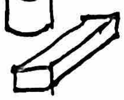
WS5 Solns

(1) Sphere: $4\pi r^2$ 

Cylinder: $2\pi r \cdot x + 2\pi r^2$ 

Box: $2(ab + bc + ac)$ 

(2) $dA = \underbrace{C}_{2\pi r\left(1-\frac{x}{h}\right)} \underbrace{d\ell}_{\frac{\sqrt{r^2+h^2}}{h}dx}$

$$\frac{2\pi r\sqrt{r^2+h^2}}{h}\int_0^h dx \left(1-\frac{x}{h}\right) = \underbrace{\pi r\sqrt{r^2+h^2}}_{\text{face}}$$

$$A = \underbrace{\pi r^2}_{\substack{\text{flat} \\ \text{circle}}} + \underbrace{\pi r\sqrt{r^2+h^2}}_{\substack{\text{slanted} \\ \text{face}}}$$

(3) $$V = \int_0^h dx\, \pi\left(r\left(1-\frac{x}{h}\right)\right)^2 = \frac{\pi r^2 h}{3}$$

(4) $E_z = 0$, by vector addition

(5) No, but if we think of the plane as a gaussian surface, it has two fluxes which exactly cancel.

(6)

$$Q = \int \rho\, dV = \int_0^h dz\, \rho_0 z\, \pi\left(r\left(1-\frac{z}{h}\right)\right)^2 = \frac{\pi r^2 h^2 \rho_0}{12}$$

(7) (8) $$\frac{Q_{enc}}{\varepsilon_0} = \frac{\pi r^2 h^2 \rho_0}{12\,\varepsilon_0}$$

(9) $$\left.\begin{array}{l} Q_{enc} = \int_0^{h/2} \rho\, dV = \frac{11}{192}\pi r^2 h^2 \rho_0 \\ Q_{ext} = \int_{h/2}^{h} \rho\, dV = \frac{5}{192}\pi r^2 h^2 \rho_0 \end{array}\right\} \rightarrow \Phi_{net} = \Phi_{outgoing} - \Phi_{incoming} = \frac{\pi r^2 h^2 \rho_0}{32\,\varepsilon_0}$$

(10) $|r| = 1$

$$E_{q_+} = \frac{kq}{r^2} = kq$$

(11) $|r| = 2$

$$E_{q_-} = -\frac{kq}{r^2} = -\frac{kq}{4}$$

(12) $E_{net} = E_{q_+} + E_{q_-} = \frac{3kq}{4}$

(13) $\Phi_{net} = \frac{Q_{enc}}{\varepsilon_0} = 0$, $Q_{enc} \leftarrow 0$

(14) $c = \int_0^{2\pi} r \, d\theta = 2\pi r$

(15) $A = \int_0^r 2\pi r' \, dr' = \pi r^2$