29.2

Similar to the previous problem, we plug $m = 10.00\,\text{g} = 10.00 \times 10^{-3}\,\text{kg}$ and $v = 331\,\text{m/s}$ into Eq. (29.1) to obtain

$$\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}\,\text{J}\cdot\text{s}}{(10.00 \times 10^{-3}\,\text{kg})(331\,\text{m/s})} = 2.00 \times 10^{-34}\,\text{m}\,.$$

29.7

Suppose that the electron is accelerated by a voltage difference of V. Then as it emerges from the accelerating potential the electron has acquired a kinetic energy in the amount of $\text{KE} = eV$, and so the momentum p of the electron is given by $p^2/2m_e = \text{KE} = eV$ to be $p = \sqrt{2eVm_e}$. The corresponding de Broglie wavelength of the electron follows from Eq. (29.1) to be

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2eVm_e}}\,.$$

Plug in $\lambda = 0.10\,\text{nm} = 0.10 \times 10^{-9}\,\text{m}$ and solve for V, the required accelerating voltage:

$$V = \frac{h^2}{2em_e\lambda^2} = \frac{(hc)^2}{2e(m_e c)^2\lambda^2} = \frac{(1240\,\text{eV}\cdot\text{nm})^2}{2e(0.511 \times 10^6\,\text{eV})(0.10\,\text{nm})^2} = 0.15\,\text{kV}\,.$$

Note that we multiplied both the denominator and the numerator by c^2 so as to use the well-known data of $hc = 1240\,\text{eV}\cdot\text{nm}$ and $m_e c^2 = 0.511\,\text{MeV}$. This is numerically a little simpler to handle than converting everything to SI units. Also note that by definition $1\,\text{eV}/1\,\text{V} = 1e$. Finally, since $\text{KE} = eV = 0.15\,\text{keV} \ll m_e c^2 = 0.511\,\text{MeV}$, we are justified in using non-relativistic approach.

29.9

Since the momentum p of the electron is given by $p^2/2m_e = \text{KE}$ to be $p = \sqrt{2m_e\text{KE}}$, the wavelength of the electron is

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m_e\text{KE}}} = \frac{hc}{\sqrt{2(m_e c^2)\text{KE}}} = \frac{1240\,\text{eV}\cdot\text{nm}}{\sqrt{2(0.511 \times 10^6\,\text{eV})(20\,\text{eV})}} = 0.27\,\text{nm}\,.$$

Note that, similar to Problem (29.7), we multiplied both the denominator and the numerator by c so as to use $hc = 1240\,\text{eV}\cdot\text{nm}$ and $m_e c^2 = 0.511\,\text{MeV}$.