Study Guide, FINAL EXAM

HISTORY & PHILOSOPHY OF SCIENCE

Our final exam will have the same format as the previous two tests. The main differences between this one and the earlier tests are that (1) this final will be twice as long, and (2) this exam will test your knowledge of material from the entirety of the course — that is, this final exam is cumulative. Expect somewhere around 20-25 short answer and multiple choice questions, and 2 essay questions. As with the previous tests, the final will especially focus on the material that we have covered in our class times. On the one hand, the multiple-choice / short answer questions will mostly test for information that you should know (names, terminology, key concepts, etc). On the other hand, the essays will be testing your grasp of the material at deeper levels of learning. In order to do well on this test, you not only need to know the content of the lecture material well, but you also need to be able to work relatively quickly. This is admittedly a lot of material to get through in a 2-hour exam. STUDY WELL!

RECOMMENDED STUDY STRATEGY

My advice for studying well is that, in addition to going carefully through this study guide, you also go back over the previous exams. Make sure that you learn from the mistakes that you made on earlier exams; also make sure that you still know those things that you did well on earlier exams.

CONTENT

My primary goals relating what I want you all to learn in this course are, as you know, laid out in the syllabus as "Course Objectives." These are precisely the things that I want to test you on with this final exam. Quoting from the syllabus:

> *"By the end of this course and completion of the course work, it is my intention that the student should be able to do the following:*
>
> 1. *accurately summarize the central questions and debates facing philosophers of science today,*
> 2. *compare and contrast the predominant philosophical positions on such questions and debates,*
> 3. *explain the importance of such issues by appeal to specific episodes from the history of science,*
> 4. *exercise an improved ability to think philosophically about scientific practice today."*

ABOUT THE MULTIPLE-CHOICE / SHORT ANSWER QUESTIONS

In order to be able to accomplish any of these objectives, you first and foremost need to know the information that you've been given thus far in this course (e.g., one cannot given a scientific-historical explanation of the importance of certain issues within philosophy of science without knowing details about the history of science and about the relevant philosophical issues). Thus, your knowledge of such information will be tested, and I'll do this using the multiple-choice / short answer questions. To help you prepare for this part of the test then, I offer you the following lists to guide your studying. You should make sure to study well all of the information that we highlighted in class times about each of these thinkers and concepts::

Key thinkers for this test (in the order in which they appeared in class lectures):

- Aristotle
- Ptolemy
- Proclus
- Maimonides
- Karl Popper
- Carl Hempel
- Copernicus
- Rheticus
- Tycho Brahe
- Johannes Kepler
- Galileo Galilei
- Karl Popper
- Simon Stevin
- Pierre Duhem
- James Robert Brown
- John Norton
- Isaac Newton
- Robert Boyle
- Joseph Black
- Antoine Lavoisier
- Count Rumford
- Villard de Honnecourt
- James Clerk Maxwell

Key concepts for this test:

- Demarcation Problem
  - Falsifiability
  - Conjecture & refutation
- Philosophical Analysis
  - Characteristics of a great analysis / definition
  - necessary and sufficient conditions
  - counterexamples: tests for necessity and sufficiency, too strong / too weak
- explanation
  - explanans
  - explanandum
  - explanatory relation
  - Deductive-Nomological account of explanation and criticisms
  - Flagpole and birth control examples
  - causal account of explanation and criticisms
- a priori and a posteriori arguments
  - as opposed to a priori and a posteriori knowledge
- confirmation / disconfirmation
  - Hypothetico-Deductive account of confirmation
  - Irrelevant conjunction

