

## Physics 423, Spring 2019

### Homework Set # 4

1. Due Friday, Feb 1 (Read §2.1):

- (a) Find the electric field on the  $z$ -axis, for  $z > 0$ , due to a semi-infinite constant line charge,  $\lambda$ , located at  $-\infty < z < 0$ .
- (b) The electric field on the  $z$ -axis, for  $z > 0$ , for a semi-infinite solid cylinder  $s = R$ ,  $-\infty < z < 0$ , with uniform volume charge density  $\rho$  is (see class notes for derivation):

$$\mathbf{E}(z) = \frac{\rho \hat{\mathbf{z}}}{2\epsilon_0} \left[ \sqrt{z^2 + R^2} - z \right].$$

Check this result against the semi-infinite line charge in the previous part. <sup>1</sup>

- (c) A hemispherical surface  $r = R$  in the half-space  $z > 0$  is covered by a uniform charge density  $\sigma$ . What is the force on a particle of charge  $q$  at the origin?

2. Due Monday, Feb 4 (Read §2.2):

- (a) Griffiths problem 2.9
- (b) A constant charge density  $\rho$  occupies the volume  $x' < x < x' + dx'$ , for all  $y$  and  $z$ . Find the electric field for  $x < x'$  and  $x > x' + dx'$ .
- (c) Use the result of the previous part to find the electric field due to the following continuous charge distribution, which holds over all space:

$$\rho(\mathbf{r}) = \frac{\rho_0 x}{b} e^{-x^2/2b^2},$$

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<sup>1</sup>Hint: Express  $\rho$  in terms of a charge per unit length  $\lambda$ , and then take the limit as  $R \rightarrow 0$ . It may help to use the binomial expansion  $(1 + \epsilon)^\alpha = 1 + \alpha\epsilon + \mathcal{O}(\epsilon^2)$ .