for Pre-Class Reading Assignments in a Flipped Introductory Physics Class

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In this paper, we illustrate the successful implementation of pre-class reading assignments through a social learning platform that allows students to discuss the reading online with their classmates. We show how the platform can be used to understand how students are reading before class. We find that, with this platform, students spend an above average amount of time reading (compared to that reported in the literature) and that most students complete their reading assignments before class. We identify specific reading behaviors that are predictive of in-class exam performance. We also demonstrate ways that the platform promotes active reading strategies and produces high-quality learning interactions between students outside class. Finally, we compare the exam performance of two cohorts of students, where the only difference between them is the use of the platform; we show that students do significantly better on exams when using the platform.

Keywords: digital education, flipped classroom, educational software, pre-class reading, physics education research

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Chapter 1: Worldviews

Worldviews

- A worldview = an interconnected system of beliefs.
- The jigsaw puzzle metaphor illustrates two features of a worldview.

1. Beliefs of a worldview are **interconnected**.
   - Beliefs of a system are not independent of each other.
   - Rather, they cohere with each other.
2. A worldview has **core** and peripheral beliefs.
   - Core beliefs are hard to replace without affecting the entire worldview.
   - Peripheral beliefs are relatively easy to replace without affecting the rest of the worldview.

Example: Aristotelian Worldview

- The Aristotelian worldview (review the list in the book)
  a. The Earth is located at the center of the universe.
  b. The Earth is completely stationary.
  c. . . .
- (a) and (b) are **interconnected**. To see why, ask yourself if the set of beliefs below is coherent:
  - The Earth is located at the center of the universe.
  - The Earth orbits in the universe.

Example: Aristotelian Worldview

- The Aristotelian worldview (review the list in the book)
  a. The Earth is located at the center of the universe.
  b. The Earth is completely stationary.
  c. . . .
- (a) and (b) are **core beliefs**. To see why, replace (a) and (b) with a core belief of the Newtonian worldview:

  The Earth and planets move in elliptical orbits around the sun.

  and see if the rest of the Aristotelian worldview can stay intact (see next).

Example: Aristotelian Worldview

- Consider another Aristotelian belief: “The element earth has a natural tendency to move toward the center of the universe.”
- If the Earth is not at the center of the universe, but the element earth falls towards the center, it’s hard to explain why the Earth is not falling towards the center, where the Sun is.
- This illustrates how (a) and (b) act as core beliefs in the Aristotelian worldview. It’s hard to replace them without affecting other beliefs in the worldview.

Example: Aristotelian Worldview

- But what about the planets? They don't exist at the center of the universe, so wouldn't it be equally hard to explain their location and motion? Why don't the plants fall towards the center of the universe (i.e., towards the Earth)?
- It would be hard if planets are also made of the element earth.

Example: Aristotelian Worldview

- But the Aristotelian worldview has other beliefs:
  - Planets are composed of a different element, ether.
  - Ether has a natural tendency to move in a perfect circle.
- With these beliefs, the worldview can explain why planets are not falling toward the Earth and why they move in a circular path over the sky.

Example: Aristotelian Worldview

- When we read about an old, discarded worldview, it's tempting to focus on what it got right: the beliefs that are close to ours.
- In history and philosophy of science, this way of interpreting the past is called *whiggish*.
  - Historian Herbert Butterfield coined the term "Whig history" to refer to a history that studies the past with reference to the present.
- A Whig history of the Aristotelian worldview is unlikely to be helpful for us to understand that worldview, because Aristotelians were not trying to anticipate Newtonian views.

Example: Aristotelian Worldview

- To better understand a past worldview, we need to remember that scientists at any point in time are working on the problems of their day: the problems that are unsolved by an *older* worldview.
- The Aristotelian worldview solved many of the outstanding problems left by pre-Aristotelian views (e.g., pre-Socratics and Plato).
- But as we'll see, there were other problems that the Aristotelian worldview didn't solve well. Scientists working on these problems eventually proposed solutions that required the rejection of core Aristotelian beliefs.

