1a). Consider the setup shown in Fig. 1 which consists of a point charge Q and a grounded conducting sphere of radius a. The point charge Q is at a distance D from the center of the sphere. It is found that the electric potential outside the sphere is identical to that due to the original charge Q and an another charge equal to $-\frac{a}{D}Q$ at P which is at a distance $\frac{a^2}{D}$ from the center of the sphere. Justify it. (即說明為何二者所建立之 potential 相等) 13%

1b). Suppose now the conducting sphere in Fig. 1 is not grounded, and its potential is held at 10 Volt. Find the expression for the potential at a general point H outside the conducting sphere in terms of Q, D, a, r, θ, etc., where r is the distance of the point H to the center of the sphere and θ is illustrated in Fig. 1. 14%

2). Show that the vector potential $\vec{A}$ at a point P due to an infinitely long straight wire containing a current I is equal to $|A| = \frac{\mu_0 I}{2\pi} \ln r$ 14%

Also indicate the direction of $\vec{A}$.

3a). Calculate the potential at a point P in the various situations in Fig. 3a, b, c, d. The circles in these figures represent spherical surfaces. 18%

3b). Find the surface charge density on the surface of the water sphere in Fig. 3a.

3c). Find the surface charge densities on the inner and outer surface of the water shell in Fig. 3b.

3d). Find the surface charge density on the separating surface of the two medium in Fig. 3d.

4). Consider a train of light wave propagating in some kind of crystal described by the following equations 14%

$\vec{B} = \hat{j}B_0 e^{j(kz-\omega t)}$

$\vec{E} = (\hat{i}E_x + \hat{j}E_z)e^{j(kz-\omega t)}$

4a) What is the propagation direction of the wave front (i.e. constant phase surface) (說明理由).

4b) What is the propagation direction of the ray. (光線).

5a) Consider the arrangement as shown in Fig.4 in which there are 2 parallel conducting plates forming a capacitor and there is a slab of solid dielectric material in between. W is the width of the conducting plate and the dielectric slab. Show that there is a force acting on the dielectric material, 14%

$$|F| = \frac{V^2}{2}\frac{\varepsilon_0 W}{d}(\varepsilon_r - 1)$$

where ε_r is the relative permittivity of the dielectric. Indicate whether this force is pulling the dielectric in the capacitor (i.e. in +X direction) or pushing the direction outside the capacitor. (i.e. in -X direction).

5b) Disconnect the battery from the capacitor. Find the force again. Indicate the nature of the force : a pulling force (i.e. in +X direction) or a pushing force (i.e. in -X direction. 13%

The following in-formation may be useful to you :

(1) Given the scalar potential due to an infinitely long electric charge of linear electric density (i.e. charge/length) λ is equal to

