# 物理电子学院2003年研究生招生复试试题

适用科目：电磁场与电磁波 / 电磁场与微波技术 / 电动力学

共5道题，任选4题，每题25分，满分100分。

闭卷考试，可带英汉词典和计算器。

考试时间120分钟，可用英文或中文答题。

**Problem 1. Vector addition of four fields.** Four 3-pC charges are at the corners of a 1-m square. The two charges on the left side of the square are positive. The two charges on the right side are negative. Find the field $\boldsymbol{E}$ at the center of the square. $\varepsilon_r = 1$ and $\varepsilon_0 = 8.85\times10^{-12} C(Vm)^{-1}$.

**Problem 2. Sandwich capacitor**. Referring to Fig. 2, the capacitor is a sandwich of two dielectric media of the same thickness ($d$=1cm). Plate area $A = 100cm^2$. Neglect the field outside the capacitor, called fringing field. Find: (a) electric fields $E_1$ and $E_2$, voltages $V_1$ and $V_2$, and electric flux densities $D_1$ and $D_2$; (b) capacitance.

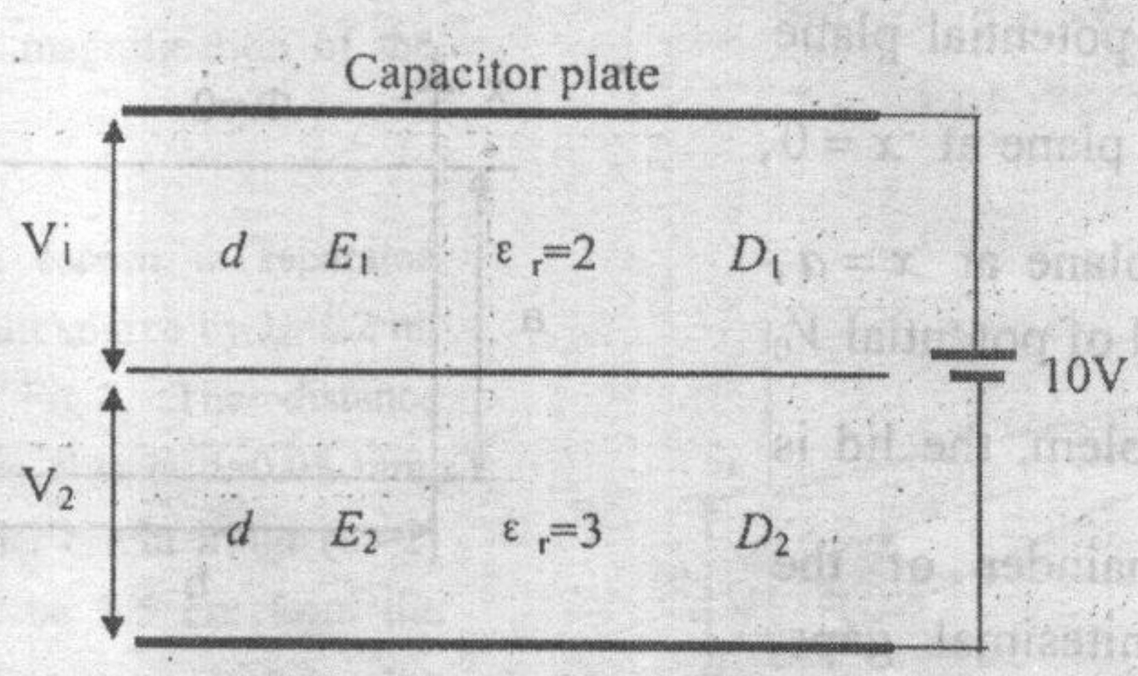


Fig.2

**Problem 3. Ocean penetration**. Calculate the ocean depths at which a $10^{-6}$Vm$^{-1}$ field will be obtained with $E$ at the surface equal to 1Vm$^{-1}$ at frequencies of 1, 10, 100, and 1000 kHz. $\sigma = 4(\Omega m)^{-1}$ and $\varepsilon_r = 80$ for sea water. What is the most suitable frequency for communication by wireless with undersea craft?

***Hint***. Let $x = 0$ at the surface of the ocean, with $x$ increasing positively into the sea water. The wave equation for the sea water is

$$\frac{\partial^2 E}{\partial x^2} - \gamma^2 E = 0$$

where $\gamma^2 = j\omega\mu\sigma - \omega^2\mu\varepsilon$, and $\mu = 4\pi\times10^{-7} Hm^{-1}$.

**Problem 4. Multiple images**. For a charge in the vicinity of the intersection of two conducting planes, such as $q$ in the region of $AOB$ of Fig. 4, find the potential in the region of $AOB$. The angle $AOB$ is 45-degree.

