The final exam will be given out at the conclusion of the last class of the semester, Thursday, June 2, and is due in by 5 PM, Friday June 10. 1 It is closed book, closed notes; all needed information is contained on the exam itself. No calculator is allowed or necessary. You may spend as long as you want on the exam, but it must be started and completed in one session. You are bound by the Honor Code in all aspects of this exam.

The exam consists of four sections, three of which are to be completed at home, and the fourth carried out as part of an oral interview.

The four sections of the exam, each worth 25% of the exam total (which itself is worth 35% of the course grade) are:

1. **Multiple Choice/True-False** – 20 questions. This section is designed to test knowledge of facts covered in the class, as well as ability to solve simple problems.

2. **Short Answer** – 4 questions. This section is designed to demonstrate ability to solve more complex problems as well as explain answers to broader questions than are given in the multiple choice/true-false section. A mix of problems and short essays.

3. **Essay** – 2 questions. A much longer format than the first two sections, these questions are designed to permit a wide scope of responses, covering a broad range of subject matter covered by the course. One of the two essay questions will have been written by one of your classmates (perhaps you!) – see this week’s handout.

4. **Quote Identification/Interpretation** – choose 3 of 4. This section will be conducted orally, in an interview to take place either before or during the exam period. This section is designed to accomplish two things: (1) Demonstrate knowledge of the primary writings that made up the core of the readings throughout the term; and (2) Demonstrate ability to make connections between the passages and the larger issues raised by the course. The selected quotes will not focus on minutiae – they will be major quotes that received significant discussion during the course itself (if not the actual quote itself, then certainly the subject matter that it is about).

The interviews will take place in Rm. 023 Robinson (most likely), and will occur on either Friday, June 3 or Thursday, June 9, after 12:00 noon on both days.2 They will last for approximately 30 minutes.

→Please indicate which day you would prefer, and then provide a list of available times (from 12:00 noon until 9 PM; you may indicate preferred meeting times in addition to those just available), on a sheet to be turned in in class on Thursday, May 26.

The format of the interview will be as follows. You will start by being handed a page with four short reading passages on it, along with a list of names of possible authors. (A sample page, complete with 4 quotes and the exact directions, is included to help you prepare for this.) You will then be given 5 minutes to collect your thoughts (without the professor in the room!), and decide which 3 you would like to discuss, and in what order (first one is worth 20 points, the last two 10 each). The important things to be sure to cover in your discussion of the quote are (1) Who you think the author of your first chosen quote is (note that partial credit will be awarded for incorrect but plausible responses if well-justified); (2) Why the ideas contained in the passage are important; and (3) How the ideas fit into the broader context of the ideas presented in our class. You may be asked further questions to help clarify and extend your response.

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1Seniors and graduate students will be able to pick up the exam from outside my office (Rm. 6 Robinson) by noon on Wednesday, June 1 (I will likely email the exam Tuesday evening), and must turn in the exam to my mailbox by 8 PM Friday, June 3.

2Seniors and graduate students must have the oral interview on Friday, June 3.
**How Should I Prepare for the Final?**

While the techniques used to prepare for the final will inevitably be as individual as each Inventing Reality student is, here’s one rough guide (i.e., it’s just a suggestion) that may help you to organize your thoughts:

1. **Review the broad scope of the course’s content.** We have covered a lot of material during this quarter! Having just finished the course, you are in a unique position to reflect back on just how we got to where we ended up, and make connections among the various parts of the course. Here’s one way to go about it:

   (a) *Page through the “overheads” section of the Reader,* since it provides a bare-bones structure for the material we discussed.

   (b) *Reread your weekly synopses.* Reap the reward for having completed these all semester long! In addition to helping you organize and reflect on the material each week, a major goal of these synopses is to provide a *lasting record* of the course material for you to look back on. If some points are unclear, looking back over the *contemporary writings* may help.

   (c) *Now, go through the Reader, and skim through all of the Primary Writings,* to cement in your mind both the content and writing style of each of the major thinkers that we have studied. Remember, for the quote identification section of the exam, *only major, readily identifiable (to those who have read it before!)* quotes will be taken.

   (d) Finally, spend some time *synthesizing* the course’s content, making connections from things discussed at the course’s outset, with material at the end.

