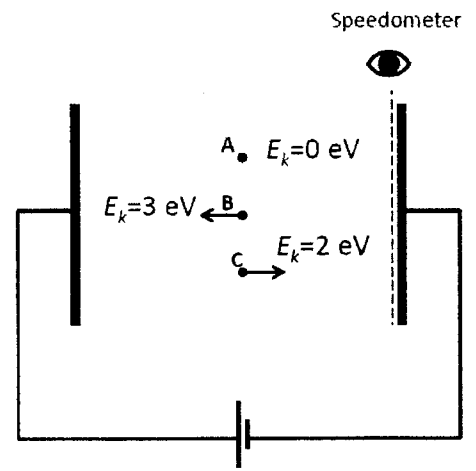


※ 考生請注意：本試題不可使用計算機

- (1) Three hydrogen ions (H^+) A, B, C are placed in the middle of a parallel-plate electric field with a potential difference of 10 volts, and a speedometer is installed in the edge of the electric field as shown in Figure 1. The initial kinetic energies E_k and moving directions of these ions are also noted in the figure respectively. Please list these ions from high to low according to their **arrival velocities** recorded by the speedometer, and give a brief explanation. (10%)



10 Volts

Figure 1

- (2) As shown in Figure 2, the electric field in the air at point P on the surface of a cylindrical dielectric rod is $\sqrt{3}\hat{x} + 5\hat{y}$. Find the electric field inside the dielectric rod at point P . (10%)

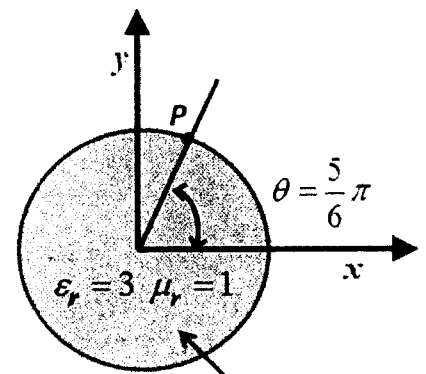


Figure 2

- (3) A uniform line charge λ is placed on an infinite straight wire, a distance d above a grounded conducting plane.
- Find the potential V in the region above the plane. (10%)
 - Find the force on the wire per unit length. (10%)
 - Find the surface charge density σ induced on the conducting plane. (10%)

(背面仍有題目,請繼續作答)

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(4) A cone of height H and radius of base R is permanently magnetized with uniform magnetization M . The vector \vec{M} is collinear with the axis of the cone (see Figure 3). Let that axis be z , and the apex of the cone the coordinate origin. What is the magnetic field along the z axis, at the distance h from the apex, $\vec{B}(h)$? (20%) Here $h+z$ is larger than the thickness of the cone at the distance z from its apex.

[Hint: model the cone as a stack of infinitesimal disks.]

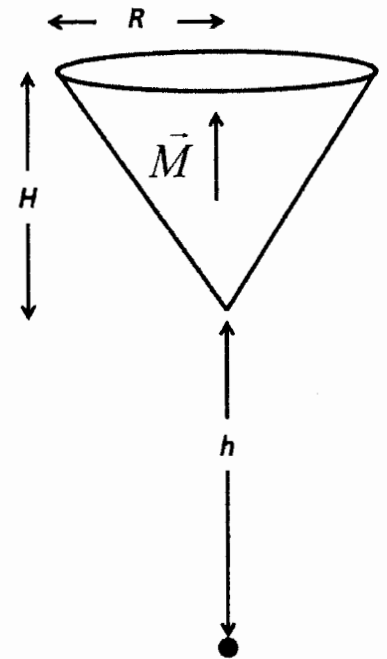


Figure 3

(5) A rectangular frame of length $2b$ along the x axis and a along the y axis is moving with constant velocity $\vec{v} = v\hat{x}$ from $x = -\infty$ into the magnetic field $\vec{B} = \hat{z} B_0 e^{\alpha x}$. The frame is made of wire with the resistance per unit length, ρ .

- If the center of the frame is at the position $x = x_c$, what is the flux through the frame? Show that the flux is proportional to $\sinh(\alpha b)$. (7%)
- When the center of the frame is at x_c , what is the electromotive force which is being generated in the frame as it is moving? (7%)
- What is the power dissipated in the frame, as a function of x_c ? (8%)
- What is the total amount of heat generated by the current in the frame as it travels from $x_c = -\infty$ to $x_c = 0$? (8%)