

Final Examination Study Questions

Part I: Mechanical versus Electrodynamical World Views

1. Sketch the history of wave and corpuscular theories of light from the seventeenth century through the early nineteenth century. Pay particular attention to phenomena and discoveries thought to favor one or the other view.
2. Describe the mechanical model for the electromagnetic ether proposed by either Thomson or Maxwell. What were some of the principal challenges facing any attempt to provide a mechanical model of the ether?
3. In what way did the introduction of the electromagnetic ether allow one to avoid the assumption of action at a distance?
4. Describe the Michelson-Morely experiment. What result had Michelson expected, and what result was obtained?
5. How did Lorentz and FitzGerald attempt to explain the result of the Michelson-Morely experiment?
6. What was the Kaufmann experiment and what did it show?

Part II: The Theory of Relativity

7. Explain the reasons for Einstein's early skepticism about classical physics. Be sure to include a discussion of the problem of electromagnetic induction.
8. What are the two fundamental postulates of special relativity and how are they made consistent by adoption of the Lorentz transformations?
9. Show how, in special relativity, one derives time dilation and length contraction. How does the phenomenon of muon decay in cosmic rays confirm time dilation?
10. Why is the twin paradox not really a paradox?
11. Why does general relativity predict the bending of light near the sun? How was this prediction first confirmed?
12. Give a sketch of the history of the concept of an expanding universe, from Einstein's introduction of the cosmological constant, through the work of Friedmann and Hubble, to the development of the big-bang model.

Part III: The Quantum World and the Completeness of Quantum Mechanics

13. What, exactly, did Planck postulate when he introduced the idea of quantization in 1900, and how did this postulate make possible his explanation of the energy spectrum of black-body radiation?
14. What is the Bohr model of the atom?
15. Explain the Born interpretation of the quantum mechanical wave function, and explain how the phenomenon of barrier penetration or tunneling was thought to support this interpretation over the interpretation favored by Schrödinger.
16. What is the two-slit experiment and what does it show?
17. Outline the history of the Bohr-Einstein debate and explain the role of the photon-box thought experiment in that debate.
18. Sketch the Schrödinger cat thought experiment. What is it supposed to show?

Part IV: Some Philosophical Lessons from Quantum Mechanics

19. Give an outline of the EPR argument for the incompleteness of quantum mechanics.
20. Explain Bell's theorem and discuss the significance of its experimental tests.
21. Experimental tests of Bell's theorem are said to demonstrate the existence of "quantum non-locality." Explain the two different ways in which this is manifested in "non-local" hidden variable theories and in standard quantum mechanics.
22. What are the essential features of Bohmian mechanics? How does it function as an alternative to the Copenhagen interpretation of quantum mechanics?
23. Using the contrast between Bohmian mechanics and Copenhagen quantum mechanics as an example, discuss the role of historical contingency in the development of science and its implications for our assessments of the truth of scientific theories.
24. Is it possible to reconcile underdetermination and realism?