$$\Phi = -\frac{\lambda}{4\pi\varepsilon_0}\ln r$$

(2) $\varepsilon_0 = 8.85 \times 10^{-12}\ farad/m$

(3) ε_r of water 1.76

注意:背面有試題

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Fig. 1

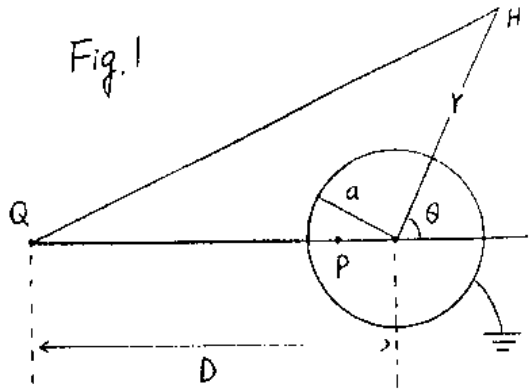


Fig. 2

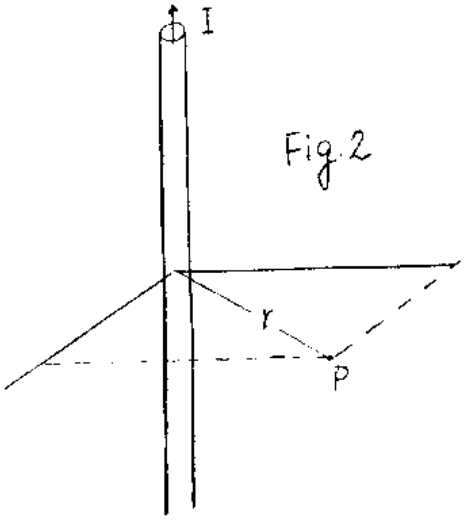


Fig. 3a

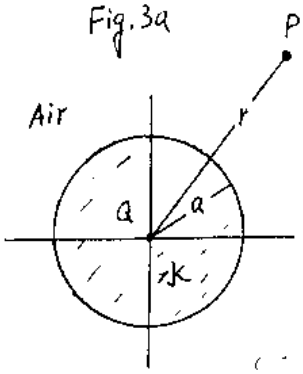


Fig. 3b

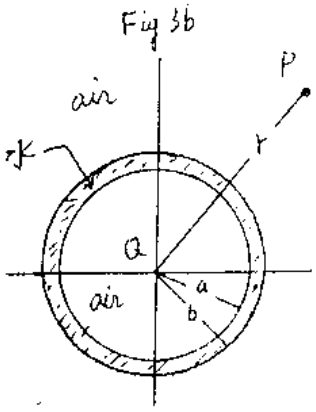
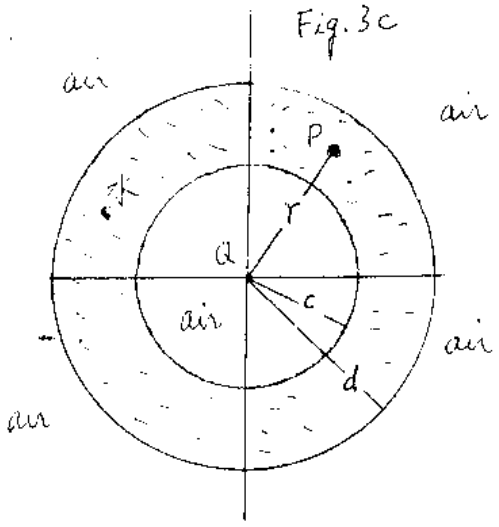


Fig. 3c



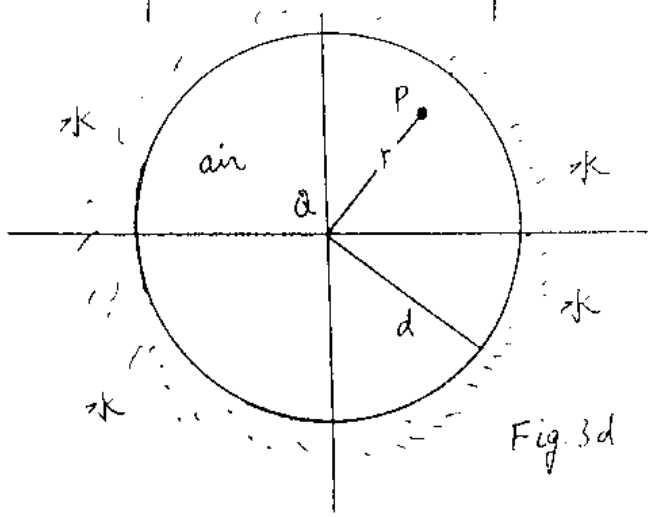


Fig. 3d

$Q = 3\times10^{-8}$ coul.

$a = 50$ cm $\quad d = 120$ cm.

$b = 70$ cm

$r = 100$ cm

$c = 80$ cm

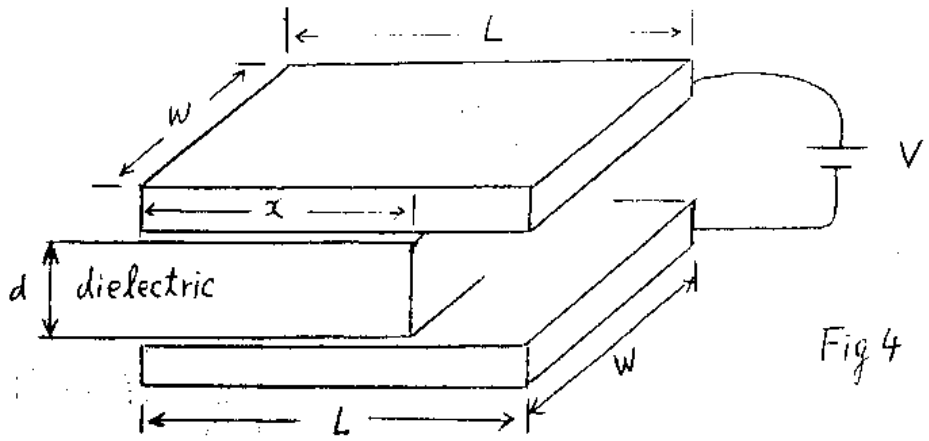


Fig 4