Advice on reading history of science

- Look back at the Aristotelian beliefs. At first you probably noticed those beliefs that are *close to the current beliefs (or yours)*.
  - But of course Aristotelians didn't hold those beliefs because they were close to Newton's! (That would be absurd.)
- To better understand the Aristotelian worldview, identify the beliefs that are *totally different from yours*.
- Then think about why some of the smartest people in history held those beliefs. You don't need to be able to come up with correct answers. But this exercise forces you to think about the reasons why the Aristotelian worldview was so successful. (See an example later.)

Worldview and Evidence

- **Direct evidence** for a belief: sensory experience that supports the belief

  E.g., You believe you are moving fast on a bicycle because you feel the wind.

- Consider one of the core beliefs of the Newtonian worldview:

  The Earth revolves on its axis, completing a revolution approximately every 24 hours.

- Do you have direct evidence for this belief?

Worldview and Evidence

- No – The Earth is rotating at about 1000 mph, but we don't feel that we are moving so fast!
- What about the belief that the Earth revolves around the Sun? Do you have direct evidence for it?
- No – even if you believe that the Earth revolves around the Sun (and that the Sun is stationary), you still see the moving Sun. This optical illusion is pronounced during sunrise and sunset.

Worldview and Evidence

- **Indirect evidence** for a belief: **the belief coheres** with other beliefs in the system of beliefs, and **the alternative belief does not cohere** with the same system.
- Core beliefs of a worldview have lots of indirect evidence for them.
- Peripheral beliefs have less such evidence. Compare:
  - The belief that there are five planets.
  - The belief that there are six planets.
- Both these beliefs cohere with the Aristotelian worldview, so they don’t gain indirect evidence.

Worldview and Commonsense

- When we are raised in one worldview (e.g., Newtonian), many of the beliefs seem obviously correct, commonsensical.
- But many beliefs of a worldview are not something we would arrive at by commonsense and ordinary experience.
  - Example next
- So the fact that our beliefs seem commonsensical is not itself good evidence that our beliefs are correct.

