

**UNIVERSITY OF LEIPZIG**  
**INSTITUTE FOR THEORETICAL PHYSICS**  
**Department: Theory of Elementary Particles**

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List of problems 5

13. Charges  $+q$ ,  $-q$  lie at the points  $(x, y, z) = (a, 0, a), (-a, 0, a)$  above a grounded conducting plane at  $z = 0$ . Find
- (a) the total force on charge  $+q$ ,
  - (b) the work done against the electrostatic force in assembling this system of charges,  
(*Hint*: To construct the system, slowly bring the charges  $+q$  and  $-q$  from infinity by the paths  $L_1 : z = x, y = 0$  and  $L_2 : z = -x, y = 0$  to their final positions.)
  - (c) the induced surface-charge density at the point  $(a, 0, 0)$ .
14. Two equal charges  $+Q$  are separated by a distance  $2d$ . Find, approximately ( $d > a$ ), the minimum radius  $a$  of a grounded conducting sphere placed midway between them that would neutralize their mutual repulsion. What is the force on each of the two charges if the same sphere, with the radius determined before, is now charged to a potential  $V$ ?
15. A grounded conducting plane has a bump in form of a half-sphere with radius  $a$  (see Figure). The center of the sphere is in the plane. A point charge  $q$  is located at distance  $b > a$  on the symmetry axis of the system. Find the potential by the method of image charges. Show that the charge  $q'$  induced on the half-sphere is of the form

$$q' = -q \left( 1 - \frac{b^2 - a^2}{b \sqrt{a^2 + b^2}} \right).$$

