Study Guide Exam Session Spring 2024 HPS

Introduction to the History and Philosophy of Science Christian Wüthrich

Written exam

Date: 10 June 2024, 14:30, Sciences II, A150

1 General instructions

Make sure you have read the instructions carefully. Some students lose crucial points simply for not following the instructions.

The exam will be **closed books**, which means that you will not be allowed to use books, notes or electronic devices with memory or communication functions during the exam. This exam is **cumulative**, which means that all course material will be tested. The different subjects covered in the course will have more or less the same relative importance.

Regardless of whether you take the exam for the annual course or just for the spring semester, the format of the exam is exactly the same, as is the time (2 hours). The difference between them is in the topics covered: in both cases, you are responsible for the topics for spring semester 2024, but only if you do the exam for the annual course you are also responsible for the topics for fall semester 2023.

The topics and problems below (see the topics for the relevant semesters) give you a list of material that has been seen in class, in the readings or both. Study them carefully. The examination will consist of three parts. The first part will consist of ten **identification questions**. You will be asked to characterise or define a term or expression using one or two short sentences. The second part will consist of six **questions requiring short answers** for which I expect one-paragraph answers. In this second part, you will sometimes be able to choose from several questions. In the third part, there will be one **essay question** which will require an argumentative text, in which you will draw on all the relevant content from the course.

The evaluation of the exam is anonymous.

2 Topics Spring 2024

Scientific explanation

- The deductive-nomological model of explanation (including conditions of adequacy)
- difficulties of the D-N model: the D-N model as unnecessary and as insufficient (know an example for each)

Laws of nature

- counterfactual support of laws, difference between Newton's law of universal gravitational and Bode's 'law'
- Humean vs non-Humean analyses of laws
- Humean supervenience
- best-systems analysis

Natural kinds and topics in the philosophy of chemistry

- reduction of molecular species to quantum physics
- reduction of substances to molecular species
- natural kinds and chemical kinds
- What are natural kinds? 3 conditions, and Hendry's arguments against each
- Two views of chemical substances: microstructuralism and macroscopic conception of substance (know an argument in favour of the former)

The biological revolution

- gradualism
- Lamarck's theory of biological evolution
- uniformitarianism
- actualism
- The main thesis, master argument, and theory structure of Darwin's *On the Origin of Species*.
- Mendel's pea plant experiment, and its explanation
- The modern synthesis

Topics in philosophy of biology: species

- Species realism vs antirelism
- punctuated equilibrium
- phenetic conception of species, and some of its problems
- biological conception of species, and some of its problems
- phylogenetic conception of species, and some of its problems
- The tree of life
- The cladistic conception of systematics

Spacetime

- Relationalism and substantivalism about space (and time)
- Newton's bucket experiment, and Mach's interpretation
- Einstein's comparison involving the magnet and the conductor
- Relativity principle and light postulate
- The relativity of simultaneity
- The principle of equivalence (in at least one of its versions)
- At least one measurable consequence of Einstein's theory of general relativity

Quantum physics

- The double slit experiment with and without monitoring
- The Stern-Gerlach apparatus and spin measurements, combing devices
- The measurement problem (Maudlin's version)
- Quantum non-locality and Bell's theorem: just the main ideas, no details necessary

Please note that gravitational waves and black holes, and the revolution in the foundations of mathematics will not be part of the exam.

3 Topics Fall 2023

History of philosophy of science

- Aristotle's theory of causality
- Newton's "hypotheses non fingo"
- Hume's solution to the problem of induction
- Mach's positivism

Science vs pseudoscience

- What is the demarcation issue?
- relevance of demarcation issue
- give some examples of criteria that could be used to demarcate science from pseudoscience

Arguments, deduction, induction

- singular and universal propositions
- observation and theoretical statements
- validity (deductive), truth, sound arguments
- general characteristics of deduction and induction, difference between the two
- Hume's problem of induction
- necessary connection between fallibility and ampliativity
- enumerative induction
- eliminative induction
- causal inference
- Mill's methods of agreement and difference
- inference to the best explanation, and its problems

Logical empiricism

- manifest of the Vienna Circle, empiricism and role of logic
- verificationist theory of meaning
- justification and epistemology of observation statements
- context of discovery vs context of justification
- the unity of science
- Nagel's model of inter-theoretic reduction
- homogeneous vs heterogeneous reduction, examples of both

Popper and falsificationism

- deductivism
- asymmetry between verification and falsification
- falsifiability, its definition and use as demarcation criterion
- degrees of falsifiability; generality, precision
- falsificationism
- conjectures and refutations
- problems of falsificationism:
  - observation statements
  - holism and immunisation of theories; ad hoc hypotheses
  - probabilistic hypotheses
  - scientific progress and corroboration (with Popper's response)

Scientific revolution

- main points of scientific revolution
- relevance of the Renaissance
- Aristotle's cosmos
- Paracelsus, Vesalius, Harvey
- Ptolemaic astronomy and its problems
- Copernican astronomy, its advantages and problems
- shipmast experiment
- idea of Galilean relativity in Bruno and Galileo
- Descartes and mechanical philosophy
- Newton and his problems with mechanical philosophy

Kuhn and scientific revolutions

- paradigm (broad and narrow sense)
- contrast with Popper
- normal science
- anomaly and crisis
- scientific revolutions and how they occur
- changing standards and Kuhn losses
- incommensurability (linguistic and methodological)
- two misunderstandings of incommensurability
- scientific progress according to Kuhn, its qualifications

Holism and underdetermination

- confirmation holism according to Duhem
- Duhem on crucial experiments in physics
- Quine's confirmation holism
- underdetermination of theories or hypotheses by data
- logical vs methodological underdetermination
- weak and strong methodological underdetermination

Chemical revolution

- imponderables and forces
- Paracelsus's notion of 'principles'
- main ideas of phlogiston theory (not all basic principles by Pott)
- Priestley and his interpretation of his discovery of oxygen
- Lavoisier's concept of oxygen and hydrogen, and the compound nature of water
- main ideas of caloric theory
- new classification and nomenclature
- Davy's destruction of Lavoisier's chemistry
- Dalton's chemical atomism

Induction and confirmation

- naive inductivism and Hempel's critique
- role of hypotheses, 'significant data'
- hypothetico-deductive reasoning, example of Blaise Pascal as illustration
- confirmation theory, general idea
- instantial model of inductive confirmation
- model of hypothetico-deductivism
- problems with the hypothetico-deductivist model:
  - Hempel's raven paradox (equivalence condition, instance condition), resolutions
  - Goodman's "new riddle of induction" (gruesome predicats), resolutions, application

Scientific realism

- scientific realism
- no-miracles argument, and the antirealist Darwinian response
- constructive empiricism
- pessimistic meta-induction, weak and strong version
- structural realism
- argument from underdetermination of theory by data or observation
- base rate fallacy