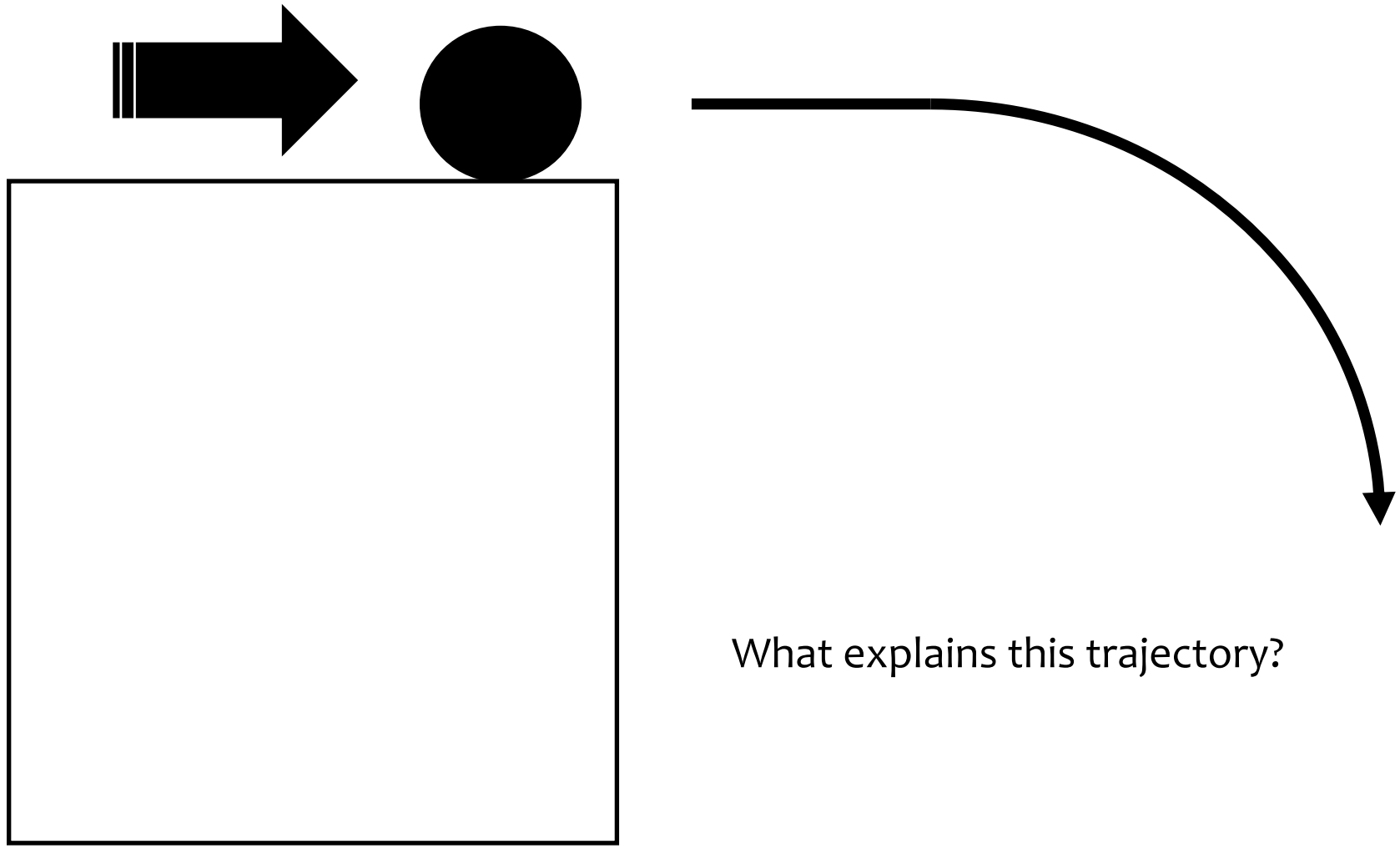
Worldview and Commonsense

- The Newtonian belief:

  Objects remain at rest or in uniform motion in a straight line unless acted upon by an external force. (this is Newton's first law)

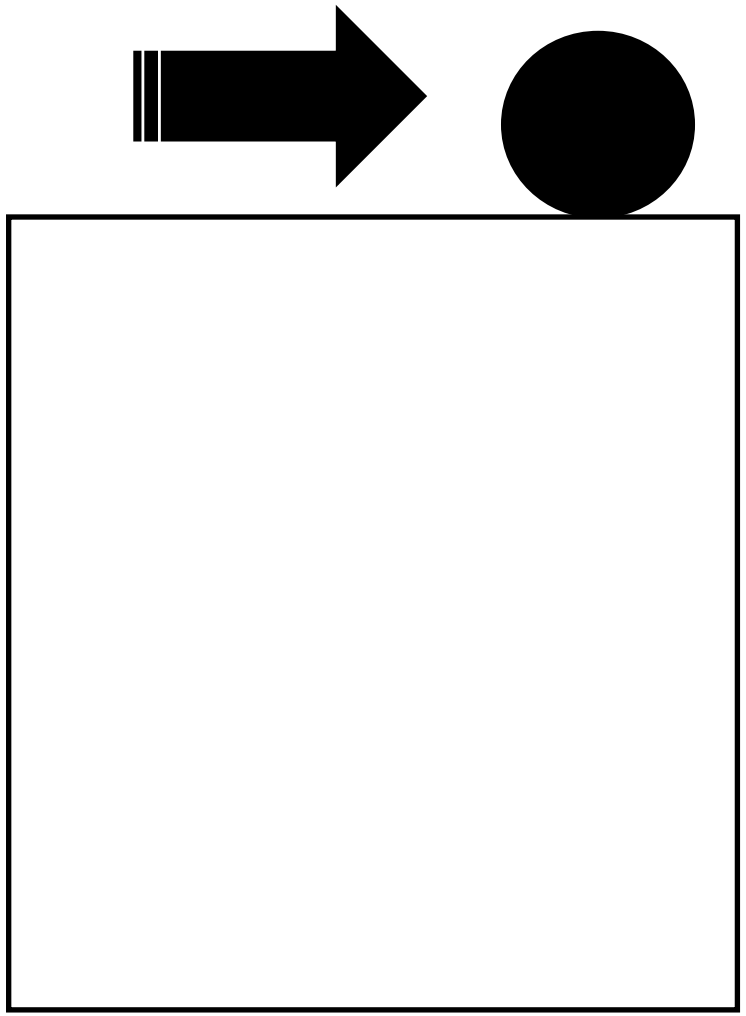
- Uniform motion in a straight line is contrary to our everyday experience.

