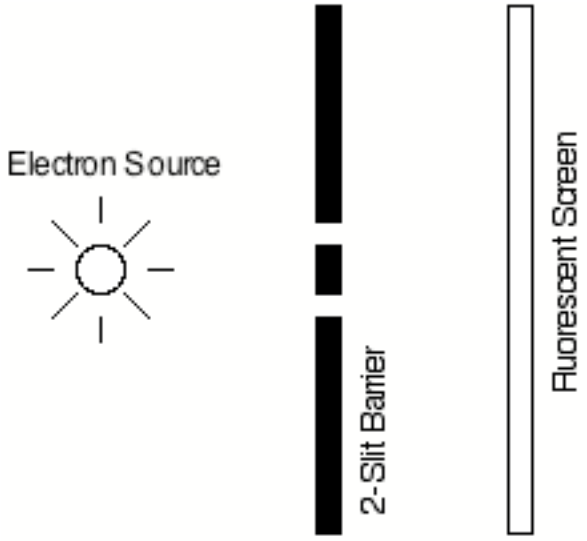
Physics

Quantum Duality Homework

1. Use Huygens' principle (including a few secondary wave crests) to demonstrate how the waves shown will diffract around each object below. (Draw your diagrams on a **separate sheet of paper**. You don't need to be very detailed with the right hand picture.)

2. Which would be better to use when looking at something through a microscope, red light or blue light? Explain why in terms of diffraction.
3. Use diffraction to explain why elephants use **low** frequency sounds to communicate over long distances where there may be objects in the way (trees, hills, etc.), but dolphins and bats use **high** frequency sounds to map out a "picture" of their environment.
4. Why is it important to use monochromatic light if you want to produce clear interference patterns?
5. Complete the **Interference Patterns** practice sheet.
6. If a pair of thin slits is illuminated with monochromatic red light, will the fringes be more widely or more closely spaced than if illuminated with monochromatic blue light? Explain why.
7. How thin should a transparent film lying on top of water be in order to produce lovely (to a bee) iridescence in the ultraviolet part of the spectrum?
8. Use interference to explain why light appears to travel in straight lines through a vacuum.
9. What percentage of the light from a (non-polarized) light bulb would be transmitted by two ideal polarizing filters that have their axes aligned? What if their axes are at right angles to one another?
10. How well would polarizing glasses work to reduce the glare off the side of a tall glass building?
11. Will brighter light eject more electrons from a photosensitive surface than dimmer light of the same frequency? Will light of half the frequency eject half as many electrons?
12. Green light is emitted when electrons in a substance make a particular energy-level transition. Do the electrons move closer to the nucleus or farther away? Would the electrons have to move more or less in order to produce blue light instead?
13. Suppose you're shining a beam of violet light on your skin. Which would be more dangerous, doubling the intensity or the frequency of the light? Justify your answer.
14. A lamp filament is made of tungsten. Why do we get a continuous spectrum rather than a tungsten line spectrum when light from such a lamp is analyzed with a spectroscope?
15. Hydrogen gas can emit light with frequencies of 2.7×10^{14} Hz (due to an electron transition from n=2 to n=1), or 7.3×10^{14} Hz (due to an electron transition from n=3 to n=1). Based on this information, can you predict some other frequency of light that hydrogen gas can emit?

16. Suppose that a cloud of hot hydrogen gas is emitting light, and that a spectroscope analyzes this light. Draw the spectrum that would result in the frequency range between 1.0×10^{14} Hz and 9.0×10^{14} Hz, and label the frequencies of the interesting features.
17. Suppose light from all frequencies between 1.0×10^{14} Hz and 9.0×10^{14} Hz shines through a cloud of cool hydrogen gas. Imagine that a spectroscope analyzes the light making it through to the other side of the cloud. Draw the spectrum that would result, and label the frequencies of the interesting features.
18. When ultraviolet light falls on certain fluorescent dyes, visible light is re-emitted. Why does this not happen when infrared light falls on the same dyes?
19. Explain why your TV glows a little after you turn it off.
20. Name three properties of laser light that distinguish it from more common monochromatic light.
21. What's special about an atom in a laser that allows it to be stimulated into emitting a photon that ends up being part of the emitted laser light?
22. If electrons behaved only as particles, what pattern would appear on the fluorescent screen pictured below? What pattern actually appears?



23. What principle advantage does an electron microscope have over an optical microscope?
24. As the speed at which the electrons are emitted from the source in problem #22 is increased, how does their de Broglie wavelength change? How does the speed of the electrons in an electron microscope affect the amount of diffraction and therefore the microscope's sensitivity?
25. What happens to an object being examined by an electron microscope as the electron speed is increased? How does this relate to Heisenberg's Uncertainty principle?