

# Polkinghorne

## Possible Exam Questions

1. Describe the photoelectric effect. Explain how Einstein's idea of a photon helps us understand what happens in the photoelectric effect.
2. What is the ultraviolet catastrophe? What did Planck do to help solve this problem?
3. What happens in Compton scattering? What idea helps us understand Compton scattering?
4. List the four theories of light we discussed in class, along with the people responsible and the approximate dates when these theories were developed.
5. Which scientists thought that light was particle-like? Which scientists thought that light was wave-like? When did they think these things?
6. Why does Polkinghorne refer to Einstein's explanation of the photoelectric effect as a pyrrhic victory?
7. Why did Rutherford and others have trouble accepting the solar system model of an atom?
8. What is the energy of a 700-nm photon?
9. What is the frequency of a light wave with wavelength 1 m?
10. The public radio station WITF in Harrisburg broadcasts at a frequency of 89.5 MHz. What is the wavelength of this radio signal?
11. A violet photon with energy 3.1 eV has what wavelength? What frequency?

12. In a 2-slit experiment with electrons, in what way do electrons behave like particles? In what way do electrons behave like waves?
13. Explain how an interference pattern in a 2-slit experiment with electrons is related to information about which slit the electron went through.
14. The Schrodinger wave equation describes waves of what? Who first suggested this interpretation?
15. What is a probability amplitude? How is it related to a probability?
16. What does the uncertainty principle say that we are uncertain about?
17. What is a hidden variable interpretation?
18. What is the measurement problem?
19. What is the correspondence principle?
20. What is quantum tunneling?
21. What is delayed in a delayed choice experiment?
22. According to the section *Sums over histories*, how does Feynman suggest that one should picture a quantum particle moving from A to B?
23. What, in particular, does Einstein not like about quantum theory?
24. At the top of page 79, Polkinghorne says that Einstein's fellow physicists interpreted things differently. In class, we talked about three different kinds of theories. In an *open-variables theory*, all of the physical quantities that we expect a particle to have have definite values, whether or not we measure them. This is the situation in classical physics. In a *hidden-variables theory*, all of the physical quantities that we expect a particle to have have definite values, but for some reason we may not be able to know all of them. For some reason, these variables are hidden. In a *no-variables theory*, some or all of the physical quantities for a particle do not even have definite values. Which of these three kinds of theories is Einstein using? Which of these three kinds of theories are his fellow physicists using?
25. What did John Bell do?

26. What did Alain Aspect do?
27. Compare positivism, realism, and pragmatism as philosophical positions.
28. How does metaphysical judgment enter into the choice of an interpretation of quantum mechanics?