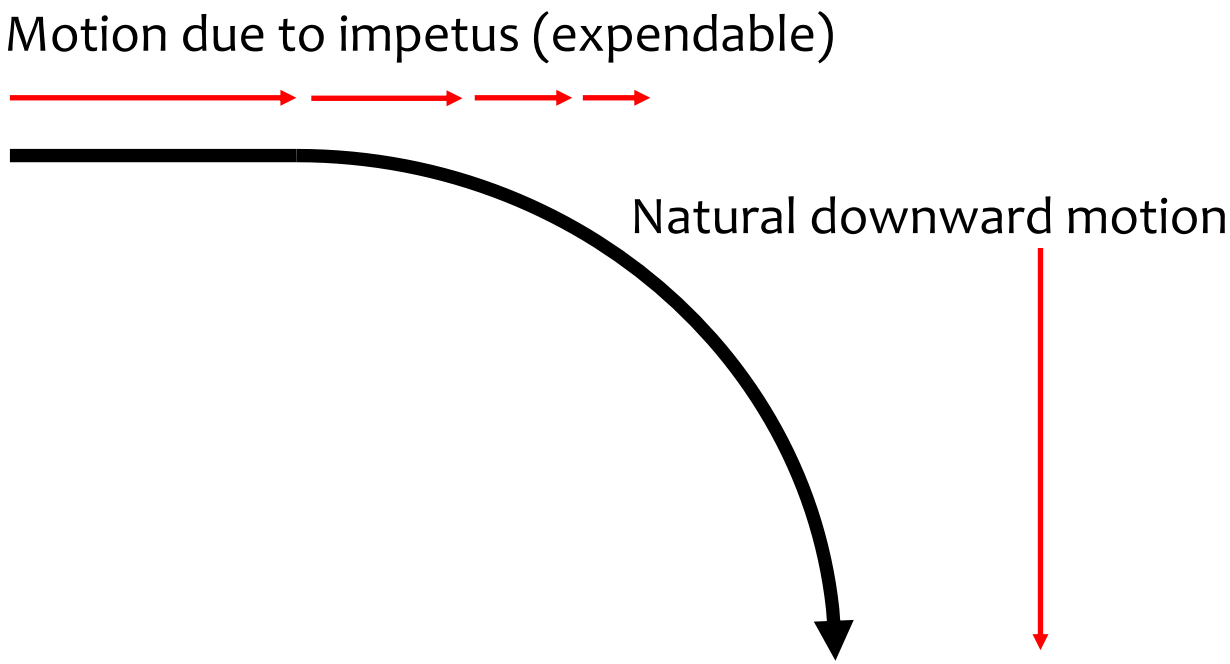
Worldview and Commonsense



What explains this trajectory?

