

Jackson

$$\begin{aligned} 2.5(a). \quad |F| &= \frac{1}{4\pi\epsilon_0} \frac{q^2}{a^2} \left(\frac{a^3}{y}\right) \left(1 - \frac{a^2}{y^2}\right)^{-2} \\ &= \frac{1}{4\pi\epsilon_0} \frac{q^2}{a^2} \frac{a^3}{y^3} (y^{-2})^{-2} (y^2 - a^2)^{-2} \\ &= \frac{1}{4\pi\epsilon_0} q^2 a \frac{y^4}{y^3} (y^2 - a^2)^{-2} \\ &= \frac{q^2 a}{4\pi\epsilon_0} \frac{y}{(y^2 - a^2)^2} \end{aligned}$$

$$|W| = \int_{\mathbb{R}} \frac{q^2 a}{4\pi\epsilon_0} \frac{y}{(y^2 - a^2)^2} dy$$

$$= \frac{q^2 a}{4\pi\epsilon_0} \int_{\mathbb{R}} \frac{y}{(y^2 - a^2)^2} dy$$

$$= \frac{q^2 a}{4\pi\epsilon_0} \left[ \frac{1}{2} \frac{-1}{(y^2 - a^2)} \right]_{\mathbb{R}}$$

$$= \frac{q^2 a}{4\pi\epsilon_0} \frac{1}{2} \frac{1}{(R^2 - a^2)}$$

$$= \boxed{\frac{q^2 a}{8\pi\epsilon_0 (R^2 - a^2)}}$$

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