5. **REASONING AND SOLUTION** The surface area of a sphere is $\text{Area} = 4\pi r^2$. But according to Equation 31.2, the radius of a nucleus in meters is $r = (1.2 \times 10^{-15} \text{ m}) A^{1/3}$, where $A$ is the nucleon number. With this expression for $r$, the surface area becomes $\text{Area} = 4\pi (1.2 \times 10^{-15} \text{ m})^2 A^{2/3}$. The ratio of the largest to the smallest surface area is, then,

$$\frac{\text{Largest area}}{\text{Smallest area}} = \frac{4\pi (1.2 \times 10^{-15})^2 A_{\text{largest}}^{2/3}}{4\pi (1.2 \times 10^{-15})^2 A_{\text{smallest}}^{2/3}} = \frac{209^{2/3}}{1^{2/3}} = 35.2$$

9. **REASONING** According to Equation 31.2, the radius of a nucleus in meters is $r = (1.2 \times 10^{-15} \text{ m}) A^{1/3}$, where $A$ is the nucleon number. If we treat the neutron star as a uniform sphere, its density (Equation 11.1) can be written as

$$\rho = \frac{M}{V} = \frac{M}{\frac{4}{3}\pi r^3}$$

Solving for the radius $r$, we obtain,

$$r = \sqrt[3]{\frac{M}{\frac{4}{3}\pi \rho}}$$

This expression can be used to find the radius of a neutron star of mass $M$ and density $\rho$.

**SOLUTION** As discussed in Conceptual Example 1, nuclear densities have the same approximate value in all atoms. If we consider a uniform spherical nucleus, then the density of nuclear matter is approximately given by

$$\rho = \frac{M}{V} \approx \frac{A \times \text{(mass of a nucleon)}}{\frac{4}{3}\pi r^3} = \frac{A \times \text{(mass of a nucleon)}}{\frac{4}{3}\pi (1.2 \times 10^{-15} \text{ m}) A^{1/3}^3}$$

$$= \frac{1.67 \times 10^{-27} \text{ kg}}{\frac{4}{3}\pi (1.2 \times 10^{-15} \text{ m})^3} = 2.3 \times 10^{17} \text{ kg/m}^3$$

Substituting values into the expression for $r$ determined above, we have
23. **REASONING AND SOLUTION** The general form for $\beta^+$ decay is

\[
\begin{align*}
\begin{array}{c}
\text{Parent nucleus} \\
\text{Daughter nucleus} \\
\text{particle (positron)}
\end{array}
\end{align*}
\]

\[
A_Z^P \rightarrow A_Z^{D-1} + {}_0^{+1}e
\]

a. Therefore, the $\beta^+$ decay process for $^9_{18}F$ is $^9_{18}F \rightarrow ^8_{18}O + {}_0^{+1}e$.

b. Similarly, the $\beta^+$ decay process for $^{15}_{15}O$ is $^{15}_{8}O \rightarrow ^{15}_{7}N + {}_0^{+1}e$.

53. **REASONING AND SOLUTION** As shown in Figure 31.19, if the first dynode produces 3 electrons, the second produces 9 electrons ($3^2$), the third produces 27 electrons ($3^3$), so the $N^{th}$ produces $3^N$ electrons. The number of electrons that leaves the 14th dynode and strikes the 15th dynode is

$3^{14} = 4782969$ electrons