

E & M

Instructions: Work all three problems.

1. A conductor at potential $V = 0$ has the shape of an infinite plane except for a hemisphere bulge of radius a . A charge q is placed above the center of the bulge, a distance ℓ from the plane.

(20 pts.) (a). What image charges need to be placed in what positions to replace the effect of the conductor? [NOTE: You may use, without derivation, the results for image charges for planes and spheres.]

(20 pts.) (b). Calculate the force on the charge.

- (30 pts.) 2. An observer is moving with constant velocity \vec{v} in a homogeneous electric field, \vec{E} . What \vec{E} and \vec{B} fields will the observer measure?

HINT: Choose the \hat{x} axis of the reference frame at rest (K) along \vec{v} , together with the \hat{x}' axis of the moving frame, K' , and the \hat{y} axis such that \vec{E} be in the (x, y) plane. It is easiest to carry out the transformation of the potentials.

- (30 pts.) 3. A parallel plate capacitor consists of two square metal plates of side L , separated by a distance $d \ll L$. A dielectric slab (with permittivity ϵ) of dimensions $L \times L \times d$ can just slide between the plates and is inserted a distance x between the plates of the capacitor (and is held there, see the Figure). The metal plates are then charged to a potential difference V and disconnected from the voltage source. Calculate the electrostatic force on the slab.

