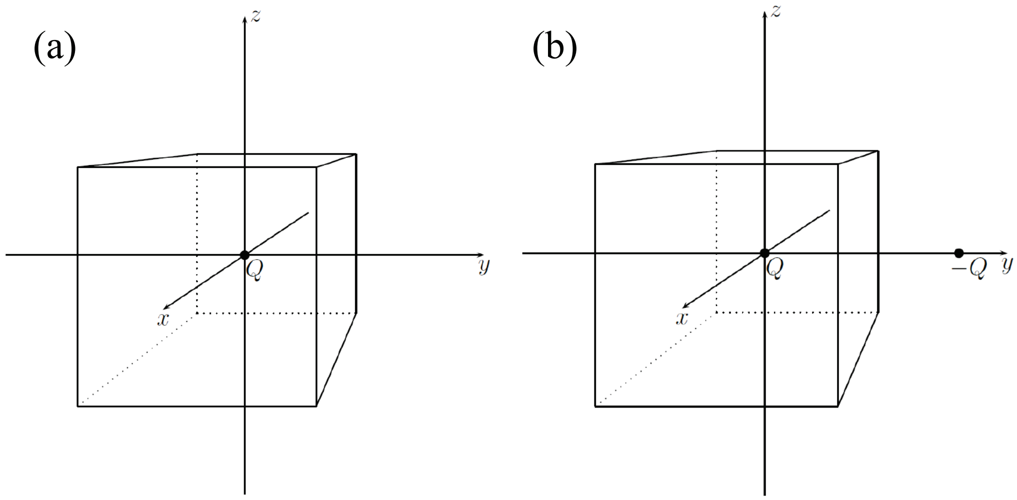
Practical 4 Questions

1. (a) A charge $Q = 10$ nC is placed at the origin $\vec{r} = (0, 0, 0)$, at the centre of a cube of side-length $a = 1$ cm whose faces are perpendicular to the x, y, and z-axes as shown below left. What is the total electric flux Φ_E through the box, and what is the average of the perpendicular component of the electric field, $E_\perp$, on the right-hand face (the one centred on $(0, a/2, 0)$)?



(b) A second charge, $-Q$, is now added at $\vec{r} = (0, a, 0)$, as shown on the right. Now what is the total flux through the box, and the average of the perpendicular component, $E_\perp$, on the face centred on $(0, a/2, 0)$?
Hint: Neither part of this question requires integration.

2. *electric field of a thick infinite slab*
A slab with thickness T and infinite in extent in the xy-plane, carries a volume charge density of ρ. Sketch the electric field as a function of z for $-2T < z < 2T$.

3. What is the electric field at a point P, a distance $h = 20.0$ cm above an infinite sheet of charge, with a surface charge density of $\sigma = 1.3$ C/m^2 and a hole of radius $R = 5.0$ cm with P directly above the center of the hole, as shown in the figure below? *(Hint: the formula for the electric field due to a uniformly charged disk is found on p.633 of the textbook:* $E(z) = 2k\pi\sigma[1 - z/\sqrt{z^2 + R^2}]$*)*