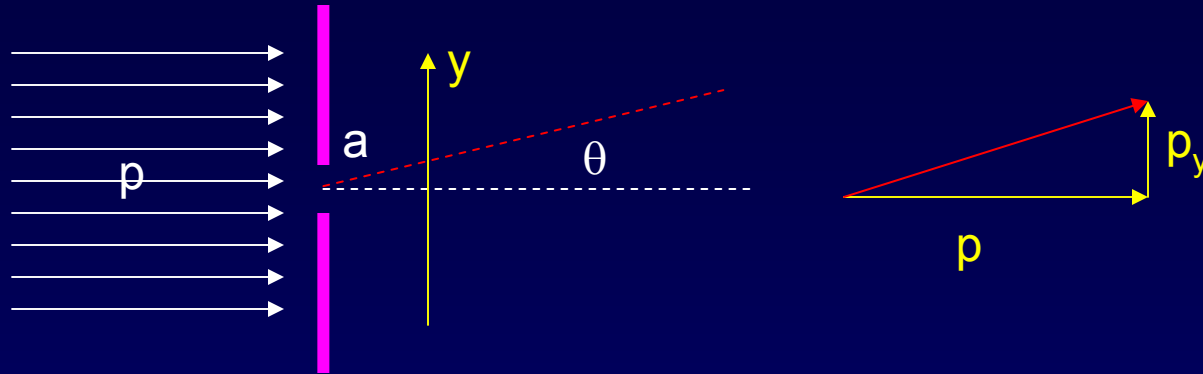


# Solution



Consider the momentum uncertainty in the y-direction.

- Before the slit, the y-position is not known, so the uncertainty of  $p_y$  can be zero. We know that  $p_y = 0$ .
- Just after the slit, the y-position has an uncertainty of about  $a/2$ . Therefore  $p_y$  must have an uncertainty  $\Delta p_y \geq 2\hbar/a$ . This corresponds to a change of direction by an angle,  $\theta = \Delta p_y / p = 2\hbar/ap$ . Using  $p = h/\lambda$ , we have  $\theta = \lambda/(\pi a)$ .

This is almost the diffraction answer:  $\theta = \lambda/a$ . The extra factor of  $\pi$  is due to our somewhat sloppy treatment of the uncertainty.

The important point is that the uncertainty principle results because matter behaves as a wave.