Microscopy II

2.33. Two light waves of equal frequency and of equal "A" amplitude interfere with each other. What is the resultant amplitude if the phase shift between the waves is 90°?

2.34. Two light waves of equal frequency and of equal "A" amplitude interfere with each other. What is the resultant amplitude if the phase shift between the waves is $\pi/2$?

2.35. Two light waves of equal frequency and of equal "A" amplitude interfere with each other. What is the resultant amplitude if the phase shift between the waves is 0?

2.36. Two light waves of equal frequency and of equal "A" amplitude interfere with each other. What is the resultant amplitude if the phase shift between the waves is 2π?

2.37. Two light waves of equal frequency and of equal "A" amplitude interfere with each other. What is the resultant amplitude if the phase shift between the waves is 180°?

6.1. The parameters of a microscope are the following: $f_{\text{objective}}$ = 2 mm, f_{eyepiece} = 20 mm, tube length: d = 8 cm. (Tube length: the distance between the focal points of objective and eyepiece. The image distance of the eyepiece is assumed as 25 cm – the average distance of clear sight.)
a) What is the magnification of the individual lenses and what is the total magnification of the whole microscope?
b) What is the apparent size of a red blood cell of 8 μm diameter in this microscope?
c) At what distance should the object be placed from the objective lens so that the intermediate image forms exactly in the focal plane of the eyepiece lens?
d) What is the half-angle of the objective lens' angular aperture in the previous case, if the diameter of the objective lens is 6 mm?
e) What is the limit of resolution if it is a dry objective and the illuminating light consists solely of a 550 nm component?

6.2. The parameters of the objective lens of a microscope are the following:
diameter = 8 mm, focal length = 10 mm. The object is 10.625 mm away from the lens if the image is sharp. The magnification of the eyepiece lens is 6-fold.
a) At what distance from the objective lens does the intermediate image form?
b) What is the magnification of the objective lens and what is the total magnification of the whole microscope?
c) Calculate the focal length of the eyepiece lens.
d) Calculate the tube length of the microscope.
e) Calculate the limit of resolution and the power of resolution considering the lower limit of the visible wavelength range and a dry objective lens.

6.3. What is the just resolvable distance with a microscope which has an angular aperture of 140°, if the illuminating light is yellowish-green (λ = 520 nm), and
a) cedar oil (n = 1,5) immersion is used,
b) water immersion is used, and
c) no immersion is used?

Solutions

2.33. $\sqrt{2}\cdot A$

2.34. $\sqrt{2}\cdot A$

2.35. $2A$

2.36. $2A$

2.37. **0**

6.1. a) **40× (objective lens), –12,5× (eyepiece lens), –500× (total)**
b) **4 mm**
c) **2.05 mm**
d) **55.6°**
e) **407 nm**

6.2. a) **170 mm**
b) **16× (objective lens); –96× (total)**
c) **41.7 mm**
d) **160 mm**
e) **0.691 µm, as well as 1.45 μm^{-1}**

6.3. a) **224 nm**
b) **254 nm**
c) **338 nm**