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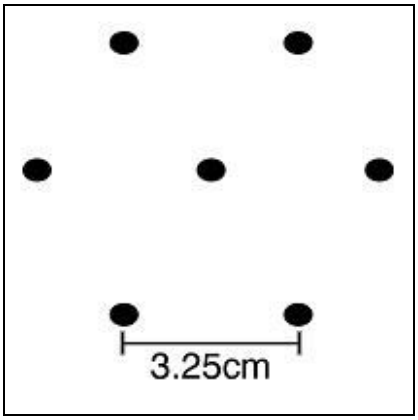
Further Questions

1. The membrane from a water purifier has millions of very small holes in it. A laser pointer was used to project the diffraction pattern from the membrane onto a screen. The screen was 1 m from the purifier membrane and produced a diffraction pattern with a spacing of 3.25 cm as shown to the right.



   What is the average distance between the holes in the water purifier membrane?

   Wavelength of laser pointer = 650 nm.

2. Early in the morning, sunlight streams through an east facing kitchen window and projects an image of the window onto the western wall of the kitchen. The window is covered by a mesh security screen. The grid spacing of the security mesh is 1.3 mm. The distance between the western wall of the kitchen and the security mesh is 2.5 m.

   a) Assuming sunlight has a mean wavelength of $\lambda = 560$ nm, what is the spacing of the diffraction pattern projected onto the western wall?

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Further Questions (cont'd)

b) The window is 1.3 m high and 0.85 m wide. Compare the spacing of the diffraction pattern to the size of the window. Would you be able to see diffraction at the edges of the image?

c) Suppose the security mesh is replaced with a much larger grill with a spacing of 1 cm between the wires? How large would the diffraction pattern be now? Could you see something this small?

3. Laser pointers often come with a little kit of holograms. One hologram, when illuminated with the laser, projects a smiley face onto a wall 3 m away. Using a red laser pointer (λ = 630 nm) the smiley face has a diameter of 63 cm. If a blue laser (λ = 400 nm) were used to project the same hologram how large would the smiley face be?

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Further Questions (cont'd)

4. Shine the laser pointer onto the wall. Try to "pinch" off the beam with your finger and thumb. What do you see as the gap becomes smaller? Explain, using the concept of diffraction, why the spot doesn't just "blink out".

5. Long Play (LP) vinyl records also have circular tracks or grooves. LP's have 240 grooves per inch.

   a) Suppose you performed the CD/DVD experiment with an LP. What would be the spacing of the dots you would observe?

   b) Why can't you store as much information on a vinyl record as a CD or DVD?

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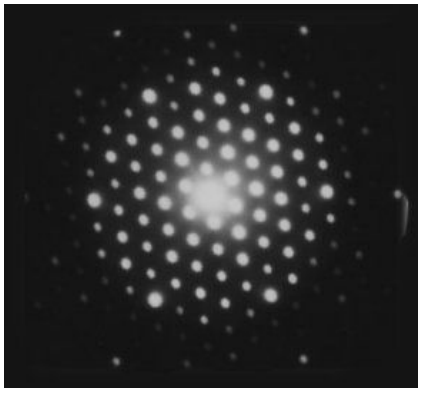
Further Questions (cont'd)

6. In an electron microscope, a beam of electrons is accelerated to great energy (1 KeV or more) and fired through thin films of material. The beam is then projected onto a screen. Here is the pattern that forms when the beam passes through a thin sheet of aluminum.



   a) Are the electrons behaving like light? How do you know?

   b) Electrons with an energy of 10 KeV have a wavelength of $\lambda = 1.2\times10^{-11}$ m. This image was taken L = 30 cm back from the aluminum film and the spots are separated by a distance of 1.6 cm. What is the distance between the aluminum atoms?

   c) Check that your answer is reasonable. One mole of aluminum atoms (6.02×10^{23}) occupies a volume of 10 milliliters. What is the average volume for each atom? If each atom were spherical, what radius would that correspond to? (***hint: your answer should confirm what you found in part b***).