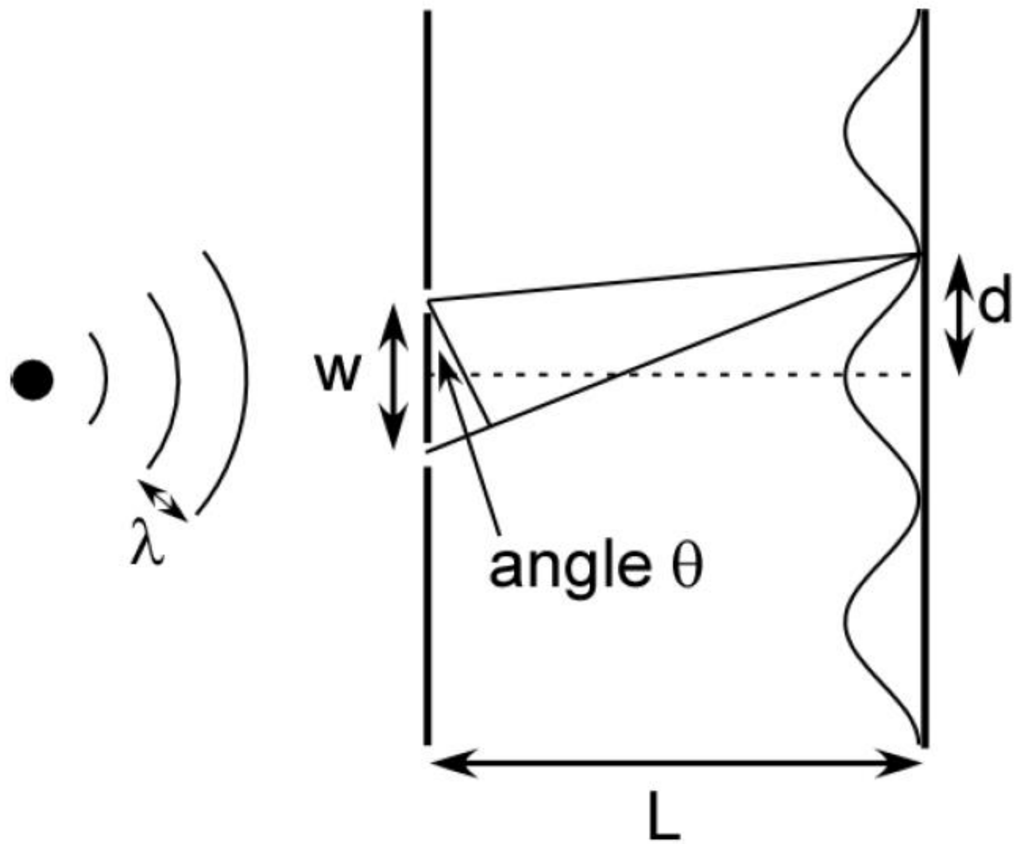
Quantum Mechanics Solutions 1:

QUANTUM DOUBLE SLIT

[easy] 1



[medium] 2. The path difference is the bottom side of the small triangle in the above diagram, i.e., $w\sin(\theta)$

[hard] 3a. For the central maximum, the path difference (p.d.) is zero. As we move away from the central maximum the path difference increases. When it reaches one half of a wavelength, a crest from one slit will be met with a trough from the other slit (since crest and trough are separated by half a wavelength). Thus, p.d. = $\frac{\lambda}{2}$. Combining this result with the result from the previous part we have $w\sin(\theta)=\frac{\lambda}{2}$.

b. $\frac{d}{L} = \tan(\theta)$. Using this expression for $\tan(\theta)$ in place of $\sin(\theta)$ in the result from the previous part we have $\frac{wd}{L} = \frac{\lambda}{2}$.

c. Using $\lambda = \frac{h}{p}$ we have $\frac{wd}{L} = \frac{\lambda}{2} = \frac{h}{2p}$, or $h = \frac{2dwp}{L}$.

d. E = 5 keV = 8 x10^{-16} J. $p = \sqrt{2mE} = 3.82 \times 10^{-23} \frac{kg\, m}{s}$. Substituting numbers into our formula from the previous part finally gives h = 6.63x10^{-34} m^2 kg/s, in excellent agreement with the accepted value for Planck's constant.