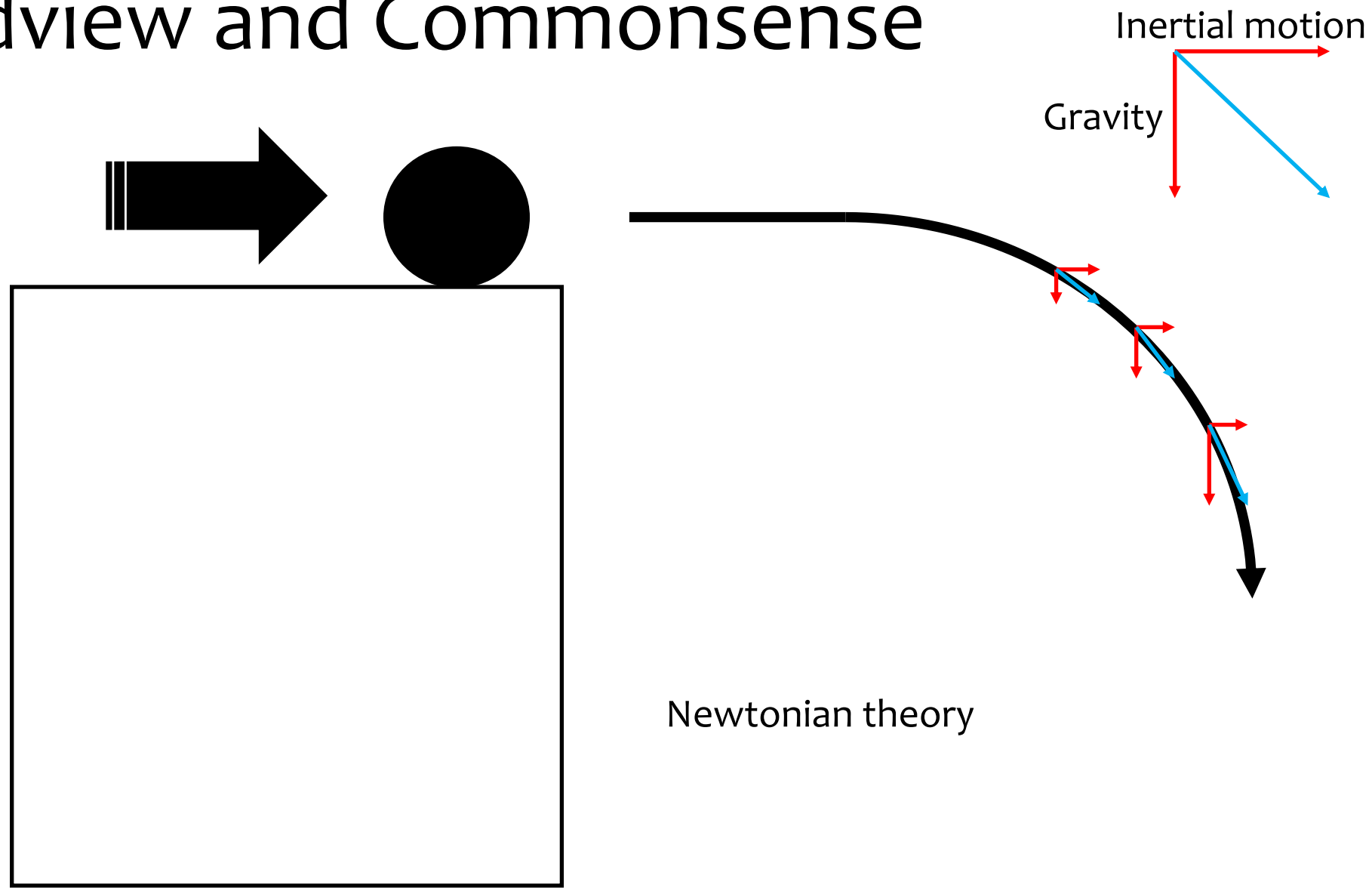
Worldview and Commonsense





Impetus theory (part of the Aristotelian worldview developed between 6th and 14th century)

Worldview and Commonsense



Newtonian theory

Chapter 2: Truth

Popular Misconceptions about Science

"It seems to be a fairly widespread belief that the accumulation of facts is a relatively straightforward process, and that science is, in large part at least, geared toward generating true theories that account for such facts" (DeWitt, Ch. 2).