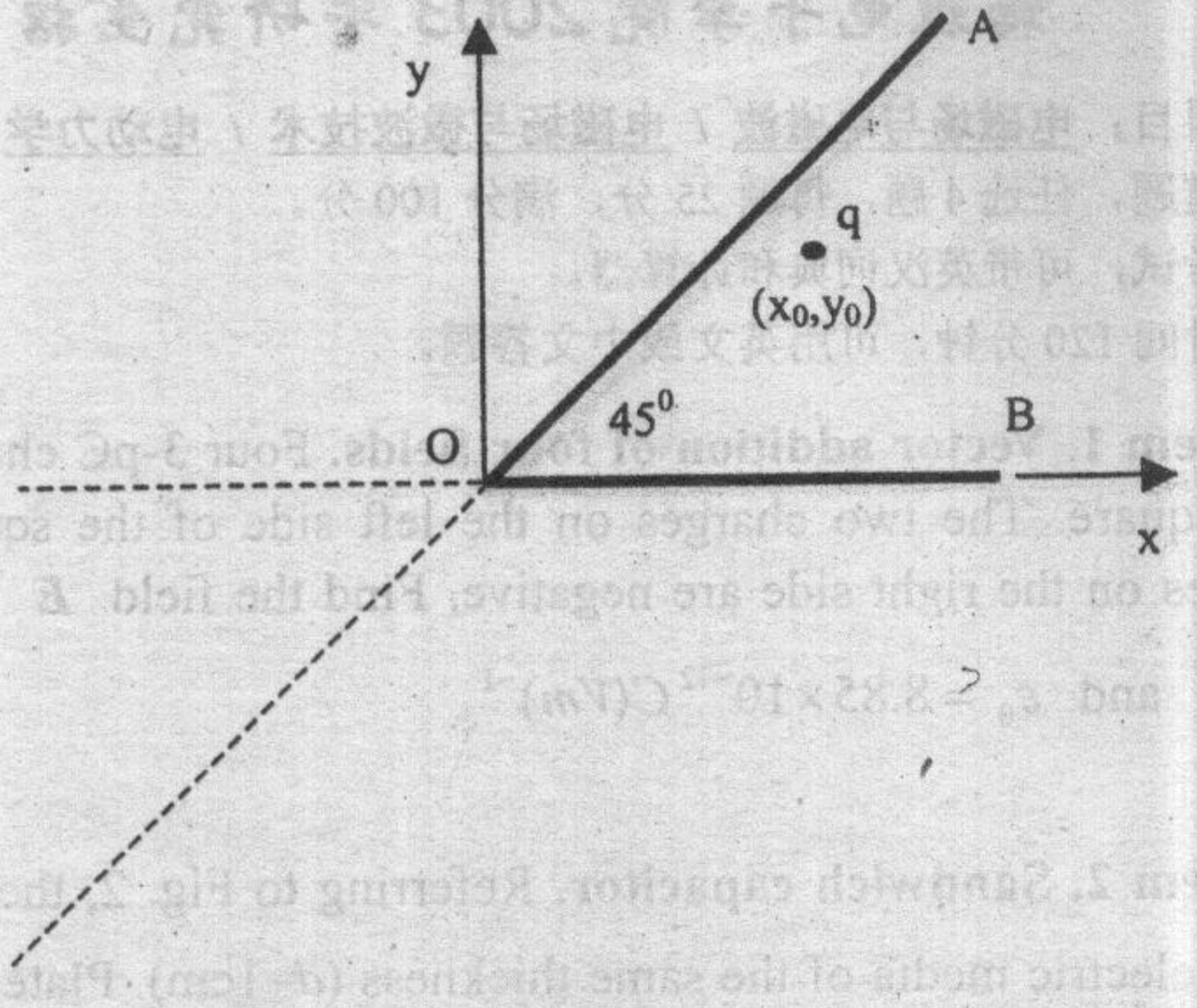


Fig.4

**Problem 5. Two-dimensional problem with specified boundary potentials.** Consider the two-dimensional region of Fig.5 bounded by a zero-potential plane at $y = 0$, a zero-potential plane at $x = 0$, a parallel zero-potential plane at $x = a$, and a plane conducting lid of potential $V_0$ at $y = b$. In the ideal problem, the lid is separated from the remainder of the rectangular box by infinitesimal gaps. Find the potential in the box.

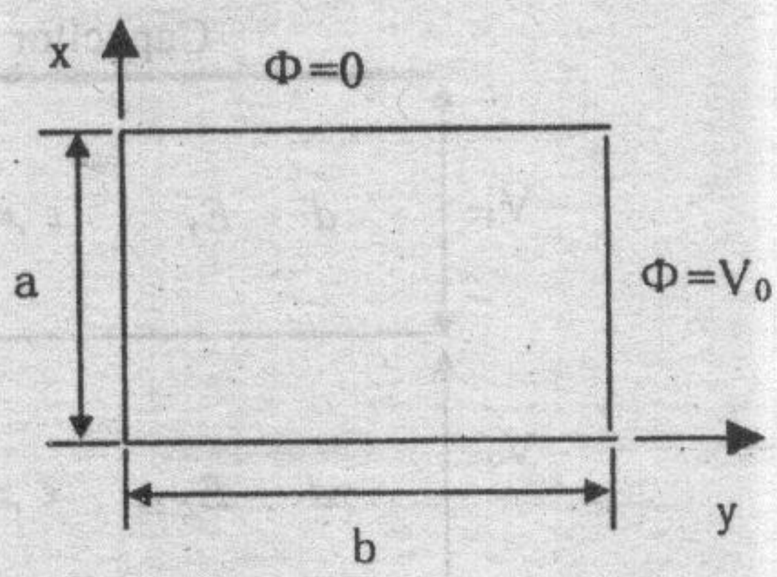


Fig.5