15-Phys-202

WINTER 2003

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Quiz 2 Name _____

Useful formulae and constants:

$$\Phi = \frac{q_{enclosed}}{\varepsilon_0}$$

$$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{C}^2/\mathrm{N}\cdot\mathrm{m}^2$$

1. You have three point charges $3q$, q, and $-q$. Describe how you would place a closed surface that encloses at least the charge $-q$ (and perhaps other charges), and through which the net electric flux is $3q/\varepsilon_0$.

   Solution

   We use the fact that

   $$\Phi = \frac{q_{enclosed}}{\varepsilon_0}$$

   For a surface which encloses all three charges

   $$q_{enclosed} = 3q + q - q = 3q$$

   and so the charges $3q$ and q must be enclosed together with $-q$.

2. A circular surface of radius $R = 5.0$ mm is immersed in a uniform electric field whose direction is perpendicular to the surface and whose magnitude is $E = 5000$ N/C. Calculate the magnitude of the electric flux through the surface.

   Solution

   The area of the circle is

   $$A = \pi R^2$$

   so that the flux is

   $$\begin{aligned}\Phi &= EA = \pi E R^2 \\ &= \pi\left(5 \times 10^3\ \mathrm{N/C}\right)\left(5.0 \times 10^{-3}\ \mathrm{m}\right)^2 = 0.4\ \mathrm{N}\cdot\mathrm{m}^2/\mathrm{C}\end{aligned}$$

3. A sphere of radius $R = 3.0$ cm is in the region of a uniform electric field $6.0\hat{\mathbf{i}}$ N/C. What is the total flux through the sphere?

   Solution

   The total flux of a uniform field through a closed surface is always zero.