

Physics 101 Part 3

Thin Film Interference:

1. A camera lens has a refractive index of 1.45 and is coated with a thin transparent film of refractive index 1.3. If the thin film is designed to prevent the transmission of light of 500 nm, how thick should it be?
2. A piece of paper is 4.2×10^{-6} m thick and is placed between two pieces of glass ($n=1.5$). An observer above sees bright fringes reflected when light of wavelength 434 nm is shone down from above.
 - a) How many fringes does the observer see?
 - b) How does the answer change when the experiment is performed under water ($n=1.3$)?
 - c) How does the answer from part a) change when the light is shone from behind the glass?

Problems of Bouyancy:

3. A piece of Aluminum is suspended from a string and then completely immersed in water. The mass of the piece of aluminum is 1 kg and the density is 2.7×10^3 kg/m³. Calculate the change in the tension of the string due to the immersion in water.
4. If the density of ice is 917 kg/m³ and the density of water at 0 °C is 1000 kg/m³, calculate the fraction of an iceberg that is submerged.
5. A piece of material has a density of 500 kg/m³. It is shaped in the form of a block of dimensions 10 cm x 10 cm x 5 cm with three holes drilled on top. The volume of each hole is 10.00 cm³. (Hint: be careful to take into account the volume of the holes when calculating the mass of the block.) A cylindrical plug of metal is placed in each hole. The plug has a volume of 20.0 cm³ so that half of its volume protrudes from the drill-hole. The density of the metal is 3300 kg/m³. Calculate where the water level on the side of the block would be if it were floating in water. If the block were turned over so that the metal plugs were submerged, where would the new water line be?

Interference single and double slits:

6. In young's experiment the slits are 2 mm apart and illuminated by 2 wavelengths, 400 nm and 500 nm. The interference pattern is observed on a screen 2 m away. At what minimum distance from the common bright fringe will the bright fringes of both colors overlap?
7. In a young's double slit experiment, the frequency of light used is 500 nm and the slits are 1.5 mm apart. Unfortunately one of the slits is covered up by a piece of Scotch tape which is 3.0×10^{-6} m thick. The index of refraction of the tape is 1.3 and the viewing screen is 1.2 m away.
 - a) Where is the central bright fringe?
 - b) Where is the second dark fringe?
8. Two slits are separated by 0.200 mm. Light of wavelength 600 nm is incident on the slits and then onto a screen 2.00 m away.
 - a) What is the separation between dark fringes on the screen?
 - b) We now close one of the slits. If the width of the slit is 0.0500 mm, what is the position of the first diffraction minimum from the central axis?

c) Sketch the resulting pattern on both sides of the central axis when both slits are open. You need only draw as far as the first diffraction minimum but you must draw the correct number of interference fringes.

d) A piece of plastic is now placed in front of one of the slits. It is 600 nm in thickness and has an index of refraction of $n=1.5$. What happens to the two slit interference function?

e) How many bright fringes are now seen under the central diffraction maximum. Draw another sketch.