

Homework 10 for September 15 2008
Due 8AM on September 16 2008
Physics 221 with Professor Jeff Terry

Average: 76%
StDev: 20%

1. A uniform electric field $a\hat{i} + b\hat{j}$ intersects a surface of area A. What is the flux through this surface if it lies: (a) in the yz plane, (b) in the xz plane, (c) in the xy plane?

$$\Phi = \vec{E} \cdot \vec{A} = E A \cos \theta = \sum_{n=i,j,k} E_n A_n$$

For the yz, xz and xy plane the area vector is $A\hat{i}$, $A\hat{j}$ and $A\hat{k}$, respectively.

$$\Phi_a = E_i A_i = aA$$

$$\Phi_b = E_j A_j = bA$$

$$\Phi_c = E_k A_k = 0A = 0$$

Notes: You should not be using units on this answer. The units are embedded in a, b and A – depending on the units of the variables, the units of the answer will be different. Additionally, throwing units on the answer actually changes the overall units. For example, suppose an answer to a question is A which is 2m^2 . You write “A m^2 ”. Now your units are m^4 , and this is wrong. If you put units on otherwise-correct answers I deducted 1 pt.

2. At the surface of a sphere, of radius r, the electric field magnitude is E and it is pointing out of the sphere perpendicular to the surface. How much charge is enclosed by the sphere?

The E field has been contrived such that it will be parallel to the area element everywhere on the surface of the sphere. This makes the problem much easier.

$$\Phi = \oint \vec{E} \cdot d\vec{A} = \oint E dA = EA$$

$$= 4\pi r^2 E = \frac{Q_{\text{inside}}}{\epsilon_0}$$

$$Q_{\text{inside}} = 4\pi r^2 \epsilon_0 E$$