314.

Problem 29.9 (RHK)

It is found experimentally that the electric field in a certain region of the Earth's atmosphere is directed vertically down. At an altitude of 300 m *the field is* 58 N C^{-1} *and at an altitude of* 200 m *it is* 110 N C^{-1}. *We have to find the net amount of charge contained in a cube of* 100 m *on edge located between* 200 *and* 300 m. *We can neglect the curvature of the Earth.*

Solution:

As the electric field in the region is directed vertically down ward, the outward normal to the Gaussian surface of the cube of 100 m on edge at the height of 300 m will be in direction opposite to the electric field, and the outward normal to the Gaussian surface of the cube at the height of 200 m will be in the direction of the field. Therefore, the total flux of the electric field through the Gaussian surface of the cube will be

$$\Phi_E = \left\{(100)^2 \times (-58) + (100)^2 \times 110\right\} \text{ N C}^{-1} \text{ m}^2$$
$$= 52 \times 10^4 \text{ N C}^{-1} \text{ m}^2.$$

According to Gauss' law

$\varepsilon_0 \Phi_E = q$, where q is the charge enclosed by the closed Gaussian surface.

Therefore, the net amount of charge contained inside the cube will be

$$q = 52 \times 10^4 \times 8.85 \times 10^{-12} \text{ C}$$
$$= 4.6 \ \mu\text{C}.$$