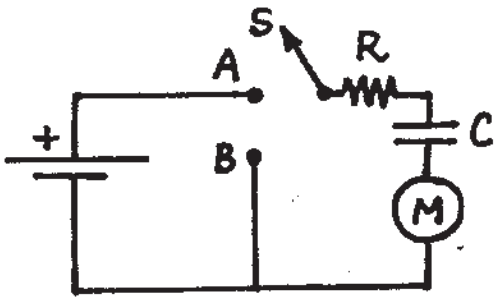
Physics 57B Second Exam August 3, 197.

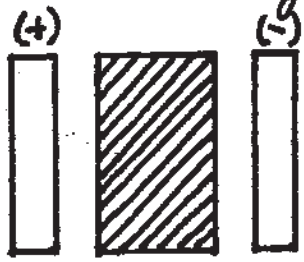
No books or papers (except a Table of Integrals) may be used, but you may use one card, not larger than $3'' \times 5''$. The exam totals 100 points. Constants: $e = 1.6 \times 10^{-19} C$; $\epsilon_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$.

(10) (1) An α-particle (charge $+2e$) is at the origin of a coordinate system. An anti-proton (charge $-e$) is at a distance of 10^{-7} meters from the α-particle and is on the x-axis. Calculate the electrostatic potential at the point midway between the two particles. (Assume that both particles are, and remain, at rest.)

(20) (2) A source of emf of 3 volts is connected to a resistor of 10^7 ohms and a capacitor of 10^{-9} farads, as shown below. Switch S is connected to point A and left overnight (12 hours). Then, at time $t = 0$ switch S is moved to point B. Meter M reads current. After how many seconds will meter M read 1×10^{-7} Amperes?



(20) (3) A slab of dielectric material of dielectric constant 7 is inserted between parallel metal plates (each of area $10^{-2} m^2$) in such a way that the charge on either plate is $8.9 \times 10^{-10} C$. In the drawing, the dielectric is shaded. Using Gauss' Law, calculate the electric field E in the dielectric. Assume E is normal to the plates and that all of the charge on the metal plates is on their inner surfaces.



(over →)

(25)(4) Given a thin circular disc, of radius R, of non-conducting material bearing a surface charge density of σ Cm^{-2}. Calculate the electrostatic potential $V(z)$ at a perpendicular distance z (on the axis of the disc) from the center of the disc.

(25)(5) Two conducting spheres have radii r and R, where $R > r$. Each sphere has on it an excess mobile charge of $+Q$ Coulombs, and the spheres are very far apart. The two spheres remain at rest, but are suddenly connected by a conducting wire. Calculate (a) the direction of transfer of positive charge; (b) the amount q of charge transfered. (Your answer to (b) will be in terms of Q, R, and r.) [(a)=10, (b)=15]

$$\int \frac{dx}{(x^2+a^2)^{1/2}} = \ln\left[x + (x^2+a^2)^{\frac{1}{2}}\right] + C$$

$$\int \frac{x\,dx}{(x^2+a^2)^{1/2}} = (x^2+a^2)^{\frac{1}{2}} + C$$

$$\int \frac{dx}{(x^2+a^2)^{3/2}} = \frac{1}{a^2}\frac{x}{(a^2+x^2)^{1/2}} + C$$

$$\int \frac{x\,dx}{(x^2+a^2)^{3/2}} = \frac{-1}{(x^2+a^2)^{1/2}}$$