You can use either CGS units or MKS units to answer the following questions.

Problem 1. (15%)
What is the principle of superposition? Please give a physical phenomenon which **does not** obey the principle of superposition.

Problem 2. (20%)
For the case of electrostatics, please start from $\nabla \times \vec{E} = 0$ to prove that the potential difference between two points in space does not dependent on the path we chosen.

Problem 3. (20%)
Consider a parallel-plate capacitor, suppose that the spacing between the plates is d and the area of each plate is A. If we fill dielectrics with the electric susceptibility χ in all of the space between two plates. Please find the capacitance C in terms of A, d, χ and other constants if needed.

Problem 4. (20%)
Please prove the following boundary conditions,
i) Normal component of $\vec{D}$ is continuous.
ii) Tangential component of $\vec{E}$ is continuous.

Problem 5 (25%)
Please find the vector potential $\vec{A}(\vec{R}) = \vec{A}(x,y,z)$ of the following current loop. Write your answer in terms of $\vec{R}$ and $\vec{\mu}$, **where** $\vec{\mu} = I a^2 \hat{z}$. (All six sides have the same length a)