Accelerating Particles Worked Solutions

A. This is the energy of 1 electron volt:
1.6×10^{-19} J

B. $E = \frac{1}{2}mv^2$ $\quad \sqrt{\frac{2E}{m}} = v = \sqrt{\frac{2 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}} = 5.9 \times 10^5 \text{ ms}^{-1}$

C. $E = \frac{V}{d}$ for a uniform field, $E = \frac{2000}{0.05} = 40{,}000 \text{ Vm}^{-1}$

You could also probably work this out from the units of electrical field strength, Vm^{-1}

d. $E = 3.5 \times 10^{12}$ eV
E in joules $= 3.5 \times 10^{12} \times 1.6 \times 10^{-19}$
$= 5.6 \times 10^{-7}$ J

$E = \frac{1}{2}mv^2$ $\quad \sqrt{\frac{2E}{m}} = v = \sqrt{\frac{2 \times 5.6 \times 10^{-7}}{1.67 \times 10^{-27}}} =$

$2.6 \times 10^{10} \text{ ms}^{-1}$

E. The kinetic energy is the same as in the previous part, because a particle with the same charge has been accelerated through the same electric field.
$E = 5.6 \times 10^{-7}$ J

Now, we have a new equation for kinetic energy. Rearranging that for V gives us

$$V = \sqrt{c^2 \times \left(1 - \left(\frac{1}{\frac{k}{mc^2} + 1}\right)^2\right)}$$

$$V = \sqrt{(3\times10^8)^2 \times \left(1 - \left(\frac{1}{\frac{5.6\times10^{-7}}{1.67\times10^{-27}\times(3\times10^8)^2} + 1}\right)^2\right)}$$

$= 299999989.2$

$3\times10^8 - 299999989.2 = 10.799$

$\frac{10.799}{3\times10^8} \times 100 = 3.5998\times10^{-6}\ \%$

$\approx 3.6\times10^{-6}\ \%$

correct to 2 S.F.