- People often believe that scientists are simply adding more facts to the existing body of facts and that they care only about truth.

"Both of these are largely *misconceptions* about facts, truth, and their relations to science" (DeWitt, Ch. 2).

Popular Misconceptions about Science

"Both of these are largely *misconceptions* about facts, truth, and their relations to science" (DeWitt, Ch. 2).

- This does **not** mean that there are no such things as facts or truth, or that science is not about facts or truth.
- What does this mean then?

Popular Misconceptions about Science

"It seems to be a fairly widespread belief that the accumulation of facts is a relatively straightforward process, and that science is, in large part at least, geared toward generating true theories that account for such facts" (DeWitt, Ch. 2).

These popular claims are misconceptions, because:

1. The accumulation of facts is *not straightforward*.
   - This doesn't mean that science does not accumulate facts.
2. Truth (of a theory) is a complicated notion, so it's controversial to say that science generates *true* theories.
   - But it is *uncontroversial* to say that science generates *well-supported* theories.

Truth

- Clarify the question, “What is truth?”
- Consider the belief that water is H_2O.
- Our question is:

  What does it mean when we say this belief *is true*?

- In other words, what does “is true” mean?

Truth

- Distinguish two types of question: definitional and epistemological.
- A **definitional** question asks what makes something what it is.
- An **epistemological** question asks how we know something is what it is.
  - Epistemological = having to do with knowledge
- This is abstract, so let's go over some examples.

Truth

- Example: What is death?
- This is a **definitional** question. It asks:
  - What constitutes death;
  - What conditions of an organism count as death; or
  - What it means when we say that an organism *is dead*.
- Example: How do we know when someone is dead?
- This is an **epistemological** question. It asks:
  - What indicates death; or
  - How we can determine if someone is dead.

Truth

- It's important to keep in mind that
  - An answer to a definitional question does not have to also answer an epistemological question.
- Example:
  - An organism is dead if its all biological functions have stopped.
    - Answers the definitional question about death.
  - Note that this does *not* answer the epistemological question of how we can know that all biological functions of an organism have stopped.
    - The epistemological question is answered differently (e.g., the stopping of pulse tells us when someone is dead.)

Truth

- Our question: What is truth?
- This is a **definitional** question. It asks:
  - What constitutes truth; or
  - What it means when we say that a belief *is true.*
- A related question: How do we know when our belief is true?
- This is an **epistemological** question. It asks:
  - What indicates truth; or
  - How we can determine if our belief is true.

Truth

- Again, it's important to keep in mind that
  - An answer to a definitional question does not have to also answer an epistemological question.
- Example:
  - A belief is true if it corresponds to reality.
    - One answer to the definitional question about truth.
  - But note that this does **not** have to also answer the epistemological question about truth.
    - Many philosophers (and you) wonder how we could come to know that our belief corresponds to reality.

Truth

- Major answers to the definitional question about truth.

1. The correspondence theory
2. The coherence theory
    a. Individualistic version
    b. Group version
    c. Science-based (group) version

Correspondence Theory of Truth

- Equivalent characterizations of the theory:
  - A belief is true if it corresponds to reality.
  - What makes a belief true is its correspondence to reality.
  - When we say that a belief is true, we mean that it corresponds to reality.
- What does this theory mean by “reality”?
  - Things in the world that are as they are independently of our beliefs about them.
    - A shorthand for this “reality” is “mind-independent, objective reality.”

Correspondence Theory of Truth

- Mind-independent, objective reality = things in the world that are as they are independently of our beliefs about them.
- Note that this does NOT mean:
  - That everything in the world belongs to the realm of objective reality; or
  - That the only reality is objective reality.

