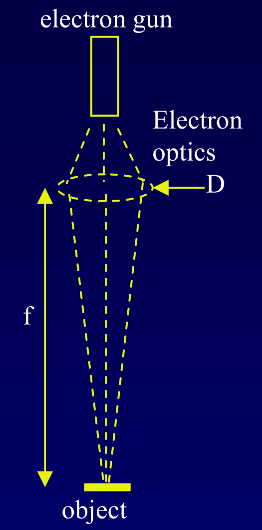
Solution

You wish to observe a virus with a diameter of 20 nm, much too small to observe with an optical microscope. Calculate the voltage required to produce an electron wavelength suitable for studying this virus with a resolution of d_{min} = 2 nm. The "f-number" for an electron microscope is quite large: $f/D \approx 100$.

Hint: First find λ required to achieve d_{min}.
Then find E of an electron from λ.



$$d_{min} \approx 1.22 \frac{\lambda}{D} f$$

$$\lambda \approx d_{min}\left(\frac{D}{1.22f}\right) = 2nm\left(\frac{D}{1.22f}\right) = 0.0164\ nm$$

$$E = \frac{h^2}{2m\lambda^2} = \frac{1.505\ eV \cdot nm^2}{(0.0164\ nm)^2} = 5.6\ keV$$

Note:
1.22λ/D is the diffraction angle, θ
f is the lever arm,
So, θf is the spot size.

To accelerate an electron to an energy of 5.6 keV requires 5.6 kilovolts .
(The convenience of electron-volt units)