Hinkle, Zachary | EM Griffiths | 09/14/18 | 1/1

4.8 The energy of a dipole, $\vec{p}_2$, in the field of a different dipole, $\vec{E}_1$, is

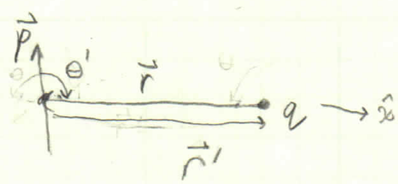
$$U = -\vec{p}_2 \cdot \vec{E}_1, \qquad \vec{E}_1 = \frac{1}{4\pi\varepsilon_0 r^3}\left[3(\vec{p}_1\cdot\hat{r})\hat{r} - \vec{p}_1\right]$$

Thus $U = -\vec{p}_2 \cdot \left(\frac{1}{4\pi\varepsilon_0 r^3}\left[3(\vec{p}_1\cdot\hat{r})\hat{r} - \vec{p}_1\right]\right)$

$$= \frac{1}{4\pi\varepsilon_0 r^3}\left[\vec{p}_1\cdot\vec{p}_2 - 3(\vec{p}_1\cdot\hat{r})(\vec{p}_2\cdot\hat{r})\right]$$

4.9 The force on the charge is given by $\vec{F}_q = q\vec{E}_{dip}$

$\vec{E}_{dip} = \frac{p}{4\pi\varepsilon_0 r^3}(2\cos\theta\,\hat{r}' + \sin\theta\,\hat{\theta}')$ here $\vec{r}' = -\vec{r} \Rightarrow \hat{r}' = -\hat{r}$



$\vec{F}_q = q\vec{E}_{dip} = \frac{qp}{4\pi\varepsilon_0 r^3}(-2\cos\theta'\hat{r} + \sin\theta'\hat{\theta}')$

The force on the dipole must be equal and opposite by Newton's 3rd law, so

$$\vec{F}_p = -\frac{qp}{4\pi\varepsilon_0 r^3}(-2\cos\theta'\hat{r} + \sin\theta'\hat{\theta}')$$