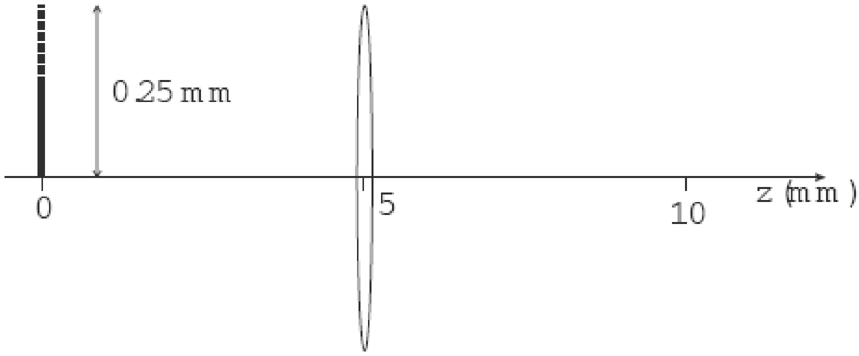
9.



A small transmission diffraction grating has width $w = 0{\cdot}25$ mm and is composed of 16 narrow slits whose centres are spaced by 15 μm. It is situated in the $z = 0$ plane with its lines oriented along the y-direction, where the z-axis is defined to lie along the optical axis of a thin lens of focal length $f = 2{\cdot}5$ mm and diameter $2w$ positioned at $z = 2f$. The grating is parallel to the lens but off-axis, extending from $x = 0$ to $x = w$. The grating is uniformly illuminated by a parallel beam of monochromatic light of wavelength 750 nm propagating in the positive z-direction (the beam has width w and just fills the grating). Find the angle to the normal of the first-order diffracted beam as it leaves the grating, and draw a ray diagram showing rays leaving the edges of the grating in the zeroth and first-order diffraction directions and propagating through the lens to $z = 10$ mm.

Sketch on a large diagram the light intensity distribution in the plane at $z = 7{\cdot}5$ mm, indicating the locations of the principal maxima and the separations of these maxima from the first adjacent minimum. Sketch on a large diagram the light intensity at the plane $z = 10$ mm.

Explain briefly how this example gives a useful insight into the resolving power of a microscope with coherent illumination.