

**Problem Set 1**

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**Due date:** Friday, September 12, 6PM

**Note:** Problems will be collected and graded. You may bring your homeworks to class or drop them in my mailbox in front of the Physics Department office by 6PM. No late homework will be considered.

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1. Jackson 1.3

2. Jackson 1.5

3. Jackson 1.6

4. Jackson 1.11

5. Jackson 1.12

6. An electric quadrupole consists of two dipoles, a dipole  $\mathbf{p}$  located at  $\mathbf{r} = \mathbf{b}/2$  and a dipole  $-\mathbf{p}$  located at  $\mathbf{r} = -\mathbf{b}/2$ . The orientation of  $\mathbf{p}$  relative to  $\mathbf{b}$  can be arbitrary. Find the potential at a location  $\mathbf{x}$  in the limit that  $b \rightarrow 0$  with  $pb$  remaining constant and both  $\mathbf{p}$  and  $\mathbf{b}$  maintaining their direction. Write the potential in the form

$$V = \sum_{ij} Q_{ij} x_i x_j / x^5, \quad (1)$$

and express the elements of the quadrupole tensor,  $Q_{ij}$ , in terms of  $\mathbf{p}$  and  $\mathbf{b}$ .

You may use the fact that the potential of an idealized dipole at location  $\mathbf{x}'$  is given by

$$\Phi_{\text{dip}}(\mathbf{x}) = \frac{1}{4\pi\epsilon_0} \frac{\mathbf{p} \cdot (\mathbf{x} - \mathbf{x}')}{|\mathbf{x} - \mathbf{x}'|^3} \quad (2)$$