

## 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  $E$  at the center of the square.

$$\epsilon_r = 1 \text{ and } \epsilon_0 = 8.85 \times 10^{-12} \text{ C(Vm)}^{-1}.$$

**Problem 2. Sandwich capacitor.** Referring to Fig. 2, the capacitor is a sandwich of two dielectric media of the same thickness ( $d=1\text{cm}$ ). Plate area  $A = 100\text{cm}^2$ . 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.

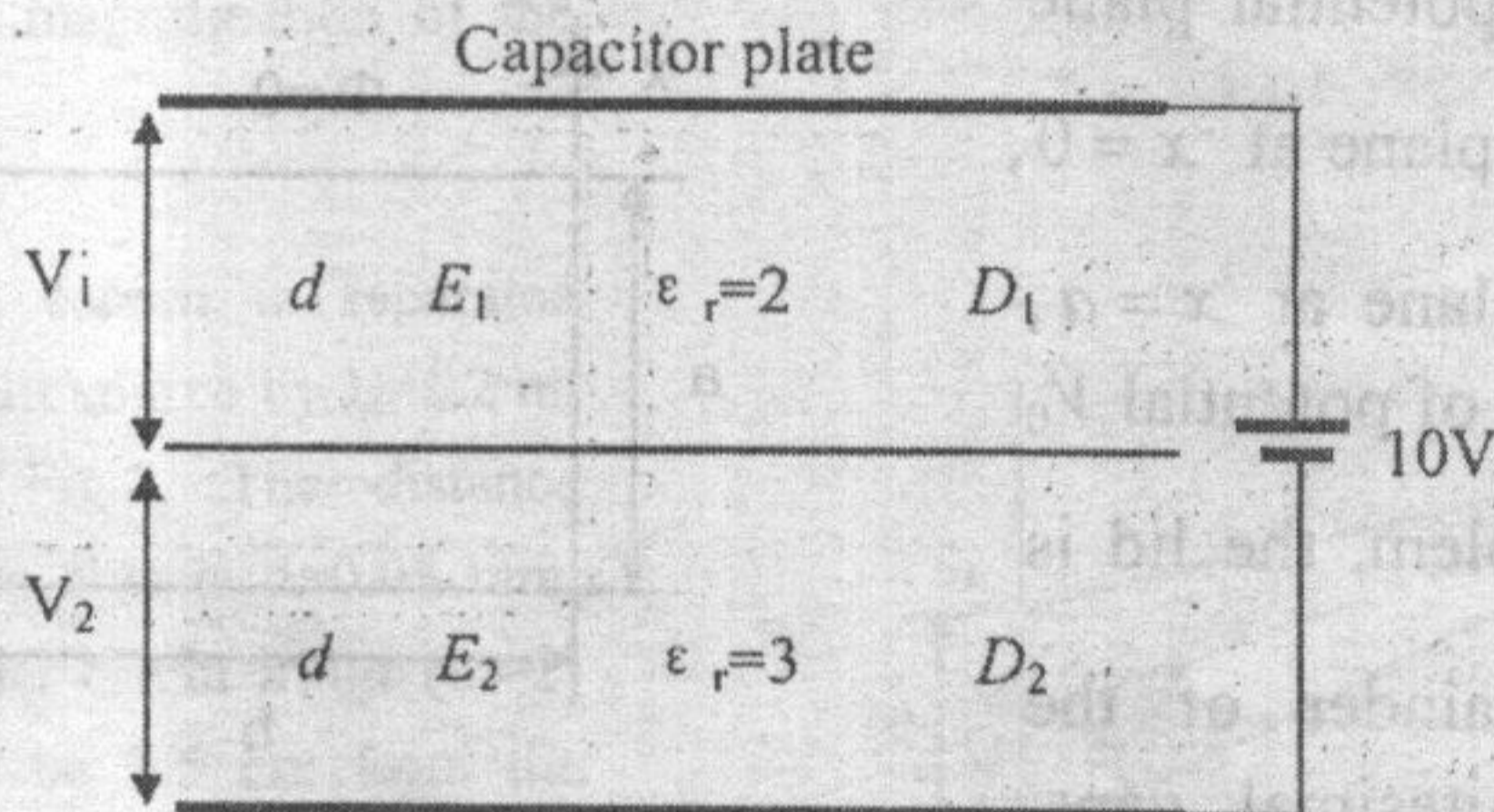


Fig.2

**Problem 3. Ocean penetration.** Calculate the ocean depths at which a  $10^{-6}\text{Vm}^{-1}$  field will be obtained with  $E$  at the surface equal to  $1\text{Vm}^{-1}$  at frequencies of 1, 10, 100, and 1000 kHz.  $\sigma = 4(\Omega m)^{-1}$  and  $\epsilon_r = 80$  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  $\gamma^2 = j\omega\mu\sigma - \omega^2\mu\epsilon$ , and  $\mu = 4\pi \times 10^{-7} \text{ Hm}^{-1}$ .

