3. An electron is accelerated from rest through a potential difference $\Delta V = 10^7$ volts. Find

(a) its kinetic energy in Joules and electron volt (eV). (2 points)

$$K = eV = (1.6\times10^{-19})(10^7) = \boxed{1.6\times10^{-12}\ J}$$
$$= \boxed{10^7\ eV}$$

(b) its total relativistic energy in eV (2 points)

$$E = K + m_0c^2 = 10\ MeV + 0.511\ MeV$$
$$= \boxed{10.511\ MeV}$$

(c) its mass (2 points)

$$E = mc^2 \Rightarrow m = \frac{E}{c^2} = \frac{10.511\times10^6\times1.6\times10^{-19}}{(3\times10^8)^2}$$
$$\boxed{m = 1.87\times10^{-29}\ Kg}$$

(d) its speed (2 points)

$$E = \gamma m_0c^2 = mc^2$$
$$\Rightarrow \gamma = \frac{mc^2}{m_0c^2} = \frac{1.87\times10^{-29}}{9.1\times10^{-31}} = 20$$
$$\gamma = \frac{1}{\sqrt{1-v^2/c^2}} \Rightarrow \frac{v}{c} = \sqrt{\frac{\gamma^2-1}{\gamma^2}} \Rightarrow v = c\sqrt{\frac{399}{400}} = \boxed{0.9987c}$$

(e) its momentum in MeV/c (2 points)

$$p = \gamma m_0 v = 20\times 9.1\times10^{-31}\times 0.9987\times 3\times10^8 = 5.45\times10^{-21}\ Kg\ \frac{m}{s}$$
$$= \frac{5.45\times10^{-21}}{5.33\times10^{-22}} = \boxed{10.23\ \frac{MeV}{c}}$$