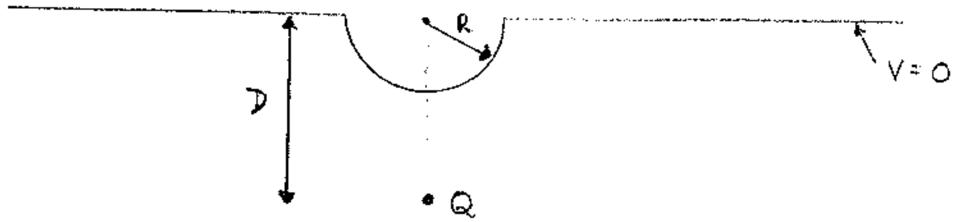
PRELIMINARY EXAMINATION

DEPARTMENT OF PHYSICS

UNIVERSITY OF FLORIDA

Part D, 15 August 2003, 14:00 - 17:00

D1. (10 points) An infinite conducting plane with a hemispherical indentation of radius R is kept at zero potential. A charge Q is placed a distance D ($D > R$) directly below the indentation, as shown in the sketch. Find the force on Q using the method of images.



D2. (10 points) Find an upper limit for the ground state energy of a spin zero particle of mass m in the potential $V(x)$, where $k > 0$ and

$$V(x) = \infty \quad \text{for} \quad x < 0 \ ,$$

$$V(x) = kx \quad \text{for} \quad x > 0 \ .$$

You might wish to recall that

$$\int_0^\infty x^n \, e^{-\alpha x} \, \mathrm{d}x = \frac{n!}{\alpha^{n+1}} \quad .$$

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D3. A laser emits a light beam of power W towards a 100% reflecting mirror M at an incident angle close to 90°. The reflected light is absorbed by a non-reflecting object O. In one case, the mirror M is stationary. In the second case, the mirror M is moving with a constant velocity v towards the laser. You can use c as the speed of light.

(a) (3 points) Find the force F_1 experienced by the mirror M when it is stationary.

(b) (2 points) Find the force F_2 experienced by the object O when the mirror M is stationary.

(c) (3 points) Find the force F_3 experienced by the mirror M when it is moving.

(d) (2 points) Find the force F_4 experienced by the object O when the mirror M is moving.