    - Auxiliary hypotheses
- Aristotle
    - Dynamics
    - Natural motion
    - Forced motion
    - Simple bodies
    - Compound bodies
    - Argument against the possibility of a void
    - *Telos*
    - Teleology
    - Nature and things derived from nature
    - Four causes
    - "man generates man"
    - Scientific method and knowledge
    - Arguments for the position, shape, relative size, stability of the earth
- Ptolemy
    - Arguments for the position, shape, relative size, stability of the earth
    - Astronomy
    - Characteristics and perceived motions of the heavenly bodies
    - Retrograde motion
    - Epicycles (and epi-epicycles)
    - Deferent
    - Eccentric
    - Equant point
    - Prediction versus explanation
- Proclus / Maimonides
    - Challenges to Ptolemaic astronomy
    - Realism / instrumentalism and the aims of a scientific theoryCopernican astronomy
- Empirical Equivalence
    - Reductionism
    - Instrumentalism
    - Pessimistic Realism
    - Explanatory Realism
- Copernicus v. Ptolemy
    - Explanatory Power / Golden Chain Argument
    - Simplicity
    - Coherence with other sciences
- Tycho's astronomy
- Kepler's astronomy
    - ellipses / foci
    - 3 laws of planetary motion
    - Kepler's dynamics of a moving earth
    - Kepler on gravity
- Scientific progress
    - Realist theories
    - Non-realist theories

    - Criteria for progress v. evidence for progress
- Galileo's astronomical findings
    - 3 discoveries with the telescope
    - crucial experiment
- Galileo's dynamics
    - Principle of inertia
    - Ship argument
    - Inclined plane thought experiment
    - Principles of free fall
- Thought experiments
    - Stevin's chain
    - Galileo's two weights
    - Newton's projectile
    - Philosophical importance
    - Skepticism
    - Rationalism
    - Empiricism
- Newtonian physics
    - The Newtonian Synthesis
    - 3 laws of motion
    - Universal gravitation
    - Newton on hypotheses and scientific method
- Textbook model of scientific method
    - Problems
    - Gather the facts!?
    - Perception as cognitively shaped and theory-laden
    - Facts as linguistic things
- Duhem-Quine Thesis
    - Confirmational holism
    - Auxiliary hypotheses
    - Skepticism about crucial experiments
    - Underdetermination of theories by evidence
- Science as a great mystery story
- Thermodynamics
    - Quantity of heat versus temperature
    - Galileo's "Thermometer"
    - Boyle's Thermometer
    - Black's experiment
    - The flow of heat
    - Caloric theory
        - quantity of heat
        - temperature
        - expansion upon heating
        - problems
    - Rumford's experiment
    - Molecular motion theory

        - quantity of heat
        - temperature
        - expansion upon heating
        - ...and Black's experiment
        - ...and Rumford's experiment
        - ...and the flow of heat
        - Brownian motion
    - 1st Law of Thermodynamics
        - Idealizations and thought experiments
        - Perpetual motion machines
    - 2nd Law of Thermodynamics
        - Irreversible processes
        - Time-reversal invariance of laws of physics
        - Entropy
        - Maxwell's Demon
        - Probabilities in the laws of science
- Scientific Laws
    - Laws of Nature versus Laws of Science (i.e., scientific laws)
    - Exceptionless Regularity Account
        - Physical Impossibility
        - Problems
    - Counterfactual Account
        - Robustness of the law
        - Problems

ON THE ESSAY

There is not much to say here in the way of specific advice. These essays are meant to gauge more directly whether or not you have accomplished the course objectives — now that we have come to the end of the course. Beyond that, I don't want to give you too much information about what I will test you on ahead of time.

To test your abilities on objectives 1 and 2, I will ask you to do more than just restate the information that you have learned about particular issues in the philosophy of science and various positions philosophers have taken regarding them. I will ask you to take this information and apply it in ways that show me that you have an understanding of the material that is deep enough to allow you to make interesting comparisons and contrasts between philosophical theories.

I will want you to display a similar richness of understanding with regards to objective 3. I won't ask you simply to regurgitate information here about episodes in the history of science. Instead, I want to see that you are thinking hard about the issues of this course; I want to test the extent to which you are relating the philosophical material of this course to the historical material. And I want to test whether you are able to see the relevance of our philosophical issues to scientific practice.

Objective 4 is perhaps the most important of the goals of this course. But it is also the most difficult to test. The hope is that, if you are able to accomplish objectives 1-3, then you will be able to accomplish objective 4 as well! Thus, I'll focus on testing you primarily on the first three objectives.