29.11

Similar to Problem (29.9), we take the mass of the neutron as $m_n = 939.6\,\text{MeV}/c^2$ and its kinetic energy to be $\text{KE} = 50\,\text{eV}$ to obtain the wavelength of the neutron:

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m_n \text{KE}}} = \frac{hc}{\sqrt{2(m_n c^2)\text{KE}}} = \frac{1240\,\text{eV}\cdot\text{nm}}{\sqrt{2(939.6\times10^6\,\text{eV})(50\,\text{eV})}} = 0.004\,0\,\text{nm}.$$

29.12

Combine $\text{KE} = p^2/2m_e$ and $\lambda = h/p$ to obtain $\text{KE} = (h/\lambda)^2/2m_e = h^2/2m_e\lambda^2$. Plug in $\lambda = 1.00\,\text{m} = 1.00\times10^{-9}\,\text{nm}$ to find

$$\text{KE} = \frac{h^2}{2m_e\lambda^2} = \frac{(hc)^2}{2(m_e c^2)\lambda^2} = \frac{(1240\,\text{eV}\cdot\text{nm})^2}{2(0.511\times10^6\,\text{eV})(1.00\times10^9\,\text{nm})^2} = 1.50\times10^{-18}\,\text{eV},$$

which is equivalent to $(1.504\,5\times10^{-18}\,\text{eV})(1.602\times10^{-19}\,\text{J/eV}) = 2.41\times10^{-37}\,\text{J}$.

29.13

Since $\text{KE} \gg \text{E}_0$ the total energy E of the particle must satisfy $\text{E} = \text{KE} + \text{E}_0 \approx \text{KE} \gg \text{E}_0$. Thus the relativistic energy-momentum relationship, $\text{E}^2 = \text{E}_0^2 + p^2c^2$, can be rewritten as $p^2c^2 = \text{E}^2 - \text{E}_0^2 \approx \text{E}^2$; so $p \approx \text{E}/c$, and

$$\lambda = \frac{h}{p} \approx \frac{h}{\text{E}/c} = \frac{hc}{\text{E}},$$

which is the same as λ_p, the wavelength of a photon of energy E: $\lambda_p = c/f = c/(\text{E}/h) = hc/\text{E}$, where we noted that the energy E of a photon of frequency f is $\text{E} = hf$.

30.4

The symbol O stands for the element of oxygen, which has 8 protons (as $Z = 8$ for oxygen). Since $A = Z + N = 15$, the number of neutrons is $N = A - Z = 15 - 8 = 7$.

30.16

The radius R of a nucleus is a function of its nucleon number, A: $R = R_0 A^{1/3}$ [see Eq. (30.1)], where $R_0 \approx 1.2\,\text{fm}$. For the gold nucleus, plug in $A = 197$ to obtain

$$R = R_0 A^{1/3} \approx (1.2\,\text{fm})(197)^{1/3} = 7.0\,\text{fm}.$$