(iv) The surface that we choose for the application of Gauss's law is called the Gaussian surface. You may choose any Gaussian surface and apply Gauss's law. However, take care not to let the Gaussian surface pass through any discrete charge. This is because electric field due to a system of discrete charges is not well defined at the location of any charge. (As you go close to the charge, the field grows without any bound.) However, the Gaussian surface can pass through a continuous charge distribution.

(v) Gauss's law is often useful towards a much easier calculation of the electrostatic field *when the system has some symmetry*. This is facilitated by the choice of a suitable Gaussian surface.

(vi) Finally, Gauss's law is based on the inverse square dependence on distance contained in the Coulomb's law. Any violation of Gauss's law will indicate departure from the inverse square law.

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Example 1.11 The electric field components in Fig. 1.27 are $E_x = \alpha x^{1/2}$, $E_y = E_z = 0$, in which α = 800 N/C m$^{1/2}$. Calculate (a) the flux through the cube, and (b) the charge within the cube. Assume that a = 0.1 m.

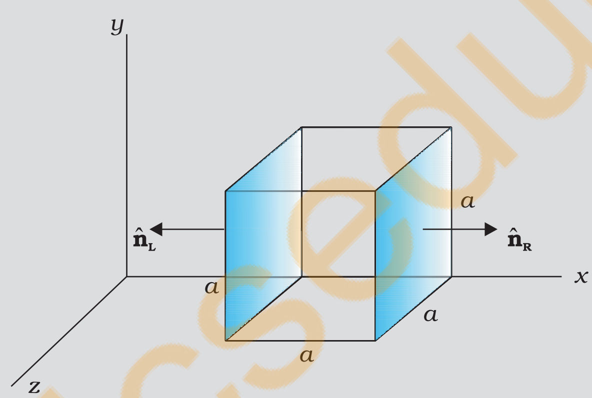

FIGURE 1.27

Solution

(a) Since the electric field has only an x component, for faces perpendicular to x direction, the angle between **E** and Δ**S** is $\pm\,\pi/2$. Therefore, the flux $\phi = \mathbf{E}.\Delta\mathbf{S}$ is separately zero for each face of the cube except the two shaded ones. Now the magnitude of the electric field at the left face is

$E_L = \alpha x^{1/2} = \alpha a^{1/2}$

($x = a$ at the left face).

The magnitude of electric field at the right face is

$E_R = \alpha\, x^{1/2} = \alpha\,(2a)^{1/2}$

($x = 2a$ at the right face).

The corresponding fluxes are

$$\phi_L = \mathbf{E}_L\cdot\Delta\mathbf{S} = \Delta S\,\mathbf{E}_L\cdot\hat{\mathbf{n}}_L = E_L\,\Delta S\cos\theta = -E_L\,\Delta S, \text{ since } \theta = 180°$$

$$= -E_L a^2$$

$$\phi_R = \mathbf{E}_R\cdot\Delta\mathbf{S} = E_R\,\Delta S\cos\theta = E_R\,\Delta S, \quad \text{since } \theta = 0°$$

$$= E_R a^2$$

Net flux through the cube

EXAMPLE 1.11

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