Ch. 11 Prob. 30

a) Find the voltage needed to accelerate electrons to 6.00×10^7 m/s. (I think the textbook has a typo. If it really were 6.00×10^{-7} m/s, then there would not be enough energy to free the electron from an atom.)

$$\frac{1}{2}mv^2 = \Delta U = q\Delta V \rightarrow \Delta V = \frac{mv^2}{2q} = \frac{(9.11\times10^{-31}\,kg)(6.00\times10^{7}\,m/s)}{2(1.6\times10^{-19}\,C)}$$

$$= 1.02\times10^{4}\,V$$

$$\boxed{10.2\,kV}$$

b) Find the radius of curvature in a B-field of 0.500T

$$qvB = F = \frac{mv^2}{r} \rightarrow r = \frac{mv^2}{qvB} = \frac{mv}{qB}$$

$$r = \frac{(9.11\times10^{-31}\,kg)(6.0\times10^{7}\,m/s)}{(1.6\times10^{-19}\,C)(0.500\,T)}$$

for an electron $\rightarrow r_e = 6.83\times10^{-4}\,m$

Accelerate a proton

$$\tfrac{1}{2}mv^2 = q\Delta V \rightarrow v = \sqrt{\frac{2q\Delta V}{m}}$$

$$v = \sqrt{\frac{2(1.6\times10^{-19}\,C)(1.02\times10^{4}\,V)}{(1.67\times10^{-27}\,kg)}} = 1.4\times10^{6}\,\frac{m}{s}$$

radius of curvature for the proton

$$r = \frac{mv}{qB} = \frac{(1.67\times10^{-27}\,kg)(1.4\times10^{6}\,m/s)}{(1.6\times10^{-19}\,C)(0.500\,T)}$$

$$\boxed{r_p = 0.029\,m}$$

$2.9\,cm$