730.

Problem 50.14 (RHK)

We have to find the accelerating voltage required for electrons in an electron microscope to obtain the same ultimate resolving power as that which could be obtained from a gamma ray microscope using 136-keV gamma rays.

Solution:

Wavelength of 136-keV photon is

$$\lambda = \frac{hc}{E} = \frac{6.63\times10^{-34}\times3\times10^{8}}{136\times10^{3}\times1.6\times10^{-19}}\ \text{m}$$
$$= 9.1\times10^{-12}\ \text{m}.$$

Momentum of an electron having de Broglie wavelength of 9.1 pm will therefore be

$$p = \frac{h}{\lambda} = \frac{6.63\times10^{-34}}{9.1\times10^{-12}}\ \text{kg m s}^{-1}$$
$$= 7.28\times10^{-23}\ \text{kg m s}^{-1}.$$

Kinetic energy of an electron with momentum $p = 7.28\times10^{-23}\ \text{kg m s}^{-1}$ will be

$$KE = \frac{p^2}{2m} = \frac{\left(7.28\times10^{-23}\right)^2}{2\times9.11\times10^{-31}}\ \text{J}$$

$$= 2.90\times10^{-15}\ \text{J} = \frac{2.90\times10^{-15}}{1.6\times10^{-19}}\ \text{eV}$$

$$= 1.82\times10^{4}\ \text{eV}$$

$$= 18.2\ \text{keV}.$$

Accelerating potential of 18.2 kV will be needed to produce the electron beam needed for obtaining the desired resolution using the electron microscope.