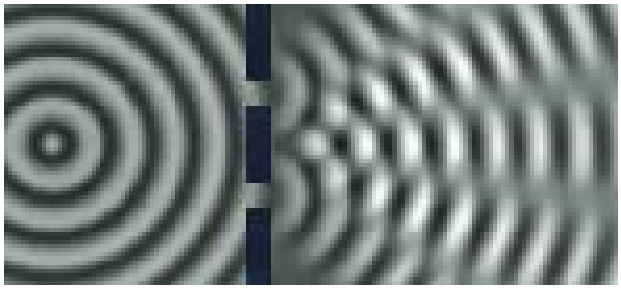
Worksheet 01:

Video Summary

Useful Equations: $\lambda = h/p$ $E = hf$

01. Baseballs are fired at a barrier with two narrow slits. Behind the barrier is a wall. Draw a distribution that shows where the baseballs hit the wall.

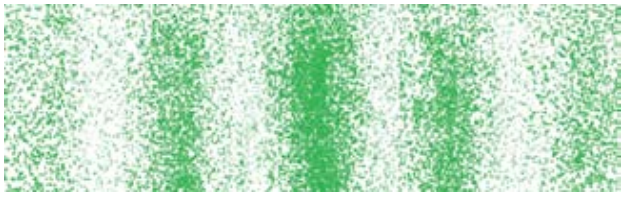
02. A water wave passes a two-slit barrier, as shown below, generating an interference pattern.



(b) Describe where the energy is greatest. How does the energy distribution between maxima mimic the energy distribution in a double-slit interference pattern for light?

A diagram of wave intensity vs. position will suffice here.

03. The photograph below shows an interference pattern from the **electron** double-slit experiment.



(a) The distance between neighbouring interference maxima is 120 µm. Why is this distance so much smaller than the distance between maxima for water waves?

(b) What aspects of the image illustrate the particle nature of electrons?

(c) What aspects of the image illustrate the wave nature of electrons?

(d) How can an electron be a particle and a wave at the same time? Spend a few minutes formulating your explanation for what is going on and then discuss it with your neighbour.

04. The double-slit experiment is performed using **light** with a wavelength of 580 nm. The light's intensity is so low that only one photon passes through the slits each second. This means no two photons ever interact with each other in the experiment.

(a) What is the energy of each photon emitted?

(b) What aspects of this experiment demonstrate the particle nature of light?

(c) What aspects of this experiment demonstrate the wave nature of light?

05. One of the largest objects that physicists have used to produce an interference pattern is a molecule called PFD (perfluoroalkyl-functionalized diazobenzene, $C_{30}H_{12}F_{30}N_2O_4$). It has a mass of 1.7×10^{-24} kg. In the experiment, the molecule had a de Broglie wavelength of 2.8×10^{-12} m.
Calculate the molecule's velocity in m/s AND km/h.

06. What happens to the interference pattern created in the electron double-slit experiment when detectors are used to determine which slit an electron is passing through? How do the researchers explain this result?

07. You are discussing the electron double-slit experiment with a friend. She says: "Physicists understand the experiment completely. Each electron leaves the source as a classical particle and hits the screen as a classical particle. All researchers agree that an electron is a classical particle in the experiment." Write a three to four line reply to your friend that explains why she is mistaken.

08. Quantum physics is part of your everyday life. List at least five of the technological applications discussed in the video.

Quantum physicists use math to help describe the dual quantum nature of electrons. A <u>'wave function'</u> is a mathematical description. A wave function <u>describes the probability of finding an electron in any one spot</u>. As a wave, this function has amplitude. The greater the amplitude at any one spot, the greater the probability of finding the electron there. It becomes a question of probability.