Correspondence Theory of Truth

- Many of you pointed out that perception of color does not fit this conception of reality.
- But we can also recognize *mind-dependent, subjective reality* as things in the world that are as they are because of how we feel or think about them.
  - Color perception (at least partly) belongs to the realm of subjective reality.
- Consider two beliefs:
  1. The belief that the composition of water molecule is H_2O.
  2. The belief that tap water in Athens is tasty.
- Which of these beliefs *can be true*, according to the correspondence theory? (Note we are *not* asking which belief is true.)

Correspondence Theory of Truth

- A water molecule has the chemical composition that it does independently of what we think or believe about water.
- So the chemical composition of water belongs to the realm of objective reality.
- So the belief that the composition of water molecule is H_2O *can be true*, according to the correspondence theory.
  - And it is true if water is really H_2O.

Correspondence Theory of Truth

- How tap water tastes at least partly depends on what we feel about it.
- So the taste of water belongs to the realm of mind-dependent, subjective reality.
- So the belief that tap water in Athens is tasty is *neither true nor false*, according to the correspondence theory.
  - We can say that this belief is an *opinion*.

Correspondence Theory of Truth

Correspondence Theory of Truth

- Equivalent characterizations of the theory (refined):
  - A belief is true if it corresponds to *mind-independent*, *objective* reality.
  - What makes a belief true is its correspondence to *mind-independent, objective* reality.
  - When we say that a belief is true, we mean that it corresponds to *mind-independent, objective* reality.
- The correspondence theory makes the *epistemological* question about truth really difficult.
  - Epistemological question: How can we know if our belief corresponds to mind-independent, objective reality?

Correspondence Theory of Truth

- The correspondence theory makes the *epistemological* question about truth really difficult.
  - Epistemological question: How can we know if our belief corresponds to mind-independent, objective reality?
- DeWitt explains the difficulty in his discussion of a representational theory of perception.
- But we can also explain the difficulty directly by looking at scientific practice.

Correspondence Theory of Truth

- Scientists often posit and study unobservable entities and processes in order to explain observable entities and processes.
  - Example: Kinetic theory of gases explains changes in temperature (observable) by changes in the average speed of molecules (unobservable).
- How can we know if kinetic theory corresponds to the mind-independent, objective reality?
  - It would require that we step outside the theory and have a theory-independent access to the unobservable parts of reality and compare them to the theory. But we don't know how this could be done.

Correspondence Theory of Truth

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Coherence Theory of Truth

- General characterization:

  A belief is true if it coheres with an overall collection of beliefs.

- Individualistic version:

  An individual's belief is true if it coheres with an individual's overall collection of beliefs.

- Group version:

  An individual's belief is true if it coheres with some group's overall collection of beliefs.

- Science-based (group) version:

  An individual's belief is true if it coheres with scientists' overall collection of beliefs.

Coherence Theory of Truth

- Individualistic version:

  An individual's belief is true if it coheres with an individual's overall collection of beliefs.

- Suppose someone believes that the US Election Day in 2021 is November 3, and this belief coheres with other things he believes.
- According to the individualistic version of the coherence theory, his belief is true.
- But many philosophers think that this analysis is mistaken: an adequate theory of truth should allow us to explain why his belief is false. (The Election Day is November 2, 2021.)

Coherence Theory of Truth

- Group versions also have problems (see DeWitt's discussion in the reading).

Truth

- We don’t have a perfectly satisfactory answer to the definitional question about truth.
- But this does not imply that there is no such thing as truth or that the concept of truth is unimportant or that we shouldn’t use the concept of truth.
  - Analogy: there is no satisfactory definition of life. But it doesn’t follow that there is no life or that the concept of life is unimportant or that we shouldn’t use the concept of life.
- What this shows is that truth is a complicated notion, and we should be careful about saying (like the popular view) that science is geared toward generating true theories.