First Year Electricity & Magnetism **Classwork 2** **11 Feb. 2008**

Numbers in italics refer to the Exercise number in the 12th Edition of Young & Freedman's "University Physics". Answers to odd-numbered questions are at the back of the book.

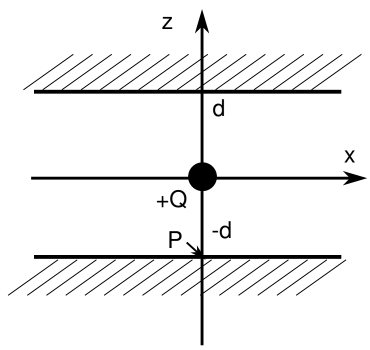
1. [*22.2*] A flat sheet is in the shape of a rectangle with sides of length 0.400 m and 0.600 m. The sheet is immersed in a uniform electric field of magnitude 75.0 N/C that is directed at 20° from the plane of the sheet. Find the magnitude of the electric flux through the sheet.

2. a) A closed surface encloses a net charge of $-3.60\,\mu$C. What is the net electric flux through the surface? b) The electric flux through a closed surface is found to be 780 N m^2/C. What quantity of charge is enclosed by the surface? c) The closed surface in part (b) is a cube with sides of length 2.50 cm. From the information given in part (b), is it possible to tell where within the cube the charge is located? Explain.

3. [*22.13*] A 9.60 μC point charge is at the centre of a cube with sides of length 0.500 m. a) What is the electric flux through one of the six faces of the cube? [*Hint: THINK before you calculate.*] b) How would your answer to part (a) change if the sides were of length 0.250 m? Explain.

4. [*22.23*] A hollow, conducting sphere with an outer radius of 0.250 m and an inner radius of 0.200 m has a uniform surface charge density of $+6.37 \times 10^{-6}$ C/m^2. A charge of $-0.500\,\mu$C is now introduced into the cavity inside the sphere. (a) What is the new charge density on the outside of the sphere? (b) Calculate the strength of the electric field just outside the sphere. (c) What is the electric flux through a spherical surface just inside the inner surface of the sphere?

5. (more challenging) Two infinite planar conductors are parallel to one another and to the $x - y$ plane and pass through $z = \pm d$. A point charge $+Q$ is placed at the origin. Using the method of images, show that there are, in fact, an infinite number of images, of charge $Q_n = (-1)^n Q$ located at $z_n = 2nd$ for $n = \pm 1, \pm 2, ...$ Use your results to find the electric field at the point P ($z = -d$) just above the surface of the bottom conductor. [*Hint: What do you see if you stand inbetween two parallel mirrors?*]



Remember ISEE: *Identify* the relevant concepts, including the target variable (what you need to find); *Set Up* the problem, usually with the help of a sketch; *Execute* the calculation needed to find the value of the target variable; finally *Evaluate* your answer: does it correspond to the symmetry of the problem, does the answer seem reasonable?

Some possibly useful information and formulae:

$$\Phi_E = \oiint \mathbf{E} \cdot \mathbf{dA} = \frac{Q_{encl}}{\epsilon_0}$$

$$Q = \iiint \rho \, dV$$

Symbol	Value	Units
ϵ_0	8.85×10^{-12}	C^2/N m^2
$1/4\pi\epsilon_0$	8.99×10^{9}	N m^2/C^2

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