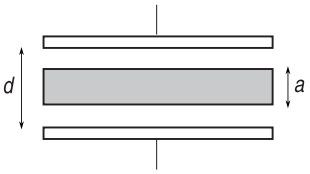
First Year Electricity & Magnetism **Classwork 5** **25 February 2008**

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. Some useful formulae are given at the end of this sheet.

1. [*24.7*] How far apart would parallel 1-pence pieces have to be to make a 1.00 pF capacitor? Does you answer suggest that you are justified in treating these coins as infinite sheets? Explain. [The diameter of a 1-pence piece is roughly 2 cm.]

2. [*24.66*] An air capacitor is made by using two flat plates, each with area A, separated by a distance d. Then a metal slab having thickness a (less than d) and the same shape and size as the plates is inserted between them, parallel to the plates and not touching either plate. a) What is the capacitance of this arrangement? b) Express the capacitance as a multiple of the capacitance C_0 when the metal slab is not present. c) Discuss what happens to the capacitance in the limits $a \to 0$ and $a \to d$.



3. [*24.48*] A parallel-plate capacitor has plates with area 0.0225 m^2 separated by 1.00 mm of Teflon. (a) Calculate the charge on the plates when they are charged to a potential difference of 12.0 V. (b) Use Gauss's law to calculate the electric field inside the Teflon. (c) Use Gauss's Las to calculate the electric field if the voltage source is disconnected and the Teflon is removed. [Teflon has a relative permittivity $K \equiv \epsilon_r = 2.1$]

4. A particle initially moving south in a vertically downward magnetic field is deflected toward the east. What is the sign of the charge on the particle? Explain your answer with a diagram.

5. [*27.1*] A particle with a charge of -1.24×10^{-8} C is moving with an instantaneous velocity $\mathbf{v} = (4.19 \times 10^4 \text{ m/s})\hat{\mathbf{i}} + (-3.85 \times 10^4 \text{ m/s})\hat{\mathbf{j}}$. What is the force exerted on this particle by a magnetic field a) $\mathbf{B} = (1.40 \text{ T})\hat{\mathbf{i}}$? b) $\mathbf{B} = (1.40 \text{ T})\hat{\mathbf{k}}$?

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 (see also the handout on Dieletrics):

$$C = Q/V \qquad \mathbf{D} = \epsilon_o \epsilon_r \mathbf{E}$$

$$C = \epsilon_0 A/d \qquad E = E_0/\epsilon_r$$

$$U = \frac{1}{2}CV^2 \qquad u_E = \frac{1}{2}\epsilon_0 E^2$$

$$C = \epsilon_r C_0 \qquad u_E = \frac{1}{2}\epsilon_r \epsilon_0 E^2$$

$$\oiint \mathbf{D} \cdot \mathbf{dA} = Q_{\substack{encl \\ free}} \qquad \mathbf{F} = q\mathbf{v} \times \mathbf{B}$$

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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25 February 2008