NAME: KEY

Quiz 2, Physics 9C, Winter 2016

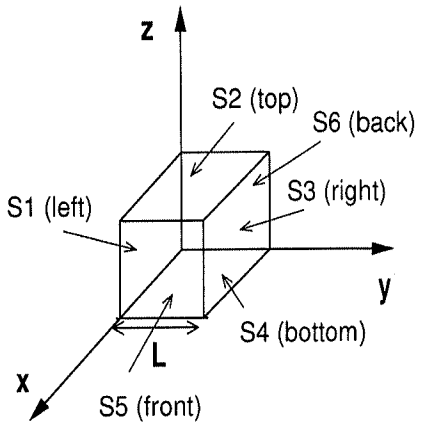
General Instructions: This quiz is closed book. Only a calculator is allowed. Please show all your work, and give units for all answers and on all graphs. Credit will only be given for complete solutions. The constant k in Coulomb's law is $k = 9 \cdot 10^9$ Nm^2/C^2.

The cube in the figure has sides of length $L = 12$ cm. The electric field, has magnitude $E = 600$ N/C and is parallel to the xy plane at an angle $\theta = 20°$ measured from the $+x$ axis towards the $+y$ axis.

(a) What is the electric flux through each of the six faces?
(b) What is the charge density ρ?
(c) Is Gauss' Law obeyed?
(d) If, instead,

$$\vec{E} = (3x + 5y)\,\hat{x} + (x - y^2)\,\hat{y}$$

were not uniform, what would the charge density ρ be?



a) $\vec{E} = 600(\cos 20\,\hat{x} + \sin 20\,\hat{y}) = 564\,\hat{x} + 205\,\hat{y}$ N/C

Flux through a face is, since $\vec{E}$ = const, given by $\vec{E}\cdot\hat{n}\,L^2$ (area)

S1: $\hat{n} = -\hat{y}$ $\quad \vec{E}\cdot\hat{n}\,dA = -205\,L^2 = -2.95$ Nm^2/C

S2: $\hat{n} = \hat{z}$ $\quad \vec{E}\cdot\hat{n}\,dA = 0$

S3: $\hat{n} = +\hat{y}$ $\quad \vec{E}\cdot\hat{n}\,dA = +2.95$ Nm^2/C

S4: $\hat{n} = -\hat{z}$ $\quad \vec{E}\cdot\hat{n}\,dA = 0$

S5: $\hat{n} = +\hat{x}$ $\quad \vec{E}\cdot\hat{n}\,dA = 564\,L^2 = 8.12$ Nm^2/C

S6: $\hat{n} = -\hat{x}$ $\quad \vec{E}\cdot\hat{n}\,dA = -8.12$ Nm^2/C

b) since $\vec{E}$ = const $\quad \rho = \epsilon_0 \vec{\nabla}\cdot\vec{E} = 0$

c) Gauss law is obeyed since $Q_{enclosed} = 0$ and $\Phi_{TOT} = 0$

d) Now $\rho = \epsilon_0 \vec{\nabla}\cdot\vec{E} = \epsilon_0 \frac{\partial}{\partial x}(3x+5y) + \frac{\partial}{\partial y}(x-y^2) + \frac{\partial}{\partial z}0$
($\uparrow E_x$, $\uparrow E_y$, $\uparrow E_z$)

$= \epsilon_0(3 - 2y)$