40. We imagine a spherical Gaussian surface of radius r centered at the point charge $+q$. From symmetry consideration E is the same throughout the surface, so

$$\oint \vec{E} \cdot d\vec{A} = 4\pi r^2 E = \frac{q_{\text{encl}}}{\varepsilon_0} \ ,$$

which gives

$$E(r) = \frac{q_{\text{encl}}}{4\pi\varepsilon_0 r^2} \ ,$$

where q_{encl} is the net charge enclosed by the Gaussian surface.

(a) Now $a < r < b$, where $E = 0$. Thus $q_{\text{encl}} = 0$, so the charge on the inner surface of the shell is $q_i = -q$.

(b) The shell as a whole is electrically neutral, so the outer shell must carry a charge of $q_o = +q$.

(c) For $r < a$ $\quad q_{\text{encl}} = +q$, so

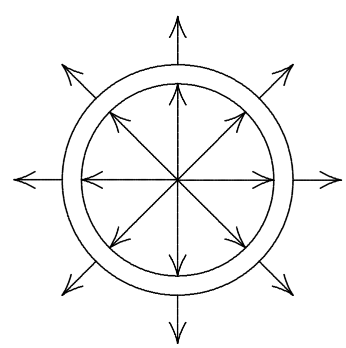
$$E\bigg|_{r<a} = \frac{q}{4\pi\varepsilon_0 r^2} \ .$$

(d) For $b > r > a$ $\quad E = 0$, since this region is inside the metallic part of the shell.

(e) For $r > b$ $\quad q_{\text{encl}} = +q$, so

$$E\bigg|_{r<a} = \frac{q}{4\pi\varepsilon_0 r^2} \ .$$

The field lines are sketched to the right.



(f) The net charge of the central point charge-inner surface combination is zero. Thus the electric field it produces is also zero.

(g) The outer shell has a spherically symmetric charge distribution with a net charge $+q$. Thus the field it produces for $r > b$ is $E = q/(4\pi\varepsilon_0 r^2)$.

(h) Yes. In fact there will be a distribution of induced charges on the outer shell, as a result of a flow of positive charges toward the side of the surface that is closer to the negative point charge outside the shell.

(i) No. The change in the charge distribution on the outer shell cancels the effect of the negative point charge. The field lines are sketched below.