**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.

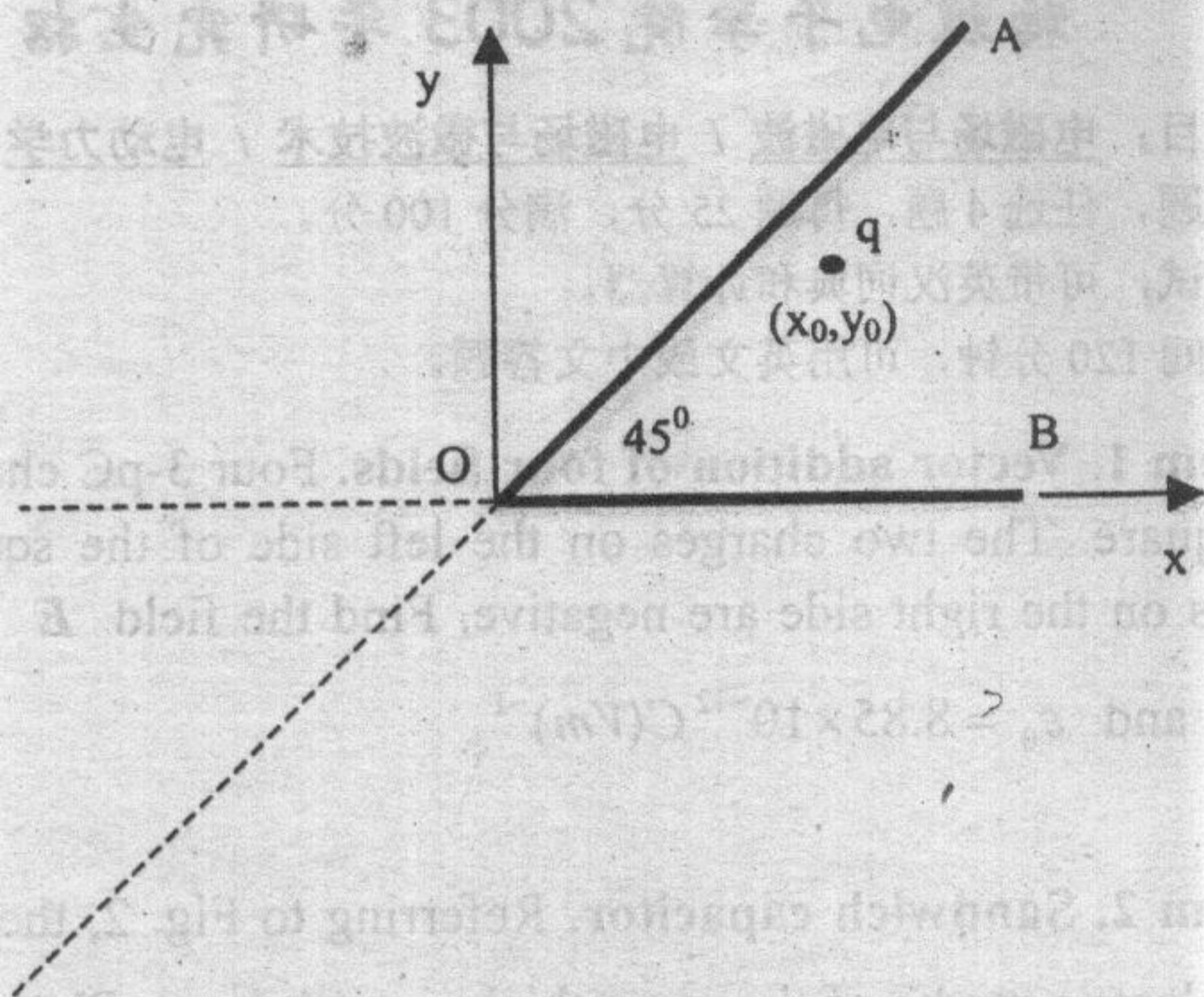


Fig.4

