320.

Problem 29.17 (RHK)

A conducting sphere carrying charge Q is surrounded by a spherical conducting shell. (a) *We have to find the net charge on the inner surface of the shell.* (b) *Another charge q is placed outside the shell. In this situation we will find the net charge on the inner surface of the shell.* (c) *Let us now assume that the charge q is moved to a position between the shell and the sphere. In this situation we will find the net charge on the inner surface of the shell.* (d) *We will answer whether our answers are valid if the sphere and the shell are not concentric.*

Solution:

In answering this problem we will use the fact that inside a conductor the electric field at all points is zero and the Gauss' law.

(a)

We consider a Gaussian surface which encloses the inner surface of the conducting shell but is contained inside the

shell. As the electric field inside the conducting shell is zero, the flux on the Gaussian surface will be zero.

The Gauss' law states that

$\varepsilon_0 \Phi_E =$ total charge enclosed,

and as the charge on the spherical conductor is Q so the net total charge on the inner surface of the spherical shell has to be $-Q$.

(b)

When another charge q is placed outside the shell the net total charge on the inner surface of the spherical shell will remain unchanged and will be $-Q$.

(c)

When the charge q is moved to a position between the shell and the conducting sphere, the charge on the inner surface of the conducting shell will become $-(Q+q)$.

This has to be so because the net charge enclosed inside the Gaussian surface enclosing the inner surface but contained inside the shell has to be zero because the electric field inside a conductor is always zero.

(d)

Our answers above did not require spherical symmetry, so they are valid even when the shell and the conductor are not concentric.