Types of Gauss' Law Problems

There are a limited number of Gauss' Law problems, and certain types of equations that will always come up in each type.

Notation: Below, I'll always use r for the radius of the Gaussian surface, and use a for the radius of physical charged objects. It is rarely the case that you want r and a to be the same.

Problem Type	Charge densities likely to be involved
Conductor with Cavity *Always* use a Gaussian surface that passes through "the meat" of the conductor (shape is unimportant), so that $0=\varepsilon_0\Phi=q_{\text{enc}}=Q_{\text{surrounded}}+Q_{\text{inner surface}}$ *Likely* to want to use charge conservation on the conductor: $Q_{\text{conductor}}=Q_{\text{outer surface}}+Q_{\text{inner surface}}$	Q, σ
Spherical Symmetry *Always* use Gaussian surface (sphere with radius r), so that $\varepsilon_0 E\left(4\pi r^2\right)=\varepsilon_0\Phi=q_{\text{enc}}$ *Likely* to want to use some combination of the following to get q_{enc} $q=\sigma\left(4\pi a^2\right)$ $q=\rho\left(\frac{4}{3}\pi a^3\right)$	Q, σ, ρ
Cylindrical Symmetry (infinitely long) *Always* use Gaussian surface (cylinder with radius r and length h), so that $\varepsilon_0 E\left(2\pi rh\right)=\varepsilon_0\Phi=q_{\text{enc}}$ and you will *always* find that $q_{\text{enc}}\propto h$. *Likely* to want to use some combination of the following to get q_{enc} $q=\lambda h$ $q=\sigma\left(2\pi ah\right)$ $q=\rho\left(\pi a^2 h\right)$	λ, σ, ρ
Planar Symmetry (infinite in two directions) *Always* use Gaussian surface (right prism with length L and ends with area A), so that $\varepsilon_0\left(E_{\text{right end}}A-E_{\text{left end}}A\right)=\varepsilon_0\Phi=q_{\text{enc}}$ and you will *always* find that $q_{\text{enc}}\propto A$. Note that $E_{\text{right end}}$ and $E_{\text{left end}}$ might be positive (field pointing right) or negative (field pointing left). *Likely* to want to use some combination of the following to get q_{enc} $q=\sigma A$ $q=\rho aA$	σ, ρ
Conductor Surface *Always* use same Gaussian surface as planar symmetry, one end in conductor, so that $\varepsilon_0\left(E_{\text{outside}}A\right)=\varepsilon_0\Phi=q_{\text{enc}}=\sigma A$	σ