**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.

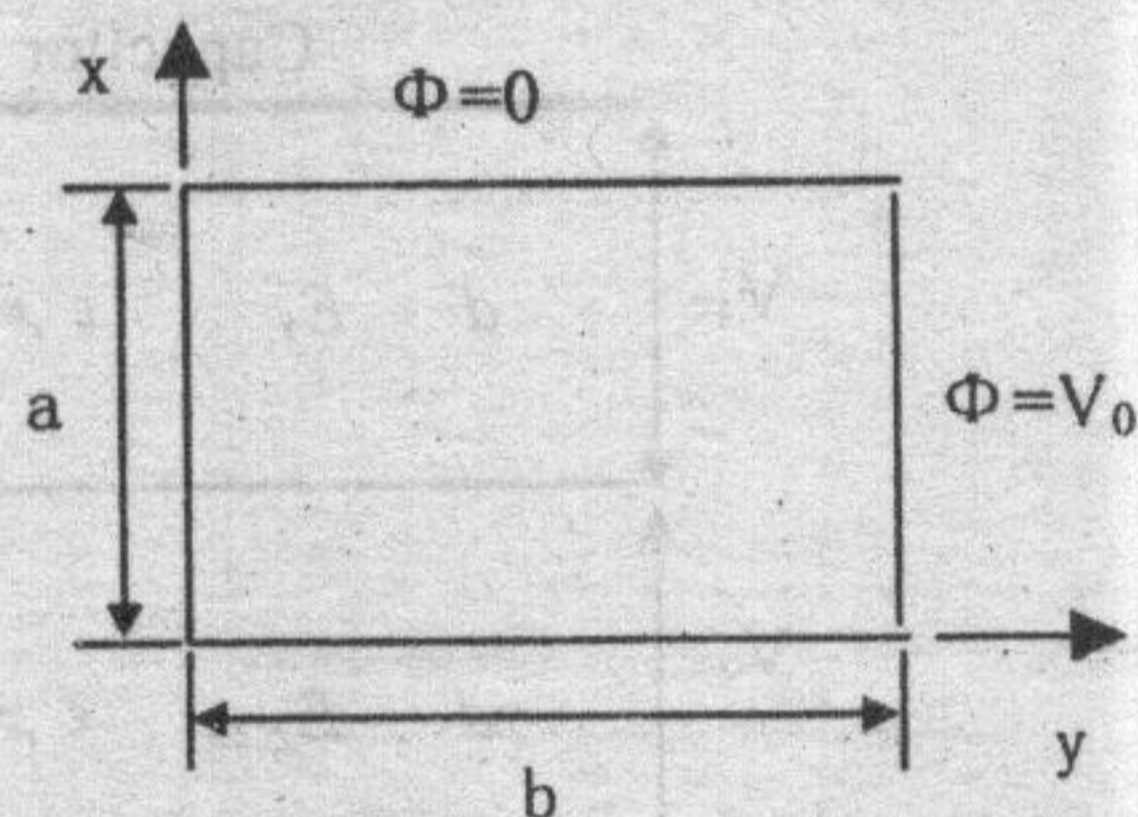


Fig.5