Thumbing through the Reader and thinking about the course myself, here’s a brief list of terms/ideas/questions that I jotted down as having been discussed at some length in this class; it may be helpful to look through these (and also to realize just how much we have covered!). This list is *of course* not all-inclusive:

**Stuff We Talked about in Inventing Reality in Rough Chronological Order**

- Prehistoric attitudes towards nature and explanation: individual explanations for individual events.
- The Pythagorean Brotherhood.
- Basic philosophies of antiquity: can senses be trusted?
- Socrates and his ruthless inquisition.
- Plato’s world of forms. Geometry is fundamental.
- Ancient non-geocentric cosmology of Aristarchus.
- Aristotle, and physical causation. Explanations of motion. Natural vs. violent motion.
- Aristotle’s 5 elements; the lunar sphere.
- Euclid’s axiomatic method, and its influence.
- Ptolemy’s epicycles; Ptolemy’s great predictive success.
- Science in the Middle Ages: Islamic culture keeps it alive.
- Copernicus’ system; explanation of retrograde motion and phases of Venus; reasons he created a helio-centric system.
- The Copernican Revolution, and why it happened.
- Tycho’s great observations.
- Kepler smashes the circle: Kepler’s 3 Laws – what they were and what their significance was.
- Galileo’s achievements (and things he just took credit for!). The rise of observation as the way to discover truth!
• Descartes’ world of vortices, and laws of motion.
• Isaac Newton: Law of gravity ($F = \frac{GM_1M_2}{d^2}$); 3 laws of motion; $F = ma$; the meaning of acceleration: change in either speed or direction.
• Newton’s non-scientific pursuits: alchemy, spiritualism.
• Laplace’s nightmare of determinism.
• Properties of waves: $v = \lambda \nu$. The important idea that the velocity of waves is constant (i.e., it is independent of frequency) for a given medium.
• The nature of light: Historical experiments (Young’s 2-slit interference) performed to deduce its properties, and what we’ve ultimately come to believe about its true nature.
• Doppler effect: red-shift and blue-shift for light.
• The electro-magnetic spectrum, and the idea that visible light makes up only a small part of it!
• Spectroscopy, and the fingerprints of the elements.
• Kirchoff’s Laws of spectral analysis.
• The discovery of the quantum nature of matter and light.
• $E = h\nu$.
• Bohr’s quantum atom: what were his postulates?
• What do you see when you disperse the light from a gas through a prism (or diffraction grating, as we did in class) – how is it different from what you see when you disperse sunlight (i.e., white light) through a prism?
• Einstein’s explanation of the photoelectric effect.
• The probabilistic interpretation of Schrödinger’s equation – what does it tell you? What are the different interpretations of quantum mechanics? Which one is believed today? How might quantum mechanics rid us of the Nightmare of Determinism? Do you believe that it does?
• Collapse of the wave function.
• The Heisenberg Uncertainty Principle. Also, the idea that it represents a fundamental limitation to our knowledge of an object: it’s not that we’re bad at measuring these things!
• Electrons, and the wave-particle duality of nature.
• How does quantum mechanics allow a ball, sitting in a glass, to suddenly appear outside the glass? Why do we never observe this effect?
• How did we come to understand the true nature of the “nebulae”? What were the competing theories? How did Edwin Hubble help to settle the dispute?
• Cepheid Variables, and how they can be used as distance indicators.
• General relativity and the curvature of spacetime – how is Einstein’s gravitational theory different than Newton’s?
• Basic idea behind black holes.
• The Hubble Law: $v = H_0d$. Relationship between velocity and distance for galaxies – note that the Hubble Law does not work for stars in the Milky Way!!
• Bell’s Theorem, and the EPM paradox.
• The Milky Way.
• Galaxies – what are the basic types? (Spirals, ellipticals, irregulars).
• Looking out into space = looking back in time.
• The Big Bang cosmology.
• Dark matter.
• The acceleration of the Universe: how was it measured, and what it may it tell us about the fate of the universe.
• Dark energy.
• Global geometry of the universe in closed, critical, and open cases.

OK, so that’s it. I hope this little review has helped. The attached Sample Exam was drawn from the actual exam — i.e., a too-long exam was written, and then random numbers determined which questions would appear on the Sample Exam, and which on the actual exam. So, this Sample Exam should give you a fairly good idea of what types of questions to expect on the actual exam. If you have any concerns about any portion of the exam, I encourage you to come speak with me.
Important Dates

- **Thursday, May 26**: Turn in a piece of paper at the start of class stating which day you would like the Oral Interview to take place, either Friday, June 3 or Wednesday, June 8, and what times you are available (after noon both days).

- **Thursday, June 2**: Receive Final Exam at the end of class.

- **Thursday, June 2 → Friday June 10**: Study for the final, and then set aside a 2-3 hour block of time to take the exam, all in one session. Have oral interview either on Friday, June 3, or Thursday, June 9.

- **Friday, June 10, 5 PM**: Turn in your exam by this time, either to my mailbox on the ground floor, or to my office in Rm. 6 Robinson, if I am around.